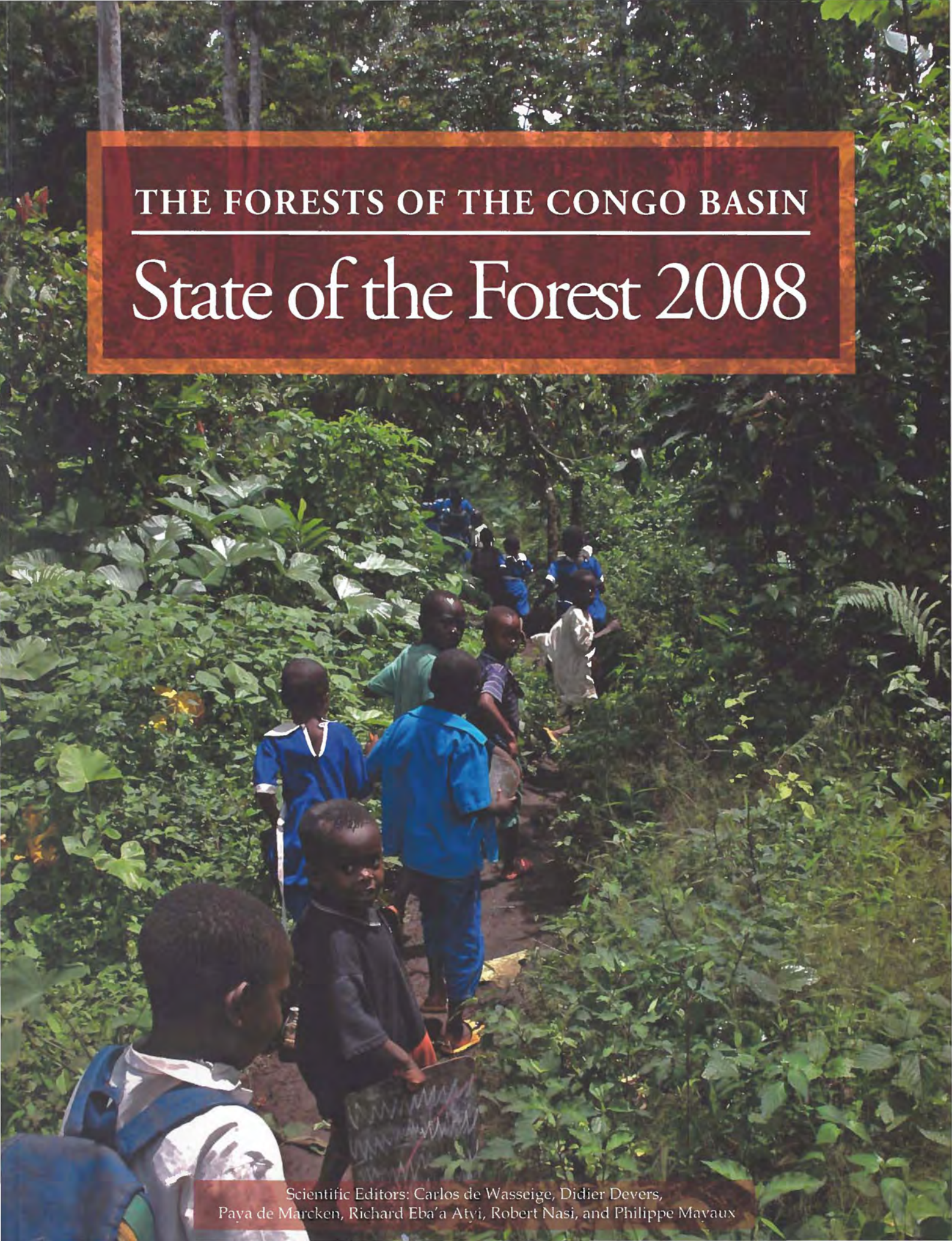
THE FORESTS OF THE CONGO BASIN

State of the Forest 2008



Scientific Editors: Carlos de Wasseige, Didier Devers,
Paya de Marcken, Richard Eba'a Atyi, Robert Nasi, and Philippe Mayaux

The Forests of the Congo Basin - State of the Forest 2008

Editors : de Wasseige C., Devers D., de Marcken P., Eba'a Atyi R., Nasi R. and Mayaux Ph.
Cover picture : Environmental Education, Cameroon. © Frank Ribas – GTZ

The State of the Forest 2008 is a publication of the *Observatoire des Forêts d'Afrique centrale* (OFAC) and the Congo Basin Forest Patnership (CBFP)
http://www.observatoire-comifac.net/ - http://www.cbfp.org

Unless stated otherwise, administrative limits and other map contents do not presume any official approbation. Unless stated otherwise, the data, analysis, and conclusions presented in this book are those of the respective authors.

All images are subjected to copyright. Any reproduction in print, electronic or any other form is prohibited without the express prior written consent of the copyright owner.

The required citation is: The Forests of the Congo Basin - State of the Forest 2008, Editors : de Wasseige C., Devers D., de Marcken P., Eba'a Atyi R., Nasi R. and Mayaux Ph., 2009, Luxembourg: Publications Office of the European Union, ISBN 978-92-79-13210-0, doi: 10.2788/32259

Europe Direct is a service to help you find answers to your questions about the European Union.

Freephone number (*):
00 800 6 7 8 9 10 11

(*) Certains mobile telephone operators dp not allow access to 00 800 numbers or these calls may be billed.

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server (http://europa.eu).

Bibliographic information is included at the end of the book.

Luxembourg: Publications Office of the European Union, 2010

ISBN 978-92-79-13210-0
doi: 10.2788/32259

© European Union, 2010
Reproduction is authorised provided the source is acknowledged.

Printed in Belgium
PRINTED ON RECYCLED PAPER

THE FORESTS OF THE CONGO BASIN

State of the Forest 2008

CONTRIBUTORS

Coordination

de Wasseige Carlos - FORAF *
Devers Didier - FORAF *

Map design

Mfuka Confiance - FORAF *
Wong Minnie - UMD (United States)

Text review and revision

Devers Didier - FORAF *
de Marcken Paya - WWF *
Altstatt Alice - UMD (United States)
Davies Diane - UMD (United States)
Brock Sophie - CARPE-USAID (United States)
Steil Matthew - WRI *
Wong Minnie - UMD (United States)
de Wasseige Carlos - FORAF *
Mfuka Confiance - FORAF *

Page design and setting

de Wasseige Carlos - FORAF *
Mulumba Rodin – PIXIFSOLUTIONS

Scientific committee

Hall Jefferson - SI *
Nguinguiri Jean-Claude - FAO *
Ruiz-Perez Manuel - UAM (Spain) *
Russell Diane - USAID (United States)
Sayer Jeffrey - IUCN
Wilkie David - WCS
Wunder Sven - CIFOR

Authors

Altstatt Alice - UMD (United States)
Amougou Joseph Armathé - Cameroon Climate Focal Point
Ampolo Alain - WCS
Aveling Conrad - Consultant
Bayol Nicolas - FRM (France) *
Billand Alain - CIRAD (France) *
Bodson Thierry - WWF
Bokelo Didier - AWF *
Bout Nicolas - WCS
Brown Ellen - WCS
Brummett Randall - WFC
Buhendwa Roy - WWF
Cassagne Bernard - FRM (France)
Cerutti Paolo - CIFOR
Chevalier Jean François - FRM (France)
Colom Alejandra - Consultant
Davies Diane - UMD (United States)
de Marcken Paya - WWF *
De Wachter Pauwel - WWF
de Wasseige Carlos - FORAF *
Demarquez Benoit - TEREA *
Devers Didier - FORAF *
Dupain Jef - AWF *
Eba'a Atyi Richard - FORAF *
Esono Fidel - MFA (Equatorial Guinea) *
Etsa Jack - WWF
Guislain Patrick - ZSM (United States)
Hamel Olivier - CIRAD (France)
Hart John - Consultant
Huijbregts Bas - WWF
Ilambu Omari - WWF *
Ingram Verina - CIFOR
Inkamba Nkulu Clément - WCS
Inogwabini Bila Isia - WWF *
Karsenty Alain - CIRAD (France)
Kasulu Vincent - DRC Climate Focal Point *
Kernan Christopher - CI
Kibambe Jean Paul - UCL (Belgium)
Ladel Julie - AMESD
Languy Marc - WWF
Le Duc Yeno Stéphane - WWF
Lescuyer Guillaume - CIFOR/CIRAD *
Mabiala Noe - MINEF (Congo)
Maisels Fiona - WCS
Makambo Emola - Pact
Malonga Richard - WCS
Marien Jean-Noël - CIRAD (France) *
Martinez Santiago - FRM (France)
Mayaux Philippe - JRC *
Mehlman Patrick - CI *
Moussavou Makanga Bede Lucius - WWF
Mugnier Antoine - FRM (France)
Munzimi Yolande - SDSU (United States)

Mwinyihali Robert - WCS *
Nackoney Janet - UMD (United States)
Nasi Robert - CIFOR *
Ngungu Baby - WCS
Nishihara Tomo - WCS
Nse Esseng Sandra - WCS
Nzooh Zacharie - WWF
Obama Crisantos - MFA (Equatorial Guinea) * -- COMIFAC
Obiang Diosdado - MFA (Equatorial Guinea) *
Pandi Albert - CICOS
Parnell Richard - WCS
Reinartz Gay - ZSM (United States)
Rokotondranisa Désiré - Pact
Russel Aaron - WFC
Sonwa Denis - CIFOR
Starkey Ruth - WCS
Steel Lisa - WWF
Stiassny Melanie - AMNH (United States)
Tanania Charles - CICOS
Telfer Paul - WCS *
Thieme Michele - WWF
Tsoumou Apolinaire - WCS
Twagirashyaka Felin - WCS
Usongo Léonard - WWF
Vanleeuwe Hilde - WCS
Wells Mto - Pact
White Sue - Cranfield University (United Kingdom)
Williams David - AWF
Yoko Alfred - WWF

Contributors to chapters

Abo Eyafa Henri Christian - MINFOF (Cameroon)
Assoumou Solange - MEFEPPN (Gabon) *
Boundzanga Georges - CNIAF (Congo) *
Bwangoy Jean-Robert - SDSU (United States) *
Defourny Pierre - UCL (Belgium) *
Ebia Ndongo Samuel - MINFOF (Cameroon) *
Foé Jean Philippe - MINFOF (Cameroon)
Foé Alain - MINFOF (Cameroon)
Hart Terese - Consultant
Hashim Emola - Pact
Ikakanzamio Déogracias - Equatorial Guinea Climate Focal Point
Itoua Adélaïde - Congo Climate Focal Point
Kabinda Makagai Etienne Massard - Gabon Climate Focal Point
Kondaoulé Josiane - PARPAF (CAR)
Kongape Jean Avit - MINFOF (Cameroon) *
Lindquist Erik - OSFAC/SDSU *
Maidou Hervé - PARPAF (CAR) *
Malele Sébastien - SPIAF/MECNT (DRC)
Malibangar Aline - CAR Climate Focal Point
Masselink Joel - USAID (United States)
Massimba Claude-Etienne - DFAP/MEF (Congo) *
Mwamba Philomène - DGF (DRC) *
Nakoé Gaston - CDF (CAR) *
Ngassa Roger - MINFOF (Cameroon)
Nguéma Magnagna Viviane - MEFEPPN (Gabon) *
Njiang Antoine - MINFOF (Cameroon)
Nkéoua Grégoire - DF/MEF (Congo) *
Oyele Minile Sako - MEFCPE (CAR)
Palla Florence - RAPAC *
Starkey Malcom - WCS
Tunguni Jacques - SPIAF/MECNT (DRC) -- COMIFAC *
Verhage Bas - WWF
Verhegghen Astrid - UCL (Belgium)
Wong Minnie - UMD (United States)
Yata Frank - ICCN (DRC) *

Other contributors

Agnangoye Jean-Pierre - RAPAC
Angu Angu Kenneth - IUCN
Bakanseka Jean-Marie - FORAF *
Bastin Didier - ALPICAM (Cameroon)
Bélanger Lyna - WRI *
Benga Joseph - MINFOF (Cameroon) *
Besacier Christophe - MAE (France) *
Bissohong Elizabeth - COMIFAC Executive Secretariat
Bonannée Michel - MEFCPE (CAR) -- COMIFAC *
Botamba Floribert - AWF *
Boundja Patrick - WCS
Bourguignon Hervé - IFIA *
Brock Sophie - CARPE-USAID (United States)
Cottam Andrew - UNEP - WCMC *
de Francken Amélie - De Wolf & Partners (Belgium) *
Duchochois Philippe - MAE (France) *
Edjang Jose Rafael - MFA (Equatorial Guinea)
Ekiama Pierre - SETRAF *
Ekondzo Damase - MEF (Congo)
Eneme Francisca - INDEFOR (Equatorial Guinea)
Engbwen Luc - MINFOF (Cameroon)
Ernst Céline - UCL (Belgium)
Eyebe Antoine - CARPE
Falkenberg Claus-Michael - GTZ (Germany) *

Fesneau Vincent - PAPPFG (Gabon)
Flynn John - CARPE-USAID (United States) *
Freez Nzimbili Léon - PAPPFG (Gabon)
Gitadi Erick - FIB (DRC) *
Got Henri - EU *
Hakizumwami Elie - WWF
Hansen Matthew - SDSU (United States) *
Issola Dipanda - MINFOF (Cameroon)
Kibambe Nina - FORAF *
Kouam Elizabeth - COMIFAC Executive Secretariat
Koubouana Felix - WRI *
Koulagna Denis - MINFOF (Cameroon) *
Laporte Jérôme - TEREA
Lefeuvre Jean-Claude - CAWFHI *
Lejonc Grégoire - Greenpeace *
Lumbuenamo Raymond - WWF *
Machia Abdoulaye - MINFOF (Cameroon)
Magnagna Viviane - MEFEPPN (Gabon)
Makon Samuel - GTZ (Germany)
Mamfoumbi Emile - MEFEPPN (Gabon) -- COMIFAC *
Mankoto Samy - UNESCO *
Mbaro Théodore - MEFCPE (CAR) *
Mbemba Martin - FORAF *
Mbitikon Raymond - COMIFAC Executive Secretariat *
Mertens Benoit - WRI/GFW
Mfuka Confiance - FORAF *
Mituy Abaga Ramon - INDEFOR (Equatorial Guinea)
Mofouma Aurélien - RAPAC
Moleka Nelly - DFID *
Molenge Tousssaint - FORAF *
Mukongo Rémy - ATO (Gabon)
Mulumba Pierre - OCEAN (DRC) *
Ndikumagenge Cleto - IUCN *
Ndjoukam Raphael - IRAD (Cameroon)
Ndomba-Ngoye Raymond - COMIFAC Executive Secretariat *
Neba Shu Gidéon - WRI/GFW
Nguinguiri Jean-Claude - FAO *
Njifakue Isaac - IMCS (Cameroon)
Nkoulou Jervais - Consultant
Ntsame Célestine - ITTO (Gabon)
Ntsiba François - CNIAF (Congo) -- COMIFAC
Ouoguia Blandine - GFBC (Cameroon)
Oyele Minile Sako - DFAP/MEFCPE (CAR)
Pérodeau Bruno - WWF *
Romijn Janneke - CIFOR *
Saracco Filippo - EU *
Schoorl Jaap - GTZ *
Sionneau Jean-Michel - ECOFAC *
Steil Matthew - WRI *
Stenmans Franck - PGDRN (Cameroon)
Tadoum Martin - COMIFAC Executive Secretariat *
Tchamou Nicodème - CARPE *
Tellier Laurent - Sylvafrica *
Triaille Jean-Paul - De Wolf & Partners (Belgium) *
Tshombe Richard - WCS *
Wandja Zacharie - Jeunes Exploitants Nationaux (Cameroon)

* participant of the meeting in Kinshasa on November 18-20, 2008

Table of contents

Contributors 1
Preface 7
Foreword 9
Introduction 11

PART 1
STATE OF THE FORESTS IN CENTRAL AFRICA: REGIONAL AND NATIONAL SYNTHESES 13

CHAPTER 1 State of the Forests of Central Africa: Regional Synthesis 15
CHAPTER 2 The Forests of Cameroon in 2008 43
CHAPTER 3 The Forests of Gabon in 2008 57
CHAPTER 4 The Forests of Equatorial Guinea in 2008 71
CHAPTER 5 The Forests of the Central African Republic in 2008 83
CHAPTER 6 The Forests of Congo in 2008 97
CHAPTER 7 The Forests of the Democratic Republic of Congo in 2008 111

PART 2
CROSS-CUTTING CHAPTERS ON ENVIRONMENTAL SERVICES 125

CHAPTER 8 A New Tool for Sustainable Forest Management in Central Africa: Payments for Environmental Services 127
CHAPTER 9 Water Resources, Forests and Ecosystem Goods and Services 141
CHAPTER 10 The Contribution of Biodiversity to the Maintenance of Forest Goods and Services 159
CHAPTER 11 Congo Basin Countries and the Reduced Emissions from Deforestation and Degradation (REDD) Process 173
CHAPTER 12 A First Look at Carbon Stocks and their Variation in Congo Basin Forests 191
CHAPTER 13 Peri-Urban Forests and Wood Energy: What Are the Perspectives for Central Africa? 209

PART 3
THE CONGO BASIN FOREST PARTNERSHIP PRIORITY LANDSCAPES 223

CHAPTER 14 The Congo Basin Forest Partnership (CBFP) Priority Landscapes 225
CHAPTER 15 Monte Alén-Monts de Cristal Landscape 233
CHAPTER 16 Gamba-Mayumba-Conkouati Landscape 241
CHAPTER 17 Lopé-Chaillu-Louesse Landscape 255
CHAPTER 18 Dja-Odzala-Minkébé (Tridom) Landscape 267
CHAPTER 19 Sangha Tri-National (TNS) Landscape 283
CHAPTER 20 Léconi-Batéké-Léfini Landscape 295
CHAPTER 21 Lake Télé-Lake Tumba Landscape 305
CHAPTER 22 Salonga-Lukenie-Sankuru Landscape 317
CHAPTER 23 Maringa-Lopori-Wamba Landscape 329
CHAPTER 24 Maiko-Tayna-Kahuzi-Biega Landscape 339
CHAPTER 25 Ituri-Epulu-Aru Landscape 351
CHAPTER 26 Virunga Landscape 361

Bibliography 371
Acronyms 387
Annexes 393

Preface

The need for a periodic report on the state of the forests of Central Africa was first recognized by the Congo Basin Forest Partnership (CBFP) in 2004. The intent was to provide the various CBFP members (States, international organizations, non-governmental organizations, private sector companies, research organizations, and international and civil society) a reliable basis of information to support both political and technical decision-making, with the overall objective of improving the living conditions of populations and conserving biodiversity through improved forest management.

In the second strategic axis of its convergence plan, the Commission for the Forests of Central Africa (COMIFAC), a member of the CBFP and the regional body in charge of orienting and harmonizing forestry and environmental policy in the sub-region, also expressed the need to form a monitoring structure in order to establish baselines and produce regularly updated information on forest resources.

Wide recognition of the need for reliable and timely information on forests inspired the idea for a permanent Observatory for the Forests of Central Africa (OFAC). One of the principal duties of OFAC would be to periodically prepare a report on the state of the forests in Central Africa. The idea for the Observatory was taken up by the European Commission (EC), which launched the FORAF project in April 2007. The main objective of FORAF is to dynamically build OFAC through the process of preparing the 2008 and 2010 State of the Forest (SOF) reports.

The 2008 SOF report would not have been possible without the financial, technical and scientific support of many CBFP partners. This document reflects a strong desire for collaboration from partners that transcends institutional divisions and ideologies. We are grateful to them all.

Emmanuel Bizot
Minister
President of the Council of
Ministers of COMIFAC

Hans Schipulle
German Facilitation
to the Congo Basin
Forest Partnership

Foreword

The idea for a report on the state of forests in Central Africa progressed from concept to reality at the 2005 Heads of States Summit in Brazzaville. At the Summit, a preliminary report based largely on experience and data collected through the USAID-funded Central Africa Regional Program for the Environment (CARPE) was released. The development of the preliminary report laid the groundwork for the preparation of a more comprehensive report in 2006: "Forests of the Congo Basin: State of the Forest 2006".

The 2006 report was jointly funded by the European Union, France and the United States and involved the work of over a hundred individuals. The development of the 2006 State of the Forest report consolidated the practices established during the advancement of the 2005 preliminary report. The production of the 2008 report has consolidated the process even further, while also providing an opportunity to welcome new partners and contributors.

Recognizing the broad interest generated by the 2006 report and the evolution of a dynamic process, Germany, the ECOFAC Program and UNESCO joined existing financial partners to support the 2008 report. The number of institutions and individuals contributing to the report grew with the keen engagement of the forestry administrations in Central African countries.

This principal objective of the SOF report remains to detail the status of dense moist forest in Central Africa. Its focus comprises the six Central African countries containing this type of forest: Gabon, Republic of Congo, Democratic Republic of Congo, Equatorial Guinea, Cameroon, and the Central African Republic. As such, unless otherwise specified, the term "Congo Basin" in the 2008 SOF refers to the area occupied by these 6 countries.

Preparing the 2008 SOF

The process of drafting the SOF 2008 began with the definition and selection of indicators for monitoring the state of forests in Central Africa. These indicators are structured around three themes: (i) status and trends of forest cover; (ii) management of production forests; and (iii) conservation and enhancement of biodiversity. The indicators are presented in a hierarchical structure at three levels: regional, national and management unit (specifically logging concessions and protected areas). The indicators were validated by a representative panel of stakeholders in the management of Central Africa forests during a workshop held in Kribi in February 2008.

Based on established indicators, national groups of four to ten individuals working within the forestry administration collected data between April and August 2008. The data were primarily from 2006 and 2007, and were subsequently validated in national workshops attended by government officials as well as representatives of environmental NGOs, the private sector and development projects. Finally, the data were provided to the authors of the chapters in the report. The entire report was reviewed by a scientific committee of international renown.

The SOF beyond 2008

The first two editions of the SOF report (2005 and 2006) exist in paper and digital forms. The 2008 version is also available in paper and digital forms, but is it being complimented with an interactive internet version. On the Observatory website, users will find dynamic links to additional information. Data on individual sites and management units are only accessible via the Observatory website at www.observatoire-comifac.net.

The practice of collecting, harmonizing and disseminating data on a regular basis is most meaningful if it is part of a long-term process. The production and release schedule for future reports will depend on the efforts and willingness of COMIFAC and its partners to continue the work that has been started.

Introduction

Central Africa is the second largest continuous block of rainforest on the planet after the Amazon Basin. Although disturbed in places, forest cover is relatively well preserved overall. While annual deforestation rates have been comparatively low, between zero and one percent, there are strong indications that Central African forests are at a critical turning point for the future.

If current rates of demographic growth remain constant, the population of the Congo Basin will double between now and 25 to 30 years time. According to key socio-economic indicators, the population is characterized by a high level of poverty and under-development, with subsistence farming and the use of forest products often representing the only means for survival. For most of the population, forest resources represent the buoy keeping them above the survival threshold.

Agriculture represents a main threat to the forest since farming is primarily carried out through unproductive traditional techniques and slash-and-burn cropping practices that can occupy significant forest area. Furthermore, the potential development of agro-industry and agricultural units to produce biofuels or oil may threaten forests.

Extensive logging in the sub-region has not generally led to significant loss of forest cover, and does not compromise forest sustainability directly. Nevertheless, forest roads associated with logging open up and penetrate previously untouched forest areas, increasing accessibility and opening up forests to more indirect threats.

Firewood harvesting far exceeds timber extraction in terms of volume of wood harvested. However, it rarely impacts rainforest except close to large urban centers (e.g. Kinshasa, Brazzaville, Bangui, Yaoundé) where deforestation circles, which can only be contained by firewood plantations, often form.

In this context, the sustainable utilization and economic development of forest resources are important development issues. Forests represent a major source of economic revenue for countries both in the formal sector (i.e. industrial, semi-industrial timber logging) and the informal sector (e.g., non-timber forest products, artisanal timber extraction, fuelwood collection). Gradually, countries are becoming better organized to manage the logging of their forests and to administer the income generated by such activities. On the other hand, the forests of the Congo Basin are subject to increasing pressure and use, which continues to result in net deforestation and degradation.

Maintaining forest cover in both production and conservation forests will be a major challenge in the coming decades. Addressing this challenge involves solving a series of other challenges related to improving governance, the modernization of the agricultural sector, population growth and the informal sector, improved management, widespread forest certification and management plans, payment for environmental services, national zoning of land use, etc.

The new trend of paying for environmental services provided by forests is discussed in detail in this report and may be essential if we want to make economic and social choices to maintain forests. New financing mechanisms for the payment for environmental services are galvanizing Congo Basin around this idea, clearly demonstrated by the robust and proactive negotiation dynamic.

New trends and challenges necessitate greater knowledge and understanding of the Congo Basin forests. Current data are often partial, fragmented and relevant only at a local scale; at the level of the Congo Basin available information is generally based on estimates and extrapolation. The collection of data and information that are accurate, objective and relevant to the three scales considered is a major challenge. The 2008 SOF report summarizes information at the country and regional levels, with local issues being covered in the CBFP landscapes.

While the reports in 2005 and 2006 focused largely on the CBFP landscapes, the component dedicated to reporting on national approaches to Congo Basin forests is greatly strengthened in the 2008 SOF and is reflected in the new structure of the indicators.

The report is divided into three major sections: national and regional summaries; thematic chapters; and landscape chapters. The six national chapters are structured in a similar fashion. Each chapter starts with a brief presentation of the macro-economic and political context of the country in question. The authors then analyze forest cover and its progression since 1990. The chapters also describe the legal and institutional framework for managing biodiversity resources and recount the results of data collected on the status of and value added through biodiversity, logging and the timber industry. A regional chapter summarizes the six country chapters and provides the reader with a synoptic perspective of the information.

The second part of the report is devoted to six thematic chapters presenting more detailed information on a series of issues pertaining to environmental goods and services. The first chapter addresses a new tool for sustainable forest management in Central Africa: payment for environmental services (PES). The second chapter gives an overview of water resources and their role in the sub-region. Biodiversity as a source and means of maintaining environmental services is covered in the third chapter. The fourth chapter provides a historical overview of the position of Central African countries in Reduced Emissions from Deforestation and Degradation (REDD) negotiations, while the fifth chapter gives a first estimate of carbon stocks and variations in the region. Finally, the sixth and final chapter raises the issue of peri-urban forests and fuelwood in Central Africa.

The third section of the report is comprised of 12 chapters detailing progress in the CBFP landscapes. Each chapter begins with a description of land use planning activities, followed by a description of human activities. The chapters also include a brief analysis of forest cover and its evolution as well as reports on large mammal and human sign monitoring. Finally, the chapters conclude with a brief presentation of a topic of special interest in the landscape.

CHAPTER 1
State of the Forests of Central Africa: Regional Synthesis

Richard Eba'a Atyi, Didier Devers, Carlos de Wasseige, and Fiona Maisels

Introduction

The 2008 Central Africa State of the Forest report covers six countries: Cameroon, the Republic of Congo, the Democratic Republic of Congo, the Central African Republic, Gabon, and Equatorial Guinea. These countries cover a total area of 4,048,470 km² and in 2005 had a population of about 86 million inhabitants. The Central Africa sub-region is generally characterized by very strong population growth, estimated at 2,87 %/year, with the total number of inhabitants projected to reach about 99 million by 2010 (United Nations, 2007) and doubling by 2030.

According to an analysis of economic indicators (table 1.1), there exists widespread poverty in the sub-region. DRC and CAR - which when combined represent more than 73 % of the total sub-regional population - are classified among the lowest income countries in the world (GNI/inhabitant < $ 935, according to the World Bank ranking, 2006). Additionally, Cameroon and Congo are classified as lower middle income. Only two countries, representing a mere 2 % of sub-regional population, are middle-income (Gabon) or high income (Equatorial Guinea). Complementing these raw economic figures is a generally high degree of disparity in distribution of national wealth - situating the management of forest resources in the Congo Basin against a background of ubiquitous impoverishment among its population.

Photo 1.1: Typical profile of a dense humid riparian forest in Central Africa.

The majority of inhabitants of the sub-region depend on small-scale slash-and-burn shifting agriculture for subsistence - a farming practice which uses the forest as a land reserve for expansion. In addition to slash-and-burn shifting cultivation, people in the Congo Basin subsist by harvesting forest products for both food and domestic energy (fuelwood and charcoal).

Table 1.1: Summary of economic development indicators in Congo Basin countries in 2006

Country	Population (millions of inhabitants)	Population density	Life expectancy (years)	Child mortality (/1000)	GNI (billion $)	GNI/inhabitant ($/inhabitant)
Cameroon	18.2	39	50.3	86.8	17.7	980
Congo	3.7	10.8	54.8	79.5	6.0	1,370
CAR	4.3	6.9	44.4	114.5	1.6	370
DRC	60.6	26	46.1	129.0	8.1	130
Gabon	1.3	5	56.7	60	7.5	5,360
Equatorial Guinea	0.5	18.4	51.1	123.6	94.9	8,510

Source: World Bank, 2006.

Photo 1.2: On the edge of the massif, forests share space with human-impacted savannas (North Kivu - DRC).

Forest Cover in the Congo Basin

Forested Area

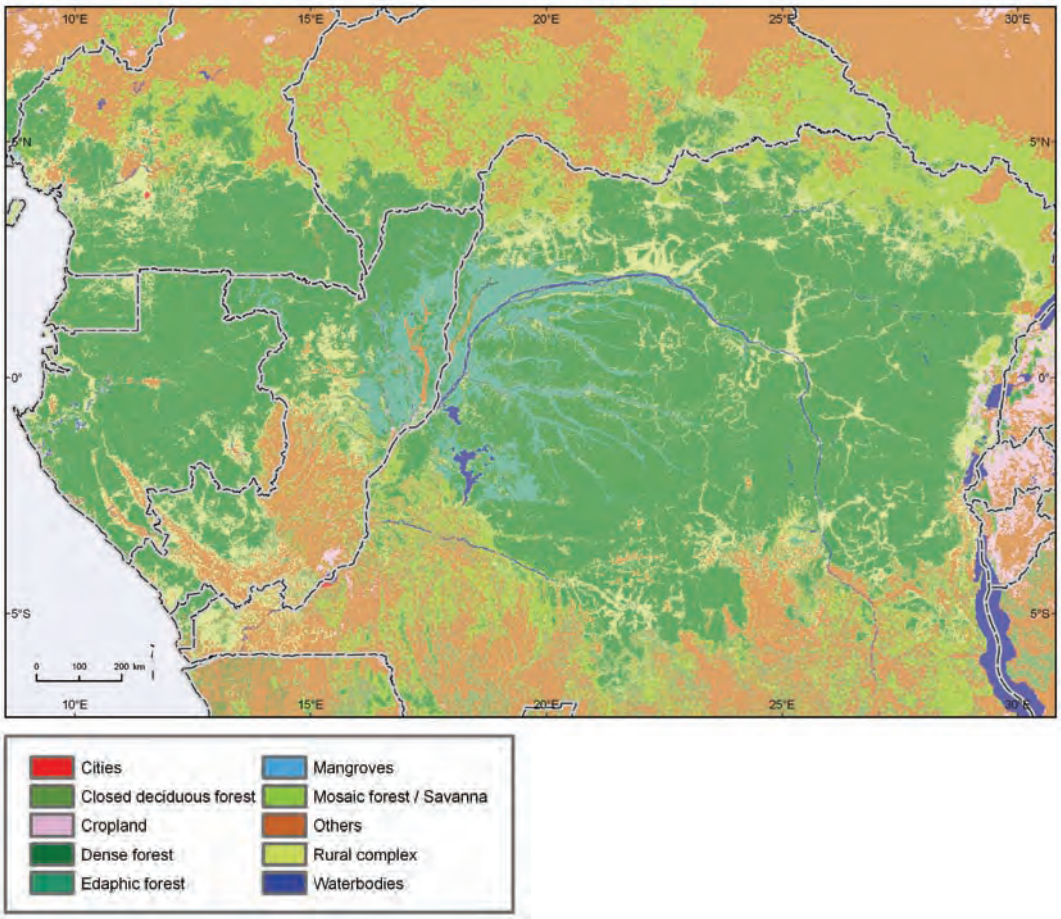
Box 1.1: Mapping Congo Basin forests using satellite remote sensing

Remotely sensed data offer a unique and valuable information source for quantifying tropical forest area and forest change at regional scale. However, the primary limitations to large area high spatial resolution mapping include the development of generic and robust methods, overcoming data quality issues and having the resources to purchase required data sets. For a region like the Congo basin, data needs are intensive in order to overcome the presence of cloud cover. Of the three main tropical forest zones including Amazon and South-East Asia, the Congo Basin represents the most challenging due to the persistence of cloud cover and the relative fine-spatial scale of the prevailing change dynamics found there.

For the 2008 State of the Forest Report, all of the available data and state of the art methods have been used to deliver the most recent and best area estimates currently available from satellite remote sensing. Forest area for the Congo Basin was estimated from five complementary sources provided respectively by South Dakota State University and the *Université catholique de Louvain*. Wall-to-wall mapping of forest cover was performed using 30-m Landsat data for the year 2000 covering the majority of the Congo Basin. However, this forest map did not exhaustively map the entire Basin. In order to derive an estimate that included all lands of the CBFP-member nations that constitute the Congo Basin, the Landsat-derived map product was used to calibrate data from the MODerate Resolution Imaging Spectroradiometer (MODIS) sensor in mapping humid tropical forest area. Eight years of 250-m MODIS data were used as inputs to overcome atmospheric contamination.

Based on the GLOBCOVER experience, a new forest map including edaphic forests was produced using 300-m resolution Medium Resolution Imaging Spectrometer (MERIS) data for the 2005-2006 year for CAR and DRC. For the 4 coastal countries of the Congo Basin, all 1-km daily observations of SPOT-Vegetation acquired over the last 9 years provided an even clearer mosaic allowing a better forest/no forest delineation. Finally, the SRTM 90-m digital elevation was used to classify forest types according to an altitudinal gradient.

Combining and averaging these 5 complementary sources, areal extent of the different forest types was obtained at the basin level as well as for the CBFP-member countries. It is also important to mention that these forest statistics both improve and update the previous figures delivered in the 2006 State of the Forest Report.



Sources: UCL, JRC, SDSU, and FORAF.

Figure 1.1: Land cover in Central Africa

Table 1.2: Forested area (ha) of the six forest countries of Central Africa in 2008

Forest cover category	Cameroon	Congo	CAR	DRC	Gabon	Eq. Guinea
Lowland dense forest	16,467,570	14,384,835	4,614,732	83,761,542	20,982,690	1,972,044
Sub-montane forest (900-1500 m)	270,540	612	1,440	5,995,494	14,445	27,450
Montane forest (>1500 m)	17,685	0	0	955,071	36	2,619
Swamp forest	0	4,108,545	27	8,200,098	17,766	0
Mangrove	120,348	0	0	0	71,919	351
Total dense forests	**16,876,143**	**18,493,992**	**4,616,199**	**98,912,205**	**21,086,856**	**2,002,464**
Forest-cropland mosaic	4,501,395	5,805,468	1,816,380	21,144,384	3,120,219	624,438
Forest-savanna mosaic	5,867,865	1,351,890	22,774,437	28,592,334	185,931	28,647
Dense deciduous forest (Miombo)	105,984	1,251,531	922,923	28,023,714	176,643	0
Other vegetation	14,066,352	6,824,178	30,970,737	50,825,421	1,404,630	39,231
Cropland	4,873,077	215,514	917,676	825,390	33,480	2,637

Sources: consolidation of land cover data produced by UCL, JRC and SDSU.

Change in Forest Cover

Photo 1.3: Forest cover is mapped using a combination of remote sensing and ground validation.

The ability to monitor changes in forest cover in the Congo Basin has been strained during the last five years due to reduced availability of adequate satellite images (technical failure of Landsat ETM+), combined with diminished quality due to persistent cloud cover for certain areas of the sub-region (notably for the Atlantic coastal area of Equatorial Guinea, Gabon and Cameroon). A recent analysis of satellite images dating from 1990 and 2000 (Duveiller *et al.*, 2008; Hansen *et al.*, 2008a), focused only on densely forested areas in the Congo Basin, found the average annual rate of net deforestation to be 0.16 %. For these purposes, "deforestation" is considered as the conversion of dense forests or degraded forests to any other type of land use. This net deforestation rate is calculated from an estimated gross deforestation rate of 0.17 % combined with an estimated reforestation rate of 0.01 % (table 1.3).

Table 1.3: National average annual deforestation and reforestation rates in the dense forest zones of the Congo Basin between 1990 and 2000

Country	Gross deforestation (%)	Net deforestation (%)
DRC	0.21	0.20
Congo	0.07	0.02
CAR	0.19	0.06
Cameroon (*)	0.14	0.14
Gabon (*)	0.09	0.09
Eq. Guinea (*)	0.10	
Congo Basin	**0.17**	**0.16**

(*) due to the low sampling rate in the study of Duveiller et al., 2008, the figures for the Equatorial Guinea are taken from Hansen et al., 2008a.
Sources: adapted from Duveiller et al., 2008 and Hansen et al., 2008a.

The highest net deforestation rates were found in DRC and Cameroon, respectively (table 1.3). These findings are largely explained by the fact that both countries have the highest densities, in Central Africa, of rural populations who practice slash-and-burn shifting cultivation. The relatively high population growth rate in these two countries exerts an increasing demand on surrounding land for agricultural development to meet consummate growing food needs. However, the deforestation phenomenon remains relatively modest in the Congo Basin overall - especially if the phenomenon in dense forest zones is disaggregated from that in the savanna ecosystems. Higher national deforestation rates have been published (e.g., FAO, 2001b); however these include figures from savanna ecosystems – which are often more populated and more active in farming, than dense forested ecosystems. Additionally, deforestation is much more pronounced around the major urban areas.

Box 1.2: Congo Basin forest area change from satellite remote sensing

Implementing operational monitoring of tropical deforestation is a major challenge. The primary limitation for humid tropical forest monitoring is persistent cloud cover that confounds efforts to operationalize land cover change characterizations. Many land cover mapping activities rely on photo-interpretation, or other approaches that are labor-intensive, costly, and difficult to replicate in the consistent manner required for long-term monitoring (e.g., Africover).

One way to overcome these limitations is to use sampling methods for estimating national and regional forest cover change. Sampling has a number of advantages over wall-to-wall mapping. First, it requires only a portion of the region to be studied, reducing processing requirements. Second, sampling methods provide a measure of uncertainty, indicating confidence of the resulting estimates of cover and change. Third, sampling reduces data input needs, as cloud-free data are required only for the sample block areas. Last but not least, the sampling approach currently allow a more detailed forest type characterization providing estimates not only for the deforestation, but also degradation, reforestation and regeneration.

Wall-to-wall mapping, on the other hand, has obvious comparative advantages to sampling as spatially explicit estimates of forest cover change are produced for the entire region. This enables results to be subset in a way not possible with a sample population. However, producing wall-to-wall estimates of forest cover change is difficult. Persistent cloud cover means that methods for automatically processing images are required, as the more persistent are the clouds, the more images one needs as inputs to acquire good land observations. Mapping the Congo Basin in this way entails mass-processing of data to filter atmospherically contaminated pixels and to identify and characterize good land observations. As such, the logistics and quality control of wall-to-wall mapping are much more difficult to manage than sampling approaches.

The unique 30-m Landsat data archive has been processed at Basin level according to both methods, i.e. the sampling approach and the wall-to-wall approach, respectively by the *Université catholique de Louvain* with the Joint Research Centre and South Dakota State University. The results presented here correspond to the change between 1990 and 2000 periods. On-going efforts will result in forest change estimates for the 2000-2005 interval using these same methods.

In addition to deforestation, forest degradation (conversion of dense forests into degraded forests), Duveiller *et al.*, (2008) estimate the average annual rate of net degradation of dense forests in the Congo Basin to be 0.09 % (table 1.4). This quantified measure of degradation is based solely on significant detected change in forest cover and not in qualitative terms (i.e. change in species composition). Degradation is largely offset by recovery (transition from degraded forest to dense primary forest), when considered nationally.

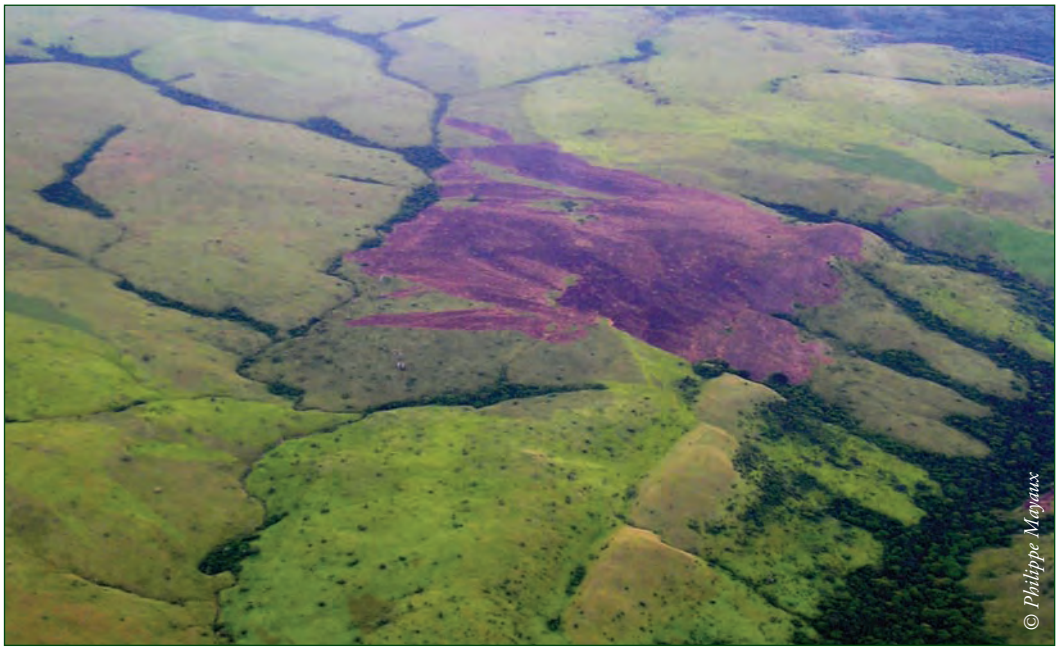


Photo 1.4: Human land use profoundly impacts forest landscapes.

Table 1.4: Average annual degradation and recovery rates in dense forest zones in the Congo Basin between 1990 and 2000

Country	Gross degradation (%)	Gross recovery (%)	Net degradation (%)
DRC	0.19	0.07	0.12
Congo	0.04	0.04	0.00
CAR	0.06	0.04	0.02
Cameroon (*)	0.07	0.06	0.01
Gabon (*)	0.09	0.01	0.08
Eq. Guinea (*)	0.00	0.32	
Congo Basin	**0.15**	**0.06**	**0.09**

(*) These figures from should be interpreted cautiously given the low to very low sampling rate.
Source: adapted from Duveiller et al., 2008.

Forest Logging in Central Africa: Progress and Challenges

Contribution of the Forestry Sector to Economic Development in Central African Countries

Photo 1.5: Felled trees serve as the primary source for the timber sector.

Photo 1.6: ... but some logs are abandoned.

The formal forestry sector has played an important role in the Congo Basin since the colonial era. However, the sector's contribution to GDP has decreased gradually and consistently - especially for countries where the oil sector has been growing rapidly, notably in Congo, Gabon and Equatorial Guinea. According to data collected in ministerial departments in charge of economy and finance in the countries concerned, the lowest forest sector contributions to GDP are found in Equatorial Guinea (0.22 %) and DRC (1 %). The decline in importance of the forestry sector in the economy of Equatorial Guinea is almost entirely due to the oil sector, which has literally exploded in the last five years, making it also the only high-income country in the sub-region. In DRC, on the other hand, the forest sector's collapse has been largely due to the disintegration of the underlying economic and state institutions, combined with a neglected infrastructure network that has led to inflated transportation costs for the industry. The latter is all the more striking, occurring in a country that has urgent need for financial resources (the country with the lowest GNI *per capita* see table 1.1) and largest forest area of the continent. Table 1.5 presents the contribution of the forestry sector in terms of tax revenue and percentage of GDP for each country of the sub-region. As is indicated here, Cameroon generates the greatest amount of revenue from the forest sector in the sub-region.

However, the consideration of the forestry sector's role in the national economy cannot be limited solely to its estimated contribution to GDP. For example, in spite of only being 6.3 % of GDP, CAR's timber exports contributed 41 % to national export earnings in 2007. In both CAR and Gabon, the forest sector is the second largest employer in the national economy after the state. Jobs in the forestry sector are of particular importance because a large proportion of employees come from surrounding rural areas. In Congo, for example, there are about 4,000 employees[1] in the logging and timber sector in the provinces of Sangha and Likouala alone. In DRC, with very little rural employment in the formal sector, there are 15,000 direct jobs listed in the timber industry.[2] In rural forested areas across the Congo Basin, the formal forestry sector is by far the largest private employer.

[1] See 'The forests of Congo in 2008' chapter in this report.
[2] See 'The forests of the DRC in 2008' chapter in this report.

Table 1.5: Contribution of the forestry sector to GDP and tax earnings in the Congo Basin

Country	Contribution to GDP (%)	Contribution to tax earnings (million €)
Cameroon	6	62.1
Congo	5.6	10
Gabon	4.3	31.3
Eq. Guinea	0.22	13.8
DRC	1	1.7
CAR	6.3	-

Sources: Cameroon: Ministère des Finances; Congo: Document stratégique de Réduction de la Pauvreté (DSRP); DRC: World Bank; CAR: Institut centrafricain de Statistiques et d'Études économiques et sociales; Gabon: Direction générale des Impôts; Equatorial Guinea: Documento de la 2da Conferencia Económica.

Photo 1.7: … while others will be turned into charcoal.

Photo 1.8: The timber industry is the primary job provider in rural areas (sawmill FOREEX - Gabon).

Photo 1.9: The African forests consists of many important tree species, but only 50 species are exploited.

Forest Statistics and Flow

Log Production from the Formal Sector

In 2007, the formal forestry sector in Central Africa produced about 8.4 million cubic meters of timber (table 1.6). Gabon, with nearly 3.4 million cubic meters, is the largest producer followed by Cameroon (approximately 2.3 million m³). The smallest producer is DRC, with 310,000 m³.

The formal timber sector logs more than 50 species across the sub-region, but only a dozen are well known and tend to dominate the market. The most harvested species is okoumé, representing over 32 % of timber products from Central Africa. It is found mainly in Gabon, but also in Equatorial Guinea and Congo to a lesser extent.[3] Second to okoumé is sapelli, found in most countries of the sub-region, this species accounts for nearly 16 % of overall timber volume. The third most abundant timber species, ayous, represents nearly 11 % of overall wood volume harvested. Combined, these three species represent about 59 % of log production in Central Africa. Overall, logging in the Congo Basin is still very selective towards high grade timber, and many species are under targeted or not targeted at present - due mainly to lack of market or a very low profit margin for these species. A lack of focus for certain species is often linked as well to their unfavourable specific technical properties (including extremely dense and/or fibrous species), or to a high tendency of being infested by insects or fungus (high phytopathological sensitivity). There is an ongoing progressive diversification of species logged, but it is occurring very slowly and only in forests near the ports of export and/or with lower production costs (Cameroon, the coastal area in Gabon, southern Congo and the province of Bas-Congo in DRC). For example, azobé is widely logged on the coast of Cameroon but hardly at all in Northern Congo despite being present. Furthermore, ilomba, an abundant peeling species in all forests of the sub-region, is only harvested in Equatorial Guinea.

Table 1.6: Harvested timber volume and primary species logged by country in 2007

Country	Production (m³)	Main species logged
Cameroon*	2,296,254	Ayous, sapelli, tali, azobé, iroko
Congo	1,330,980	Sapelli, sipo, bossé, iroko, wengué
Gabon	3,350,670	Okoumé, azobé, okan, movingui, ozigo
Eq. Guinea	524,799	Okoumé, tali, azobé, ilomba
DRC	310,000	Sapelli, wengué, sipo, afromosia, iroko
CAR	537,998	Ayous, sapelli, aniegré, iroko, sipo
Total	**8,350,701**	

** Data 2006.*
Source: National ministries of forestry.

[3] It should be noted that okoumé statistics are aggregated with those of ozigo, now banned from harvesting in Gabon.

Photo 1.10: In recent years, the timber industry in Central Africa has focused on first-stage wood processing (CPBG peeling mill in Port Gentil).

In Central Africa, industrial timber transformation facilities are mainly oriented towards primary processing (sawing, peeling and slicing). Of the 225 industrial processing units listed, 177 (nearly 80 %) are sawmills. Gabon has the highest number (73) of industrial plants followed by Cameroon (60) – combined, they represent 60 % of sub-regional processing capacity (table 1.7). The existence of a sawmill structure, however, does not always translate into it being operational. This point is especially relevant in DRC, where the worsening socio-political context in the 1990s led to the stoppage or abandonment of many plants where the equipment is now obsolete. Official statistics do not record artisanal sawmills, which often operate in the informal sector and that, considered as an entity, can be a significant contribution to the wood processing sector.

Peeling plants are often associated with plywood facilities and thus incorporate a secondary processing element. A growing number of sawmills are associated with industrial planning facilities and produce planed sawn wood (flooring, molding...). The amount of processed dried wood has also risen sharply in recent years across Central Africa.

Table 1.7: Distribution of industrial timber processing plants in Central African in 2007

Type of industry	Cameroon	Congo	DRC	CAR	Gabon	Eq. Guinea	Total
Sawmill	51	25	33	7	60	1	**177**
Peeling plant	5	6	6	1	12	5	**35**
Slicing plant	4	0	2	2	1	4	**13**
Total	**60**	**31**	**41**	**10**	**73**	**10**	**225**

Source: National ministries of forestry.

The number of industrial plants does not provide the full picture regarding the volume of wood processed because as mentioned above some of the processing units are not functional and information on the processing capacity of these plants is often incomplete. From the statistics on factory input volumes, which are fairly well monitored in all countries except DRC, it is possible to estimate the processing rate for each country (table 1.8) using statistics on felled volumes (table 1.6). From an analysis based on available data, it appears that Cameroon is the most active timber processing country, with nearly 75 % of timber processed in-country. This high timber processing rate in Cameroon flows from a policy introduced in the Forest Code of 1994, which mandated a stop to log exports within five years. This strict policy has been somewhat eased by allowing the export of some logs through a quota system - but its impacts have been nonetheless significant. Cameroon is followed by Congo, which has a processing rate of approximately 65 %.

Although it is increasing, the timber processing rate in Central Africa remains low overall and log exports still dominate. By improving the conversion rate in each country, the forest sector's contribution to national economies could be increased - especially if companies operating in the sub-region move beyond mere primary processing of wood. Incentive policies aimed at removing current obstacles to an augmentation in processing, could help achieve this. Paradoxically, it remains often more profitable to export raw logs, transported hundreds of kilometers, than sawn timber.

Table 1.8: Rate of industrial timber processing in Central Africa

Country	Processing plant input volume (m^3)	Volume felled (m^3)	National processing rate (%)
Cameroon	1,716,566	2,296,254	74.8
Congo	861,768	1,330,980	64.7
DRC	-	310,000	-
CAR	128,473	537,998	23.9
Gabon	1,131,566	3,350,670	33.8
Eq. Guinea	73,151	524,799	13.9

Source: National ministries of forestry.

Photo 1.11: Logging roads are essential to export logs from forest areas.

Table 1.9 presents the volume of primary industrial timber products processed in 2007 in Central Africa. In comparison with the volumes exported of the same processed timber products (table 1.10), only a slight difference is observed. While this low discrepancy in volumes may be due in part to certain data inconsistencies, it nonetheless signals that little of the industrial processed timber is sold locally. In all countries of the sub-region, the majority of local demand is met through the informal timber sector. This informal sector is largely supplied either through traditional wood processing operations (pit sawyers) or by absorbing the "waste" wood by-products of the formal sector. However, in either case, these transactions are not captured as part of the formal timber sector market.

Table 1.9: Primary industrial timber processing products in Central Africa in 2007

Volume (m^3)	Cameroon	Congo	Gabon	Eq. Guinea	CAR	Regional total
Sawn wood	613,000	212,719	296,406	784	97,001	**1,219,910**
Peeled veneer	3,204	44,826	180,516			**228,546**
Plywood	22,000	8,665	84,795	293	740	**116,493**
Sliced veneer	64,286	0	1,285	27,644	4,300	**97,515**
Planed sawn wood	64,000	11,300				**75,300**

Source: National ministries of forestry.

Exports

Table 1.10 presents the volume and types of industrially processed timber products exported through the formal sector in Central Africa. As mentioned above, unprocessed logs represent the largest product category exported from Central Africa. The largest producer of logs, Gabon, is also the largest exporter of this product, with nearly 53 % of sub-regional log exports. The second largest sub-regional export is sawn wood. Cameroon is the only exception in the sub-region, where the volume of processed products exported surpasses that of logs. As mentioned above, this can be seen as a result of deliberate policy to encourage in-country wood processing,

Gabon is the largest producer of peeled veneer and plywood – owing to an abundance of okoumé, which is particularly adapted to this type of processing.

Slicing remains a marginal activity, with high added value and exclusively for very high quality wood.

The main destination of overall timber exports from Central Africa remains the European Union, although the importance of Asia is rapidly increasing. As an example, China has recently become the main destination for Gabonese timber exports.

Photo 1.12: CPBG peeling mill in Port-Gentil (Gabon).

Table 1.10: Quantities and types of timber products exported through the formal sector in Central Africa

Exported product (m^3)	Cameroon	Congo	Gabon	Eq. Guinea	CAR	DRC	Regional total
Logs	266,000	522,497	1,938,079	547,299	193,213	208,087	**3,675,175**
Sawn wood	613,000	209,122	157,856	600	76,042	30,382	**1,087,002**
Peeled veneer	64,286	15,307	144,135	31,101	4,300	0	**259,129**
Sliced veneer	3,204	0	1,889	0	0	1,392	**6,485**
Plywood	22,000	1,755	28,384	0	740	6,762	**59,641**
Planed sawn wood, flooring, molding…	3,205	0	0	0	0	1,152	**4,357**
Log for pulp and paper	0	250,746	0	0	0	0	**250,746**

Source: National ministries of forestry.

Advancing Sustainable Forest Management in Central Africa

Improving Legal and Institutional Frameworks

Following the 1992 Earth Summit in Rio de Janeiro, all of the Central African countries have embarked on a revision of their forest laws in order to make them compatible with the needs of sustainable forest resource management. These new laws and regulations, most of which have already been adopted, include important new developments. Notable amongst these laws are certain novel obligations: (1) the requirement to manage production forests based on (sustainable) management plans; (2) the need for greater participation from local people in forest resource management; (3) specific conservation objectives to be achieved across the national territory; and (4) to reduce the negative impacts of resource extraction on forest ecosystems through a series of regulations and guidelines. In addition to legislation specific to managing forest and wildlife resources sustainably, some countries (Cameroon, Congo, Gabon, and Equatorial Guinea) have already adopted laws on environmental protection in a broader sense, while others (DRC and CAR) have already prepared similar draft legislation, that is currently winding its way through the legislative process. Institutionally, management of forest resources and environmental protection have also grown in political clout across the sub-region, through the creation of new ministerial departments in charge of implementing and developing government policies in the forest/environment field. State financing for biodiversity resource management is also improving. Cameroon, CAR, Equatorial Guinea, and Congo have set up national funds to finance public service activities for forest and wildlife management, and biodiversity conservation. In principle, the DRC has a forest capital trust fund created in 1985, but which has ceased operating since the socio-political events of the 1990s. With the support of technical and international financial partners, different countries have developed restructuring programs. At present, only the Forest and Environment Sector Program (PSFE) in Cameroon and the Forest Environment Program (EFP) in Gabon are operational. The National Forest and Conservation program (PNFoCo) in the DRC and Congo's PSFE remain in preparatory phase. Apart from restructuring programs and traditional bilateral and multilateral initiatives in the forest sector, the international community has instituted a number of instruments and financing mechanisms for Congo Basin forests. The new funding initiatives are often linked to the issue of climate change, payment for ecosystem services or contribution to the Millennium Goals. One such initiative is the Congo Basin Forest Fund (CBFF), which aims to reduce poverty and mitigate climate change by reducing deforestation across the sub-region. The CBFF is designed as a multi-donor fund and has already received capital inputs of around $ 100 million through contributions from the United Kingdom and Norway. Another example is the GEF's (Global Environmental Facility) strategic program to support sustainable forest management in the Congo Basin. In support of this endeavor the GEF aims at pooling a total of $ 200 million - commitments have already been made for $ 54.7 million from GEF agencies (World Bank, FAO, UNDP, UNEP) and the rest is to come from national governments and co-financing from various donors and NGOs (Simula, 2008).

Towards Better Forest Governance

Improving forest governance in Central Africa is generally pursued through three approaches: the FLEGT process (Forest Law Enforcement Governance and Trade), independent third party observers and timber certification and/or legality systems operating in the Congo Basin.

The FLEGT process initiated by the European Union, aims to culminate in the signing of bilateral Voluntary Partnership Agreements (VPA) between all the timber-exporting states of the sub-region and the European Union. Once signed, these agreements will restrict timber exports to the EU to wood that meets the legal conditions agreed to by the signatories. The first VPAs should be signed by the EU with Cameroon and the Congo during the first half of 2009. Other countries have already begun informal discussions with the EU and negotiations will take place in 2009.

Before the implementation of the FLEGT process, some countries in the sub-region had already adopted the process of linking Independent Observers (IO) to the monitoring of forest operations for greater transparency. The oldest and most varied experience is that of Cameroon. Since 1999, Cameroon has involved regular IOs during the allocation of forest concessions. Subsequently, NGOs working to promote transparency such as Global Witness and Resource Extraction Monitoring (REM) were involved in forest monitoring - a sovereign state activity - and their monitoring reports were widely disseminated at international level. Cameroon has also worked with the World Resource Institute (WRI) to develop an interactive forestry atlas, making it available to users interested in basic information on forest concession management. The Republic of Congo has also involved IOs in forestry operations and an initial version of its forestry atlas (prepared with WRI) has already been published. All sub-regional countries are currently developing joint forest atlases with WRI. The notable transparency in DRC, both in developing the legal framework for forest management and in converting former logging titles to concessions, should also be emphasized. At each stage of the process, the forestry administration has worked consistently with national and international NGOs, as well as technical, international donor and private sector partners.

In development by COMIFAC, the OFAC (*Observatoire des Forêts d'Afrique centrale*) will help all Central African countries to make a wide variety of forest sector data available in a transparent fashion, including: forest cover, logging, biodiversity conservation and biodiversity development statistics.

Additionally, countries of the sub-region signed an agreement in 2008, under the auspices of COMIFAC, to strengthen forest law enforcement and monitoring.

The private sector is also involved in initiatives to improve the law on forestry operations and enhance transparency. Thus far, 25 certificates of legality (total area of 2,606,340 ha) have been granted to private companies following audits by independent bodies, including SGS and Bureau Veritas (see table 1.12). Many companies are also involved in the Forest Transparency Initiative (FTI), a project funded by the Cooperation Agency of the United Kingdom (DFID) and implemented by the World Resources Institute (WRI) with the aim of making information on forest resource management available to interested members of the public.

Photo 1.13: Better management of production forests involves the adoption of management plans.

Implementation of Forest Management Plans: Significant Progress

Implementation of forest management in logging titles has experienced ten years of notable progress in Central Africa. From zero hectares managed in 2000, the sub-region had over 11.3 million ha of forest concessions in 2008, managed in accordance with state-approved plans. Forest management plans are in effect in four countries of the sub-region: Cameroon, Congo, Gabon, and the CAR (see table 1.11). In CAR, 8 of the 11 concessions awarded already have management plans approved and in operation (or 75.2 % of the licensed area), with the three remaining concessions expected to have approved plans by the end of 2009. For the sub-region, about 36.4 million ha have been allocated in the form of 256 forest concessions - 87 of which are already operating under approved management plans, representing 31 % of the area allocated (11.3 million hectares). These figures will likely increase significantly during the next five years, as management plans in another 142 concessions (21.4 million ha) are finalized. The French Devel-

Photo 1.14: Dense forests represent a succession of dominant and dominated trees.

opment Agency (AFD) is supporting two projects (PAPPG in Gabon and another in development in Congo) whose objectives are to find workable solutions for logging titles which have thus far remained outside of the formal sustainable forest management process.

The DRC will see significant change in the near future - following the recent forest title conversion process. At present, 65 titles[4] (about 9.7 million ha) have been converted, due to their adherence to regulations and their commitment to sustainable management. Within four years, these convertible titles must have management plans approved. 91 titles (about 12.7 million ha) are still undergoing review.

Forestry Certification: International Recognition of Progress Made Towards Sustainable Forest Management in Central Africa

Since the advent of forest certification in the early 1990s, a number of private logging companies operating in Central Africa have pursued this internationally recognized process through adherence to standards of sustainable forest management. Among several competing processes, the Forest Stewardship Council's (FSC) certification system is considered the most demanding at the international level - focusing not only on technical, but also social and environmental aspects of forest management. The FSC system uses the same principles, basic criteria and indicators (PCI) to assess forest management around the world. Thus, the granting of an FSC certificate to an enterprise amounts to international recognition of the quality of forest management.

Leroy Gabon achieved the first FSC sustainable forest management certificate in Central Africa in 1996 (Eba'a Atyi, 2006). However, their certificate was almost immediately withdrawn at the request of some NGOs, who claimed that the company's management plan was not satisfactory, since the State had not yet defined the procedure for preparing forest management plans. It took 10 years for another FSC certificate to be issued in the sub-region, this time on a concession of 42,000 hectares in Cameroon (Wijma). From zero hectares in early 2006, FSC-certified forest area ballooned to a total of more than 3 million hectares in October 2008, spread over three countries: Cameroon (899,822 ha), Congo (834,302 ha) and Gabon (1.3 million ha). These FSC-certified areas are managed by seven companies: four in Cameroon (Wijma, SEFAC, TRC, Pallisco), one in Congo (CIB) and two in Gabon (CEB and Rougier-Gabon).

Apart from the FSC system, Keurhout is another sustainable forest management certification system that has granted certificates for about 1.2 million hectares of production forests in Gabon (table 1.12). These Keurhout certificates are gradually being replaced by FSC certificates. In Central Africa, some companies have also opted for environmental management certification (ISO 14001) primarily in Gabon with 549,327 ha, in addition to a certification of legality or sustainable forest management (FSC or Keurhout).

Decentralization, Increased Local Participation and Benefit Sharing in Forest Resource Management

Among the most important innovations within the new forest laws adopted by Central African countries are those relating to the participation of local populations, decentralization and benefit sharing. These innovations are illustrated by the introduction of the concepts of community forests, municipal forests, decentralized communal forests and forest revenue distribution to decentralized entities. The same concepts, relating either to forest management or taxation, can be found with variable wording in the legislation of all countries. However, Cameroon is the only country where many of these concepts are being translated to concrete actions on the ground. Data from the Cameroonian forestry administration (MINFOF) indicate that 177 community forests[5] covering 632,000 ha had been allocated by 2007. Of these community forests, 143 (564,000 ha total) had a simple management plan approved by the forest administration. Also in 2007, council forests were allocated to six Rural Councils in Cameroon (141,000 ha total), four of which already have approved management plans (110,000 ha total).

[4] See 'The forests of DRC in 2008' chapter in this report

[5] Community forests are managed by village communities to produce forest goods, and services benefiting the communities concerned.

Cameroon instituted a decentralized forest taxation system in 1997, and Rural Councils in the forested zone have since received 50 % of annual forestry fees (*Redevance forestière annuelle*, RFA), paid to each of these local authorities by the central government. The amount of RFA redistributed depends on the extent of forest concessions within a given Rural Council, as well as to the amount paid by companies by unit area. Statistics from the Ministry of Finance show that in 2007 CFA 6.7 billion (€ 10.2 million) were transferred to rural communities of Cameroon under this revenue distribution process. The CAR also has a decentralized taxation system, redistributing a fee of 1,000 CFA/m³ of timber extracted from logging concessions to the municipality having jurisdiction.

In other countries, community forestry is sometimes provided for by the legislative framework but not yet implemented on the ground (notably, in Gabon and DRC). Decentralized taxation is called for by legislation in both Congo and DRC, but its implementation remains as of yet ineffective.

Photo 1.15: Practical training on how to measure the diameter of a tree.

Table 1.11: Status of forest management implementation in Central Africa in 2008

	Cameroon		Congo		Gabon		Eq. Guinea		CAR		DRC		Total area (ha)	Total number
Forest concessions	**Area (ha)**	**Nbr**	**Area (ha)**	**Nbr**	**Area (ha)**	**Nbr**	**Area (ha)**	**Nbr**	**Area (ha)**	**Nbr**	**Area (ha)**	**Nbr**		
Management process not started			3,696,109	27									**3,696,109**	**27**
Under definitive agreement (management plan approved)	4,207,862	65	1,907,843	3	3,449,131	11			1,739,055	8		0	**11,303,891**	**87**
Under provisional agreement (management plan in preparation)	1,866,171	38	6,371,718	22	6,018,597	33			582,789	3			**14,839,275**	**96**
Total concessions allocated	**6,074,033**	**103**	**11,975,670**	**52**	**9,467,728**	**44**				**11**	**9,170,246**	**65**	**39,009,521**	**275**
Total annual harvestable areas (AACs) in 2007	**247,758**	**91**	**181,687**	**26**	**74,392**	**12**			**81,684**	**10**			**585,521**	**139**

Source: data collected by the FORAF Project, 2008.

Table 1.12: Status of forest certification in Central Africa in 2008

	Cameroon		Congo		Gabon		CAR		DRC		Total number of concessions	Total certified area (ha)
Type of certificate	**Nbr conc.**	**Certified area (ha)**	**Nbr conc.**	**Certified area (ha)**	**Nbr conc.**	**Certified area (ha)**	**Nbr conc.**	**Certified area (ha)**	**Nbr conc.**	**Certified area (ha)**		
Concessions with certificates of legality (TLTV, OLB)	21	1,722,786	0	0	2	622,399	1	195,500	1		**25**	**2,540,685**
FSC	8	899,822	2	834,302	4	1,304,963					**14**	**3,039,087**
ISO 14001					1	549,327					**1**	**549,327**
Keurhout					2	1,166,027					**2**	**1,166,027**
PAFC			0	0							**0**	**0**
Total of certified sustainable management forests	**8**	**899,822**	**2**	**834,302**	**4**	**1,304,963**					**14**	**3,039,087**
Total	**29**	**2,622,608**	**2**	**834,302**	**9**	**3,642,716**	**1**	**195,500**	**1**		**42**	**7,295,126**

(*) In Equatorial Guinea there are no certified forests either for sustainable management or for legality.
Source: data collected by the FORAF Project, 2008.

Remaining Obstacles to Sustainable Forest Management

Inadequate Legal and Institutional Frameworks

Central African nations have made considerable progress with regards to legislation aimed at sustainable forest resource management. Nonetheless, existing laws are not always supported by the necessary implementing provisions and often contain inconsistent or incoherent elements. For example, several countries have laws referring to community forests and decentralized communal forests, but the lack of the necessary associated by-laws prevents concrete implementation from taking place on the ground. The same is true for the frequent absence of specific terms referencing the modalities of forest revenue distribution.

The application of new laws is also complicated due to inconsistencies between different texts on similar topics. A comparative study of forestry legislation in Congo Basin countries (Perthuisot and Durrieu de Madron, 2008) highlights several of these inconsistencies.

Lack of Adequate Forest Sector Statistics and Information

Most governments have limited forestry statistics, and forest administrations consequently are often unable to provide reliable information on ongoing development projects in the sector, on their financing, and on their implementation period. Administrations are also not always aware of recent developments in the forest certification process in their respective countries.

The mechanisms for information exchange between civil society (NGOs), the private sector and forestry administrations are inadequate. Forestry administrations have no information on the amount of financial support garnered by NGOs nor on the level of technical capacity of NGOs and private companies operating in the forest sector. As a result, the institutional capacity of the forestry sector has always been poorly estimated in Central Africa.

By creating the *Observatoire des Forêts d'Afrique centrale* (OFAC), COMIFAC aims to help countries bridge the information gap in the forest sector, in support of improved decision-making capabilities. To do this, however, countries must build adequate institutions and avenues to collect data; these structures remain absent to date.

Photo 1.16: A team from the Cameroonian ministry in charge of forests is trained in the use of GPS.

Poorly Understood Resources

Despite the forest management projects undertaken in the sub-region, forest ecosystems are still poorly understood because of insufficient and disparate research efforts. This lack of knowledge is in part a result of the absence of a network of permanent observation plots for monitoring forest dynamics in almost all countries of the sub-region. In the few countries where there are such plots, such as CAR, they are not representative of all forest types or they are very recent and cannot yet provide results applicable to forest management.

The large databases established during forest management inventories contain a vast wealth of information and should be better used at the sub-regional level to improve knowledge of forest ecosystems. Various initiatives in this direction are underway.

A Prominent and Relatively Unknown Informal Sector

As mentioned above, the informal sector plays an important role in the forestry sector in Central Africa. The informal sector ranges from supplying rural populations with forest products for traditional usage, to meeting the lumber and firewood needs of large urban centers, and, sometimes, to providing sub-regional and international markets (often relatively insignificant quantities). Despite its importance, the informal sector for forest products remains relatively unknown and data are patchy and incomplete at best. More systematic studies should be conducted in the near future in order to better guide holistic decision-making for the forest sector. Studies are underway in the framework of the FORAF project, in order to provide additional data and define the methodologies to monitor this sector in the future.

Persistent Governance Problems

Despite recent efforts to improve forest governance, problems persist in this arena largely because forest monitoring and enforcement institutions remain generally weak and ineffective. However, it should be noted that governance problems observed in the forestry sector are characteristic of the general socio-political context present in Central African countries. In the case of Cameroon, for example, the praiseworthy implementation of decentralized forest revenue sharing is slow to produce significant impacts on local development in forest areas. Although the central government is transferring large amounts of forest-derived revenue to forest zone municipalities in a transparent fashion, the management of this money by locally elected officials remains opaque. The poor capacity of the managers of funds received under decentralized taxation, compounded by poor local governance, produces low impacts.

Perspectives for Timber Production in Central Africa

The change in the state of Central African forests for the next five years will likely largely be affected by five key elements impacting the management approaches of government institutions, the private sector and civil society.

Implementation of the New Forest Financing Instruments and Mechanisms

The new financing instruments mentioned above are in launch phase. This is particularly true for CBFF, the GEF Strategic Program of Support for the sustainable management of the Congo Basin and the trust funds being created in some CARPE/CBFP landscapes (case of TNS, for example). These instruments and mechanisms should soon become operational and be a source of capacity building. This is particularly important for conservation activities, for which low-income countries cannot logically give high budgetary priority. Similarly, these new funding initiatives will enable better coordination of sub-regional forest management policies, coordination efforts that have been undertaken for some years thanks to COMIFAC. The CBFF launched a first call for projects, which was a huge success, with 94 projects preselected. A significant number (about twenty) of the selected projects are supranational, with activities planned in at least two sub-regional countries. The effectiveness of such coordination will depend on the ability of the Executive Secretariat of COMIFAC to fulfill this role.

Result of the FLEGT Process

By 2013, at least four of the six timber-exporting countries in the sub-region should have signed VPAs with the EU in the framework of FLEGT. As the EU is the largest customer of Central Africa for timber exports, the VPAs will provide additional incentive for countries in the sub-region to become more involved in combating illegality in the forestry sector. There is a risk that EU countries, faced with the economic crisis, will reduce demand for tropical timber more than Asian countries, which are traditionally less demanding in terms of legality. Nevertheless exchanges already underway between Central Africa, the EU and China on FLEGT should mitigate such risks. One of the interests of VPAs is that during negotiations, timber traceability systems are improved and the use of independent observers will be widespread during application.

Trends in REDD Negotiations

The rules for reducing carbon emissions from deforestation and forest degradation (REDD) are being negotiated. These should come to fruition in the coming years, and according to the terms adopted, REDD may provide an incentive to Congo Basin countries to better preserve current forest biomass in return for financial resources. Conversely, the outcome of negotiations could encourage states with enormous land resources like DRC to turn to new alternatives for wealth generation such as the production of biofuels across large areas of palm oil crop, for example. From this perspective, COMIFAC coordination is required to give more weight to the best REDD options for Central Africa. Eventually, each state will be able to make a combination of three options to develop their forestry potential, namely: (i) sustainable management of production forests, (ii) carbon markets and (iii) payments for environmental services (PES), especially through conservation concessions.

Forest Certification

The first FSC certificates obtained in the sub-region appear to have had a snowball effect, encouraging firms hesitant to engage in forest certification. Almost all companies engaged in sustainable forest management of the territories granted to them now seek sustainable forest management certification, which was far from being the case five years ago. Similarly, international markets buying Certified African tropical timber will be reassured by a more consistent supply of certified timber. It is reasonable to expect that Central Africa will have 7 to 10 million hectares of certified forests in the next five years. Widespread forest certification will lead to a substantial improvement in governance for forest concession management, because the certification audits are independent and based on internationally-recognized requirements.

The Outcome of Reforms in DRC

Owing to the socio-political instability that prevailed over the past 20 years, the DRC has the least developed national forestry sector. With political stability gradually returning, the DRC has undertaken a number of forest sector reforms supported by the international community. As these reforms progress, DRC will become the main focal point for forest management in Central Africa. Its role and potential for REDD should make the country a leader in the next few years. One process that will likely have a ripple effect on forest management in the sub-region is the successful conversion of former logging titles to concessions in DRC, according to the new Forest Code. At the end of an exemplary process to validate the legality of logging titles, more than 10 million ha of production forests are now moving towards the implementation of sustainable concession management. Land use zoning remains to be done in a progressive fashion, in order to be able to define vocations for forest areas (production forest, industrial forestry, development for local people, conservation).

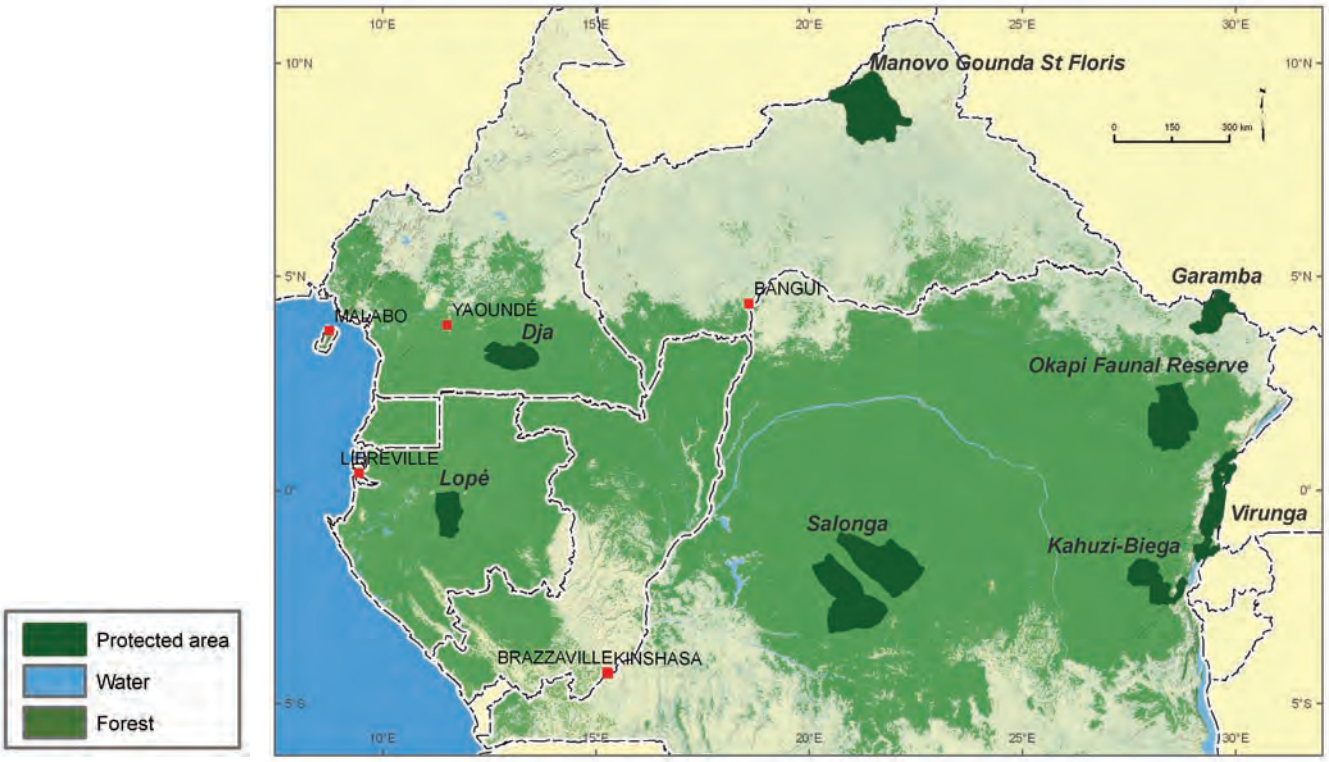
Photo 1.17: An ICCN guard scans the horizon for wildlife.

Biodiversity Development and Conservation

State of Biodiversity in the Congo Basin

Most of the Congo Basin is in the biome of tropical forests and subtropical rainforest (Olson *et al.*, 2001). Using the "human footprint" approach according to Sanderson *et al.* (2002), large areas of this biome have been identified as part of 10 % of the wildest areas on Earth (center and north-east of Gabon, a large portion of northern Congo, and several major regions of DRC). More recently, while mapping African biodiversity, Burgess *et al.* (2006) found that the richest areas in vertebrate and plant species are those that surround the central Basin.

These authors have described Congo Basin forests as relatively intact and of exceptional species diversity. By comparison, although more vast, the Amazon Basin forests have long since lost their terrestrial megafauna, and many seed dispersal agents no longer play a role (Janzen and Martin, 1982). In some areas of Africa, the same phenomenon has come to pass, while in the Congo Basin, elephants, great apes and other megafauna remain an integral part of the sub-region's ecology (Blake *et al.*, 2009).



Sources: INC/ WCS, WRI, WWF, ECOFAC, ICCN, and FORAF.
Figure 1.2: World Heritage sites in Central Africa

A detailed review of the biodiversity was not possible for the SOF 2006, because the intensity of inventory was biased in favor of the western part of Central Africa and the Albertine rift (CBFP, 2006)

Since the last report on the State of the Forest (CBFP, 2006), the state of knowledge on the Congo Basin has improved significantly. A concerted effort has been made within twelve CARPE/CBFP landscapes to standardize inventory methods and approaches, but the human and financial resources are insufficient to draft a full and comprehensive status report on biodiversity in Central Africa. However, since the objective of conserving these forests is to maintain the functionality of ecosystems still present, monitoring some indicators representative of the most intact forests will enable us to draft a biodiversity status report.

Elephants and apes were chosen as the indicators of intact, functioning ecosystems because, if a forest is being unsustainably hunted, these spe-

Box 1.3: World Heritage sites in Africa

The 1972 UNESCO World Heritage Convention contributes to the Biodiversity 2010 Objective to reduce the rate of biodiversity degradation, in particular by safeguarding habitats for threatened species through the classification of transborder natural sites and the establishment of protected ecological corridors. In Sub-Saharan Africa, the Convention was ratified by 43 out of 46 UNESCO member-states.

The global status of the World Heritage Convention is as follows:

World Heritage sites by region

Regions	Cultural	Natural	Mixed	Total	%	Member States with listed sites
Sub-Sahara	40	33	3	**76**	9	27
Arab States	60	4	1	**65**	7	16
Asia and Pacific	125	48	9	**182** *	21	27
Europe and North America	372	54	9	**435** *	50	49
Latin America and the Caribbean	82	35	3	**120**	14	25
Total	**679**	**174**	**25**	**878**	**100**	**145**

The site "Uvs Nuur Basin" (Mongolia, Federation of Russia) is a transregional site located both in Europe and Asia and Pacific. Here it is entered under Asia and Pacific.

Today, the concept of World Heritage is well understood by partners, and can be used as a catalyst for international cooperation, allowing World Heritage sites to receive financial assistance from a wide variety of sources for projects to conserve and manage common heritage for humanity.

Natural sites listed as World Heritage in the Congo Basin

Sites by country	Criteria	Year classified
Democratic Republic of Congo		
Virunga National Park	Natural	1979
Kahuzi-Biega National Park	Natural	1980
Garamba National Park	Natural	1980
Salonga National Park	Natural	1984
Okapi Faunal Reserve	Natural	1996
Cameroon		
Dja Faunal Reserve	Natural	1987
Central African Republic		
Manovo-Gounda St Floris National Park	Natural	1988
Gabon		
Lopé-Okanda ecosystem and cultural landscape	Mixed: cultural and natural	2007

The UNESCO mission to promote World Heritage involves:

- encouraging Convention member-States to propose sites on their own territory for listing on the World Heritage list;
- encouraging member-States to formulate management plans for the listed sites and set up systems for reporting on the state of conservation of the World Heritage sites;
- helping member-States safeguard World Heritage sites by providing technical assistance and vocational training;
- mobilizing international cooperation for conserving world forest heritage in Central Africa;
- providing emergency assistance to World Heritage sites in the event of immediate danger;
- supporting member-States activities to sensitize the public to the safeguarding of World Heritage sites;
- encouraging local people to participate in safeguarding their cultural and natural heritage.

It should be noted that inclusion on the World Heritage List is only the first step towards site protection. Management and protection are continuous processes, which involve local people, site managers and national authorities. When the original characteristics that led a site to be classified as World Heritage are threatened, being recognized on the List of World Heritage in Danger can be an effective conservation tool to address threats. It draws the attention of the international community to sites being threatened by natural conditions (e.g., earthquakes and natural disasters) or human activity (e.g., war, armed conflict, pollution, poaching or uncontrolled town planning) and mobilizes international resources so that urgent measures can be taken.

cies are the first to be hunted out. This is because they are (i) selected for by hunters, as they give the best rate of return (in terms of kilograms of meat) per unit effort; (ii) generally occur at lower density than smaller species and (iii) because of their slower reproductive rate, are harvested faster than their rate of replacement.

Two other indicators were used for the State of the Forest. The first is the abundance of signs of human presence. Human sign has been documented to be inversely proportional to the density of elephants and great apes, at least in places where there is no anti-poaching activity or other wildlife protection measures. The second indicator employed was the rate of loss of forest cover, equivalent to net deforestation.

Since 2000, over one hundred biological inventories have been conducted in the Congo Basin (see the section devoted to managing the CARPE/CBFP landscapes). Whether they have been carried out along transects or recces, they have provided the following information:

- elephant dung and ape nest group density on transects (figures 1.3 and 1.4);
- elephant dung and ape nest group encounter rate on recces (figures 1.5 and 1.6) of these and also of human sign (on transects and on recces: figure 1.7);
- encounter rate of human signs on transects and on recces (figure 1.7).

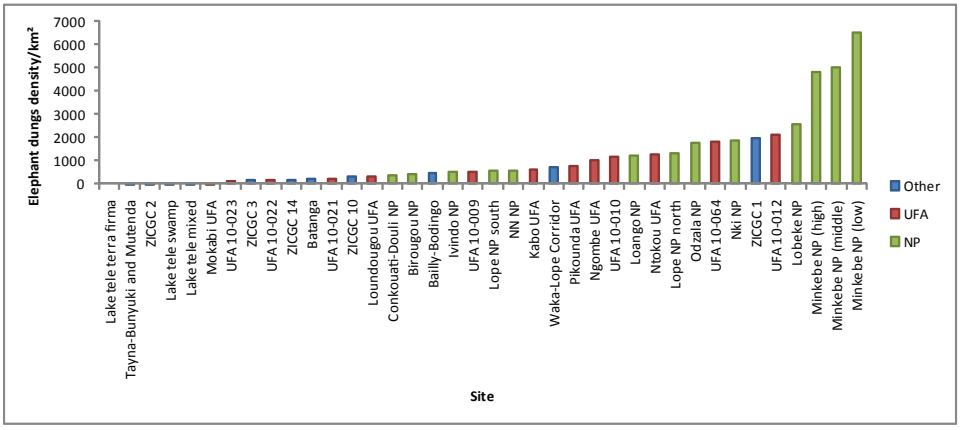


Figure 1.3: Elephant dung density per km²

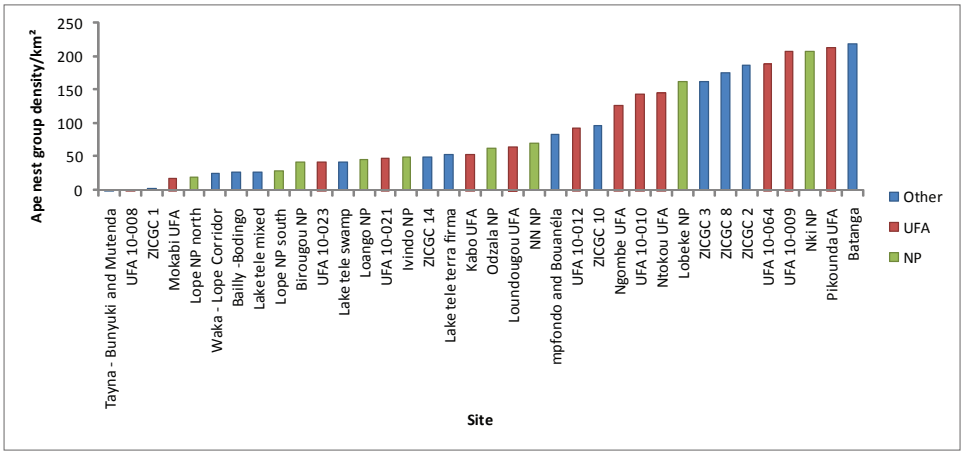


Figure 1.4: : Ape nest group density per km²

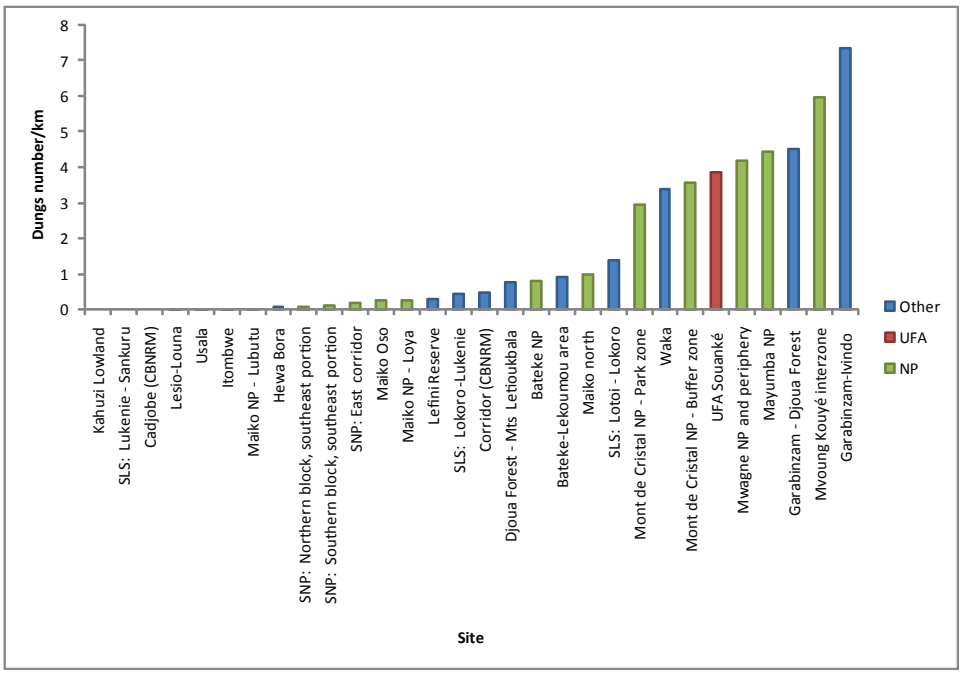


Figure 1.5: Encounter rate of elephant dung per kilometer on recces

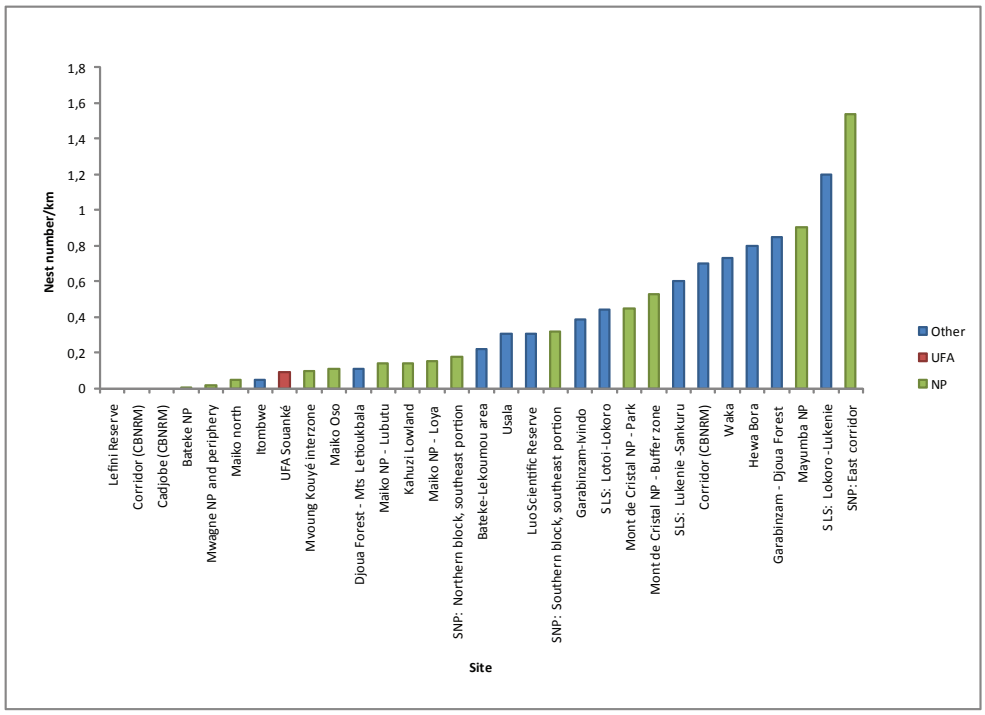


Figure 1.6. Encounter rate of ape nest groups per kilometer on recces

Photo 1.18: An elephant and its mother at a bai in Dzanga-Ndoki National Park.

Relevance for Land Use Planning

The importance of protected areas for elephants is very clear (figures1.3 and 1.5). Most of the sites where there was a low encounter rate (and low density) of elephant dung were community managed zones, or hunting zones. All the sites where elephant dung was abundant were in protected areas.

Most of the protected areas fall into the top half of the graphs, with the logging concessions fairly scattered throughout. Importantly, concessions with no fauna protection measures are in the lower half of the graph, whereas some concessionaires that are already certified or who are working towards certification are placed higher up.

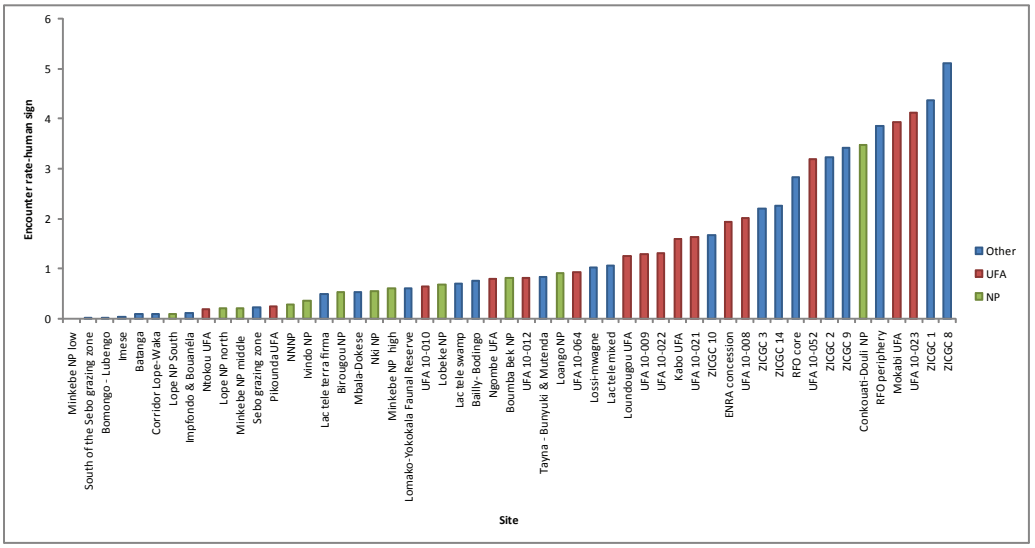


Figure 1.7: Human sign encounter rate on transects and recces

For apes no clear land use pattern emerges (figures 1.4 and 1.6). In logging concessions, community management areas or hunting zones their nest sites can be at low, medium or abundant density. Only two protected areas (Nki and Lobeké) were in the top part of the scale. There was also clearly a subregional difference - all the protected areas in the bottom half of the scale were in Gabon, and all those in the top were either in northern Congo or southeastern Cameroon. However among the hunting areas and the community management areas there was no regional skew - Cameroonian and Congolese sites were found at both ends of the scale (and in the middle). This is probably due to the effect of the recent (1996-2003) Ebola epidemics in the central-eastern Gabon and western Congolese landscapes having almost wiped out the ape populations even in some of the most remote, unhunted areas (Minkebé, Mwagne). Bonobos were poorly represented in the dataset, as only three landscapes hold them; nevertheless they are still present in all three (Salonga, Tumba and Maringa-Lopori).

A more formal regional analysis of data would be necessary before drawing firm conclusions on land use patterns. It has to be said that in general, all wildlife in the DRC landscapes were far less abundant than in those in the other countries. Of the 51 sites for which elephant dung encounter rate data were available, DRC did not figure at all in the top 50% of sites. Of the 38 sites for which elephant dung density were available, only two sites in DRC figured at all, and both were very low indeed on the list. Of the 53 sites for which data was available for ape nest group encounter rate, none of the top 14 included a DRC site.

Formal biodiversity management in Central African countries occurs mainly in protected areas. Regionally, the protected areas in categories I to VI as defined by IUCN (IUCN, 1994) total 341, covering an overall area of 57.1 million ha[6] (table 1.13). The exact distribution of protected areas between different IUCN categories is difficult given the differences in conceptions between the stakeholders and laws of different countries. Classifications made in different countries nevertheless agree on national parks (category II of IUCN) and the recreational hunting zones and hunting reserves (IUCN category VI).

In terms of proportion, the 341 protected areas represent 14 % of the territory covered by the six forest-rich nations in Central Africa. The highest number of protected areas and largest proportion of national territory covered can be found in Cameroon and CAR. It is however important to note that recreational hunting zones cover large areas in both these countries.

Subtracting the protected areas in IUCN category VI (i.e. recreational hunting zones, hunting reserves and community reserves - all usually containing relatively little forest) the number of protected areas in the sub-region decreases to 188, with a total area covered of approximately 37.7 million ha. For Cameroon and CAR, the number of protected areas is reduced to 106 (4,360,761 ha) and 15 (6,066,115 ha), respectively.

Photo 1.19: The Red-vented Malimbe (Malimbus scutatus) is on the IUCN Red List of Threatened Species.

Table 1.13: Protected areas (IUCN categories I to VI) in Central Africa

Country	Number of protected areas	Area (ha)	Proportion of national territory (%)
Cameroon	174	10,437,336	22
Congo	14	3,513,438	10
CAR	73	17,330,015	28
DRC	50	26,314,330	11
Gabon	17	2,431,367	9
Eq. Guinea	13	590,955	21
Total	**341**	**57,104,003**	**14***

** Proportion of sub-regional territory.*
Source: FORAF, 2008.

Outside the protected areas in category VI, biodiversity management in Central Africa is dominated by 46 national parks covering about 18.8 million ha (table 1.14). National parks make up the bulk of protected areas in countries like Gabon, which has 13 national parks out of 17 protected areas, covering an area of 2.2 million ha out of a total of 2.4 million hectares.

Table 1.14: Distribution of national parks in Central Africa

Country	Number	Area (ha)
Cameroon	15	2,682,407
Congo	3	2,189,161
CAR	5	3,188,700
DRC	7	8,240,000
Gabon	13	2,191,367
Equatorial Guinea	3	303,000
Total	**46**	**18,794,635**

Source: FORAF, 2008.

[6] These figures include recreational hunting zones, and hunting reserves.

Apart from these formally recognized classifications of biodiversity management, populations in Central Africa use forest resources abundantly in daily life to meet nutritional, medicinal, domestic energy and cultural demands. Many non-timber forest products (NTFP) are traded from the local to the international level. Trade in NTFP is largely informal and is poorly monitored by forestry authorities.

Box 1.4: ECOFAC Program

Since 1992, the ECOFAC program has taken part in the conservation and rational use of the forests and ecosystems of Central Africa, cooperating with States and enlisting the participation of local populations. Within the program two fundamental and complementary objectives are closely combined: conservation and sustainable development. ECOFAC cements the European Union's commitment to combat forest degradation and biodiversity loss, while supporting sustainable development in Central Africa.

ECOFAC IV (2007-2010) is the fourth phase of the most important regional environmental program financed by the 9th European Development Fund in Central Africa. It works in 7 of the Central African countries spanning the entire Congo Basin and in 8 protected areas, stretching over nearly 15 million hectares.

For the first time since ECOFAC began, the Democratic Republic of Congo entered the program with the inclusion of Salonga National Park. Salonga National Park (also a World Heritage site) is the largest national forestry park in all of Africa. In DRC, Garamba (in the north) and Virunga National Parks are also receiving ECOFAC support.

Thanks to the support of the three previous program phases, the ECOFAC protected areas (see table below) are gradually becoming management models to sustain over the long-term. Achieving this sustainability is the main priority of ECOFAC IV, even if all protected area managers know the road may be long.

Country	Protected area	Area (km^2)
Cameroon	Biosphere Reserve of Dja	5,260
Congo	Odzala-Kokoua National Park and Sanctuary of the Lossi Gorillas	13,200
Gabon	Lopé National Park	5,360
Equatorial Guinea	Monte Alén National Park	2,000
CAR	Mbaere-Bodingue National Park (Ngotto)	9,000
CAR	Village hunting zones (in northern - CAR)	80,000
Sao Tomé and Principe	Obo Natural Reserve	295
DRC	Salonga, Garamba and Virunga National Parks	Respectively 33,166, 5,112 and 7,769

The ECOFAC program is based around four strategic guiding principles

• Strengthening the capacity of actors

Strengthening of capacity occurs at the local level (officers and technicians in charge of protected areas), at the provincial level (decentralized administrations), centrally (national agencies in charge of protected areas) and at the sub-regional level (international support to Central Africa).

• Institutional support

The support provided to national institutions aims at improving the legal, regulatory and technical framework for managing protected areas and peripheral zones, by incorporating this theme into the sustainable development policy of different sectors.

• Integrated management of protected areas

Protected area management is considered within the framework of «land use planning». It supports the installation of local level consensus-building platforms for multiple stakeholders with the goal of ensuring concerted management of protected areas and development planning in peripheral zones, as well as, the operational and institutional dynamics necessary to sustain this approach.

• Sustainable economic development

Protected areas must contribute to local economic development and to combating poverty in neighboring populations through the expansion of non-timber forest products (sectoral approach) and wildlife opportunities (ecotourism, community hunting, etc), or by developing community forestry and supporting targeted means of improving productivity in agrarian systems.

A regional vision

At the regional level, program coordination and the implementation of national components are carried out:

- Through close partnership with the Network of Protected Areas of Central Africa (RAPAC) to strengthen the regional coordination of protected area management.
- By engaging other donors in dialogues within the framework of the Congo Basin Forest Partnership (CBFP) to support the joint implementation of regional activities, such as the FLEGT action plan in the peripheral zones of protected areas or the identification of additional funding sources.
- By associating with regional institutional mechanisms like the Central African Forest Commission (COMIFAC).
- As much as possible, at official or sub-regional levels, ECOFAC also supports international sustainable financing mechanisms currently in development (carbon marketplaces, REDD and others).

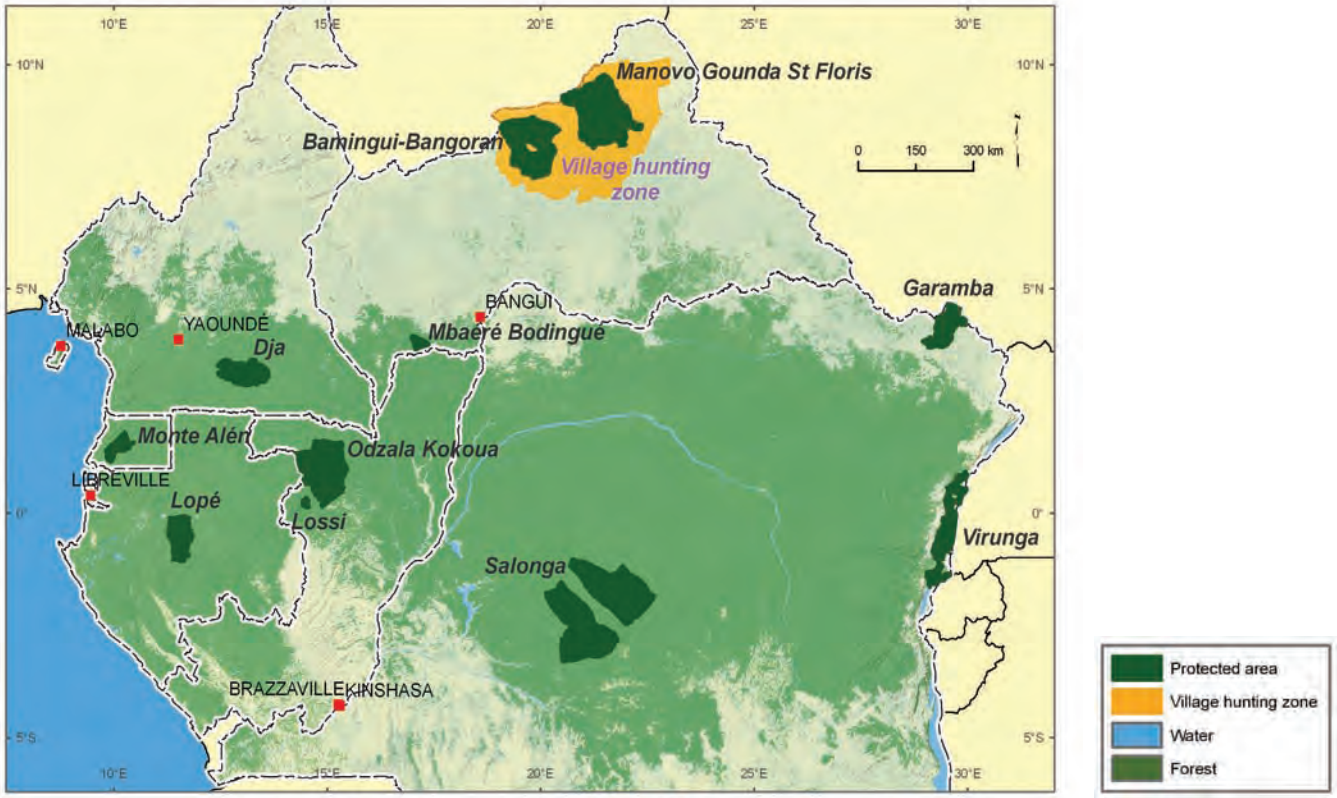
A well mobilized team

Program implementation is supported by a Regional Coordination team based in Libreville (Gabon) and teams in each country, made up of technical support staff for protected areas, 11 international technical assistants and local staff. This staff also receives full support from the national park conservators, wildlife directors, and the ministries and agencies involved.

A Regional Technical Monitoring Committee meets every six months to evaluate the progress of the annual work program and activities, in tandem with the various stakeholders involved in natural resource management in Central Africa.

Contacts: ECOFAC IV Regional Coordination

BP 15 115 Libreville GABON Tel/Fax: (241) 73.34.90 Email: ecofac@ecofac.org web site: www.ecofac.org



Sources: ECOFAC, INC/WCS, INDEFOR, PARPAF, ICCN, WRI, WWF, and FORAF.

Figure 1.8: Intervention sites of ECOFAC IV

Of 314 protected areas, only 10 (covering approximately 2.9 million ha) are managed according to development/management plans approved by the state and adopted for implementation by all stakeholders. Eight of these ten areas are in Cameroon (covering about 2.2 million ha) and two in Gabon (covering 689,748 ha). Among the 10 protected areas with management plans, there are nine national parks and one wildlife reserve (the Dja Reserve in Cameroon also classified as a Biosphere Reserve).

Economic Development of Biodiversity

The economic valorization of biodiversity is mainly through ecotourism and recreational hunting tourism. However, despite the potential offered by the sub-region's exceptional biodiversity, the biodiversity-related tourist sector remains underdeveloped and is poorly monitored by the public administration. For example, apart from Cameroon and CAR (see national summaries of these countries), where recreational hunting zones are formally managed, hunting tourism is neither organized nor monitored in any of the other countries - despite legal provisions to promote this sub-sector.

In Cameroon, it is estimated that biodiversity-related tourism contributed 1.35 % to the balance of trade and provided tax earnings of about € 697,328 in 2007. During the same fiscal year, the biodiversity-related tourism sector directly employed nearly 800 people in CAR and provided tourist revenues estimated at nearly € 1 million, despite the safety issues this country is experiencing. Partial data provided by the ICCN in DRC indicate tax revenues of around € 52,847 in 2007 with tourist revenues of € 22,525 (FORAF, 2008).

Photo 1.20: Mountain gorilla tourism has the potential to be highly profitable.

Conclusion

Central African forests still represent a resource of global significance and remain relatively well preserved. Forest resource management in Central Africa takes place against a background of widespread poverty, but the forest sector has the potential to help reduce poverty not only through sustainable management of forest concessions, but also biodiversity conservation and enhancement activities. To valorize the potential available, forest resource management in Central Africa will have to seize all the opportunities offered by the new approaches to develop biodiversity resources (e.g., carbon and other environmental services) and the associated mechanisms for mobilizing funding.

Since the first report on the state of the forests in Central Africa in 2006, significant progress has been made towards sustainable concession management. These advances come from the implementation of management plans, progress in forest certification and a tendency for greater

involvement of all social strata in managing forest resources and sharing the benefits generated. However, in all sub-regional countries, the impact of these efforts has been undermined by continuing governance problems and an unregulated informal sector with scarce information.

Progress has also been made towards improving the protection of vulnerable species within logging concessions in the sub-region. By extension, this protection has also benefited other species which constitute an important component of these ecosystems. However, more efforts are needed – especially in concessions where no conservation component exists in the management plan (generally part of the certification process), as well as in community-managed areas.

In DRC, it appears that the «syndrome of the empty forest» (Redford, 1992) - or at least the «half-empty forest» (Redford and Feinsinger, 2001) - has become widespread, and a broader and more concerted effort is needed to reverse the biodiversity loss incurred.

To date, there is little economic valuation of biodiversity in the sub-region. This absence of any directly linked economic incentive to conserve biodiversity, often results in a general lack of interest amongst the population to engage in such activities - in the context of a sub-region facing immediate large-scale development demands. In order to mobilize the resources necessary to adequately support conservation and sustainable development of the Congo Basin's forests, improved communication efforts are needed regarding the status of these forest resources, as well as ongoing activities and potential opportunities to implement sustainable management strategies in the sub-region.

CHAPTER 2
The Forests of Cameroon in 2008

Paolo Omar Cerruti, Verina Ingram, Denis Sonwa
With contributions from: Samuel Ebia Ndongo, Jean Avit Kongape, Jean Philippe Foé, Henri Christian Abo Eyafa'a, Alain Jean Jacques Foé, Roger Ngassa, and Antoine Njiang

Introduction: The Macro-Economic and Political Context

Cameroon is a unitary republic that in 1992 introduced a multiparty democracy. In an area of 466,326 km2, including 6,000 km2 of which is water, there is an estimated population of 17.8 million. The population of Cameroon has doubled since 1975 (UNDP, 2008), with a population growth rate of 2.7 % and growing urbanization, estimated at 54 % of the population, putting increased pressure on land. Population density varies significantly across the country. The mostly lowland rainforests of the east (7.5 inhabitants/km^2), the south (12.5 inhabitants/km^2) and the savanna transition zone in Adamawa (12.6 inhabitants/km^2) are sparsely populated, while the more urbanized and mountainous areas in the west (151.7 inhabitants/km^2), the north-west (112.5 inhabitants/km^2), the coastal plains of Littoral Province (105.2 inhabitants/km^2) and the savannas of Far North Province (85.5 inhabitants/km^2) have higher population densities.

Higher population density increases pressure on natural resources in Far North, West, South West and Littoral provinces, which are already characterized by widespread soil degradation. Soil degradation is also classified as a major risk in the northwestern and central provinces. Pressures on forests differ according to forest type. The forests in the north are primarily used for fuelwood and non-timber forest products (NTFP), while the tropical humid forests are also exploited for timber (MINEP/UNDP, 2007). Although 76 % of Cameroon's energy comes from renewable biomass (UNDP, 2008), continuing soil degradation indicates this energy source is unsustainable if used at current rates. Cameroon's economy is based on agriculture and livestock (44 % of GDP), industry (16 %) and services (40 %) (CIA, 2008). Exports are dominated by oil (49.9 %), but cocoa, cotton and wood (6.5 %) also provide significant income. The Gross National Product (GNP) was $ 14,494 million in 2004 (UNDP, 2008). It grew 3.2 % in 2006 and 3.6 % in 2008 (UNDP, 2008). In 2005, GNP *per capita* amounted to $ 2,299; in 2008, it was estimated at $ 1,995 *per capita* (The Economist, 2008). Despite the rapid increase in commodity and oil prices, economic growth in 2008 slowed down due to a decline in trade with the EU, growing competition from countries with low costs, under-application of investment budgets, social problems and a difficult economic environment (The Economist, 2008).

The Human Development Index (HDI) for Cameroon (0.532 in 2007/2008) positions the country in the "medium human development" category, 144th place out of 177. There has been little change in factors influencing the HDI over the past decade: life expectancy is 49.9 years; the rate of population with primary, secondary, or tertiary education is 62 %; and the adult literacy rate is 67.9 % (UNDP, 2008). The poverty line, which was established at CFA 533[7] per day in 1996, was revised upwards to CFA 637 per day in 2001. However, in 2005, 17 % of the population still lived on less than $ 1 per day, 50 % with less than $ 2 per day, and 40 % were under the national poverty line (UNDP, 2008).

Between 1988 and 2000, Cameroon implemented three programs for economic and financial structural adjustment credits with support from the World Bank and the IMF. Of the three programs, the first, in 1981, helped reform forestry and environmental sector law and the third incorporated specific clauses on forest management and logging, including the rationalization of land rights, the benefits for communities, usage rights, taxation systems and public institutions.

In October 2003, Cameroon became eligible for debt relief under the initiative for Highly Indebted Poor Countries (HIPC), and reached the criterion of eligibility in May 2006. It should also be noted that Cameroon's qualification for debt relief under the Multilateral Debt Relief Initiative (MDRI)[8] allowed a 50 % reduction of the total external debt due to the IMF, International Development Association and the African Development Fund (Global Insight, 2007).

[7] 1 Euro = CFA 655,957

[8] The Multilateral Debt Relief Initiative (MDRI) provides for 100 percent relief on eligible debt from three multilateral institutions to a group of low-income countries. The initiative is intended to help them advance toward the United Nations' Millennium Development Goals (MDGs), which are focused on halving poverty by 2015. (http://www.imf.org/external/np/exr/facts/fre/mdrif.htm).

Photo 2.1: The large variety of plant species is reflected in the variety of color and structure in the forest canopy.

The April 2003 Poverty Reduction Strategy Document led to a lending arrangement with the IMF's Poverty Reduction and Growth Facility.[9] This arrangement ended in May 2008 but will be followed by a new instrument of support from the IMF. Governance reform is a major element of all these policies, as Cameroon has consistently ranked poorly on the list of perceived corruption (Transparency International, 2007), despite a campaign against corruption in 2006 and the establishment in 2007 of the Extractive Industries Transparency Initiative.

According to the Ministry of Finance (INS, 2002), the forest sector contributes 6 % to GDP. In addition, this sector generated tax revenues of € 62,101,631 in 2005 and employed around 163,000 people in 2006, with 13,000 employees in the industrial sector (MINFOF, 2008a). The government of Cameroon recognizes that the forestry sector plays an important role in poverty reduction and this sector has been included in the Poverty Reduction Strategy Document[10] (MINFOF, 2008a).

Forest Resources and Land Cover Change since 1990

Forest Areas

Cameroon is triangular in shape and contains a multitude of forest resources. The country is bordered by Lake Chad in the north; by Chad and CAR to the east; by the Republic of Congo, Gabon and Equatorial Guinea to the south; and by the Atlantic Ocean and Nigeria to the west.

The country covers two major climatic areas, the humid equatorial area to the south and the dry area to the north (Neba, 1987). The equatorial humid climate area is located between the second and sixth degrees of latitude north and has two variants. The first variant, the Guinean type, is characterized by abundant rainfall (1,500 to 2,000 mm), a high consistent temperature (25 degrees Celsius) and four seasons (two dry and two rainy). The second variant is the Cameroon type in the south and south-east of the country. It is characterized by heavy rainfall during one season lasting nine months. The dry/tropical climatic domain also has two variants. The humid tropical climate, or Sudano climate, is characterized by five months of dry season and is between the sixth and tenth parallel north. The Sahel tropical climate covers the basin of the Benue, the plain of Mayo Danay and the Diamare. It extends to Mount Mandara and is characterized by a dry season lasting seven months.

A non-negligible part of these forest resources are covered by agro-industry (e.g., Hevea) and agro-forestry (cocoa), which covers 400,000 ha of land in Cameroon (Losch *et al.*, 1991).

Table 2.1: Forested area of Cameroon by land cover category

Land cover	Area (ha)
Lowland dense forest	16,467,570
Sub-montane forests (900-1,500 m)	270,540
Mountane forest (>1,500 m)	17,685
Swamp forest	0
Mangrove	120,348
Total dense forests	**16,876,143**
Forest-cropland mosaic	4,501,395
Forest-savanna mosaic	5,867,865
Dense deciduous forest (Miombo)	105,984
Other plant formations	14,066,352
Cultivated land	4,873,077
Other land uses (town, villages, industrial sites…)	341,766
Total	**46,632,582**

Source: compilation of land cover data produced by UCL, JRC and SDSU.

[9] The Poverty Reduction, and Growth Facility (PRGF) is the IMF's low-interest lending facility for low-income countries. PRGF-supported programs are underpinned by comprehensive country-owned poverty reduction strategies. (http://www.imf.org/external/np/exr/facts/prgf.htm)

[10] Poverty Reduction Strategy Papers (PRSP) are prepared by governments in low-income countries through a participatory process involving domestic stakeholders, and external development partners, including the IMF and the World Bank. A PRSP describes the macroeconomic, structural and social policies and programs that a country will pursue over several years to promote broad-based growth and reduce poverty, as well as external financing needs and associated financing sources (http://www.imf.org/external/np/exr/facts/fre/prspf.htm).

A recent study of deforestation in Central Africa (Duveiller *et al.*, 2008) estimated that from 1990 to 2000, the net rate of deforestation in Cameroon was 0.14 %, net deforestation being the difference between the average gross deforestation (0.20 %) and gross reforestation (0.06 %). The same study estimates the net rate of forest degradation in Cameroon as 0.01 %. Although this rate of deforestation puts Cameroon in second place after DRC in the Congo Basin, it generally remains low, as does the average rate of deforestation in the Congo Basin.

This rate of deforestation is very different from the FAO estimate for Cameroon, which assigns a rate of deforestation of 1 % (FAO, 2007). This difference is mainly due to the fact that the work of Duveiller *et al.* only takes into consideration the dense forest areas of Cameroon (mainly in the south and east), which are very sparsely populated (7 to 13 inhabitants per km²), while FAO takes into account the whole national territory including all woody vegetation (savanna, suburban forest and forest-savanna mosaics). Also, the forest-savanna transition mountainous zones have densities sometimes exceeding 150 inhabitants per km² (see above), with a very active farming sector and a far higher rate of deforestation than in dense forest areas.

The prime factor leading to the loss of forest cover is agriculture, which accounts for more than 80 % of forest cover loss in Cameroon (CARPE, 2005). This includes not only slash-and-burn shifting cultivation, long recognized as a key driver of deforestation in areas of dense forest (Ndoye and Kaimowitz, 2000), but also cash crops, most notably cocoa. The cocoa crop has been promoted by the state from independence up to the 1980s with considerable impact on forest integrity in Cameroon (World Bank, 2008). After cocoa crop cultivation ran out of steam in the 1990s, Cameroon revitalized the program in 2005 to extend cocoa crops at the expense of forests. Fuelwood harvesting, which is often linked to agriculture and associated population increase also poses a threat to forest integrity.

Another important factor causing forest loss and degradation in Cameroon is illegal forest logging to produce timber, which takes place mainly in the informal sector. Indeed, Cerruti and Tacconi (2006) considered that informal logging removes approximately 540,000 cubic meters of wood annually without state supervision or monitoring. Uncontrolled illegal logging on such a scale without planned infrastructure will clearly have negative impacts on forest cover.

Mining represents a final emerging factor which may have a growing negative impact on the forest sector. From independence through 2000, mining contributed only marginally to Cameroon's economy, despite existing evidence of minerals. Since the beginning of this decade, there has been growing interest in the mineral resources of Cameroon, especially from US and Chinese companies, which will require the creation of major transport infrastructure covering hundreds even thousands of kilometers in dense forest areas. Already, Geovic, a US-based mining company has mining permits inside the permanent forest domain of Eastern Province.

In contrast, a number of developments since 2000 have had favorable impacts for the stabilization of forest cover in dense forest areas of Cameroon. A World Bank report (2008) states "changes in the dimensions and types of forest... new protected areas, forests and hunting areas have been established and are rapidly expanding." A report from a German Technical Cooperation (GTZ) project noted that "while the total forest area decreased, it appears that the establishment of permanent forests in 1994 and better controls over the past few years have produced a positive effect from 2003... Between 2002 and 2005 the decreasing trend in forest area has slowed down" (GTZ-MINFOF, 2006). Thus, the adoption of a land use plan in Cameroon and the implementation efforts underway have helped stabilize forest cover.

Photo 2.2: For the transportation of logs, rivers can be obstacles or a means of transportation.

Legal and Institutional Framework for Managing Biodiversity Resources

Legal Framework

The State is the main body in charge of forest management in Cameroon as it defines the general policy of the forestry sector and laws, and grants logging rights. The previously existing law on environmental management (1981) has been reformed comprehensively by two laws, one in 1994[11] and the other in 1996,[12] which define the new legal framework for environmental management.

These laws, combined with a series of implementing measures developed since 1996, define access to forest resources, including customary rights for traditional and aboriginal users, forest areas, the system of title allocation, sustainable logging practices, taxation, protection and management of flora and wildlife, and the institutional framework.

The purpose of restructuring the legal framework was to convert the forest sector into a crucial sector for poverty reduction and a major source for industrialization and exports from Cameroon. During the past two years, amendments have been made to allow laws to address conflicting issues such as the reclassification of protected fauna,[13] the forestry system,[14] the classification of special forest products[15] and small-scale forest logging permits.[16] The forest logging regime in Cameroon currently recognizes nine different logging titles (see table 2.3).

The distinction between the permanent and non-permanent forest estate is made for the time being by a legal framework still under revision, including, among others, a land tenure law (1979),[17] a decree on land use (1995),[18] and the Forest Act of 1994. The area of permanent forest domain maintains the forest and/or wildlife habitat permanently, while the non-permanent forest domain is made up of forest land which can be used for multiple other purposes. Under article 22 of the 1994 Act, the permanent forest estate should cover at least 30 % of national territory and represent the ecological diversity of the country. The different types of forests included in the permanent and non-permanent forest areas are listed in table 2.2.

Table 2.2: Area cover by forest type according to the official classification of the zoning plan in cameroon

Forest type	Total area (ha)	Value relative to the total forest area (%)
Production forests	7,574,280	34
Protection, recreational, educational and research forests, reforestation perimeter, natural ecological reserves	931,398	4
Botanical gardens	44	
National parks	2,682,407	12
Wildlife reserves	702,995	3
Hunting zones	5,465,467	24
Zoological gardens belonging to the State	8	
Wildlife sanctuaries	254,342	1
Council forests	437,354	2
National forest domain	4,475,437	20
Total	**22,523,732**	**100**

Note: the national forest domain belongs to the non-permanent forest domain and can be converted into other land use types.
Source: MINFOF, 2008c.

The permanent area includes forests that are classified and those which are going to be classified. These include production forests and protection forests in the public or private domain. Protection forests include protected areas, for which there are eight levels of protection. Four of the category levels – reserves, biospheres, national parks and botanic gardens – allow research,

[11] Law N° 94/01 of 20 January 1994 on Forestry, Wildlife and Fisheries.
[12] Law N°96/12 of 5 August 1996 relating to Environmental Protection.
[13] Decree N°0648/MINFOF of 18 December 2006 establishing the list of animals in protection categories A, B and C, and Decree N°0649/MINFOF of 18 December 2006 describing the distribution of animal species whose killing is authorized as well as the latitude of killing per type of sports hunting permit.
[14] Decree N°2006/ 0129/PM of 27 January 2006 modifying and completing some provisions of decree N°95/531/PM of 23 August 1995 establishing the modalities for implementing the forest regime, and Decree N°2007/0342/PM of 7 March 2007 modifying and completing some provisions of decree N° 95/531/PM of 23 August 1995 establishing modalities for implementing the forest regime.
[15] Decision N°0336/D/MINFOF of 6 July 2006 establishing the list of special forest products of particular interest to Cameroon.
[16] Circular N°0131/LC/MINFOF/SG/DF/SDAFF/SN of 20 March 2006 relating to the procedures for issuing and monitoring small-scale logging permits.
[17] Law N° 79/05 of 29 June 1979 pertaining to the land and estate regime.
[18] Decree N°95-678 PM of 18 December 1995 instituting the land use reference framework.

(eco) tourism and education but not logging. The other types of protected areas, wildlife reserves, forest reserves and forest and marine sanctuaries, exclude hunting and fishing operations. The permanent domain also includes community forests that are in the private domain of a municipality. The new decentralization laws of July 2004,[19] which *inter alia* concern communal environmental action plans, forest regeneration actions and the possibility of creating municipal forests, will have an impact on the management of the environment and forests both at the provincial and local levels.

The non-permanent forest (also called "agroforestry zones") includes community forests. These forests with an area of up 5,000 ha, and for which a community develops and agrees on a management plan for development in collaboration with the Ministry of Forestry and Wildlife (MINFOF) for a maximum period of 15 years, give communities access and logging rights and oblige participatory management of forest resources in and around villages. Other forests in the national domain (including private forests) can be allocated to other uses and are managed to benefit local communities or private individuals.

Cameroon has signed most bilateral and multilateral conventions and agreements applicable to the forestry and environmental sector. It ratified the 1971 Convention on Wetlands of International Importance and identified a number of Ramsar sites in 2006. Cameroon has also been a signatory of the *Commission des Forêts d'Afrique centrale* (COMIFAC) since 2005.

Photo 2.3: Undergrowth along the ascent of Mount Cameroon.

Institutions and Capacity

MINFOF is the main institution responsible for the sustainable management of forests and wildlife. It includes 870 employees, 30 % of them with college degrees. The Ministry was created in 2004 together with the Ministry of Environment and Protection of Nature (MINEP), both stemming from the Ministry of Environment and Forests (MINEF), which was established in 1992. The National Agency for Forest Development (ANAFOR), which replaced ONADEF in 2001, aims at supporting forest regeneration. The main ministry policy is defined in the Forest Environment Sector Plan (PSFE). This program was finalized with support from international partners in 2003 and has been operational since 2004. This program is supported by: 1) government funds (in 2007, CFA 5.2 billion); 2) financial support from the World Bank, GEF, the International Development Association and the United Kingdom through a mechanism for direct budget support to the Ministry of Finance (in 2007, CFA 6.4 billion); 3) contributions from the HIPC initiative (for the RIGC project[20]); and 4) a common fund financed and managed by international donors. PSFE also serves as a guide for local and international NGOs as well as for bilateral partner activity (MINFOF, 2008a).

There is still no final report describing the degree of involvement, nor the budget level, of civil society, the private sector, research institutions and the media in the establishment of the PSFE. However, the implementation of a few initiatives in 2006 to broaden participation of stakeholders in PSFE, such as the Facility for Forest Governance and the multi-party parliamentary group for conservation, suggest that involvement generally remains low.

In 1994, two special funds were created: the Special Fund for Forestry Development (FSDF) to fund the management, conservation, restoration and development of forest resources; and the Special Fund for Wildlife (FSF) to support management and equipment of protected areas and wildlife conservation.

Since 2006, the institutional reforms under the PSFE included the recruitment of 1,550 new employees to replace the aging workforce and to enhance its quality and capacity for innovation. These reforms were complemented by anticorruption initiatives and by a capacity-building program for employees through the development of a strategy to link the PSFE and research organizations. The National Program for Environmental

[19] Law N° 2004/017 of 22 July 2004 on Orientation and Decentralization; Law N° 2004/018 of 22 July 2004 establishing the rules that apply to communes; Law N° 2004/019 of 22 July 2004 establishing the rules that apply to regions.

[20] Project to enhance community management initiatives on forest and wildlife resources

Management, adopted in 1996, implemented by MINEP and for which a review process was initiated in December 2006 (MINEP/UNEP/APREN, 2006), forms a complementary policy to PSFE.

Regional institutions have played an increasingly important role in the national forest sector, focusing particularly on harmonizing laws and establishing standards for information exchange. Cameroon hosts the COMIFAC Secretariat, plays an active role in the Congo Basin Forest Partnership (CBFP), and is a member of the Conference on the Ecosystems of Forests and Wetlands of Central Africa (CEFDHAC), an initiative launched in 1998 and supported by IUCN.

A number of institutions are dedicated to providing the necessary academic and professional training for the forestry sector. The *École nationale des Eaux et Forêts* (ENEF), based in Mbalamayo and established in 1949, offers professional training in forestry management for students, most of whom will go on to become civil servants. The *École de Faune* in Garoua, established in 1970, provides a similar education but focuses on wildlife management. The Universities of Buea (Environmental Science), Dschang (FASA-DEPFOR, CRESA, Faculty of Science), Yaoundé I (Faculty of Science), Yaoundé II (Faculty of Economics), Douala, the Catholic University of Central Africa and Ngaoundéré all offer programs from undergraduate to doctoral levels, in fields linked to the forest sector such as the environment, politics, economics and agroforestry. Polytechnic institutions specializing in technical aspects of forestry, such as CRESA and technical schools, also provide practical training.

The research sector falls under the authority of the Ministry of Scientific Research and Innovation (MINRESI) and is largely driven by the Institute of Agricultural Research for Development (IRAD), with programs covering ecosystems, wildlife, flora, land, forestry, and agroforestry. Other institutions whose activities are relevant to forestry, with programs such as anthropology, sociology, hydrology, ecology, mapping, or health, include the Institute of Medical Research and Medicinal Plants (IMPM), the *Institut de Recherche pour le Développement* (IRD), and the *Institut national de la Cartographie* (INC).

In general, national educational institutions lack capacity and resources for research and training. The results of their research are poorly valorized and research programs are insufficiently tailored to the priorities of the sector. International organizations such as CIFOR, ICRAF, CIRAD and Tropenbos are also active in Cameroon. A review of potential links between academic and research institutions has identified practical ways to involve the educational sector in the PSFE strategy so that research focuses on collaboratively preidentified PSFE priorities and assures better, more formalized and more institutionalized coordination among stakeholders (MINFOF, 2008b).

Forest Logging and the Timber Sector

Typology of Forestry Titles

In 2008, nine different types of forest title (table 2.3) could be granted by the Ministry of Forests.

Table 2.3: Types of forest title

1	Harvesting permit for timber
2	Harvesting permit for special products
3	Harvesting permit for firewood and poles
4	Personal harvesting authorization
5	Timber recovery permit (timber salvage authorization and timber removal authorization)
6	Community forest
7	Sales of standing volume
8	Council forest
9	Timber concession

Source: compiled by the authors, based on the 1994 Act pertaining to Forestry, Wildlife and Fisheries.

Under the 1994 Act, logging permits (types 1, 2, 3) are permits to operate or to collect well-defined quantities of forest products in a given area. These products may be special products, volumes of raw timber not in excess of 500 m³, or firewood and poles extracted for profit. Operating permits for timber and some special forest products on a list drawn up by the forestry authority are granted after notice from a competent committee for a maximum period of one year non-renewable. For other special forest products, firewood and poles, logging permits are awarded by mutual agreement by the Minister of Forests.

A personal harvesting authorization (type 4) is an authorization issued to an individual for personal and non-profit use to collect wood volumes that cannot exceed 30 m³ gross. This provision does not apply to forest residents who retain their customary rights. The personal harvesting authorization is granted by mutual agreement for a period of three months non-renewable.

Timber recovery permits (type 5) may be issued as part of a development project likely to cause disruption or destruction in a forest. These permits are only issued after a prior environmental impact assessment has been conducted by the applicant in compliance with norms set by the environmental authority.

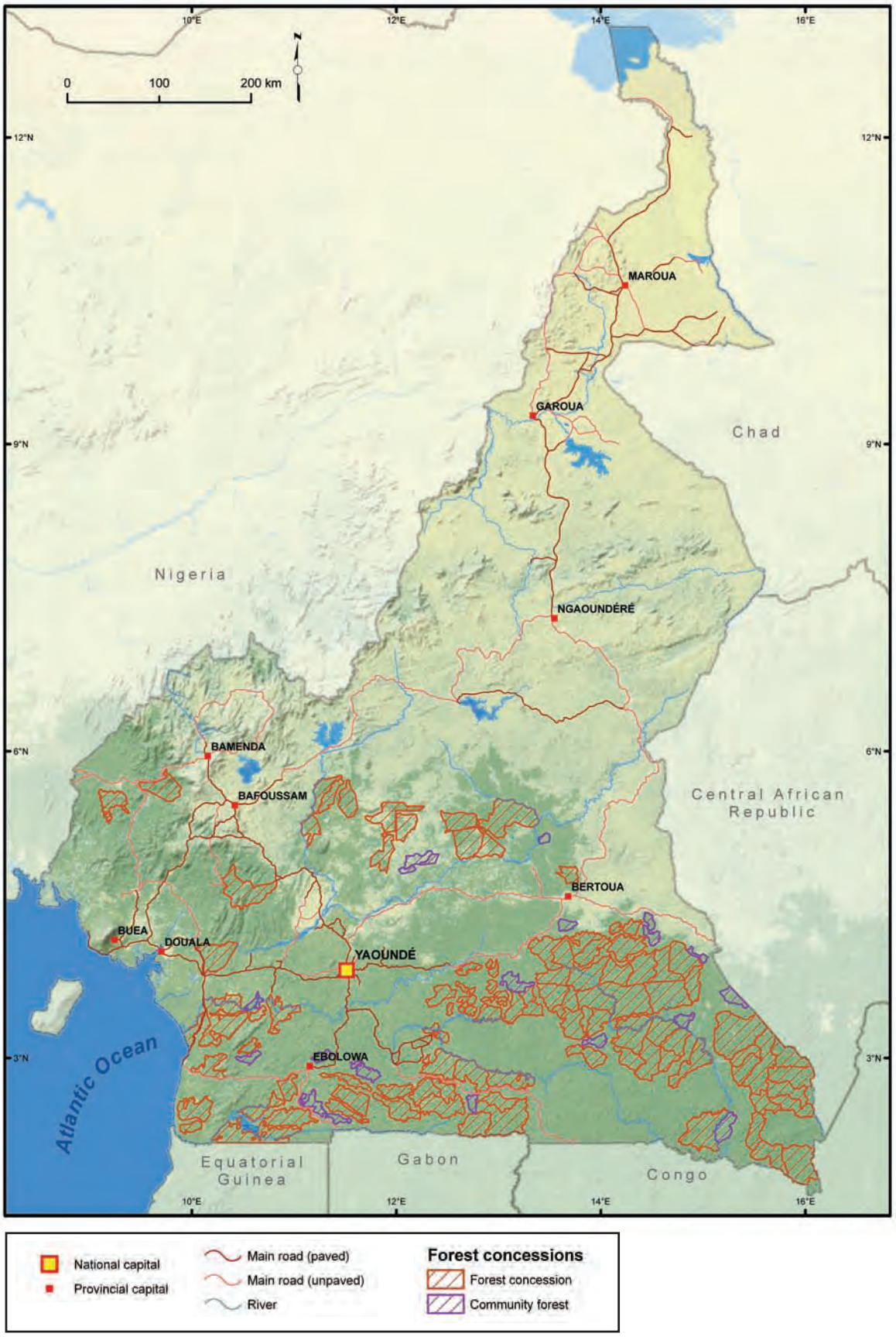
Community forests (type 6) are granted for a maximum area of 5,000 ha. Logging takes place on behalf of the community--by local government control *("en régie")*-- by sales of felled timber, by personal logging authorization or by permit, in accordance with a simple management plan approved by the forest authority. Any community wishing to manage a community forest must hold a consultation meeting, including all stakeholders from that community, to designate a management officer and to define the objectives and limits of that forest.

Under the 1994 Act, sales of standing volume (type 7) in a national forest area is a license to log in an area that does not exceed 2,500 ha or a specified volume of standing timber for sale. Any allocation of sales of standing volume in a forest domain must be preceded by a public call for tender. Sales of standing volume are allocated based on a notification from a relevant committee, for a maximum period of three years non-renewable.

Council forests (type 8) have a management plan approved by the forestry authority. The management plan is established at the behest of the heads of municipalities, and any activity must comply with it. Forest products of any kind resulting from operations in council forests belong exclusively to the municipality.

Timber concessions (type 9) are assigned after notification from an Inter-ministerial Committee, and following a public call for tender. The concessions belonging to one company may not exceed a total area of 200,000 ha. Once the concession is attributed, the company signs a provisional agreement for a 3-year concession contract during which a plan for the sustainable management of the concession must be prepared by the company and approved by the Forestry Administration. Concessions are granted for a period of 15 years renewable.

Photo 2.4: Sawmill for salvaged wood.



Source: WRI and FORAF.

Figure 2.1: Forest concessions in Cameroon

Formal Logging in Natural Forests

In 2006, total national production reached 2,296,254 m³. The most exploited species are listed in table 2.4.

The various logging titles (table 2.3) contribute differently to the total annual production. According to the national land use plan, the total area planned for Forest Management Units (FMU) is about six million hectares. However, active logging is only taking place in Annual Cutting Areas (AACs) established by the Ministry. In 2007, only 91 AACs were active, covering an area of approximately 248,000 ha. In 2006, FMUs produced approximately 1.7 million m³. In addition to the FMUs, council forests, sales of standing volume and timber recovery permits produced 210,000 m³, 275,000 m³ and 155,000 m³ of timber, respectively. The same year, ten companies[21] produced an estimated 829,000 m³ of wood by using these logging titles, i.e. about 36 % of the total annual production of about 2.3 million m³.

In 2008, six council forests, covering an area of about 141,000 ha were allocated. Four of them are logging timber through an approved management plan for a total area of 110,000 ha. The same year, 177 community forests were allocated (for an area of 632,000 ha), and 143 of these forests had an approved simple management plan, covering an area of 546,000 ha. No data were available on the contribution of community forests to the national timber production. In 2008, timber recovery permits covered an area of 38,000 ha.

In 2007, 2,859 ha of plantations were established (by ANAFOR, a few NGOs and some private organizations) bringing the total area of forest plantations in Cameroon to 17,133 ha.

The same year, a total volume of 968,490 m³ was exported from the port of Douala. Logs accounted for 266,000 m³ of exports, sawn timber for 613,000 m³ and veneer and plywood for 89,490 m³. On the whole, sawn timber exports grew compared to 2006 (601,000 m³), but remained lower than in 2005 (660,000 m³). On the other hand, log exports dropped in 2007 compared to 2006 (316,000 m³), but are much higher than exports in 2005 (146,000 m³).

Table 2.4: The ten most logged species in the formal sector in Cameroon in 2006

Species	Percentage
1: Ayous/obéché	34.84
2: Sapelli	16.43
3: Tali	6.96
4: Azobé/bongossi	5.11
5: Iroko	3.9
6: Okan/adoum	3.82
7: Fraké/limba	3.77
8: Movingui	2.22
9: Kossipo/kosipo	1.98
10: Red padouk	1.97

Source: MINFOF, 2008c.

As for special products, in 2006, around 2,378,808 kg were exported. These exports are divided into 1,059,080 kg of pygeum, 566,980 kg of ebony, 377,295 kg of yohimbe, 356,663 kg of voacanga and around 18,000 kg of coal.

The European Union remains the preferred partner for exports of processed products (sawn timber, veneer and plywood), importing in 2007 81 % of exported products from Cameroon. On the other hand, 77 % of log exports from Cameroon go to countries other than the European Union, mainly China.

Industrial Timber Processing

In 2007, 51 industrial mills were active plus 9 veneer and plywood units. Total processing capacity was estimated at around 2.2 million m³ in 2007. Cameroon has enforced a partial embargo on log exports since 1999 in order to increase the share of national production processed locally. Since 1999, only a few species can be exported in the form of logs, and for some of them, such as ayous, annual quotas are established and granted to logging companies.

[21] GRUMCAM, Pallisco, STBK, CFC, CUF, SEFAC, GWZ, CIBC, SIBAF and SFID, in diminishing order of production.

Informal Sector

According to the grey literature, informal timber production in Cameroon, i.e. production without logging title or with unrecorded logging titles in official statistics by national artisanal loggers, amounts to about 1 million m³ (see e.g., Plouvier *et al.*, 2002).[22] Unfortunately, despite the importance in terms of the volume produced and the impact of this sector on employment and local standards of living, the domestic timber market is not yet formally regulated.

Progress Towards the Sustainable Management of Production Forests

In 2008, 65 concessions had an approved management plan, covering an area of 4,207,862 ha, while 38 concessions, covering 1,866,171 ha, were in the process of preparing their plans. FSC certificates were awarded to 13 concessions as of October 2008, covering an area of about 900,000 ha. Finally, 14 concessions have received an OLB certificate and 7 concessions have been granted a TLTV certificate for an area of about 1.7 million ha.

As the law requires management plans to be reviewed every five years, management plans that have been approved in the past will be re-assessed and likely revised.[23] Since all the FMUs were allocated in 2006, in the short term (3 to 5 years), all logging should be occurring under approved management plans.

It is difficult to predict future trends for forest certification given that the process may be affected by the recent financial and economic crises' impacts on logging companies. Many companies operating in Cameroon were already very advanced in the process in mid-2008, and should be able to achieve FSC certification shortly, but the crisis could negatively impact these companies because they still need to make substantial investments before being ready for FSC certification.

Since 2001, international NGOs have also played a critical role as "independent observers" during the formulating of different forest policies. WRI is assisting the government in monitoring and mapping forest titles and protected areas, as well as for the monitoring and mapping of activities linked to forest activities such as road construction. The British NGO, Resource Extraction Monitoring (REM), and before them Global Witness, works with MINFOF provincial and national brigades to monitor forest activities on the ground. The reports from these missions on the ground are widely distributed. Finally, the role of international partners in the policy dialogue in the framework of PSFE was institutionalized and harmonized by the signing in January 2006 of a code of conduct between MINFOF and 13 NGO partners.

Under the Action Plan on Forest Law Enforcement, Governance and Trade (FLEGT), Cameroon and the EU signed a declaration in September 2007, which should lead to negotiations towards a voluntary partnership agreement to regulate timber trade exchange between Cameroon and the EU. Texts are being developed to incorporate a system of traceability and verification of legal timber and to monitor related tax revenues.

Photo 2.5: The Red-Eared Guenon (Cercopithecus erythrotis), found in low altitude dense humid forests.

Biodiversity Conservation and Development

Biodiversity Components in Cameroon

Cameroon has a considerable diversity of flora, fauna and important ecosystems maintained by a network of protected areas, covering 18.24 % of the country. Protected areas in Cameroon cover tropical forests, dry forests and forest-savanna mosaic. Some wildlife species such as lion, chimpanzee, gorilla, elephant, bongo, and certain species of flora as such as assamela, ebony, the doussie red, sapelli and ayous are explicitly protected by various MINFOF decisions.

If assamela and ebony are fully protected throughout the territory, a license is needed for their extraction. Logging of species such as sapelli and doussie depends on management inventory results to guide their potential exploitation. In general, 90 % of animal species, over 95 % of plant species, about 65 % of habitats and 80 % of ecosystems are represented in this network of protected areas (MINFOF, 2008c).

[22] In 2009, a study in progress, led by CIFOR in collaboration with MINFOF, will provide new estimates of the volumes of wood used by the domestic market.

[23] A recent assessment of management plans in Cameroon showed that their quality is still unsatisfactory (Vandenhaute and Doucet, 2006; Cerutti *et al.,* 2008).

The variety of terrain and climate give the country a rich and varied vegetation. There are four major ecosystems (Alpert, 1993):

- dense forest (semi-evergreen or deciduous), divided into 3 main variants: the coastal forest, located in the often-flooded lowlands; the Atlantic forest located between 200 and 900 m altitude; and semi-deciduous forests in the interior (Sayer *et al.*, 1992);

- "humid" savannas, with variations as a function of human pressure;

- altitude forests and grasslands, divided into sub-montane forest (200-900 m), mountain forest (900-3,000 m) and the Afro-subalpine grassland (higher than 3,000 m);

- the northern savannas which include the Sudano-Guinean tree and shrub savannas, wooded savanna and medio-Sudano dry woodlands, and the Sudano-Sahel wooded savanna.

Formal Management of Biodiversity

The protected area system in Cameroon contains 15 national parks covering a total of 2,682,407 ha. This system also contains 6 game reserves, 1 botanical garden, 3 zoological gardens, 4 wildlife sanctuaries and 77 forest reserves. Table 2.5 presents the main forms of formal biodiversity management, as well as total areas, in the permanent domain.

Table 2.5: Main forms of biodiversity protection

Type of protection	IUCN category	Number	Area (ha)
National park	II	15	2,682,407
Wildlife reserve	Ib	6	702,995
Botanical garden	Ia	1	44
Zoological garden	Ia	3	8
Wildlife sanctuary	III	4	94,811
Forest reserve	Ia	77	880,496
ZICGC	VI	22	1,396,382
ZIC	VI	46	4,680,193
Total		**174**	**10,437,336**

Source: MINFOF, 2008c.

From 1988 to 1998, the national system of protected areas remained fixed (Doumenge *et al.*, 2001). More recently it underwent a change with the addition of Ma'an and Mbam and Djerem.

In terms of protected area monitoring and control, according to the UCLB-MINFOF annual report (MINFOF, 2007), 1,484 incidents took place in 2007, resulting in 19 legal actions. In the same year, 302 guns, traps and ammunition, and 22,400 kg of meat were seized.

Efforts are underway to provide protected areas with management plans. As of January 2008, the protected areas of Benue, Dja, Mbam and Djerem, Waza, Korup, Campo Maan, Lobéké and Faro had management plans for a total area of 2,230,430 ha (table 2.6).

Table 2.6: Protected areas with management plans by category

Protected area	Category	Area (ha)	Year when the management plan was adopted
Benue	National park	180,000	2002
Dja Biosphere Reserve	Wildlife reserve	526,000	2007
Mbam and Djerem	National park	416,512	2007
Waza	National park	170,000	1997
Korup	National park	126,000	2002
Campo Ma'an	National park	264,064	2006
Lobéké	National park	217,854	2006
Faro	National park	330,000	2008
Total		**2,230,430**	

Source: MINFOF, 2008c.

To manage protected areas, the government of Cameroon allocated € 2,355,000 in 2008 and employs 376 senior managers and 391 technicians. In addition, many NGOs (e.g., WWF, WCS), and bi/multilateral structures (e.g., GTZ) also deploy human and material resources to assist the State in its conservation efforts. The GEF budget, for example, is € 2,203,300. Partner support in protected areas in terms of budget assistance is € 325,457 while the budget allocated by conservation partners under the common PSFE fund is € 2,493,902.

The Cameroonian government is also concerned about protecting natural resources located outside protected areas. In forest concessions, measures are taken to protect flora species such as mukulungu, bassam mahogany, white padouk, the ovengkol/bubinga and parallel naga. The conservation status of these species varies from one concession to the next as a function of the results of management inventories done prior to logging operations.

Hunting laws and regulations cover the entire country and protect some wildlife species such as the elephant, the lion, the python, the gorilla and the chimpanzee in forest concessions. Despite these measures, poaching to provide food for employees and for commercial purposes still occurs in logging concessions. Threats to plant resources mainly involve non-compliance with the list of non-harvestable species, the failure to respect certain minimum diameters, and non compliance with AACs.

Economic Development of Biodiversity

The ecological and cultural diversity of the country is an asset for tourism in Cameroon. Tourism could be a means to develop the forest sector outside of timber, wood crafts and NTFP. Even though Cameroon is trying to valorize biodiversity, specific and ecosystemic, through ecotourism, this sector is still under-developed. In 2007, tourism revenues, i.e. ecotourism in protected and hunting areas, amounted to € 297,260. According to INS (2006), the country has only 19 tourist sites, including 15 parks, 3 zoos and 1 botanical garden as mentioned in table 2.5. The 2006 INS yearbook also indicates that although some protected areas are visited by tourists (e.g., Dja Biosphere Reserve and a future marine park at Kribi), there is a lack of adequate structures to valorize their resources. In 2008, 20 protected areas had information centers. Following a MINFOF decision of 5 September 2007, 5,465,467 ha were designated as hunting zones (ZICA).These ZICAs correspond to 45 hunting zones, covering 4,069,085 ha, and 22 hunting zones under community management, covering 1,396,382 ha.

In 2007, the country granted 606 hunting permits, in contrast to 244 permits in the previous year. The main wildlife resources in these ZICA are bongos, elephants, buffalos, sitatungas, giant forest hogs and yellow-backed and black dorsal striped duikers. Despite efforts to organize hunting and to valorize the genetic resources through recreational hunting, some illegal behavior, not necessarily by tourists, took place in hunting areas. In 2007, monitoring and control in ZICA and ZICGCs recorded 995 offenses, which resulted in 62 legal actions.

Source: WRI and FORAF.
Figure 2.2: Protected areas in Cameroon

Conclusions

Since the early 1990s, Cameroon has outpaced other Congo Basin countries in developing, adopting and implementing a legal and environmentally progressive forest framework. The most innovative concepts introduced by the Forest Act of 1994, in which sustainable forest management plays a major role, include: 1) the auction, with the participation of independent observers, for the granting of forest concessions in place since 2000; 2) the redistribution of forest taxes to municipalities and rural communities bordering the forest concessions; and 3) the concept of council and community forests. All these novel concepts have not been established at the same pace or with the same success rate, but the ministry's efforts, often supported by national and international partners, have yielded good results in the forestry sector. MINFOF recently admitted that the changes that were made to the forestry sector during the last 15 years had been so broad and vast that it would probably be better to revise and update the 1994 Act completely. The ministry made this task part of its priority agenda for 2009. Until the revision of this Act takes place, the main challenges lie in the continued enforcement of laws and the participation of non-governmental stakeholders in the forestry sector, particularly at local and community level. In 2006, all logging concessions available had been allocated at least once, and in 2008 more than 60 % of the available concessions had an approved management plan. However, the quality of these plans leaves much to be desired. The forest certification process, including FSC, is well underway with certificates awarded to 13 concessions as of October 2008, and other concessions engaged in the process. Log production stabilized over the period 2000-2007 to about 2 million m^3, while log exports were overtaken by exports of processed products after a partial embargo on log exports came into force in 1999. Some species continue to dominate both exports and production (51 % of total production in 2006 consists of only two species, the ayous and sapelli), but there are positive signs that lesser known species, such as okan, are being used. Regarding the adoption of forest management plans and sustainable management of forests, we should mention that recently several mining concessions were awarded in areas already allocated to logging concessions. If communication and data exchange are not maintained between the ministries involved, the mining permits will not only have a negative impact on the forest activities proposed in the management plans but will also create conflicts among the parties involved, both in the public and private sectors.

The will to increase the area covered by protected areas is openly acknowledged by the ministry. The challenge is to make this commitment an operational reality with stakeholders who have an interest in and around protected areas. It is also necessary to find synergies between protected areas and other emerging issues, such as payments for environmental services, in such a way that the interests of the populations can be taken into account. New activities, such as REDD, should constitute an important opportunity for conservation and climate change issues in the country.

The forest-environment sector program has recently experienced some difficulties, especially in terms of spending the allotted budget and implementing and coordinating activities. However, it remains an organic framework which will be gradually adjusted and used to plan the activities of forestry and environmental stakeholders in a strategic, coordinated and participatory fashion.

CHAPTER 3
The Forests of Gabon in 2008

Jean François Chevalier
With contributions from: Viviane Nguema Magnagna and Assoumou Solange

Introduction: The Macro-Economic and Political Context

Gabon covers 262,090 km².

In 2005 Gabon was reported to have 1.3 million inhabitants (UNDP, 2007; UNPP, 2008), giving an average population density of five inhabitants/km². For the period 2005 to 2010, the average rate of demographic growth was estimated at 1.48 %. There is strong disparity between the rural environment, which is lightly populated and the urban zones, where most of the population is based (85 % of the total). Urban population is currently growing at a rate of 2.2 %.

The population is mainly young with 56.7 % under 25 years old in 2005 (UNPP, 2008).

The rural zones are sparsely populated and traditional agriculture as well as agro-industry are under-developed. The population ratio per hectare of arable and cultivated land is 0.9 (UNFPA, 2008). This figure is the lowest in Central Africa (with an average of 2.02 for the Congo Basin countries). Cropped areas represent about 5 % of national surface area (Nasi *et al.*, 2006).

Gabon has dense forest covering some 21.09 million ha, more than 80 % of the national territory (Mayaux *et al.*, 2004). This coupled with low population density results in Gabon having the highest rate of forest surface *per capita* in Africa. Between 1990 and 2005, the recorded loss of forest surfaces remained very limited, 0.15 million hectare (less than 1 %) (UNDP, 2007).

The gross domestic product (GDP) of Gabon is $ 8,100 million resulting in a *per capita* GDP of $ 5,821 (UNDP, 2007). Natural resource exploitation is the cornerstone of the Gabonese economy: oil, forests and mining make up half of the GDP. The oil sector alone accounts for 42.4 % of GDP. The forest sector is in second place (6.0 %) followed by mining (1.9 %) (Nasi *et al.*, 2006).

Gabon has a presidential regime and is a relatively stable Central African nation.

Forests have always played an important role in the country's development. Economically, they were the main national asset, before being overtaken by oil at the beginning of the 1970s. At present, the forest sector is in second place for state export earnings and remains the primary employer in the private sector with about 12,868 jobs generated directly (MEFEPPN-FORAF, 2008).

The contribution of the forest/environmental sector to the national economy is presented in table 3.1.

Despite the strong *per capita* GDP (mainly from oil earnings and low population density) improvements can still be made in the fields of education, health and services. In fact, despite major efforts undertaken, especially for literacy, Gabon is in 123rd place out of 177 in the human development index (UNDP, 2005), life expectancy at birth being 59.7 years and the rate of child mortality 53.8 for every 1,000 births.

Table 3.1: Contribution of the forest sector to the national economy in 2007

	Absolute value (billion francs CFA)	Relative value (%)
Contribution to GDP	232.9	4.3
Contribution to the balance of trade	191.8	5.4
Tax earnings	20.5	1.3

Source: MEFEPPN, 2007.

Forest Resources and Land Cover Change since 1990

Forest Areas

Gabon has a dense forest covering more than 80 % of its surface area (Mayaux *et al.*, 2004). Three main types of dense rain forest can be distinguished, coastal forests (0-300 m): 32.6 %, intermediary forests (300-1000 m): 66.7 %, and flooded forest and mangrove: 0.7 % (CBFP, 2006). The rest of the country is made up of forest-savanna mosaic, swampy zones and mangrove.

Photo 3.1: Because of the steep slopes, the undergrowth is often dense shrub, even in the old growth forest of Monts de Cristal.

Table 3.2: Forested area of Gabon by land cover category

Land cover	Area (ha)
Lowland rain forest	20,982,690
Sub-montane forest (900-1500 m)	14,445
Mountain forest (>1500 m)	36
Swamp forest	17,766
Mangrove	71,919
Total dense forest	**21,086,856**
Forest-cropland mosaic	3,120,219
Forest-savanna mosaic	185,931
Dense deciduous forest (Miombo)	176,643
Other plant formations	1,404,630
Cropping land	33,480
Other land use (town, villages, industrial sites…)	201,213
Total	**26,208,972**

Source: compilation of land cover data produced by UCL, JRC and SDSU.

Change in Forest Cover since 1990

Recent analysis of satellite data (Duveiller *et al.*, 2008) estimated the change in forest cover over all countries in the Congo Basin region. In terms of deforestation rate, Gabon, the Republic of Congo and the Central African Republic, are among those countries where the deforestation dynamic is still relatively low with an annual rate of 0.09 % for a regional average of 0.21 % per year (± 0.05 %). As for the net rate of degradation of forest cover, Gabon has a rate of 0.08 % for a regional average of 0.15 % per year (± 0.03 %). However, in the authors' view, a certain margin of interpretation should be maintained given the low volume of data available for the country.

Legal and Institutional Framework for Managing Biodiversity Resources

Legal Framework

Forest and wildlife activities are governed by law 16/01 pertaining to the Forest Law of Gabon. The text was enacted on December 31, 2001, after several years of preparation. The two main axes are:

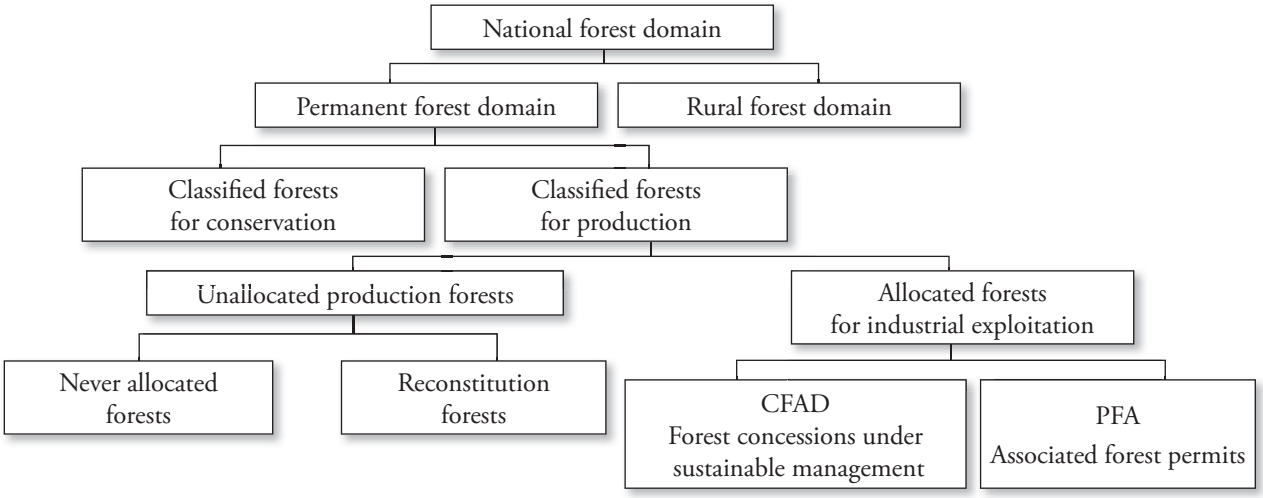
- sustainable and rational management of forest resources through an effective adjustment of facilities;
- more advanced local processing due to a framework favoring investment (greater areas allocated over longer durations, rebalancing fiscal aspects).

At the time, this law facilitated innovative organization of the forest domain into the permanent forest estate of the State and the rural forest estate. The distinction between private and public estate is no longer expressed and all forests are in the national estate. Forests in the permanent forest estate can be used for production or protection (classified forests). The permit holder commits vis-à-vis the state to provide a management plan during the provisional agreement period of three years. They are responsible for preparing and applying the management plan. The management plans are prepared using both flora and wildlife management inventories and socio-economic studies. The decision choices included in the management plan should thus be the result of a broad consensus-building process between the different stakeholders including the logging company, administration and local people. The management plan is valid for a minimum 20-year rotation. Official management norms exist to help the manager assess the management plan proposed.

In the rural forest estate, forests set aside for use by village communities can be set up as community forests as provided for in law. These community forests are subject to simple management provided by central administration. The village communities have to draft supply contracts with local processing companies. The allocation of cutting permits by trunk, so called *gré à gré* (by mutual consent), is also possible in the rural forest domain.

Among the many provisions planned under this law, many have still not been adopted.

The current partition of the forest estate is presented in figure 3.1.



Source: Forest law of Gabon.
Figure 3.1: Organization of the national forest estate.

Photo 3.2: Students head home from classes through a local yard of logs.

Law 16/93 for environmental protection and improvement constitutes the Environmental Law in the Republic of Gabon. A national environment action plan was drafted in 2000.

Other important texts related to natural resource management are law 15/2005 for the Fisheries and Aquaculture Code, law 05/2000 for the Mining Code, and law 15/63 on the land ownership regime in the Republic of Gabon.

The land allocation plan by zoning in Gabon is in preparation. The stratification project to manage the first forestry zone set up at the end of the 1990s with ITTO support can be considered the first stone of the building. However, this was neither expanded upon nor implemented.

Institutions and Capacity

The main management institutions operating in the forest sector are presented in table 3.3.

At present, there is neither a forest fund nor a fund for wildlife and conservation. The financial resources allocated to the Ministry for the Forest Economy in 2007 are summarized in table 3.4.

Table 3.3: Main institutions operating in the forestry sector

Institution	Year of creation	Mission
Ministère de l'Économie forestière, des Eaux, de la Pêche et des Parcs nationaux	1983	Design of government policy in the ministry´s area of competence
Ministère du Tourisme et des Parcs nationaux	1984	Design of government policy in the ministry´s area of competence
Ministère des Mines, du Pétrole, des Hydrocarbures, de l'Énergie, des Ressources hydrauliques et de la Promotion des Énergies nouvelles	1977	Design of government policy in the ministry´s area of competence
Ministère de l'Agriculture et du Développement rural	1973	Design of government policy in the ministry´s area of competence
Ministère de l'Environnement, du Développement durable et de la Protection de la Nature	1972	Design of government policy in the ministry´s area of competence
Société nationale des Bois du Gabon (SNBG)	1975	Wood trade
Agence nationale des Parcs nationaux (ANPN)	2007	Management of national parks
Gabontour	1988	Office of Tourism
Centre national Antipollution (CNA)	1976	Anti-pollution control
Commission nationale du Développement durable	2005	Economic and social development

Source: MEFEPPN-FORAF, 2008.

Photo 3.3: Abandoned logs on the beaches of Gabon.

Table 3.4: Financial resources allocated to the Ministry of Forest Economy in 2007

Entity	Amount (million CFA)
Central administration	8,000
Decentralized services	525
Regulated institutions	4,006
Total	**12,531**

Sources: MEFEPPN-FORAF, 2008.

Generally, the central administration operates in good conditions, but field level deployment is largely insufficient and hampers good support to sectoral activity.

Table 3.5 indicates human resources by level of training (with the exception of trainees and transferred staff), involved in forest resource management.

Table 3.5: Human resources involved in forest resource management in 2008

	Central administration*		Decentralized services		Total
Level of training	**Forest**	**Wildlife**	**Forest**	**Wildlife**	
University	34	7	2	-	**43**
Senior technicians	68	22	84	-	**174**
Technicians	15	19	78	-	**112**
Others (excluding staff from Water and Forest Services)	81	16	186	-	**283**

** Not including staff from the General Secretariat, the General Inspection of Services, and ministerial cabinets.*
Source: MEFEPPN-FORAF, 2008.

Gabon enjoys a developed network of public research institutions and schools of international renown. Research falls under the authority of the Ministry for Further Education, Research and Technological Innovation. The National Center for Scientific and Technological Research (CENAREST) groups the five large research institutes in the forestry frield: IRAF (*Institut de Recherche agronomique forestière*), IPHAMETRA (*Institut de Pharmacopée et Médecine traditionnelle*), IRET (*Institut de Recherche en Écologie tropicale*), IRISH (*Institut de Recherche en Sciences sociales*) and IRT (*Institut de Recherche technologique*) (PFBC, 2006).

In parallel, forestry training is offered by the University Omar Bongo, USTM (*Université des Sciences et Techniques de Masuku*) and various schools. The *École nationale des Eaux et Forêts* (ENEF) set up in 1975 and located in Cap Esterias is in charge of training officers in the fields of forestry, fisheries and aquaculture, and management of wildlife and protected areas. Since 1976, the *École nationale des Cadres ruraux d'Oyem* (ENCRO) has been training young people for careers on working the land. The *Office national du Développement rural* (ONADER), set up in 1983, provides extension services for rural farming techniques.

A forest/environmental sectoral program was started in 2003 and is ongoing. Its objective is to coordinate actions from the various donors, in addition to budgetary support from the World Bank, to the three ministries responsible for natural resources management (forest, environment, and mining). The coordination cell has however experienced problems and is seeking additional financing to cover the provisional action program. In the meantime, the programs in progress support artisanal fishing (BAD), biodiversity (GEF) and the forest sector (AFD).

The *Projet d'Aménagement des petits Permis forestiers Gabonais* (PAPPFG; the project to manage small forestry permits) financed by AFD, FFEM and the gabonese State, in operation since mid-2007, aims to play a key role in structuring the sector. Born from the observation that small permit holders cannot meet legal obligations without institutional support, the project aims at providing a platform of services to title holders keen to group together for whom a management plan is conceivable and prepared using project assistance. Thus doing, the place of national players in the sector will be maintained, institutional capacity strengthened, and the sustainable management process will find a genuine dynamic.

Forest Logging and the Timber Sector

According to Christy *et al.* (2003), logging began before 1900 in Gabon, with okoumé already as the main product. At the beginning of the 20th century, production was limited by the rudimentary logging modalities. Thus it remained concentrated around the main waterways in the country. Rapidly the advent of improved transport techniques enabled more intensive production of logs and okoumé became established on the European market (mainly Germany and then France). During the 20th century, production increased constantly with improved machine development and the progressive incursion of operators into the land.

From the 1960s, there has been logging of so called diverse species with the share of okoumé brought down from 94 % in the 1950s to 85 %. This share is still high today, representing 80 % of production until the year 2000 and beyond. The advent of oil production in 1966 saw timber lose ground to oil as the main source of national wealth.

Typology of Forestry Titles

With the enactment of law 16/01, the typology of forestry licenses was reviewed. The denominations in force are presented in table 3.6.

Legislation provides three types of title. Forest concessions under sustainable management (*concession forestière sous aménagement durable*, CFAD) have an area ranging from 50,000 to 200,000 hectares. A permit holder can own several CFAD, with the total not able to exceed 600,000 hectares. Associated forest permits (*permis forestiers associés*, PFA) are permits for smaller surface areas (maximum 15,000 hectares if the permit is integrated into a CFAD, or 50,000 ha if the permit is a managed unit in itself) reserved for nationals where the management is integrated into a pre-existing CFAD. It is possible to group several PFAs together to make their own CFAD.

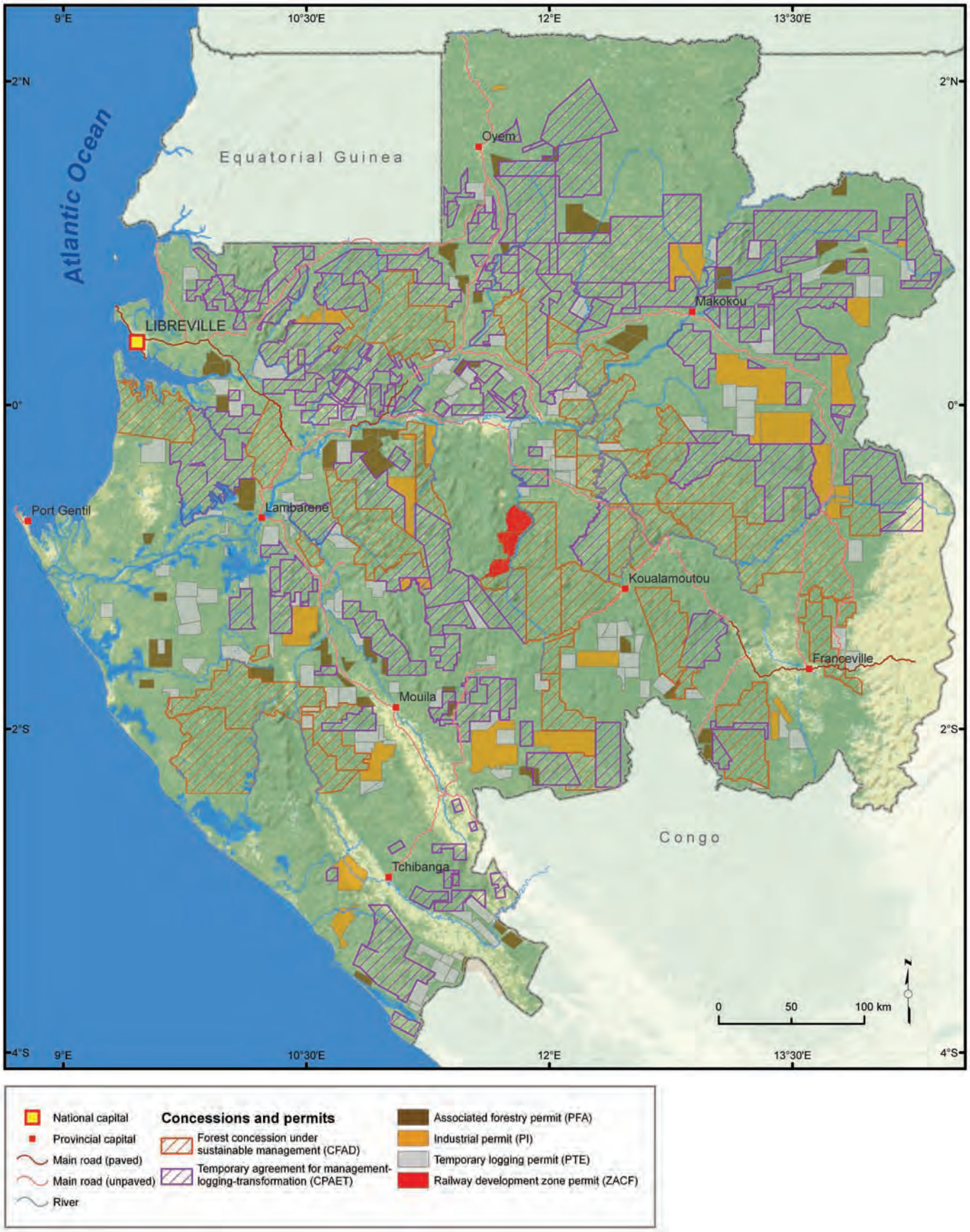
The permis de *gré à gré* (permit by mutual consent, PGG) is issued exclusively to national residents in the rural forest domain. This is for artisanal operations for a maximum of 50 units in a perimeter that was delineated previously by the administration. Unlike CFADs and PFAs where management is compulsory, PGGs are not subject to special management rules.

Table 3.6: Typology of forest permits

Permit	Basis for allocation	Mode of allocation	Management requirement	Size	Exploitation
Forest concession under sustainable management (CFAD)	Surface	Auction/by mutual consent	Management plan and industrialization plan	50,000 ha to 600,000 ha, in one or several plots of 15,000 ha to 200,000 ha	Industrial
Associated forest permit (PFA)	Surface	Auction/by mutual consent; reserved to nationals	Integrate into an existing CFAD or form a CFAD by grouping other PFAs	15,000 ha if integrated into a CFAD, and 50,000 ha if managed by the title holder	Industrial
Permit by mutual consent (*Permis de gré à gré*) (PGG)	Number of trees	By mutual agreement; reserved to nationals	None	50 trees	Artisanal

Source: MEFEPPN-FORAF, 2008.

At present community forests are not planned in Gabon. As mentioned previously, there are legal provisions for community forests and they can be awarded upon request from the village communities concerned. The conditions for their Implementation are still being studied, especially through a pilot project in Ogooué Ivindo. It is planned they will be managed through a simple management plan prepared by the Administration.



Sources: CARPE, INC, WCS, WRI, and FORAF.
Figure 3.2: Forest concessions in Gabon

Annual national production in the formal sector is traditionally presented by distinguishing between okoumé and ozigo in one group and various other woods on the other (table 3.7). Note that these two species account for more than two thirds of total production, okoumé alone accounting for a dominant share. Detailed distribution of the total 2007 volume entering plants for the ten main species is presented in table 3.8.

The matching export statistics are presented in table 3.9. In the first 11 months of 2006, roundwood exports were mainly dominated by okoumé (almost 50 %), okan, padouk, kevazingo, moabi, dabéma, tali, béli and ozigo (MEFEPPN-FORAF, 2008).

The log market for okoumé and ozigo is mainly oriented towards Asia, (China in particular), while for various timber species, Europe is the main customer.

Table 3.7: National annual production (formal sector) of logs from 2005 to 2007

m³	2005	2006	2007
Okoumé/ozigo	1,772,737	2,061,412	2,144,434
Various wood	997,165	1,159,544	1,206,244
Total production	**2,769,902**	**3,220,957**	**3,350,678**
Part entered into wood processing plants	1,183,875	1,104,989	1,131,566

Source: MEFEPPN-FORAF, 2008.

Table 3.8: Total volume sent to processing plant in 2007

Species	2007 (m³)
Okoumé	931,473
Azobe	37,700
Okan	20,522
Mouvingui	18,713
Ozigo	14,903
Izombe	9,253
Bahia	9,174
Moabi	9,144
Iroko	8,564
Agba	5,440
Other species	66,679
Total entered in processing plant	**1,131,566**

Source: MEFEPPN-FORAF, 2008.

Table 3.9: Export by type of product from 2005 to 2007

Product (m³)	2005	2006	2007
Logs	1,586,228	1,768,080	1,938,079
Sawn wood	152,724	164,537	253,227
Peeled veneer	121,899	194,150	163,048
Sliced veneer	2,256	1,582	1,347
Plywood	67,177	29,906	58,439
Planed wood	ND	ND	ND

Source: MEFEPPN-FORAF, 2008.

Tablea 3.10: Distribution of processing units

Type of unit	Number	Theoretical national capacity (m³)
Industrial sawmill	60	1,013,487
Peeling plant	12	673,600
Slicing plant	1	10,000
Total	**73**	**1,697,087**

Source: MEFEPPN-FORAF, 2008.

The primary processing industrial units are divided according to table 3.10.

A survey carried out in 2008 in the framework of PAPPFG reported 48 sawmill facilities, 9 peeling units and 3 plywood plants, for a theoretical processing capacity of approximately equivalent to 1,697,087 m³ of logs per year.

There are still relatively few secondary processing units, and they are definitely under-inventoried (table 3.11).

Table 3.12 summarizes the quantities produced by type of processed product.

Table 3.11: Distribution of secondary processing units

Type of unit	Number	Theoretical national capacity (m³)
Plywood plant	4	236,000
Planed timber (floorings, moldings)	-	-
Other	-	-
Total	**4**	**236,000**

Source:MEFEPPN-FORAF, 2008.

Table 3.12: Quantities produced by type of processed product

Product (m³)	2005	2006	2007
Sawn wood	200,151	200,239	296,406
Sliced veneer	2,856	-	1,285
Peeled veneer	396,581	297,290	180,516
Plywood	180,594	32,900	84,795
Planed wood	-	-	-

Source: MEFEPPN-FORAF, 2008.

Informal Sector

By definition, this sector is difficult to quantify. However, the lack of consolidation between the various sources of statistics, and the lack of structuring among some logging operators are signs that such activity occurs, particularly in the rural forest domain.

Photo 3.4: Removing bark is the first step in wood processing.

The figure currently put forward for the planned surface area of the permanent national forest estate is 12,000,000 hectares with a quarter of forest concessions having approved management plans (table 3.13).

Table 3.13: Distribution of concessions according to their degree of involvement in sustainable management

Forest concessions	Number	Area (ha)
CFAD under definitive agreement (management plan approved)	9	3,000,000
CFAD under provisional agreement (management plan in preparation)	37	5,300,000
Plots with an uninitiated process	243	3,600,000
Total concession allocated	**-**	**11,900,000**

Source: PAPPFG evaluation, Sept. 2008.

According to Department of Inventories, Management and Regeneration (*Direction des Inventaires, de l'Aménagement, et de la Régénération des Forêts* - DIARF), production from concessions under management was 1,325,000 m^3 in 2007. In all likelihood, the surface area used to obtain such a volume was in excess of the 12 annual cutting areas listed (74,392 ha according to DIARF).

Prior to the implementation of PAPPFG, lack of conservation measures led to the revocation of a number of concession permits in the public domain. Indeed many permit holders were in non-compliance with the obligation to manage forest resources sustainably; measures set up to assist initiating the management process did not last more than a few months. However, these numerous permit returns should be compensated by an allocation process by on going adjudication.

Voluntary commitment to certification only involves a few operators, but for quite sizeable areas, as shown in table 3.14. Thus 1,300,000 ha are FSC certified today.

Table 3.14: Distribution of concessions and operators and associated areas according to type of certificate

Type of certificates	Number of concessions	Area (ha)
Keurhout	1	576,642
FSC	4	1,304,963
PAFC	0	0
Total certified sustainable management forests	**5**	**1,881,605**
OLB	3	622,399
TLTV	0	0
Total concessions with legal certificates	**3**	**622,399**
Company with ISO norm 14001	1	549,327

Source: MEFEPPN-FORAF, 2008.

Photo 3.5: Artisanal activities can be quite profitable, but remain marginal.

Forest Plantations

According to DIARF, total planted areas account for 30,000 ha (Christy *et al.*, 2003). Since the 1980s, there have been no new plantation programs. The ones in place are not subject to planned logging.

Biodiversity Conservation and Development

Biodiversity Components in Gabon

Ecosystem diversity

As forests cover more than 80 % of Gabon, they occupy most of the country, with the exception of some savanna zones such as the Batéké plateaux and part of the Franceville basin in the south east, or the plains of Ngounié and Nyanga in the south west.

Four main types of forest can be differentiated:

- Mangroves (mainly red mangrove) can be found in the estuaries of Como, of Mondah and Rio Muni, and the delta of Ogooué.
- Forests on hydromorphic, marshy or seasonally flooded soils can be found in all regions of the country, on valley bottoms. They are more numerous in the coastal sedimentary basin and on the north eastern plateaux.
- Secondary forests can be found along roads and throughout the country at different stages of growth.
- Old forests. Forests without okoumés can be found in the north east and east of the country, okoumé being present elsewhere in the country. It is difficult to identify other clear zones but two gradients do appear: one North-South, with a variety of large trees getting broader to the north; and an East-West gradient with a variety of large trees broadening out to the west, and more semi-deciduous trees in the east.

Of the 12 landscapes in the CARPE program, Gabon has five in part (Monte Alén-Mont de Cristal, Gamba-Mayamba-Conkouati, Lopé-Chaillu-Louesse, Dja-Odzala-Minkébé, Léconi-Batéké-Léfini). These cross border zones make up a vast regional network as basis for implementing conservation priorities (see landscape chapters for more details).

Formal Management of Biodiversity

Protected areas cover 11 % of national territory, accounting for most of the habitat for animal and plant species (MEFEPPN-FORAF, 2008). The area of the different categories of protected area according to IUCN are summarized in table 3.15 while the typology is shown in table 3.16. To this list we can add the World Heritage listed sites (protection of unique natural and cultural elements). Zones put into reserve in logging concessions, conservation series, also help maintain biodiversity. The 13 national parks do not have approved management plans.

Table 3.15: Protected areas in Gabon

	Area (ha)	Percentage of the total forest area in the country
Area of conservation forests	> 2,919,000	> 13.2
Area category I-II IUCN	2,919,000	13.2
Area category IV	?	?
Protected forests in landscapes CARPE/CBFPC	2,778,000	95 (of total area of protected forests in the country)
Conservation series	115,000	-

Source: CBFP, 2006.

Sources: CARPE, INC, WCS, WRI, and FORAF.

Figure 3.3: Protected areas in Gabon

Table 3.16: Typology of protected areas in Gabon

Type of protected area	Protection goal	Development modes	Restrictions
Integral natural reserve	Total protection	Soil, water, flora, wildlife	Permission for researchers, water and forestry agents
Biosphere reserve	Total protection	Soil, water, flora, wildlife	Permission for researchers, water and forestry agents
National park	Total protection	Flora, wildlife, landscape	Organized and regulated tourism
Wildlife reserve	Total protection	Flora, wildlife, landscape	Regulated access
Botanical and zoological garden	Total protection	Exhibition of live animals	Regulated access
Sanctuary	Total protection	Animal or plant species	Regulated access
Hunting zone	Total protection	Wildlife	Limit on kills

Source: adapted from the Gabon Forest Code.

Economic Development of Biodiversity

Non-timber forest products (NTFP) are mentioned in the Forest Code. When the management plans for forest concessions are being prepared, they study the presence and sometimes the geographical distribution of the main NTFP, while the traditional economic sectors are described in the socio-economic diagnostic.

Three protected areas (Lopé, Pongara and Iguela) have accommodation with a total of 23 bedrooms. ANPN trained 48 ecoguardians in 2007.

The *Zones d'Intérêt cynégétique amodiées* (ZICA or designated hunting reserves) do not exist in Gabon, because big game hunting ceased in 1981. For the 2007 hunting season, 1,684 small game hunting permits and weapon permits were issued.

Conclusions

The current legal and institutional framework in Gabon supports good forest resource management and undeniable progress has been made in terms of sustainable management. The country was even seen as a pioneer on several fronts from the beginning of 2000 onwards but the process ran out of steam, as the administration in charge of that sector had insufficient resources to guide and finance activities. In this respect, a considerable number of the areas under provisional management agreements have not seen any firm commitment to sustainable management.

The state is seeking to address this issue and secure the resources and institutional support to improve forest management. This is being achieved through decentralization and this role will gradually taken over by PAPPFG (*Projet d'Aménagement des petits Permis forestiers gabonais*). When the texts will come out for awarding forest permits, this project of the Ministry of Forest Economy should thus extend its action over a considerable part of the forest area under concession.

In terms of biodiversity development, the new national park network represents a major asset and management plans should be developed over time.

Photo 3.6: Although not fully developed, the potential for ecotourism in Gabon is great.

CHAPTER 4
The Forests of Equatorial Guinea in 2008

Antoine Mugnier and Santiago Martinez-Plaza
With collaboration from Obiang Diosdado, Obama Crisantos, and Esono Fidel

Introduction: The Macro-Economic and Political Context

The mainland of Equatorial Guinea is located just north of the Equator; the continental part borders Cameroon to the north (2° 10'N parallel and Ntem River) and Gabon in the south (parallel 1° N and estuary of the Muni) and east (11° 20'E and Kie River). The western boundary of the continental territory is defined by the western Atlantic (9° 30'E). The continental region comprises three different regions, from west to east: (1) the coastal zone; (2) a more rugged terrain with a chain of seven mountains, the Wele depression, the Niefang chain (Monte Alén) and the massif of Monte Mitra; and (3) the plains in the north-eastern section of the country (from the Kie Ntem peneplain to the central peneplain). Bioko island, of volcanic origin, is dominated by the Pico Basile (3,011 m).

The climate is equatorial with two short dry seasons between two rainy seasons. Rainfall varies from 3,500 mm on the highest parts of the mainland to less than 2,000 mm on the peneplains. The southernmost part of Bioko Island experiences some of the strongest rainfall in Africa with more than 10,000 mm per year. The main dry season is from December to March and the longest rainy season starts late March or early April and ends in June (Atlas of Equatorial Guinea, 2001).

Mainland soils are metamorphic (gneiss, granite), except for the coastal strip, which is of sedimentary origin.

The territory of Equatorial Guinea covers an area of 27,211 km², divided between the mainland, called Rio Muni (25,015 km²), and the islands, including Bioko (2,196 km²) and Annobon (17 km²). The maritime territory (Exclusive Economic Zone) of Equatorial Guinea covers approximately 312,000 km² (Atlas of Equatorial Guinea, 2001).

According to UN estimates, the population of Equatorial Guinea was around 484,000 inhabitants in 2006 and is expected to reach 545,000 inhabitants in 2010 (United Nations, 2006). However, according to the government census of 2002 published in 2004 by the Ministry of Planning and Economic Development, the population was estimated at 1,014,990 inhabitants, a significant population increase as the population was estimated at 450,000 inhabitants in 1994. This increase can be largely attributed to the development of oil reserves over the last ten years. This development led to the massive return of Guineans who had emigrated and an equally massive immigration of workers (mainly from western and northern Africa). Another reason for the population increase is the improved health system, which caused a drop in mortality rates. Most of the population lives in rural areas, but is increasingly drawn to the main urban centers (Bata, Malabo). There is considerable pressure on natural resources because population densities are high and traditional rural activities are not compatible with this level of population (poaching, slash-and-burn shifting cultivation). Pressure is particularly strong on Bioko Island.

GDP has increased on an unprecedented scale, thanks to oil revenue, standing at CFA 5,130 billion in 2007 (€ 7.8 billion) versus CFA 83 billion in 1995 (CEMAC, 2008). More than 90 % of GDP originates from oil. In 2008, GDP *per capita* stood at $ 7,400, a significant increase despite the dramatic increase in population. In 1994, it stood at $ 201 *per capita* (CEMAC, 2008).

Equatorial Guinea does not have a structural adjustment program. In 2006, it had outstanding loans worth approximately $ 150 million from the African Development Bank and the International Development Association (IMF, 2008).

The contribution of the forestry sector to the national economy is constantly shrinking, due to the large predominance of the oil sector. The forestry sector accounted for only 0.2 % of the GDP in 2007, with a contribution of around CFA 15 billion.

Photo 4.1: Profile of a low altitude dense forest.

Forest Resources and Land Cover Change since 1990

Forest Areas

Table 4.1: Forested area of Equatorial Guinea by land cover category

Land cover	Area (ha)
Lowland dense rainforest	1,972,044
Sub-montane forests (900-1500 m)	27,450
Mountane forest (>1500 m)	2,619
Swamp forest	0
Mangrove	351
Total dense forests	**2,002,464**
Forest-cropland mosaic	624,438
Forest-savanna mosaic	28,647
Dense deciduous forest (Miombo)	0
Other plant formations	39,231
Cultivated land	2,637
Other land use (town, villages, industrial sites…)	23,688
Total	**2,721,105**

Source: compilation of land cover data produced by UCL, JRC and SDSU.

Change in Forest Cover since 1990

According to the FAO, the deforestation rate has increased substantially, from 58.2 km² per year in 1990 to 150 km² per year over the period 1990-2005, due to deforestation for agriculture and highly intensive logging. These figures correspond to a deforestation rate of 0.9 % (FAO, 2005).

Legal and Institutional Framework for Managing Biodiversity Resources

Natural resource management in Equatorial Guinea is the object of many laws and the government structure provides for *ad-hoc* arrangements to carry out the mission of nature conservation. According to the Constitution: "[the] State shall ensure the conservation of nature [...] so that development and conservation are emerging as two inseparable components to be combined so that the well-being to which the country aspires shall be sustainable." However, nature conservation in Equatorial Guinea faces many obstacles, including the lack of financial, human and technical resources throughout the administration.

Equatorial Guinea is also firmly committed to regional initiatives, as demonstrated by its active participation in the declaration of the Heads of States in Yaoundé (1999) and its adherence to the 2005 COMIFAC convergence plan. Equatorial Guinea is also a signatory of many treaties (table 4.2).

Table 4.2: Conventions and international treaties signed by Equatorial Guinea

Text	Date of signature*
COMIFAC Treaty	05/02/2005
Ramsar Convention on Wetlands of International Importance	02/10/2003
UNESCO World Heritage	19/11/2003
Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	10/03/1992
Bonn Convention for the Conservation of Migratory Species	30/04/1983
Rio de Janeiro Convention on Biodiversity	24/11/1994
Kyoto Protocol - UN Framework Convention on Climate Change	16/08/2000
UN Convention to Combat Desertification	26/06/1997

**Most conventions signed by Equatorial Guinea come into force upon simple signature as ratification is not required by the Constitution.*
Source: MPMA-FORAF, 2008.

Legal Framework

Forestry Act

The legal basis for regulating the natural environment in Equatorial Guinea stems from the 1/1997 (February 18) Act on forest use and management and from its derived directives (Decree 97/1997 of August 12). This Act establishes the conditions for the management and for the rational and sustainable utilization of forest resources to prevent their loss. The law covers the following aspects (FAO, COMIFAC, 2007):

- the legal, economic and administrative regime of the forestry sector;
- the classification and definition of forest products;
- the operation, use and management of forest resources;
- the conservation of ecosystems;
- the transportation, industrial processing and marketing of forest resources;
- the economic and taxation regime;
- checks, violations and penalties.

This law clearly defines two areas of forestry, production and conservation. It defines a classification of areas according to uses: national forest reserves, production areas and conservation or protection areas.

Article 58 of the Act creates a "Forest Ranger Corps" and elucidates its role in monitoring, protecting and conserving national forest resources.

Environmental law

Environmental regulation is based mainly on Law 7/2003 (27 November) for environmental regulation in Equatorial Guinea. This law represents the first legal instrument designed specifically for environmental regulation and protection in Equatorial Guinea, although it is not fully operational at present. This law covers air, water and soil quality, pollution, conservation of the environment, and emergency situations and administrative responses in these areas. It also covers public actions to prevent and control contamination.

This law provides some degree of decentralization and coordination between central and local governments. To that effect, the law provides for the establishment of the National Institute for Environment and Nature Conservation (INCOMA) (*Instituto Nacional de Conservación del Medio Ambiente*) and the National Environment Fund (FONAMA) (*Fondo Nacional de Medio Ambiente*). The law also creates a special Corps of Environmental Inspectors (*Cuerpo Especial de Inspectores Medio Ambientales*), like the Forest Rangers Corps (*Cuerpo Especial de Guardería Forestal*) under the Forest Act.

According to Law Nº. 7/2003, mentioned above, the Ministry of Environment is responsible for classifying and managing protected areas such as natural parks, nature reserves, natural monuments, protected landscapes and scientific reserves.

Related texts

The environmental sector has numerous texts (laws, legal decrees and ordinances). Some of these texts predate the laws mentioned above and are still in force. Only the most recent texts will be mentioned here as the 1990s proved particularly fruitful in this regard.

- Law Nº. 4/1994 (May 31) on tax regulation, and parafiscal tax collection in the country. This law defines clearly the concept of tax and tax collection, and defines the payment modalities for any public service action related to wood products in the forestry sector (FAO, COMIFAC, 2007);
- Law Nº. 1/2000 (May 22) on the redefinition of several forest taxes;
- National Forest Action Program (PNAF-GE);
- a policy paper for the forestry sector, developed in 2000 with FAO support;
- Decree Nº. 172/2005 on trade in wildlife and flora species threatened with extinction. This document gives powers to the Ministry of Fisheries and the Environment in that domain.
- Decree Nº. 60/2002 on the establishment of the National Institute for Forest Development and Management of Protected Areas (INDEFOR-AP). This institute was established to provide the scientific and technical resources needed to manage forest resources.

Various other decrees from the Ministry of Agriculture and Forestry complement existing legislation, including the following:

- Nº. 61/2007: amendment to law enforcement rules on the use and management of forests. The decree prohibits the export of Guinean logs and provides for 100 % wood processing in the country;
- Nº. 97/1997: regulations on law enforcement on forest use and forest management.

The Ministry of Fisheries and the Environment has also issued several decrees, including:

- Nº. 17/2005: adoption of the Strategy Paper and Action Plan for biodiversity conservation;
- Nº. 3 /1997: expansion of the Monte Alén National Park;
- Decree Nº. 72/2007 to ban the hunting and consumption of apes and other primates in Equatorial Guinea.

Land Classification Plan

Law Nº. 1/1997 provides for land classification according to land use (table 4.3) and article 8 of the Act defines the role to be played by the "National Commission for Land Classification and Use" (*Comisión Nacional de Clasificación y Uso de las Tierras*). At this time, this Commission is not functional (Obama, 2007).

Table 4.3: Land classification in Equatorial Guinea

Name	IUCN type	Characteristics
National park	II	Village activities (NTFP, fisheries, hunting) possible in buffer zones, heart of the park reserved for scientific and tourist activities
Scientific reserve	I	Completely closed off, very strictly controlled
Natural reserve (national reserve)	IV	Includes towns and villages
Natural monument	III	Protection of landscapes of cultural and/or religious importance
Protected landscape	V	
Community forest	VIII	Example: *Reserva de poblados*. Permanent user rights granted to rural communities for traditional usage (these forests border rural communities)
Public production forest	VIII	
Private farming/forest properties		Family private properties for subsistence activities

Source: MPMA-FORAF, 2008.

Institutions and Capacity

The monitoring of natural resource falls under the dual jurisdiction of the Ministry of Fisheries and Environment and the Ministry of Agriculture and Forestry, which potentially leads to conflicts of jurisdiction. A case in point being protected areas, where forests are under the Ministry of Agriculture and Forestry and where overall management lies with the Ministry of Fisheries and the Environment.

There are two other bodies dedicated to protecting the environment. First there is the National Institute for Forest Development and Management of Protected Areas (INDEFOR-AP) (*Instituto Nacional de Desarrollo Forestal y de Gestión de Áreas Protegidas*), located in Bata on the country's mainland. The Institute possesses a range of competencies in various fields, including fifteen technicians trained during the ambitious CUREF project (Conservation and Rational Utilization of Forest Ecosystems in Equatorial Guinea (1996-2002) --*Proyecto Racional Utilización y Conservación de los Ecosistemas Forestales de Guinea Ecuatorial*). The Institute also hosts a geographic information systems laboratory, the only public unit of its kind in Equatorial Guinea. The second body whose purpose is to protect the environment is the National Institute for Environment and Nature Conservation (INCOMA) (*Instituto Nacional de Conservación del Medio Ambiente*) created by the Environment Act. At this time that Institute is not yet operational. There also exists the High Council for Scientific Research and Technology (CICTE) (*Consejo de Investigación Científica y Tecnológica*) attached to the Presidency, which coordinates relations between the scientific institutes and the Presidency.

For the time being, there are very few decentralized technical administrations, which limits the ground presence of state technical services. More importantly, the paucity of transportation (only 1 vehicle) for the rare existing local offices aggravates this situation. The state is developing programs to address this problem by creating local relays, in particular within the Ministry of Agriculture and Forestry.

The public administration in charge of forestry and wildlife employs 169 people. Less than a quarter of the staff works in decentralized structures. One third of the staff has a university degree, mostly from foreign countries (Russia, Cuba, Belgium, Spain, Germany, France...).

The National University of Equatorial Guinea (UNGE) remains to date the only university level institution in Equatorial Guinea. The university is relatively new (founded in 1995) and offers training courses, *inter alia*, in natural resource management (agriculture and fishing sections). Currently, the UNGE offers no doctoral training. Some NGOs (local and international) provide practical training on a variety of socio-economic and environmental topics. Several forestry and environmental projects are currently underway: ECOFAC for protected areas; Conservation International for specific forest areas; the CARPE program; and other actions conducted by ANDEGE (*Amigos de la Naturaleza y el Desarrollo de Guinea Ecuatorial*), such as the BBPP program (Bioko Biodiversity Protection Program) for the protection of protected areas in Bioko.

Forest Logging and the Timber Sector

Photo 4.2: Regular use by logging trucks can damage rural roads.

Logging in Equatorial Guinea began in the early 20th century (Nsue Ela, 1998).

Logging was first organized by the Spanish colonial authorities who granted logging concessions to Europeans. Their operation focused on okoumé and easily accessible areas (on the river bank and coast).

Later, the improvement of logging capacity resulted in the concentration of logging in more remote areas that were very rich in okoumé, particularly around the towns of Mbini and Kogo, on the southern coastal fringe of the country. The operation moved back from the coastal fringe by about ten kilometers from 1928 onwards.

After the Second World War, demand for okoumé dropped and its export share went from 95 % to only 20 %. Faced with the depletion of okoumé resources, the colonial government stopped granting concessions between 1930 and 1944. In 1945, the government proposed a first classification of forests.

In contrast to exploitation, colonial authorities passed forestry legislation, which forced operators to replant twenty seedlings for each tree felled (article 12 of the Act of 1928).

In 1950, Equatorial Guinea came under Spanish provincial status and logging continued. There were 70 concessions in 1955, covering areas ranging from 974 to 30,000 ha. The end of the colonial era (1968) signaled the peak of timber logging roads with over 1,200 km of forest roads and tracks. During that same period, logging volume increased gradually to reach 330,000 m³ in 1962, mainly exported to Spain. Okoumé alone accounted for nearly one third of this figure.

The years following the country's independence (1969-1979) marked a period of recession for forest operations and cash crops (cocoa, coffee). The government nationalized industrial logging, which reduced logging to an anecdotal level. Each Equatorial Guinean was entitled to fell four trees.

In 1979, the State restored a system of free trade and very quickly concessions were re-issued, mostly to Spaniards, for periods of five years. There were thirteen concessions in 1986 for areas covering 5,000 to 50,000 ha. The following year, exploited volume exceeded 200,000 m³, mostly for export.

Around the 1990s, a parallel logging industry began based on volume licences granted to residents but industrial logging operators ended up buying the rights from people. Although this system was terminated in 1990, it appears that logging operations in municipal forests were sometimes performed by industrial operators.

The concession system was strengthened during the 1990-1997 period and more than 70 titles were granted, on areas ranging from 2,500 to 50,000 ha. All production forests in the country were then allocated in concessions and logging took place across the entire country.

Typology of Forestry Titles

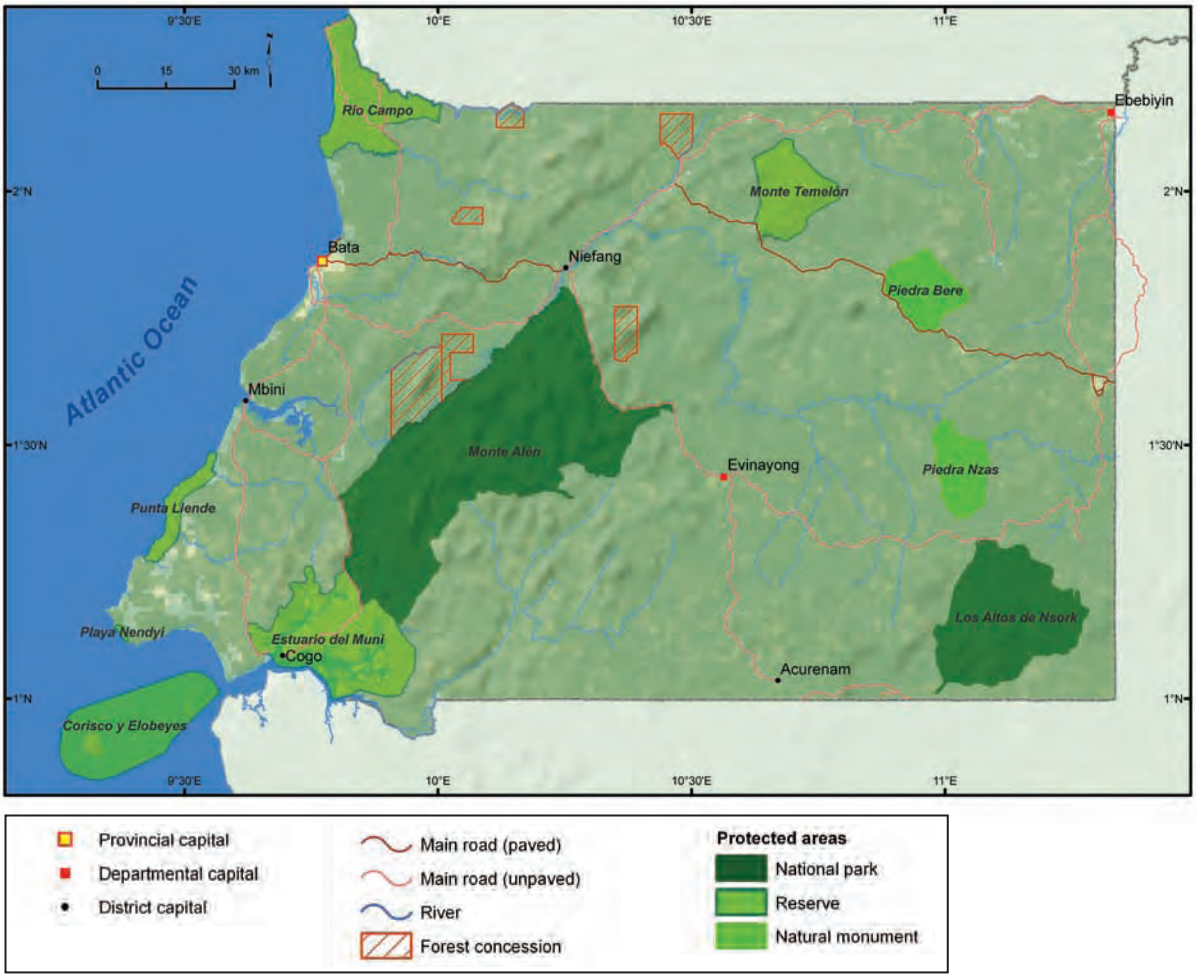
The Forest Act distinguishes between three types of forest:

- forest plot;
- municipal forest;
- national forest;

Within national forests, two types of forest title can be granted: forest concessions and special permits. All concessions have recently been cancelled.

Formal Logging in Natural Forests

Despite legislation, large-scale logging has taken place and has exceeded forest regeneration potential in Equatorial Guinea. In 1997, log production rose to more than 700,000 m³, 85 % of which was okoumé, which is 50 % higher than the FAO's estimated level of sustainable production. Table 4.4 summarizes official production figures in recent years.



Sources: INDEFOR and FORAF.
Figure 4.1: Forest concessions and protected areas in Equatorial Guinea

Table 4.4: Evolution in log production in Equatorial Guinea from 2000 to 2007

Year	Forest production (m^3)
2000	689,169
2001	475,795
2002	574,155
2003	350,675
2004	464,979
2005	450,258
2006	602,854
2007	524,799
Average	516,585

Source: Ministry of Fisheries and Environment.

In 2006, harvested species by order of importance were: okoumé, which clearly dominates production, azobé, tali, and ilomba.

It should be noted that concession licenses have become concentrated, notably by Shimmer International, a subsidiary of the Malaysian Rimbunan Hijau consortium. That company alone, which no longer operates in the country, produced in 2006 more than two thirds of the Guinean volume. Many special permits, covering several thousand hectares each, have been issued in recent years by the Ministry of Forestry. However, chronic overexploitation has resulted in forest thinning and for the past several years, many concessionaires have been handing their licenses back to the government.

The government forestry policy is to remove all concessions and only to grant special permits (six currently allocated) to allow forest regeneration.

All concessions are obliged to submit a management plan. To date, only one concession, working with the CUREF project, is operating with a management plan. All other concessions are paying a reforestation tax as an alternative. The revenue generated by this tax should allow the Forest Service to undertake plantings and forest enrichment programs. The Reforestation Service is not yet operational.

As concern the status of *reservas de poblados*, they were replaced by *bosques comunales* with better state control of forest management. Many communities are not aware of the change in status and therefore have no formal right to forests near the village. Only the coastal strip, where access to information is better than in the rest of the country, has seen villages obtaining official licenses (Cayuela Serrano, 2000).

Industrial Timber Processing

Only a small fraction of the volume (ten to 15 %) of timber is processed on site into veneer (rotary peeling), and to a lesser extent sawn timber. The country has five industrial units (four rotary plants and one sawmill), four of them located in Bata. There are also some very small sawmills supplying local markets, some of them very recent. The species that are processed include okoumé (predominantly), eyong, movingui, ilomba fraké, and Bilinga.

In 2006, Equatorial Guinea produced 26,000 m³ of veneer and 1,500 m³ of sawn timber. Almost the entireties of these volumes were exported to Europe (Spain, Italy and France) and China.

Photo 4.3: Peeling mill.

Informal Sector

The local population exerts great pressure on the forest. Significant population growth has substantially increased wood demand, and around major cities (Bata, Malabo, Evinayong) an increase in wood collection can be observed. This wood is used to build homes and there are many *chavolismos* (wood-built slums) on the outskirts of major cities.

Fuel wood collection also leads to intensive degradation on the outskirts of cities. Finally, some areas are affected by the collection of wood for smoking fish (mangroves in Cogo, south-west of the country).

Progress Towards the Sustainable Management of Production Forests

Forest concessions were not managed in the past. Only one pilot management plan was drafted in 1998 by the CUREF project. After a period of strong overexploitation, Equatorial Guinea intends to implement a policy to recover its forest cover. The objective is to restrict logging by granting special permits that will be restricted to meeting the needs of still-functional local processing plants.

The scarcity of information available on the Guinean forests represents a major obstacle to implementing this new policy. In the coming years, understanding of the terms and time required for forest regeneration should increase with the implementation of a national forest inventory.

In addition, a major effort should be made to formalize the forest sector. Equatorial Guinea should take advantage of its oil revenues and allocate a quota for environmental projects. Political will is beginning to grow, but so far no actions have materialized.

Biodiversity Conservation and Development

Biodiversity Components in Equatorial Guinea

Ecosystem diversity

Dense forest covers almost 60 % of Equatorial Guinea, 1.6 million hectares, at altitudes ranging from 0 to over 1,500 m (CUREF, 1998). Most forests are at between 300 and 1,000 m of altitude. The east of the country includes many marshland areas, as well as woody fallow patches (young secondary forest). Several forest types are found in Equatorial Guinea. The most common forest type is the lowland and medium altitude dense rainforest. This forest type has suffered greatly from heavy logging in recent decades. There are still primary forests in the country that could soon disappear if commercial logging continues unabated. Young secondary forest at low and medium altitudes is also well represented, dominated by okoumé (*Aucoumea klaineana*).

A significant part of the mainland supports either permanent or temporary swamp-type formations.

The dense tropical humid sub-montane forest is located in the highest parts of the country and on Bioko Island. However, this type of forest accounts for only a small part of national forest cover.

Along the coast, there are mangroves (*Rhyzophora, Avicenia*) in localized areas, bordering the estuaries of continental rivers and in narrow strips of 500 m wide and 15 to 20 km long.

In areas of high anthropogenic pressure, highly degraded forests are often the result of agricultural activity.

Species diversity

Many wildlife and flora species in Equatorial Guinea are threatened. The most renowned endangered species include the elephant (*Loxodonta cyclotis*), the hippopotamus (*Hippopotamus amphibius*), the gorilla (*Gorilla g. gorilla*), the chimpanzee (*Pan troglodytes*), the mandrill (*Mandrillus sphinx*) and the marine turtles (Green turtle - *Chelonia mydas*, caret turtle - *Eretmochelys imbricata*, bastard turtle - *Lepidochelys olivacea*, and leatherback turtle - *Dermochelys coriacea*), which lay their eggs on the beaches of Equatorial Guinea. Even though there exists several large collections of flora specimens as well as multiple seminal works (e.g., Wilks and Issembé, 2000) the plant species are less known in Equatorial Guinea.

The country's islands are home to many endemic species: Bioko, for example, has two subspecies of endemic primates. Marine wildlife is also very important, and has not been comprehensively inventoried.

Photo 4.4: The tropical flora displays many different forms and colors, notably the Glory Lily (Gloriosa superba).

Photo 4.5: "Mole traps" are one of the many trapping systems being used in the region.

Formal Management of Biodiversity

The status of the 13 protected areas in Equatorial Guinea is defined by the Forest Act (Nº. 1/1997 Title III), and Act Nº. 7/2003, which replaces Law Nº. 4/2000 on Protected Areas (Obama, 2007).

Table 4.5: Protected areas in Equatorial Guinea in 2008

Protected area	Type	Area (ha)	Year of creation	Staff	Location
Caldeira de Luba	Scientific Reserve	51,000	2000	14 guards and 4 technical officers	Bioko Island
Playa Nendji	Scientific Reserve	500	2000		
Monte Alén	National Park	200,000	1997	26 guards and 4 technical officers*	Monte Alén – Monts de Cristal
Altos de Nsork	National Park	70,000	2000	4 guards and 4 technical officers*	Monte Alén – Monts de Cristal
Pico Basilé	National Park	33,000	2000		Bioko island
Piedras Nzas	Natural Monument	19,000	2000	2 guards	Monte Alén – Monts de Cristal
Piedra Bere	Natural Monument	20,000	2000		
Rio Campo	Nature Reserve	33,000	2000	5 guards and 1 technical officer*	
Monte Temelon	Nature Reserve	23,000	2000		
Estuario del Rio Muni	Nature Reserve	60,000	2000	2 guards and 1 technical officer	Monte Alén – Monts de Cristal
Punta Llende	Nature Reserve	5,455	2000	2 guards	
Corisco y Elobeyes	Nature Reserve	53,000	2000	2 guards and 1 technical officer	Corisco and Elobeyes islands
Annobon	Nature Reserve	23,000	2000		Annobon Island
Total		**590,955**		**57 guards and 15 technical officers**	

** Part of the staff is supported through partner organizations.*
Source: MPMA-FORAF, 2008.

To date, only one management plan has been produced, for the Caldera de Luba Scientific Reserve, by the Spanish Cooperation and the NGO *Amigos de Doñana*. However, during the fourth phase of the ECOFAC project, the management plan for Monte Alén National Park will be developed by the European Union, CI and the State. Similarly, the management plan for Altos de Nsork National Park is being drafted, with financial support from CARPE, by ANDEGE and CI. This will also be the case for the Rio Campo Nature Reserve, where RAPAC is also providing support to ANDEGE (2008-2009).

Economic Development of Biodiversity

Non-timber forest products (NTFP) are crucial for the entire population of Equatorial Guinea. Indeed, Obama (2000) indicates that NTFP represent around 42 % of household incomes in rural areas. This industry remains highly informal and concerns a large percentage of women, 90 % of them are either involved in production or trade (FAO-COMIFAC, 2007).

The NTFP sector is relatively lightly regulated although it is mentioned in the Environment Act (7/2003) and, more exhaustively, in the Forest Act (1/1997). Products in the NTFP sector include: condiments (*Piper guineensis*), wild fruits (*Dacryodes macrophylla*), medicinal plants (*Alstonia bonnei*, *Enanthia chlorantha*, *Elaeis guinnensis*), bushmeat, bamboo (*Bambuza vulgaris*) and other handicrafts made of rattan (*Melongos*). The case of *Prunus africana*, an endangered species, is unique as its production and trade are highly regulated. Most production is done by a company called APRA (*Aprovechamiento Productos Agrícolas*).

NTFP are widely present in local markets but are also exported to neighboring countries in significant quantities. Obama (2002) reports an annual export of 250 tons of *Piper guineensis* to Nigeria.

Tourism is very limited in Equatorial Guinea. The ECOFAC project facilitated the opening of a 10-room lodge in Monte Alén National Park. At this moment, this project is still very small, employing four guides and welcoming 45 tourists in 2007. Hotel capacity in Malabo and Bata has improved significantly in recent years.

Conclusions

The Guinean forest is poorly known, and intensive logging over the past two decades has led to a general impoverishment of the forest, especially for good quality timber. While forests are becoming less interesting economically due to the scarcity of high value timber, they are becoming more interesting for conservation purposes. Led by local technicians and international NGOs (CI in particular), initiatives are being prepared to promote forest recovery. The State appears ready to engage in protecting landscapes and biodiversity. The exponential growth of oil revenues suggests that financial resources could be mobilized. But, before committing significant resources, it is necessary to better know the state of the forests in Equatorial Guinea, both in terms of forest stands and biodiversity.

Photo 4.6: Non-timber forest products in a rural market.

CHAPTER 5
The Forests of the Central African Republic in 2008

Alain Billand
With collaboration from: Gaston-Prosper Nakoé, Hervé Maidou, Josiane Kondaoulé, and Oyele Minile Sako

Introduction: The Macro-Economic and Political Context

The Central African Republic (CAR) covers an area of 620,655 km^2 and has approximately 4.2 million inhabitants, according to 2005 estimates. The table (table 5.1) of estimated population in CAR between 1980 and 2050 indicates that the population will double in the 30 years between 1980 and 2010.

The last decade has been marked by numerous rebellions and sporadic conflicts. Presidential and legislative elections were held in 2005, enabling CAR to experience a period of relative stability. Since 2007, CAR has experienced tensions on its borders to the north and east related to conflicts between Chad and Sudan. These conflicts led to the installation of an operational EUFOR detachment in Birao in March 2008. According to the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), nearly a quarter of people in CAR are victims of violence and fighting has displaced approximately 295,000 persons, with almost one third fleeing to Chad, Cameroon or Sudan.

Table 5.1: Estimated population of CAR 1980-2005 and projection through 2050

Year	Population (x 1,000)
1980	2,329
1985	2,678
1990	3,008
1995	3,450
2000	3,864
2005	4,191
2010	4,592
2015	5,021
2020	5,434
2025	5,831
2030	6,214
2035	6,586
2040	6,946
2045	7,289
2050	7,609

Source: United Nations, 2006.

Gross Domestic Product

With a GDP in 2007 of CFA 820,588 million, the Central African Republic is among the poorest countries in the world, having a *per capita* Gross National Income of $ 360. The poverty rate is close to 70 % and social indicators are very low, explaining its rank of 172nd out of the 177 countries evaluated in the United Nations 2006 Human Development Index.

In late December 2006, the external debt service and guarantee of CAR were estimated at $ 1.1 billion in nominal terms, or $ 856 million in net present value (NPV). The International Monetary Fund (IMF) conducts regular missions to review programs supported by the Poverty Reduction and Growth Facility (PRGF), including the economic and financial performance of the programs as well as progress in implementation. In late 2007, the International Development Association (IDA) of the World Bank and the IMF established that the Central African Republic was eligible to benefit from debt relief under the enhanced Initiative for Heavily Indebted Poor Countries (HIPC) and had reached its decision point. CAR is the 32nd country to reach its decision point under the Initiative.

Some creditors will grant the Government of CAR debt reduction immediately, but to receive irrevocable debt relief at its completion point, CAR will have to implement a comprehensive package of reforms starting in 2008. In particular, CAR must: continue to implement an economic program supported by the PRGF of the IMF; develop a strategy for reducing poverty; and carry out key reforms to improve public finance management, governance and transparency, markedly in the mining and forestry sectors, which are critical for growth.

Photo 5.1: Forest understory in Dzanga-Ndoki National Park.

In addition to debt relief under the HIPC Initiative, CAR will be eligible for assistance from the Multilateral Debt Relief Initiative (MDRI) when it reaches its completion point under the HIPC Initiative. This will further increase the resources that the government has to reduce poverty. Debt relief provided under the enhanced HIPC Initiative will be approximately $ 583 million in NPV terms, which represents an additional reduction of 68.1 % beyond traditional debt relief granted by bilateral and commercial creditors. The notional amount of debt relief granted under the HIPC Initiative is estimated at $ 823 million.

The IDA aid contribution to CAR under the enhanced HIPC Initiative amounts to $ 209 million in NPV terms, including the donation of $ 66 million represented by the elimination of arrears in November 2006. After the directors of the IDA and the IMF determined that CAR had reached its decision point, the IDA began providing the remaining balance of their aid ($ 143 million). The IMF will provide assistance in the amount of $ 27 million (equivalent to SDR 17.33 million[24]) in NPV terms under the HIPC Initiative. According to principles established with regards to sharing the burden of the enhanced HIPC Initiative, the other creditors of CAR will provide the balance of the debt relief under the Initiative.

Assuming that CAR reaches its completion point before the end of 2009, debt relief granted by IDA under the MDRI framework would amount to $ 75 million in NPV terms at the point of decision, or approximately $ 182 million over the entire period. Debt relief granted by the IMF under the MDRI is estimated at some $ 1.6 million in nominal terms (World Bank, 2008).

The 2007 value-added of the forest sector was CFA 51,722 million or 6.3 % of GDP. The value of exports (all sectors combined) was calculated by ICASEES (*Institut centrafricain des Statistiques et des Études économiques et sociales*) at CFA 124,618 million with 41.1 % CFA allocated to the forestry sector.

Forest Resources and Land Cover Changes since 1990

Forest Areas

Photo 5.2: Savanna landscapes dominate CAR.

With 283,136 km² of dense forest, dense deciduous forest and forest-savanna mosaic, forest cover occupies nearly half (45.6 %) of the national territory, with a predominance of open forest. Closed forest (i.e. dense, semi-humid, dry and gallery forests) covers about 92,500 km² or about 15 % of the territory. Only a fraction of the closed forest is considered production forest, where the State has instituted industrial logging permits. The production forest represents 3,800,000 ha in the south-western forest region.

Change in Forest Cover since 1990

Forest cover in CAR, and its evolution since 1990, has been estimated using different sampling methodologies by several organizations and groups.

Every five years, the FAO carries out a review of global forest resources. The last available assessment is from 2005 and indicates a total forest area in CAR of 23.203 million hectares, supplemented by 10.122 million hectares classified as "other wooded land." These data for 2005 are accompanied by an estimate of the annual rates of change in forest area, for the periods 1990-2000 and 2000-2005. For these two periods, the change in the extent of forest appeared stable with a loss of 0.1 % of forest area per year.

[24] The SDR is an international reserve instrument created by the IMF in 1969 to complete official financial reserves in member countries. SDRs are allocated to member countries in proportion to their quota-share in IMF. The SDR is also an account unit at the IMF and certain other international bodies. Its value is determined using a basket of currencies.

Table 5.2: Forested area of CAR by land cover category

Land cover	Area (ha)
Lowland dense forest	4,614,732
Sub-montane forests (900-1500 m)	1,440
Mountain forest (>1500 m)	0
Swamp forest	27
Mangrove	0
Total dense forests	**4,616,199**
Forest-cropland mosaic	1,816,380
Forest-savanna mosaic	22,774,437
Dense deciduous forest (Miombo)	922,923
Other plant formations	30,970,737
Cropping land	917,676
Other land uses (town, villages, industrial sites…)	47,106
Total	**62,065,458**

Source: compilation of land cover data produced by UCL, JRC and SDSU.

Table 5.3: Change in forest cover in CAR from 1990 to 2005

Forest							Other forested areas		
Area			Annual rate of change				Area		
1990	2000	2005	1990-2000		2000-2005		1990	2000	2005
*1,000 ha	*1,000 ha	*1,000 ha	*1,000 ha/yr	%	*1,000 ha/yr	%	*1,000 ha	*1,000 ha	*1,000 ha
23,203	22,903	22,755	-30	-0.1	-30	-0.1	10,122	10,122	10,122

Source: FAO, 2005.

In 2004, another estimate of forest area in CAR was published by the JRC (Mayaux *et al.*, 2004) which used a different method for identifying forests by satellite and relied on a different forest typology than that used by FAO. This estimate suggested that forest cover in 2000 consisted of 8.227 million hectares of dense forest, 21.395 million hectares of forest mosaics, 24.746 million hectares of wooded land, and 5.665 million hectares of woody brushlands.

Finally, in 2008, Duveiller *et al.* (2008) published a new estimate of the rate of deforestation for the period 1990-2000, using a sampling of high-resolution satellite images. This estimate indicates a gross deforestation rate for the dense forest strata of 0.13 % per annum between 1990 and 2000. The authors nevertheless express reservations about the accuracy of this information for CAR because it was obtained from a limited number of samples.

Photo 5.3: Landscape mosaics are formed by alternating areas of forest and savanna.

Legal and Institutional Framework for Managing Biodiversity Resources

Legal Framework

Forests

Until 2008, the primary text relating to forests and wildlife was Law N°. 9003 from June 9, 1990. At the end of 2008 and after nearly two years of drafting and consultation, this law was the subject of major reform and was formally approved by CAR's parliamentary institutions in September 2008. The text came into force on October 17, 2008 (Law N°. 08.022).

As concerns logging, three implementing provisions of the 1990 Act are in force. Decree N°. 91098 of February 2, 1991 lays down detailed rules for granting logging and management permits ("*Permis d'exploitation et aménagement*"). A May 2006 ministerial decision cancelled special cutting permits ("*Permis spéciaux de coupe*"), putting an end to a logging system that was difficult to track and had poor sustainability. Finally, Ministerial Decree N°. 019 MEFCPE from July 5, 2006 validated the national norms for preparing management plans that remains in force.

Wildlife and protected areas

In 1916, the first law on wildlife protection was promulgated, prohibiting hunting in reserves, and in 1925, the first two game reserves were created in the eastern part of the country. In 1929, a decree was enacted which provided for the establishment of national parks and reserves on the condition that they not harm economic activity in the regions where they were established, and subsequently the first national park was created in 1933.

Under the heading "Partial hunting reserve," a new category of protected area was established in 1935 where hunting was permitted for a period of six months. Hunting was completely banned in these protected areas in 1939, at which point they became wildlife reserves. In 1940, the national parks were redefined and in 1944 all other categories of protected areas were established. Finally in 1954, the definitions of different classifications of protected area were brought into accordance with the London Convention. More recently, several official documents concerning environmental protection have been promulgated, they include:

- the July 2, 1984 Order N°. 84045 on wildlife protection and hunting regulations;
- the July 9, 1990 Law N°. 90003 establishing the Central African forestry code;
- the Act of November 9, 1965 concerning the national forest domain;
- multiple laws concerning the establishment of protected areas and their management.

Texts for wildlife are comparatively more numerous, with 14 orders and decrees identified for the period between 1971 and 2006. These texts relate to hunting weapons regulations, general hunting regulations (permitted and prohibited practices, the trade in hunted products, enforcement) and trophy hunting regulations (guides, sectors and areas, quotas). An official land management plan exists for CAR which divides the territory into different management units according to land use: agricultural zones, forest areas, hunting areas, etc. In practice, grazing and mining are increasing both in forest areas and hunting zones.

There are four other important texts for natural resource management. Among these texts, the Environmental Code is new, while other important texts are part of the first generation of laws created after the country's independence:

- Environmental Code, Law 07018, of December 28, 2007;
- Law 62/350 on the organization of wildlife protection in CAR;
- Law 65/61 regulating ranching in CAR;
- Law 61/208 on the mining code.

Finally, at the international level, it should be stressed that the Central African Republic has signed the following conventions concerned with biodiversity: the African Convention of Algiers; the World Heritage Convention (UNESCO); the Washington Convention (CITES); the Berne Convention; and the Bonn Convention.

The Ministry of Water and Forests, Hunting and Fisheries and the Environment (*Ministère des Eaux et Forêts, Chasse et Pêches et de l'Environnement* -MEFCPE) has had several names in the past, but its main mission to sustainably manage ecosystems and renewable natural resources, has remained constant since 1982.

A Forest Fund supported by forest taxes was established in 1992 to contribute to forest and tourism development in the country. This fund was transformed into the Trust for the Development of Forestry and Tourism (*Compte d'Affectation spécial pour le Développement forestier et touristique* CAS-DFT), which split into two separate funds in 2008: forestry development (CAS-DF) and tourism development (CAS-DT). The tax recovery rate for the DF account is high, reaching nearly 100 % annually, despite occasional delays from some concessionaries. The fund has been used to provide matching funds for large forestry projects benefitting from international public assistance. Through 2007, CAR was successfully able to honor its commitments to donors, which is exemplary in the sub-region. The fund has also permitted CAR to cover membership fees or dues to international associations (i.e. UN, FAO) and supported the participation of CAR in important international meetings. This financial mechanism is the only one that has been maintained, with IMF requesting the closure of other funds and accounts in the sector. Unfortunately, since 2007, the CAS-DF has regularly been requisitioned by the government and has accumulated major payment delays. The CAS-DT created jointly by the MEFCPE and the Ministry of Tourism in 2008 is devoted to combating poaching and promoting tourism.

The wildlife administration has a total of 80 staff, with varying levels of training, that are divided between their central administration and decentralized services.

Table 5.4: Number of staff in the CAR wildlife administration according to division and level of training

Level of training	Central administration		Decentralized services		Total	
	Wildlife	Forests	Wildlife	Forests	Wildlife	Forests
University	8	12	5	48	13	60
Advanced technicians	4	6	8	32	12	38
Technical officers	25	12	30	80	55	92
Total	**37**	**30**	**43**	**160**	**80**	**190**

Source: MEFCPE-FORAF, 2008.

In terms of logistical capacity, MEFCPE has a network of radio transmitters, 25 vehicles, 11 motorcycles and 18 buildings, including the Ministry headquarters in Bangui and 17 more decentralized buildings. In some provinces, the decentralized services responsible for wildlife or forests share space with other administrative services, such as *préfets* or *sous-préfets*. The Ministry had a budget of CFA 5.3 billion in 2007, which declined to CFA 3.6 billion in 2008. These amounts are incredibly low (about € 8,000). The CAS-DF Forest Fund has received increasing revenues, rising from CFA 1.8 billion in 2006 to CFA 2.1 billion in 2007. The structure of this type of extra-budgetary fund means it cannot be used directly by the ministry for current expenditures. However, most of the CAS-DF appears to be used for purposes other than the forestry sector. The funds for wildlife and tourism development are financed by taxes on hunting. CAR has established an independent mechanism for wood export controls on its borders with BIVAC, a company providing import control and inspection services. BIVAC, which is managed by a private international supervisory body, oversees the collection of forest export taxes and transfers them to the customs office after deducting their compensation.

Photo 5.4: Water is an omnipresent element in Central Africa.

Training and Research

CAR has three levels of forestry training: the university; the *Institut supérieur de Développement rural* (ISDR), which trains senior technicians and engineers; and the *Collège technique de Développement rural* (CTDR), which trains technicians who successfully completed the equivalent of three years of high school education, but were unsuccessful at the BAC.

Besides the university, there are other institutions such as the *Institut centrafricain de Recherche agronomique* (ICRA), which specializes in agricultural research. Based in Bangui, the center has branches in Boukoko, Bambari and Bouar.

Forest Logging and the Timber Sector

Typology of Forestry Titles

The only official logging license in CAR is the operating and management permit (*Permis d'exploitation et aménagement,* PEA). This permit grants industrial logging rights, according to prevailing national norms and the specific terms of a management convention. In return, the company pays rent for the area and a fee related to the volume produced and exported.

The PEA is awarded by tender, following the decision of an allocation committee and issuance of a presidential decree.

The new forest code modified the duration of PEA allocations. Previously, the duration corresponded to the lifespan of the company, but it is now limited to the rotation duration (provided the terms of the management plan are met). The granting of the PEA is conditional to the implementation of a management plan and installation of a processing plant with an industrial processing rate of over 70 % (article 44 of Law N°. 08.022 of 17 October 2008, Forestry Code).

Formal Logging in Natural Forests

Due to the small number of PEAs, forestry statistics on the production of logs have a high degree of variation. If one or two PEAS encounter problems or delays the statistics on production for the country are impacted significantly. At the end of 2007, three PEAs were returned to State control and their production halted completely. Industrial forest production in the CAR is expected to stabilize gradually after the State allocates these three PEAs to companies. All production today is done in accordance with management plans. These documents include much stricter controls on the species and the annual volumes to be harvested. In addition, the use of management plans provides the State a means to estimate expected forest revenues, which can now be predicted over practically the whole rotation period.

Table 5.5: Wood production in CAR from 2005 to 2007 (m^3)

Product	2005	2006	2007
Logs	454,402	624,861	537,998
Sawn wood	71,386	84,304	97,001
Sliced veneer	-	-	-
Peeled veneer	4,686	6,293	4,300
Plywood	1,434	805	740

Source: MEFCPE-FORAF, 2008.

National statistics monitor over thirty commercial species. From one year to the next, two species alone represent around 70 % of the log volume harvested, sapelli and ayous. Five to seven other species have production exceeding 1 % of the total volume, including kossipo, aniégré-longhi, sipo, iroko, tiama, bossé, padouk. The other species monitored nationally are exploited in a very marginal fashion with volumes for each species below 1 % and a cumulative total of approximately 12 %.

It should be noted that logs and sawn wood exports stabilized for the period 2006 and 2007.

Table 5.6: Tree species logged in CAR and corresponding volume of logs produced from 2005 to 2007 (m³)

Species	2005	2006	2007
1. Acajou	8,075	4,841	1,926
2. Ayous	108,577	93,557	81,279
3. Bossé	4,263	5,177	5,122
4. Dibétou Bibolo	1,270	9,419	8,390
5. Various red wood	4,793	10,332	11,110
6. Iroko	32,062	18,620	22,458
7. Kossipo	6,786	37,174	24,033
8. Longhi aniégré	46,228	29,327	34,506
9. Padouk	0	2,019	6,195
10. Paorosa	0	17,538	1,107
11. Sapelli	215,220	335,604	295,954
12. Sipo	21,896	28,909	21,098
13. Tiama	3,095	14,399	14,561
14. Doussier	0	4,051	3,059
15. Bété	0	1,033	840
Other (16 to 34)	2,138	12,862	6,360
TOTAL	**454,403**	**624,862**	**537,998**

Source: MEFCPE-FORAF, 2008.

Table 5.7: Wood product exports from CAR between 2005 and 2007 (m³)

Product	2005	2006	2007
Logs	145,912	192,259	193,213
Sawn wood	52,940	70,779	76,042
Peeled veneer	4,686	6,293	4,300
Sliced veneers			
Plywood	4,880	475	513
Planed sawn wood			
Other			

Source: MEFCPE-FORAF, 2008.

Production statistics by region and importing countries demonstrate the sensitivity of Central African production to fluctuations in international markets. After steadily increasing since 2000, exports to China appear to be stabilizing at around a third of the total volume of logs exported. Among the significant changes in 2007, are the halting of exports to Switzerland, the strong increase in the Turkish market and the doubling of exports to France.

Forestry legislation in force in the CAR does not provide for the existence of communal or community forests.

Table 5.8: Destination of log exports from CAR between 2005 and 2007 (m^3)

Region	2005	2006	2007
Europe	113,491	111,499	83,156
South-East Asia	22,106	64,420	69,035
North America			
African countries outside of COMIFAC			
COMIFAC countries	4,896	15,166	18,832
Other destinations	5,418	1,174	22,191
Total	**145,911**	**192,259**	**193,214**

Source: MEFCPE-FORAF, 2008.

Table 5.9: Importing countries of logs from CAR by annual imported volume (m^3)

Country	2005	2006	2007
Germany	26,772	29,906	28,925
England	15,504	24,505	26,628
Belgium	178		
France	13,260	10,357	20,150
Italy		404	3,758
EU	4,073		3,695
Switzerland	53,704	46,328	
China	16,434	27,498	24,035
Hong Kong	5,673	36,790	45,000
Shangaï		132	
Cameroon	4,896	14,953	18,832
Congo		213	
Turkey	178	619	22,191
Other	5,240	555	
Total	**145,912**	**192,260**	**193,214**

Source: MEFCPE-FORAF, 2008.

Industrial Timber Processing

Wood processing is performed by seven industrial sawmills, with a total capacity of 500,000 m^3, and a peeling plant. There is only one secondary processing unit, a plywood plant, which mainly serves the sub-regional market (MEFCPE-FORAF, 2008).

Informal Sector

As in all Central African countries, people in CAR use wood extensively as a source of domestic energy. Data on the volumes of wood harvested in the informal sector, as well as the sectors affected and revenue generated, are under-represented in national statistics.

There is an important artisanal timber sector, which creates legal problems particularly when the artisanal sector processes logs that are accounted from PEAs under State contract.

In terms of bushmeat hunting, an FFEM-funded project, PGTCV, implemented by CIRAD, showed that between 1999 and 2006 the tonnage of bushmeat sold in the main market in Bangui (PK12) did not change. The turnover of this market alone was estimated at CFA 14 billion per year, or 2.2 % of GDP in CAR.

Photo 5.5: Collecting wood is an important informal sector activity upon which rural communities depend.

Progress Towards the Sustainable Management of Production Forests

At the end of 2008, all awarded PEAs had agreements with the State noting their management plans were either in preparation or operation. An area assigned to the forest company SEBOCA was authorized by the Administration to carry out logging without PEA status, despite the fact that PEA is the only legally recognized status. Consequently SEBOCA production is not subject to PARPAF support and has no commitment to a management plan. The company is nevertheless subject to the same taxes as the PEAs, which they pay regularly at least in terms of surface area and felling, and is also among the companies under the purview of the BIVAC independent auditor for exports.

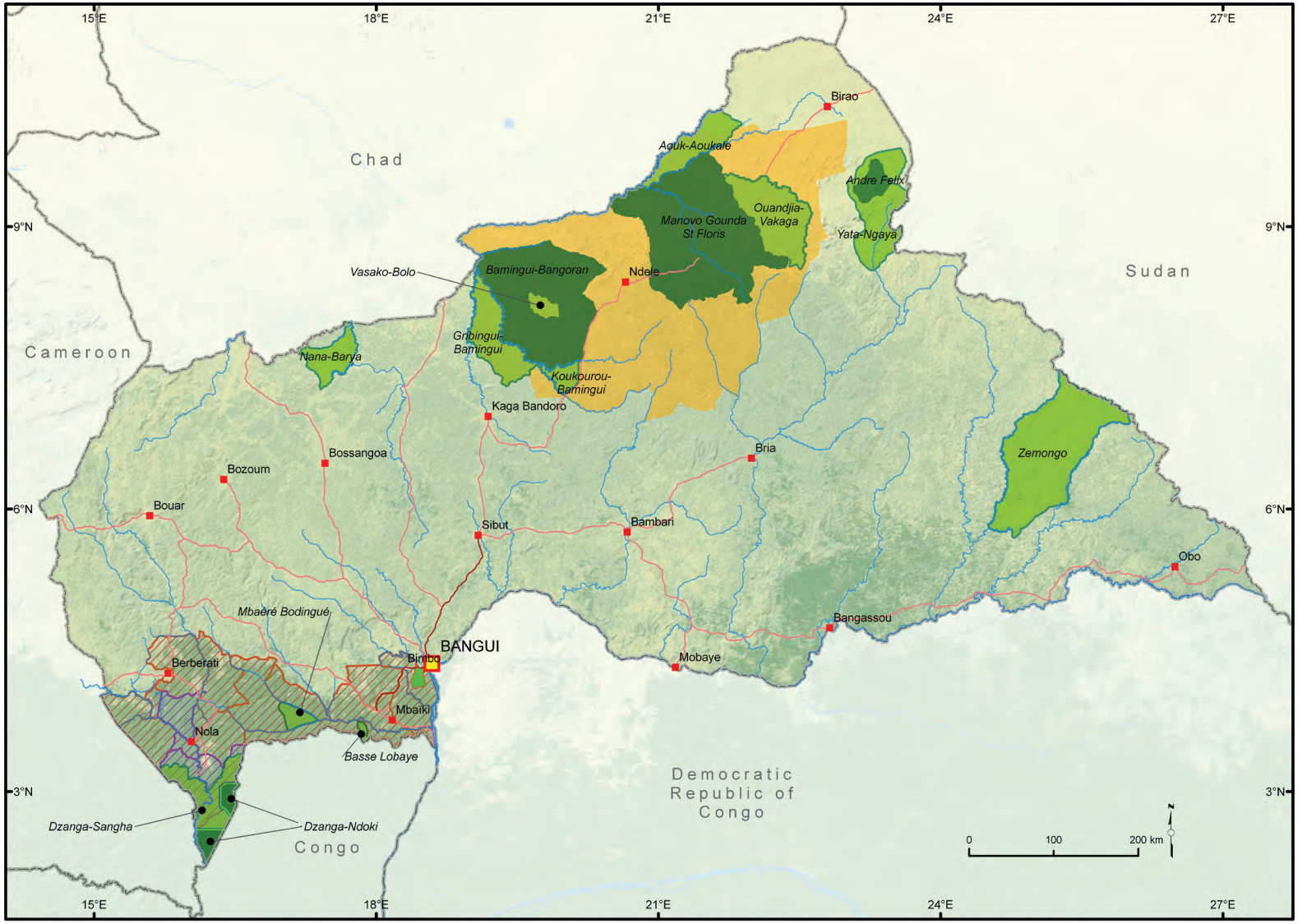
Table 5.10: State of forest management in CAR in 2008

Forest concessions	Number	Area (ha)
Under final agreement (approved management plan)	8	1,739,055
Under provisional agreement (management plan in preparation)	3	582,789
Process not initiated	3	
Total concessions already allocated	**11**	**2,321,844**
Total annual cutting zones (AAC) in 2007	**10**	**81,684**

Note: the annual cutting zones only affect those concessions with final agreement. SCAD has three open zones and SEFCA has two.
Source: MEFCPE-FORAF, 2008.

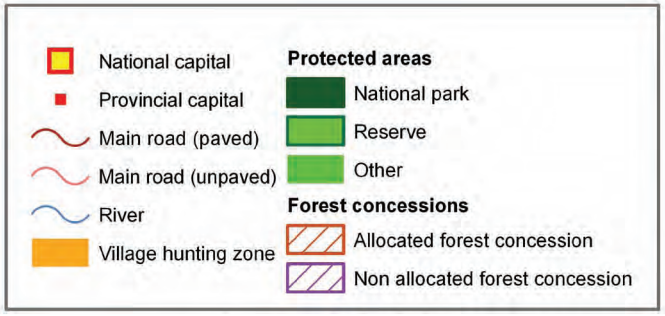
As of mid-2007, the PEA 169, assigned in 2006 to the company IFB, had an OLB legal certificate covering 19,550 hectares. No CAR company is formally committed to a process of voluntary eco-certification; however, preliminary contacts have been made between SCAF and WWF for possible support in this direction.

Since 2007, CAR has taken first steps towards the FLEGT process, with a letter of intent to engage in negotiations towards a voluntary agreement and the establishment of a AFLEG/FLEGT focal point, with support from the European Union.



Sources: PARPAF, PARN, ECOFAC, GTZ, WRI, and FORAF.

Figure 5.1: Forest concessions and protected areas in CAR



Biodiversity Conservation and Development

Biodiversity Components in CAR

Ecosystem diversity

CAR is covered by four major ecological domains, which from south to north include the dense equatorial forests, the Sudano-Guinean woodlands, the Sudan savanna woodlands and the Sudano-Sahelian steppes.

Table 5.11: Ecological and phytogeographical domains of CAR

Ecological domain	Vegetation	Observations
Congo-Guinean	- Dense humid forest (south-western tip) - South eastern forests (Bangassou) - Peri-forest savanna in the south west	The dense forests in the south west are the only forests in industrial production.
Sudano-Guinean Medio-Sudano	- Wooded and tree savanna - Dense semi-humid forests and gallery forests	All the central, eastern and western part of CAR, more than 2/3 of the territory.
Sudano-Sahel	- Shrub savanna, grassy savanna on cuirasse and steppes	Far north of the country

Source: Boulvert, 1986.

Diversity of species

There is no comprehensive report on biodiversity in CAR. The report "National Strategy and Action Plan on Biodiversity" (MEEFCP, 2000) presents a count of 3,602 species of plants, including 2.8 % endemic species, "out of a potential of 5,000 assumed to exist on the national territory." The report further states "with regard to wildlife, it has proved very difficult to get an accurate picture of the abundance of different species inhabiting different ecosystems in particular in forests and outside protected areas and game reserves."

According to the World Conservation Monitoring Center (WCMC), CAR has about 1,010 known species of amphibians, birds, mammals and reptiles, of which 1 % are endemic and 1.5 % are threatened. IUCN reports 224 species of mammals in the CAR, of which four are classified as endangered, eight are vulnerable and nine are threatened. The most detailed information available on wildlife comes from inventories carried out in specific protected areas. Since 2002, forest concessions have also included surveys of wildlife in their inventory management statistics, but the data have not been analyzed to evaluate biodiversity throughout the dense forest area in the south west. The northern areas are rich in wildlife and have been open to game hunting for many years. They are nevertheless experiencing major poaching problems related to sub-regional tensions. Table 5.12 presents the results of a survey conducted in August 1998 in Manovo Gounda Saint-Floris National Park.

Table 5.12: Population numbers of key mammal species

Species	Number
Leopard	900
Lion	170
Cheetah	50
Elephant	2,000
Hippopotamus	900
Giraffe	475
Waterbuck	200
Kob	3,500
Reedbuck	1,400
Giant Eland	900
Damalaisque	300
Hartebeest	1,000

Source: MEEFCP, 2000.

Overall, there is agreement that due to a series of factors there has been a significant decrease in wildlife in CAR over the past two decades, especially in savanna areas. Certain mammal species have almost completely disappeared, as is the case with the white rhino (in 1950) and black rhino (in 1985) (MEEFCP, 2000). Many other species have been significantly affected, including elephants, hippopotamuses, crocodiles and giraffes. It is estimated that 75 % of elephants disappeared in north CAR between 1982 and 1985 at the peak of the heavy poaching period. After a respite between 1990 and 2000, elephant poaching is once again intensifying due to the growing demand of the illegal trade in ivory.

Protected areas and hunting zones

There are a total of 15 protected areas in IUCN categories I to IV. In addition, 33 designated hunting zones and 11 community-based hunting zones have been identified under Order 019 of August 30, 2007. In total, the protected areas of CAR (all categories) cover an estimated area of 17,330,015 ha, representing approximately 28 % of the national territory.

Table 5.13: Protected areas in CAR by IUCN category

Type of protected area	IUCN category	Number	Total area (ha)
Integral reserve	I	1	**86,000**
National park	II	5	**3,188,700**
Special reserve	IV	2	**316,815**
Wildlife reserve	IV	5	**2,440,000**
Biosphere reserve	I and IV	2	**14,600**
Designated hunting zone	VI	47	**7,931,800**
Community-based hunting zone (ZICGC) (11 set up and operational)	VI	11	**3,332,100**
Total		**73**	**17,330,015**

Source: MEFCPE-FORAF, 2008.

No protected area is implementing an approved management plan, including those that have enjoyed long-standing project support. However, most sites are under management and in the process of developing management plans, with draft versions of management plans available.

Table 5.14: State of protected areas management in CAR in 2008

Protected area	IUCN category	Area (ha)	Status of management plan
Vassako Bolo Integral Reserve	I	86,000	In preparation
Dzanga Ndoki National Park	II	122,000	1st draft finalized
Manovo Gounda National Park	II	1,740,000	In preparation
Bamingui Bangoran National Park	II	1,070,000	In preparation
Mbaéré Bodigué National Park	II	86,700	In preparation
André Félix National Park	II	170,000	Nonexistent
Dzanga Sangha Special Reserve	IV	315,900	1st draft finalized
Gbazabangui Special Reserve	II	915	2001
Basse Lobaye Biosphere Reserve	IV, V	14,600	Nonexistent
Zémongo Faunal Reserve	IV	1,010,000	Nonexistent
Aouk Aoukalé Faunal Reserve	IV	330,000	Nonexistent
Gribingui Bamingui Faunal Reserve	IV	230,000	Nonexistent
Yata Ngaya Faunal Reserve	IV	450,000	Nonexistent
Nana Barya Faunal Reserve	IV	420,000	Nonexistent
Designated hunting sector (80 set up but only 47 are used)	VI	7,931,800	Nonexistent
ZICGC (11 set up and operational)	VI	7,207,600	In preparation
Total		**21,185,515**	

Source: MEFCPE-FORAF, 2008.

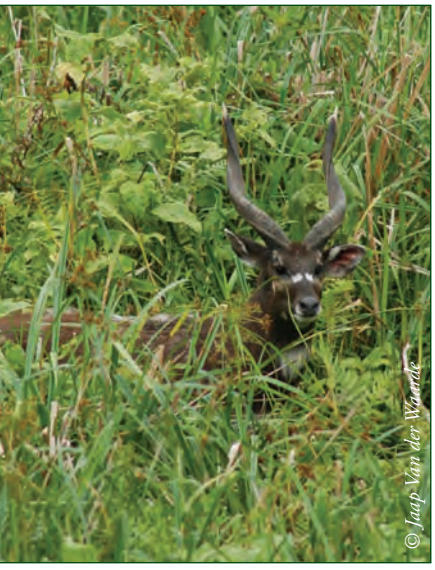


Photo 5.6: A male sitatunga (Tragelaphus spekei).

Biodiversity management in forest concessions

Within forest concessions there are two different types of zones that contribute to the protection of biodiversity:

- Conservation zones, whose main objective is the maintenance and preservation of special or fragile ecosystems. Logging is forbidden and the installation of new settlements or any form of agricultural practice is not permitted. Harvesting of non-timber forest products, fishing and hunting are permitted with restrictions imposed based on the Forest Code and the Code for the protection of wildlife.

- Integral protection zones, whose main objective is the integral protection of a section of a PEA and represents the equivalent status of protection of a wildlife reserve. They are defined taking into account biological surveys, in particular looking at elephant and ape presence and diversity among woody species. All forms of activity, including traffic, are prohibited except for research and ecosystem conservation purposes.

It should be noted that the limits of conservation zones and PEAs may be altered depending on the outcomes of participatory stakeholder workshops.

Economic Development of Biodiversity

Tourist infrastructure in protected areas

There is capacity for tourism and hunting in the country in the sites where 15 companies operate safaris. There are also two lodges in CAR: one at the Sangha Dzanga National Park (Doli Lodge of Bayanga) and one at the Mbaéré National Park (Red Buffalo Camp). There are an estimated 135 guest beds available in the periphery of protected areas. Forty-two guides operate in the protected areas (MEFCPE-FORAF, 2008).

In the north of the country, roads maintained for tourism and hunting are not accessible due to safety issues. All tourist facilities were destroyed in this region by armed conflict. In the south, 140 km of trails were constructed in the Bayanga sector.

Tourism

A total of 1,500 tourists visited the south of CAR in 2007 (MEFCPE-FORAF, 2008).

For recreational hunting, an estimated 190 visitors were recorded in 2007. They mainly frequented northern CAR despite security issues in the area. The giant eland remains the most prized species, a quota of 161 permits having been issued in 2007. Further, for 17 hunting companies, the hunting quotas in 2007 for the five major species were significantly higher compared to the previous year (30 % for the giant eland, 300 % for the lion) (MEFCPE-FORAF, 2008).

Table 5.15: Animal quotas allocated in CAR in 2006 and 2007

Species	Quotas 2006	Quotas 2007
Giant eland	127	161
Buffalo	280	364
Bongo	61	69
Leopard	41	56
Lion	9	27

Source: MEFCPE-FORAF, 2008.

For the hunting year 2006-2007, the number of permits granted stood at 190 big game/non resident permits, 24 big game/foreign resident permits, 13 big game/national permits and 57 medium game/national permits (MEFCPE-FORAF, 2008).

The number of medium game permits only affects the city of Bangui, where the residents acquire their licenses on the spot to go hunting in the provinces.

According to safari companies, the sector generated 800 direct jobs and 2,000 indirect jobs in 2007.

Conclusions

CAR has allocated nearly all of its production forests in the south west as PEAs, with the only other type of allocation being protected areas and reserves. Since the elimination of the special cutting permits, there are no other types of logging permits. Community forests do not exist according to the 1992 Act, however, the new forest code of 2008 provides for the establishment of municipal and community forests.

With the support of the PARPAF project, funded through AFD and the government of CAR via the CAS-DF, forest management has improved. At the end of 2008, all 11 PEAs allocated to concessionaries had formally approved management plans (8) or plans in preparation (3). Three other concessions were awaiting assignment in 2008.

Regarding the status of protected areas, there are significant differences between the situations in the north and the south. Management in the vast northern parks has been made difficult by the proximity of countries in conflict, which have created and sustained insecurity in large parts of the territory. Major support provided to some protected areas of northern CAR over 15 years by the European Union, through the NRDP and then the ECOFAC project, should be completed in 2010. The sustainability of the financing of protected areas in the north, and the surrounding village hunting areas, remains an important challenge. The possible decommissioning of a Biosphere Reserve unfortunately reflects the powerlessness of the country and of its international partners to ensure the sustainable integrity of some of the protected areas affected by conflict.

Park managers, forest concession managers and other local stakeholders in the south of the country are now part of a regular and constructive dialogue aimed at building sustainable and constructive relationships over the long term. The sustainability of these partnerships will depend on closer cooperation between the MEFCPE departments in charge of protected areas (DFAP) and forest management (DIAF).

Another challenge for the Administration will be to better harmonize conservation practices in the protected areas partnering with different projects and conservation NGOs, particularly with regard to management plans.

CHAPTER 6
The Forests of Congo in 2008

Nicolas Bayol and Richard Eba'a Atyi
With contributions from: Georges Claver Boudzanga, Grégoire Nkéoua and Claude Etienne Massimba

Introduction: The Macro-Economic and Political Context

Demography

Congo covers 342,815 km² and has an estimated population of 3.6 million (UNPP, 2006),[25] corresponding to a relatively low population density of 10.5 inhabitants per km². This population is mostly urban, with more than half of all Congolese living in the 6 largest cities. Population growth remains high, although in slight decline to 2.9 % per annum (CNSEE, 2006).[26] There are strong disparities, the forest area in the north being very sparsely populated, with fewer than 1.5 people/km² in the *départements* of Sangha and Likouala.[27] This population is distributed along the main communication axes, leaving vast areas uninhabited. The forests in the south are more populated and there are more serious threats to resources: subsistence farming, hunting, intensive logging for many years without any management planning to date.

Economy

Gross National Income in the Congo amounted to $ 6 billion in 2006, representing a *per capita* gross national income of $ 1,370 (World Bank, 2006). Growth remained high even during the period of conflict, and reached more than 7 % in 2007. The economy depends heavily on the oil sector, which accounted for 64 % of GDP in 2005. The country enjoys a favorable economic climate, with rising crude oil prices and growing domestic oil production (OECD, 2007). Despite this strong growth, with a growth rate of 6.8 % in 2006, Congo is still classified as "low human development" by the UNDP, with low life expectancy (52 years), and persistently high infant mortality albeit in considerable decline (approximately 70 per 1000) (ADB, 2008). The country lacks infrastructure. Rural people live mostly in isolation and the public health and education structures lack adequately trained staff.

Political Context

Congo suffered an armed conflict between 1997 and 2003, which greatly impoverished the country and caused considerable damage to infrastructure and the national economy. Thanks to regained stability, the country is gradually recovering from this painful episode in its history.

Contribution of the Forest/Environment Sector to the National Economy

The forestry sector contributes significantly to the national economy, although less in relative terms than the period up to the early 1970s. In 1974, timber generated 85 % of export earnings and accounted for 10 % of GDP.

The rise of oil has diminished the importance of the forestry sector. Production of timber and processed products represents the major part of the formal sector's contribution to the economy.

In 2006 forestry products made up only 5.6 % of the GDP (Anonyme, 2007). This figure masks the fundamental role played by the forest sector in terms of job creation and regional development in the most disadvantaged rural areas. The large informal forest sector is not reflected in this statistic. In 2007, about 7,400 direct jobs and 14,800 indirect jobs (MEF-FORAF, 2008) were generated from forest production. Many of these

[25] CNSEE, www.cnsee.org, provides population figures of 3,6 million for 2006 (estimate based on the last available census in 1984).
[26] According to UNDP, 2005. 2.8 % for the period 1975-2005.
[27] Calculated using CNSEE data.

employees reside in rural areas, with, for example, about 4,000 employees[28] in the forestry and timber sectors in the *Départements* of Sangha and Likouala (out of 140,000 inhabitants). The forestry sector is by far the largest provider of private employment in rural areas.

The strong contribution to the development of northern Congo is manifested *inter alia* by the recent establishment of a road network within the region, linking it to Cameroon and the Central African Republic. In addition, logging operators finance social infrastructure, facilitating the exchange of goods and people, and inject money into a previously under-monetized economy.

Forest Resources and Land Cover Change since 1990

Photo 6.1: Stilt roots are common in the dense forests of Central Africa.

Forest Areas

Forests occupy a prominent place in the Congo, with area estimates ranging from 22.4 million hectares (CNIAF, 2008) to 25.9 million hectares (Mayaux *et al.*, 2003).[29] This area is now estimated to 18.5 million hectares. The Congolese forest covers two thirds of the Congolese territory.

Table 6.1: Forested area in the Republic of Congo by land cover category

Land cover	Area (ha)
Lowland dense forest	14,384,835
Sub-montane forest (900-1500 m)	612
Mountain forest (>1500 m)	0
Swamp forest	4,108,545
Mangrove	0
Total dense forests	**18,493,992**
Forest-cropland mosaic	5,805,468
Forest-savanna mosaic	1,351,890
Dense deciduous forest (Miombo)	1,251,531
Other plant formations	6,824,178
Cropping lands	215,514
Other land use (town, villages, industrial sites…)	338,976
Total	**34,281,549**

Source: compilation of land cover data produced by UCL, JRC and SDSU.

[28] Figure obtained using available data from: IFO (950 employees), Mokabi SA (460), Likouala Timber (450), Bois et Placage de Lopola (200), CIB (1750), Thanry CONGO (exact value unknown).

[29] The State of the Forest 2006 reported an area of 22.2 million hectares of forest.

Change in Forest Cover since 1990

The annual rate of deforestation is very low, with a net rate of 0.02 %. Gross deforestation is a little higher, at 0.07 % per year, but this is offset by reforestation of 0.05 % (Duveiller *et al.*, 2008).[30] The deforestation rate is almost zero in the north of the country; the south was not included in this analysis due to lack of available satellite images, which can lead to an underestimation of national deforestation rates. In some areas the rate of deforestation is higher, for example around the city of Ouesso there was more than 2 % increase in deforested areas between 1990 and 2003 (MEF-FRM-UT, 2007). Shifting cultivation is the main cause of deforestation. This can be observed on satellite images around the main cities (Brazzaville, Pointe-Noire, Nkayi, Dolisie, Ouesso) and along roads. Human activities such as logging, firewood harvesting and bush fires can cause forest degradation (a reduction in biomass) and potentially affect biodiversity, without having a major effect on the evolution of forest cover and without compromising forest sustainability. At present, mining and agro-industry have no marked impact on Congo's forests. But many mineral operations currently under way (approximately 60,000 km² in 2005, 17.5 % of the forest estate is designated for mining permits[31]) could result in future extraction of the identified deposits. A revival of agro-industrial activities is possible; for example, re-starting palm production at the Sangha plantation near Ouesso plantation is envisaged.

Legal and Institutional Framework for Managing Biodiversity Resources

Legal Framework

The Congolese forest is made up of state forest and private forest. The state forest domain is divided into three sectors, or zones, and then into Forest Management Units (FMU or *Unités forestières d'Aménagement)*. Some FMUs, including forest areas in the south and center are sub-divided into Forest Logging Units (FLU or *Unités forestières d'Exploitation*). Law 16-2000 pertaining to the Forest Code establishes the legislative framework for forestry. Under the code, development plans must be prepared for FMUs. The assignees sign a convention with the Ministry of Forest Economy (MEF) which sets out the obligations of the contractor and general specifications, including a development plan, industrial facilities, vocational training and social and logging infrastructure. Finally, as in other regional countries, the Forestry Code introduced a bidding process for allocating FMU and FLUs.

This law was supplemented by legislation, including decree 2002-437 which establishes conditions for management and use of the forests. It also states that the assignee companies are responsible for preparing management plans for the FMU and FLUs. But in Congo, more than in other regional countries, the Ministry responsible for forests is strongly involved in developing and evaluating management plans. An MEF agent is assigned to each management cell, and steering committees provide technical monitoring of projects. Approval of reports, preliminary studies and management plans are made after a thorough technical review conducted by the administrations. In addition, there is a clear willingness to achieve the broadest validation: other ministries are consulted to validate the decisions on land use, and ultimately, management plans are approved following a public meeting involving all local stakeholders.

The national planning guidelines adopted in March 2004 set out the broad guidelines for drafting a management plan. They include:

- general management directives for forest concessions;
- specific management directives for zones for production, conservation, protection, scientific research and community development;
- the framework for drafting forest management plans.

National standards for forest management and terms of reference for preparing additional studies (socio-economic, environmental...) were adopted in December 2005. They take into account the implementation and technical organization of the following:

- forest inventories;
- dendrometric studies;
- cartographic norms.

[30] The different work carried out recently on deforestation provides estimates ranging between 0.01 and 0.6 % per year.The FAO Forest Ressources Assessment 2005 provides an estimate of 0.6 % per year for a 15-year period. The State of the Forest 2006 provides a value of 0.03 %.

[31] Estimated using data from the *Atlas interactif du Congo* (WRI/GFW, 2007)

Photo 6.2: Transportation of firewood by canoe.

In the end, this is a series of normative rules aimed at establishing conditions for implementing technical operations, with a view to facilitating the implementation and monitoring of technical works, while ensuring optimal performance.

Environmental and Wildlife Laws

Laws governing wildlife management (Laws 48/83 and 49/83 of 21/04/1983) and the environment (Law 003/91 of 23/04/1991) are in revision. For hunting, the law defines the conditions for subsistence hunting (considered as a right of use), the procedure for obtaining a hunting license, the closed seasons for hunting, the fully or partially protected species, and prohibited hunting techniques.

Land Use

The Republic of Congo has not implemented a national land use plan. A National Master Plan for land use was developed in 2005 (Ministry of Planning, Land Development, Economic Integration and NEPAD, 2005), which defines the priority vocation of each development areas but without enacting local land use.

In forest areas under development, the zoning is determined by the forest management plan. Management and use of forests is determined in accordance with the provisions of decree 200-347 of 31/12/2000. Based on article 24 and results of baseline studies, the FMUs, are divided into different development zones. For each forest management plan, this involves defining a series of zones, including production zones, conservation zones, protection zones, community development zones and scientific research zones. Other zones may be created according to the specificities of each forest concession. Of all the FMUs already managed, the areas were divided into community development zones, with a mixed goal of agricultural production and timber supply for local people.

Institutions and Capacity

As is the case in other countries in the region, the functions of the former Ministry of Forest Economy and the Environment have been reassigned to two different ministries: the Ministry of Forest Economy (MEF) and the Ministry of Tourism and the Environment. The main tasks and functions of the MEF are:

- management of the forestry sector (formulation and monitoring-evaluation of policies and strategies…);
- management of forest resources and forest management;
- the forest economy (promotion of forest product development, statistics, support for the professionalization of the artisanal sector…);
- supervision of rural forestry;
- research and training;
- management of wildlife resources.

In 2008 the staff of MEF included 750 officers, including 350 forest and wildlife technicians. The forestry administration generally suffers from a lack of staff, particularly skilled personnel. It also lacks resources, with only 16 vehicles and 30 motorcycles throughout the territory.

Under MEF supervision, four implementing agencies carry out part of the forestry mission:

- Forestry Fund (FF);
- National Reforestation Service (SNR, or *Service national de Reboisement*);
- National Inventory Center for the Management of Forest and Wildlife Resources (*Centre national d'Inventaire et d'Aménagement des Ressources forestières et fauniques* (CNIAF), responsible for formulating and developing forest management plans and monitoring implementation;
- Service to Monitor Forest and Wildlife Products for Export and Import (*Service de Contrôle des Produits forestiers et fauniques à l'Exportation et à l'Importation* (SCPFFEI), with branches in timber producing areas.

At local level, forest operations are monitored by the Departmental Directorates of the Forest Economy.

Training and research institutions

The General Delegation for Scientific and Technological Research (DGRST) is the body for implementing national research policy. It is responsible for coordinating and monitoring all research activities conducted within the national territory, both from institutions under its direct

supervision and those from other ministries and NGOs.

The main forestry training institutions are:

- the *École nationale des Eaux et Forêts de Mossendjo;*
- the *Institut de Développement rural* (IDR), which houses a forest technology division;

Restructuring programs

In 1997, Congo completed its Tropical Forestry Action Plan (TFAP), launched in 1990. The plan identified the most important orientations to forest policy with a view to:

- better integration of sustainable development into the Forest Code;
- reviewing the concepts of permanent and non-permanent domain;
- taking ecological biodiversity, as well as social data, into account in forest management;
- reviewing all FMU allocation mechanisms.

A sectoral forest and environment program (*Programme sectoriel Forêt et Environnement*-PSFE) is in preparation.

Forest Logging and the Timber Sector

Timber from Congo forests has been exploited since the early 20th century. At that time, only forests, almost all of them, in southern Congo were affected. The northern forest massif, much vaster, was not effectively logged until the 1970s. The forest of northern Congo, which contains nearly 2/3 of the productive forests in the country, provided only 18 % of national log production in 1974, compared to more than 80 % in 2000 and 65 % in 2004. To date, that zone accounts for over 70 % of production. Much of the productive forest area in northern Congo has never been subjected to logging.

In the 1970s, many projects were conducted to assess the forest resources available in the forests of Congo, much of the Congolese forest was inventoried and high quality planning documents were prepared.

Early on in their development, the FMU and FLUs benefited from a simplified planning regime, with the maximum annual volume (VMA) set for each FMU and FLU. Although this management did not include genuine concern for resource sustainability and forest function, it made the Congo a regional pioneer in the forest management field.

Typology of Forestry Titles

The commercial exploitation of all forest products in the state domain, including those that are the subject of a long-established activity among local people, is conducted either by board or by logging permit holders from the water and forest authorities. These titles, referred to in article 65 of Law 16-2000 of 20/11/2000 pertaining to the Forest Code, are the industrial processing convention (CTI or *Convention de Transformation industrielle*), the management and processing convention (CAT or *Convention d'Aménagement et de Transformation*), timber cutting permits from plantations (PCBP or *Permis de Coupe des Bois de Plantations*) and special permits (PS or *Permis spéciaux*).

An industrial processing convention (for a FMU or FLU) covers a period of 15 years. A management and processing convention (for a FMU) covers a period of 25 years. Both types of agreements include an obligation to prepare a management plan for the licensed area and may be renewed.

The permit for long term allocated areas concern FMUs, which "constitute the basic units for the execution of the tasks of planning, management, conservation, recovery, and production." Some of the FMUs were subdivided into FLUs.

The cutting permit for plantation wood only concerns forest plantations in the state forest domain.

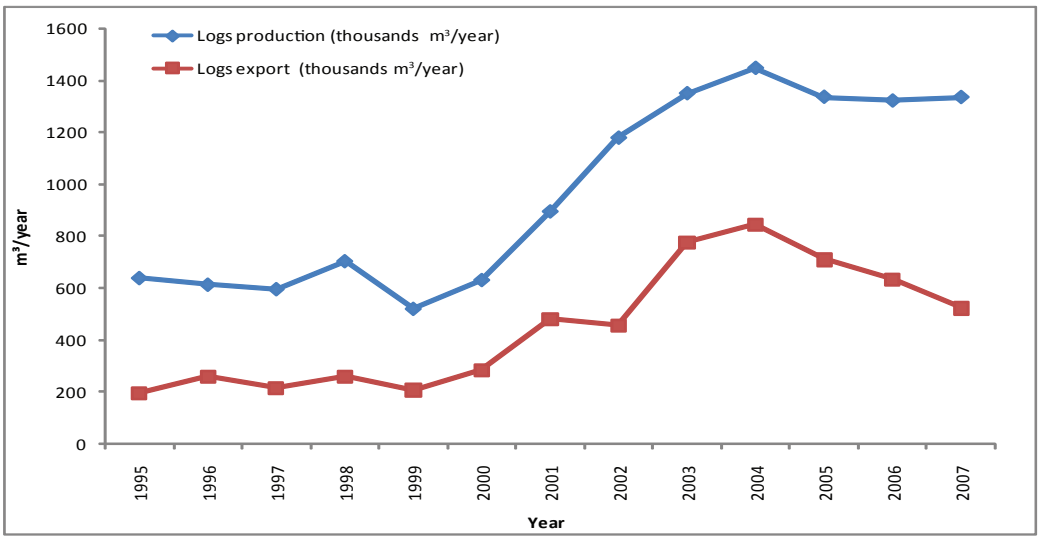
Finally, the special permit relates mainly to forest products other than timber (called in Congo accessory forest products), but may, exceptionally, be eligible to operate a fixed and limited number of timber units. This type of permit is reserved for Congolese citizens, NGOs and associations, and aims to supply local communities (art. 70 of the Forest Code).

Photo 6.3: The fruit of the Aframomum, one of the many non-timber forest products.

At the end of 2008, 52 FMUs or FLUs, covering nearly 12 million hectares of forest had been allocated with a planned area for production forest of 15.2 million ha. Some FMUs are still awaiting allocation.

The average area allocated per operator is close to 400,000 ha with large disparities, for example concessions in northern Congo are significantly larger than in the south. IPC (DLH Group) and IFO (Danzer Group) each manage more than 1 million hectares; Mokabi SA (Groupe Rougier) and Timber Likouala more than 500,000 ha.

Formal Logging in Natural Forest



Source: Data collected from the Ministry of Forest Economy in 2008.
Figure 6.2: Change in roundwood production and exports (m^3/an)

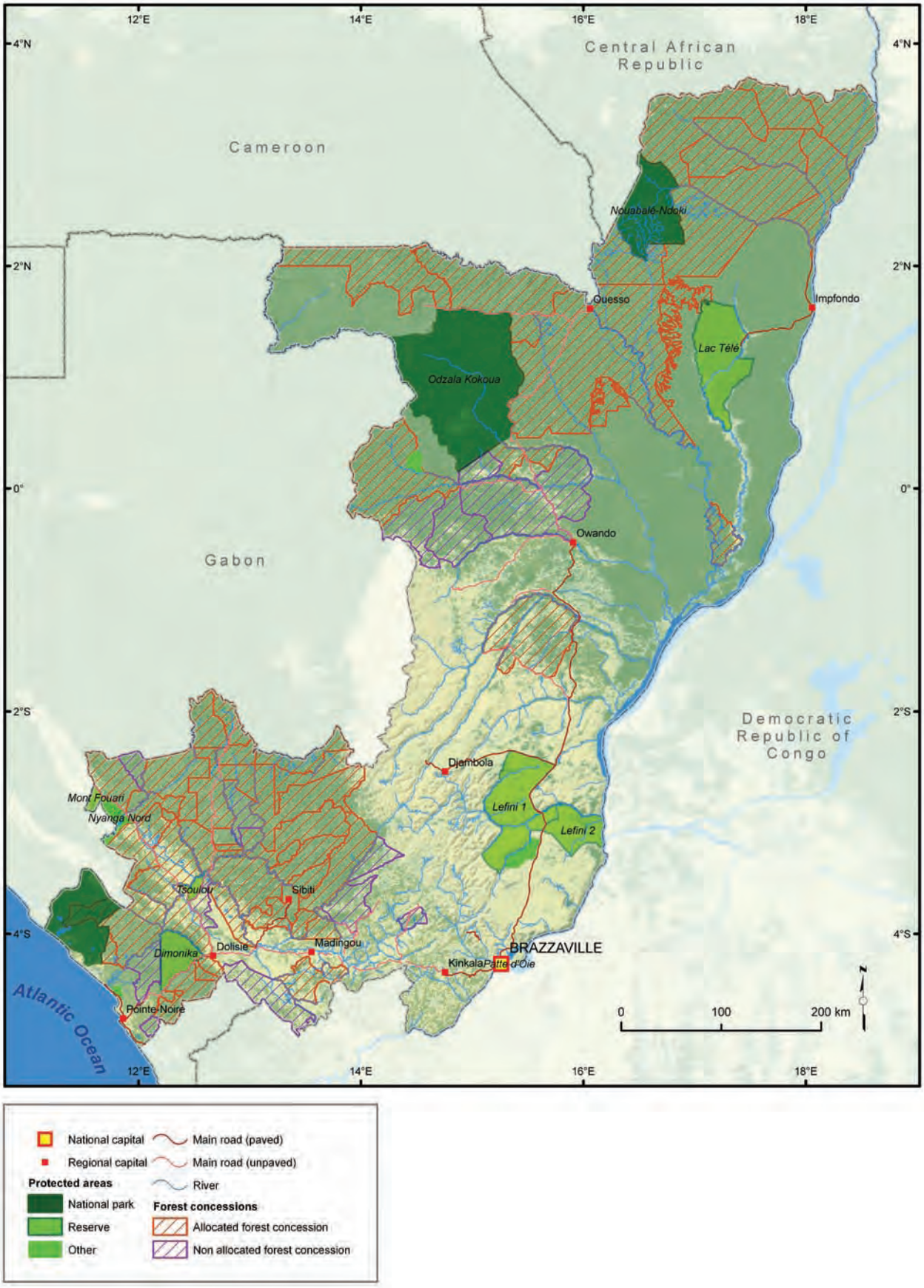
Current production grew sharply between 2000 and 2003, from 630,000 m^3 to 1.35 million m^3 (MEF-FORAF, 2008) before stabilizing at this level. This increase is very marked in the north, with the rise in production in several FMUs (Mokabi, Ngombe, Lopola, Mimbéli). The southern region has also experienced strong growth over this period, largely due to the start of activity for TAMAN, which became one of the largest producers in the country in just a few years. No statistics are available for special permit production.

In the north, sapelli still accounts for most log production (39 % of all Congo production (MEF-FORAF, 2008)). Some species, such as wenge, have gained in popularity in recent years. As the first management plans are implemented in the FMUs, production will gradually diversify. Logging in this region of Congo benefits from the abundance and quality of the resources, as well as fairly favorable logging conditions on flat terrain. In some FMUs, large swamps bordering rivers require the construction of large dams. However, transportation from production remains particularly problematic. At the moment, the only possible route is over 1,000 km through Cameroon and possibly CAR.

In the south, production is much more diverse. Okoumé represents the bulk of production (with 23 % of national production (MEF-FORAF 2008). Transport from the south by a combination of river/rail is not an option due to the discontinuation of the Congo Ocean railroad.

The Congo forest sector is relatively concentrated, the 6 largest producers[32] provide about 80 % of total roundwood production (MEF-FORAF 2008). Alone, the *Congolaise industrielle des Bois* (CIB) generates more than 30 % of the production, with about 350,000 m^3 of roundwood annually. All Malaysian-controlled companies such

[32] CIB (DLH group), IFO, CIBN, Taman, Likouala Timber, and Mokabi SA



Sources: WRI and FORAF.

Figure 6.1: Forest concessions and protected areas in Congo

as Taman Industries, CIBN and SOFIL, produce nearly 300,000 m^3 per year.

Log exports increased in tandem with production until 2004, before falling under the influence of policy incentives for local processing (including the surcharge beyond 15 % of timber exported as logs).

Collectivities Forests

Article 6 of Law 16-2000 pertaining to the Forest Code provides for public, municipal, and local community or territorial forests within permanent forest estates. The creation of municipal and other collectivities forests[33] is part of the sectoral policy of the Ministry of Forest Economy and the Ministry for Land Management and Decentralization. In addition, the ongoing decentralization process in the Congo provides for the creation of new communities. However, to date, this section of the Act was not followed up by effective creation of local or other collectivity forests.

Council Forests and Community Development Series

Legislation pertaining to community forests is not addressed by the Forest Code.The National Planning Guidelines provide for the establishment of community development zones around villages within managed FMUs. These are designed to ensure timber is used by local people, and to allocate land to meet new farming land needs for the duration of rotation in an FMU (about 30 years). These zones continue to be part of the FMU managed jointly by the concessionaries, and therefore part of the permanent state forest domain.

Industrial Timber Processing

Congo obliges industrial wood companies to process 85 % of their production in the country,[34] under penalty of paying a surcharge. Since 2004, this policy has helped reduce log exports and has been one of the major drivers for intensive industrial production. Lumber production rose from 108,000 m^3 in 2000 to more than 200,000 m^3 in 2007. If secondary processing is very little developed (11,300 m^3 produced in 2007), the trend is to produce dried lumber and greater recovery of sawn timber (installation of workshops to recover fall-offs) (MEF-FORAF, 2008).

The industry is dominated by primary processing plants, primarily by sawmills. In the north, industrial units have been installed by most FMU licensees. In the south, the abundant richness of okoumé was behind the recent strong growth of the rolling sector and plywood manufacturing. Current production is more than 40,000 m^3 of peeled veneer and more than 8,500 m^3 of plywood (MEF-FORAF, 2008).

Photo 6.4: Wood processing operations are increasing in Central African countries.

Informal Sector

The informal sector in the forestry sector is relatively unknown. It is present in the sectors of NTFP, wildlife, timber and wood energy. It is mostly used to supply the main cities (Brazzaville, Pointe-Noire, Dolisie, Nkayi).

Progress Towards the Sustainable Management of Production Forests

Law 16-2000 of 20 November 2000 pertaining to the Forest Code set up an appropriate legal framework for the sustainable management of forests and forest lands on the basis of rational resource management. As such it helps to reconcile forest product exploitation with the requirements of forest resource and biodiversity conservation for sustainable development. The Ministry of Forests shall ensure that the activities authorized in the national forest domain, are carried out in such a way as to avoid destruction and maintain sustainability, expansion and exploitation in rational conditions. In this way, it applies the principles of sustainable development, and conservation of forest stands and biodiversity.

[33] At present, there are 7 urban communes: Brazzaville, Pointe-Noire, Dolisie, Nkayi, Mossendjo, Ouesso, and Owando

[34] Decree 5206/MEFE/MEFB of July 26, 2006

Logging in natural forests in the state domain is either by agreement (CAT or CTI) or by special permit. The operating agreement is applied in accordance with the plan, either over the whole forest development unit, or a part of the unit, when zones are set aside for specific tasks such as environmental conservation, especially for biodiversity.

The forest management process in the Congo involves several stages:

1. signature of a protocol between the contractor, the State and, where appropriate, the design team responsible for developing the plan;

2. performance of work and field studies by the contractor under the supervision of the Ministry of Forest Economy (multi-resource inventory, mapping, and dendrometric, ecological and socio-economic studies);

3. monitoring and evaluation of work and field studies by the technical structures of the forest administration (CNIAF and DGEF) and steering committees (multi-partner committee);

4. validation of study results: report of multi-resource inventory, mapping study report, dendrometric study report, socio-economic report and environmental study report;

5. validation of planning decisions for land allocation: boundaries of the managed FMU and development zones;

6. adoption of a management plan. This phase involves inter-ministerial validation, national workshops and approval by the Council of Ministers.

Table 6.2: Progress in the management process

	2005		2008	
	Number of FMU	**Area (x 1,000 ha)**	**Number of FMU**	**Area (x 1,000 ha)**
Concessions allocated	60	11,387	52	11,976
Concessions committed to a management process	10	4,114	22	6,372
Certified concessions	0	0	2	834
Validated management plans	0	0	3	1,908

Sources: CBFP, 2006 and MEF-FORAF, 2008.

The process of managing production forests has experienced strong momentum since 2005, including the adoption of the first 3 management plans. The process is well underway in most of the northern FMUs. The current process should lead to 4.5 million hectares managed in 2009, 38 % of the allocated area.

However in the south, only one FLU is being managed; the Boubissi FLU, managed by TRABEC. Other companies have signed MoUs with the MEF, but have not started work. A project co-financed by the AFD is currently being put together with the goal to manage the southern Congo forest massif.

Significant progress has been made also in terms of certification, which is now seen by all assignees involved in management as a logical extension of their management plan. Currently, two FMUs are certified by FSC (IPC Company) and another enjoys a certificate of legal production (IFO, which also seeks FSC certification in the short term). Many other companies are in the process of upgrading their management systems: Mokabi SA, Bois et Placage de Lopola, Thanry Congo, and Likouala Timber.

Forest Plantations

Since 1950, the Congolese State has planted about 24,400 ha, managed by the National Reforestation Service (SNR). Since 2002, the SNR has had a mandate to technically assist private forest plantation initiatives and the establishment of orchards. Finally, since 1996, the SNR has set up pilot development, reforestation and agro-forestry units (UPAR), which aim to restore natural forest. These are managed in partnership by the MEF, the SNR and logging companies. Two UPARs are functional in the north.

The vast eucalyptus plantations in the region of Pointe-Noire, planted in the early 80s, have been managed by the Eucalyptus Fibers Congo (EFC, a subsidiary of the Canadian group Magindustries) since 2005. The 40,000 ha of plantations (the largest forest plantation area in Central Africa), with planned expansion to 60,000 ha, are under development and are subject to significant investments to valorize this resource to its maximum potential, particularly through the establishment of a manufacturing plant of 500,000 tons of wood chips for export. Eventually, EFC wants to achieve FSC production certification.

The total area under forest plantation in the Congo is approximately 70,000 ha (MEF-FORAF, 2008), producing about 250,000 m^3 of eucalyptus.

Biodiversity Conservation and Development

Biodiversity Components in Congo

The Republic of Congo, like all Central African countries, has an impressive diversity of ecosystems and of flora and wildlife species. The report prepared by the Republic of the Congo in accordance with decision II/17 of the Second Conference of the Parties to the Convention on Biological Diversity (Anonyme, 2001) gives a good summary of current biodiversity knowledge.

The Congo has three types of ecosystems: terrestrial, aquatic and marine and coastal. The terrestrial ecosystems are divided into savanna and forest ecosystems.

Dense humid forests cover the country's diverse landscapes that were formed by variations in climate, environmental conditions and man's influence. Forest ecosystems are divided mainly into three main blocks: Chaillu (4.4 million ha), Mayombe (1.5 million ha) and the Haute-Sangha (16 million ha). In addition to these three main blocks, there are coastal forests with semi-deciduous tendencies, transition formations with dense rain forest of Mayombe and contacts with the savanna and swamp formations.

Chaillu and Mayombe Forest Massif

Okoumé forest (*Aucoumea klaineana*) can be found in the Niari and in forests bordering Gabon (UNDP/FAO, 1973). The okoumé is associated with movingui (*Distemonanthus benthamianus*) or sorro (*Scyphocephalium ochocoa*), then disappears in the territories situated to the south, where no species dominates. The other abundant species are *Symphonia globulifera, Julbernardia brieyi, Gilbertiodendron dewevrei, Nauclea diderrichii* and various *Caesalpinieae*. The forest resources of this massif are poorly known because existing inventories are old, very partial in both geographic area and the species observed, and almost all of the area has been logged (one or more times) since these inventories were undertaken. The forest resource is largely dominated by two flagship species, the okoumé and limba (*Terminalia superba*).

Forest Block in the North

The northern forest block is by far the largest in area, with 15.99 million hectares (CNIAF, 2007). It consists of flooded forests, about 8 million hectares (CNIAF, 2007), and rainforests. The various facies of the flooded forests include: floodplain forest with *Oubanguia africana*, the forest with *Syzygium*, the floodplain forest with *Sterculia subviolacea* and Raphiales. The rainforest is rather semi-deciduous with evergreen understory. This forest is now well known thanks to the management inventory made in recent years. In these forests, clear forests cover about 600,000 ha, mainly in the Sangha. These forests are characterized by woodland invasion from *maranthaceae* and *Zingiberaceae*. Within the dense forests of northern Congo, the abundance of Meliaceae, particularly sapelli (*Entandrophragma cylindricum*) is a constant. In the southwestern part of the forest massif exist wenge forest (*Millettia laurentii*), further north monghinza forest (*Manilkara letouzei* and *M. fouilloyana*) very characteristic of a band situated on both sides of the border with CAR, and locally relatively young forest with ayous (*Triplochiton sceroxylon*). Pauci-specific stands of limbali (*Gilbertiodendron dewevrei*) are very characteristic and are found occasionally throughout the northern Congo, often on hydromorphic land.

Savanna

Congolese savannas are essentially part of the Guinea-Congolese grassy secondary formations (White, 1986). The National Report on Congo Biodiversity (Anonyme, 2001) distinguishes seven types of savanna ecosystems: coastal grassland formations, savanna of the Niari valley, savanna on the Tekes plateaux, stagnal grassy formations, savanna of the Léfini, savanna of Alima, and the grassy formations of Likouala.

Flora

Because of the wide diversity of ecosystems, the flora is itself very diverse. Congo is home to some stands of afrormosia (*Pericopsis elata*), species listed in Appendix II of CITES.

Wildlife

200 species of mammals have been identified in the Congo, of which 24 are fully protected and 14 are partially protected (Anonyme, 2001). Furthermore, the estimates indicate that there are 700 species of birds, 600 of which have been inventoried.

Photo 6.5: Liana (genus Paristolochia) flower in the understory of dense forest.

Formal Management of Biodiversity

Formal biodiversity management is mainly carried out in protected areas, which currently number 14 covering a total of 3,513,438 ha and representing over 10 % of the national territory. The typology of protected areas of the Republic of Congo is presented in table 6.3 below. Of all these protected areas, only the Nouabalé Ndoki National Park (414,392 ha) has a management plan.

Table 6.3: Typology of protected areas in the Republic of Congo

Type of protected area	IUCN category	Number	Area (ha)
National park	II	3	2,189,161
Wildlife reserve	V	4	87,855
Sanctuary	IV	3	280,300
Hunting reserve	VI	2	346,301
Biosphere reserve	VI	1	148,006
Community reserve	VI	1	461,815
Total		**14**	**3,513,438**

Source: MEF-FORAF, 2008.

Outside of protected areas, there are also wildlife management initiatives in forest concessions, with sustainable management in place. Efforts in forest concessions involve assessment of wildlife resources, and assessment of anthropogenic threats (hunting). Assessments result in measures such as setting up conservation zones within concessions and integration of anti-poaching regulations into internal company regulations. The major protected species, both in protected areas and forest concessions are presented in table 6.4 below.

Table 6.4: Main wildlife species protected in the Republic of Congo

Name of species	Family	Protected areas concerned
Loxodonta africana cyclotis	*Elephantidae*	Odzala/Conkouati/Nouabalé Ndoki/Léfini/Lac Télé/Mt Fouari/Mt Mavoumbou
Gorilla gorilla gorilla	*Pongidae*	Odzala/Conkouati/Nouabalé Ndoki/Dimonika/Léfini/Louna/Léssio/Lac Télé
Pan troglodytes	*Pongidae*	Odzala/Conkouati/Nouabalé Ndoki/Dimonika
Hippopotamus amphibius	*Hippopotamidae*	Odzala/Tsoulou
Tragelaphus euryceros	*Bovidae*	Odzala/Nouabalé Ndoki/Tchipounga
Panthera leo	*Felidae*	Odzala/Conkouati/Nouabalé Ndoki
Panthera pardus	*Felidae*	Odzala/Conkouati/Nouabalé Ndoki

Source: MEF-FORAF, 2008.

Hunting and Wildlife

Hunting poses local threats to wildlife near the main towns (Ouesso, Pokola, Impfondo, Enyellé), along roads and near the border with CAR where bushmeat is exported.[35] The loss of elephants and gorillas in these areas attests to the impact of human activities on wildlife.

The 3 validated management plans, (FMU Ngombe (1,159,643 ha), UFA Pokola (377,050 ha), and Kabo FMU (267,048 ha), include a wildlife management and hunting component. For successful tenders, the objective is to fight against the impacts arising directly or indirectly on large wild animals in their activities. For this reason, surveillance and anti-poaching units (USLABs) are set up within each company; their operation is governed by a protocol between the company and the MEF, with possible support from an international NGO.

Conservation Measures in Production Forests

The approved plans have created a series of conservation and protection zones. These zones complement the network of protected areas created in the country to ensure the preservation of biodiversity in Congo's forest ecosystems.

Economic Development of Biodiversity

Forest products other than timber play an important role in the informal economy.

Tourism and conservation sectors currently generate little income in Congo, with only 4 guides in service in protected areas, and for the formal hunting sector only 36 big game permits granted.[36] The conditions to encourage short-term development of these sectors are not in place.

[35] Observations made by WCS for the Nouabalé Ndoki Park and periphery, and the results of wildlife inventories carried out by Mokabi SA in the Mokabi-Dzanga FMU.

[36] DFAP, 2007

Conclusions

The Congo has a sizeable forest estate. The country is implementing a forestry policy to sustain the many benefits it draws; on the one hand it achieves this through managing a network of protected areas, maintaining exceptional biodiversity and preserving different types of forest, and on the other through the establishment of sustainable forest management for timber production. The progress made in recent years for sustainable forest management in the north of the country is exemplary in the region.

A major challenge for the coming years is to extend this dynamic to forests in the south. Further, there needs to be better development and management of other forest resources, biodiversity and environmental services.

Photo 6.6: Mirador in a bai in Dzanga-Ndoki National Park.

CHAPTER 7
The Forests of the Democratic Republic of Congo in 2008

Richard Eba'a Atyi and Nicolas Bayol
With contributions from: Sébastien Malele Mbala, Jacques Tunguni, Philomène Mwamba Kyungu, and Franck Yata

Introduction: The Macro-Economic and Political Context

Forests cover 67 % of the Democratic Republic of Congo (DRC) with an estimated area of 155.5 million ha, 99 million of which are dense humid forests. These forests represent nearly half of Africa's rainforests. According to United Nations estimates (UNPP, 2006) the population of DRC was 59 million inhabitants in 2005 and should exceed 69 million in 2010 (25 inhabitants per km²) to reach over 93 million in 2020. This population is very unevenly distributed across the country. The highest densities (over 100 inhabitants per km²) are found in the east along the borders of Uganda, Rwanda and Burundi and in the south-west around the city-province of Kinshasa and the province of Bas-Congo. Regions with high population densities are also those where greater pressure on forest resources results in a loss or degradation of forest cover. Conversely, the central basin is largely covered by vast tracts of dense forests and is still characterized by very low population density. Despite the fact that Kinshasa, the capital of DRC, is the largest urban agglomeration in Central Africa (6 to 8 million inhabitants), DRC still has the highest rural population rate in the sub-region.

According to the projections of the Strategy Paper for Growth and Reduction of Poverty (DSCRP) of DRC developed using data from 2005 (Anonyme, 2006), the Gross Domestic Product of DRC was about $ 10.4 billion in 2008 for a nominal GDP of $ 158.6 *per capita*, making DRC one of the poorest countries on the African continent. The economy is largely dominated by the primary sector (agriculture, forestry and other extractive industries), which represents nearly 53 % of GDP. According to national statistics from the *Direction générale des Recettes administratives, judiciaires, domaniales et de participation* (DGRAD), the formal forest sector contributed 1 % to GDP in 2007 with tax earnings of approximately $ 4.6 million (MECNT-FORAF, 2008). However, this figure is based solely on taxes related to the surface area of concessions. The value of timber exports grew from more than € 6.9 million in 2002 to over € 35.3 million in 2006. The industrial forest sector had 15,000 jobs in 2007 according to the Federation of Industrial Timber in DRC.

Forest resource management in DRC takes place in a post-conflict socio-economic and political context, making it fragile and special in nature. After 30 years of questionable management of the public sector, the State almost collapsed in the 1990s. The 1990s were characterized by looting that occurred in 1991 and 1993, followed by two armed conflicts: one in 1997 and the other from 1998 to 2002. From 2003, the country moved into a period of political transition until 2006, with the first free and democratic elections since the country gained independence. State mismanagement of resources for 30 years and the ensuing armed conflict have had serious consequences for the country, which has experienced a reversing trend in development. Indeed, from $ 380 in 1960, GDP *per capita* fell to $ 96 in 2002. Infrastructure was destroyed and institutions collapsed. Characterized by widespread insecurity, this situation prompted most people to turn to subsistence and informal activities. Informal activities account for 80 % of the economy (Debroux *et al.*, 2007). Agriculture is mainly subsistence-oriented and households rely on forest products for energy, food and income.

With peace gradually returning, DRC has embarked upon a vast program of economic and institutional reforms in all sectors of activity since 2002, including the forest/environmental sector.

The forestry sector is thus entering a revival phase, and several companies that were temporarily unable to access their concessions are restarting activities in the provinces of Equateur and Orientale. The government has initiated an effort to clear up the forestry contract situation, with

the repeal in 2002 of 163 titles, representing 25.5 million ha for non-compliance of contractual obligations. However, political instability during the period of political transition (before the elections of June 2006) resulted in favorable conditions for the irregular allocation of forest titles despite the official moratorium on the granting of concessions agreed in May 2002. In January 2009, the Congolese government completed the process of converting old forest titles into concessions under the new forestry law. Conversion requests had been filed for a little over 22 million ha of forest titles in January 2006. An Inter-ministerial Commission, working in consultation with civil society representatives and indigenous peoples, declared 65 forest titles as legally acquired, covering almost 10 million ha. In addition, a new 3-year moratorium for the allocation of new logging concessions was announced in October 2008 by the Minister for the Environment, Nature Conservation and Tourism (MECNT, 2008).

Forest Resources and Land Cover Changes since 1990

Forest Areas

Table 7.1: Forested area of DRC by land cover category

Land cover	Area (ha)
Lowland dense forest	83,761,542
Sub-montane forest (900-1,500 m)	5,995,494
Mountain forest (>1,500 m)	955,071
Swamp forest	8,200,098
Mangrove	0
Total area of dense forest	**98,912,205**
Forest-cropland mosaic	21,144,384
Forest-savanna mosaic	28,592,334
Dense deciduous forest (Miombo)	28,023,714
Other plant formations	50,825,421
Cultivated land	825,390
Other land use (town, villages, industrial sites…)	4,613,904
Total	**232,937,352**

Source: compilation of land cover data produced by UCL, JRC and SDSU.

Available data on forest resources in DRC covers only a portion of the Congolese territory. Until 2004, the only figures available came from national inventories or inventories carried out in areas with forest titles. These inventories covered around 20 million ha, but often with a low sampling rate. Since 2005, more exhaustive management inventories have been carried out on approximately 2 million ha.

Photo 7.1: Forest canopy in Ituri.

These studies highlight the low volumes of regularly marketed species currently available, estimated between 1 and 3 m³/ha. These results are confirmed by production data. The prospects for production development are estimated at 0.2 to 0.4 m³/ha per year, or 2 to 3 times lower than other Congo Basin countries (Cassagne *et al.*, 2007). As a result, large areas of forest will be needed to make logging a successful economic activity in DRC.

Change in Forest Cover since 1990

The annual rate of deforestation is estimated at 0.20 % per annum (Duveiller *et al.*, 2008), which, despite being the highest among Congo Basin countries, remains relatively low. However, this figure masks the real threats to forest ecosystems in DRC. An extensive network of rural roads linking villages means the forest is fragmented and agricultural clearings several kilometers wide are gradually isolating forest blocks. The rate of deforestation is much higher than the national average in heavily populated regions with a strong agricultural sector and subsistence farming remains the primary cause of deforestation in DRC. The province of Bas-Congo, the territories of Bumba and Lisala in Equateur and the Great Lakes region in the east of the country are examples of this strong local dynamism. The dense humid forests are also very densely populated in some areas. For example, in the Tumba Mai-Ndombé forest, located between two lakes and straddling the provinces of Equateur (Bikoro territory) and Bandundu (Inongo territory), socio-economic studies (Bayol *et al.*, 2008) assessed population density at more than 30 inhabitants per km². A high population growth rate of 2.4 % annually (Fa *et al.*, 2003), cf. above) and little support for modernizing food production raise fears of rapid deforestation in the future. The planned development of industrial plantations (palm oil in particular) constitutes a further threat to the forests in DRC.

Around major urban centers, the collection of fuelwood is an important cause of forest degradation and deforestation. Intensive wood collection in the province of Bas-Congo has contributed to forest degradation.

Legal and Institutional Framework for Managing Biodiversity Resources

Legal Framework

The main statute governing forest resource management in DRC is law 011/2002 pertaining to the Forest Code passed in August 2002 (Democratic Republic of Congo, 2002), which succeeded colonial legislation dating from April 11, 1949.

According to its introductory statement, the Forest Code of 2002 is "... in line with modern principles of management of forest resources and of international conventions on the environment." The objective of the Forest Code is to create "… a legal framework that allows the forest to both

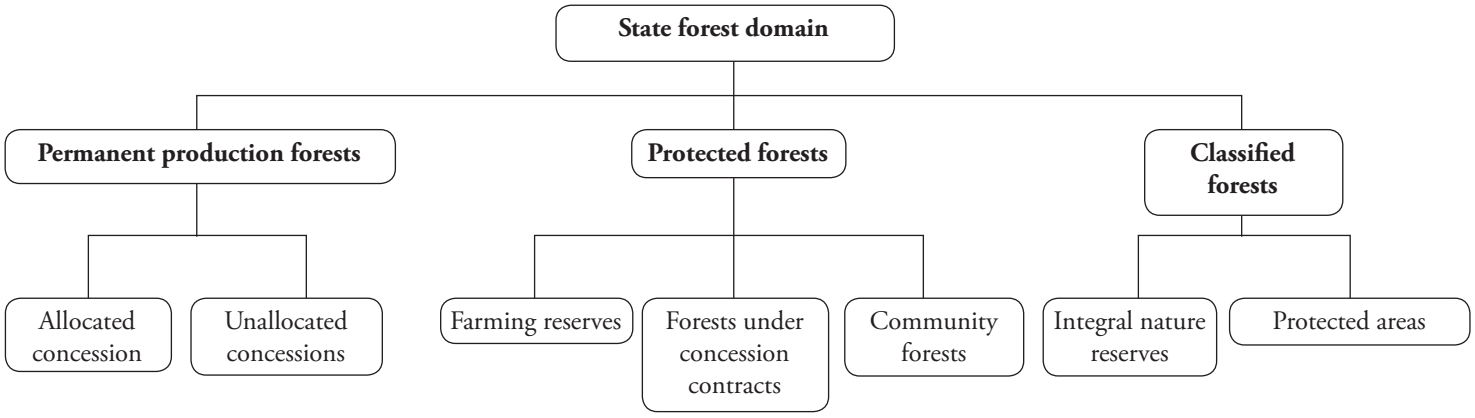


Figure 7.1: Legal forest classification in DRC according to the Forest Code of 2002 (Note: there are 9 types of classified forest; only those with the greatest and least restrictions are listed here)

fulfill its social and ecological roles in balance, the forest administration to contribute considerably to national development, and for local people to take an active part in forest management and be able to draw legitimate benefits."

According to the Forest Code in DRC, forests are owned by the State. The Forest Code classifies the forests of DRC in three categories: 1) classified forests; 2) protected forests; and 3) permanent production forests.

Classified forests are assigned a particular vocation and are subject to legal restrictions regarding user and exploitation rights. In general, classified forests are designated for environmental protection and may include: nature reserves; forests located in national parks; botanical and zoological gardens; wildlife reserves and hunting areas; biosphere reserves; recreational forests; arboretums; urban forests; and protected areas. Although the management of classified forests is the responsibility of the Ministry in charge of forests (art. 24), the Ministry can delegate this management to public corporations or associations acknowledged to be of public benefit (art. 25).

Protected forests are subject to less restrictive legal regimes in terms of user and exploitation rights than classified forests. In practice, forests in this category are areas reserved for activities such as small-scale farming (art. 42). However, they may also be granted as concessions for logging with contracts not to exceed 25 years. Protected forests may serve as community forests as they can be granted to communities upon request (art. 22).

Permanent production forests include previously allocated concessions and forests already used for timber production, identified through a public survey process (art. 23), and designated for allocation via auction. These forests have commitments from industrial logging concessionaires to institute sustainable forest management.

Although the State owns the forest, the law details different procedures for its use by local people and private concessionaires (individuals or corporate entities). Local people may collect forest products within the framework of user rights to meet individual or community subsistence needs (art. 36). For protected forests, people may collect forest products for their needs (food, energy, construction, etc.) and also clear the forest for crops (art. 42). However, a permit issued by the provincial governor is required (art. 53) to deforest an area of more than two hectares.

Individuals or entities wishing to conduct industrial logging in DRC must obtain a forest concession from the State. Concessions are awarded by tender (art. 83) or, in exceptional circumstances, by mutual agreement (art. 86). After allocation, the beneficiaries should sign concession contracts with technical and financial guarantees (art. 87). One of the requirements of the new Forest Code is the need to develop management plans for logging concessions (art. 99).

Apart from local communities, and private entities (individuals or corporations), the permanent production forests of DRC can also be used and regulated by the forestry administration and decentralized administrative entities or by a public body established for that purpose (art. 97).

To date, the Forest Code has been supplemented by 38 pieces of legislation including 3 ordinances, 5 decrees and 30 ministerial decrees[37]. In addition to these purely legal texts, the Ministry in charge of forests has issued operational guidelines to establish technical standards for implementing management work (inventories, mapping, low-impact logging, developing management plans etc.) in forest concessions.

Despite this volume of legislation, some say that this legal arsenal is not yet complete and that a total of 60 implementing provisions will be needed to make the Forest Code function satisfactorily (Mpoyi Mbunga and Way Nana, 2007).

Besides the Forest Code, DRC also has a law that regulates hunting activities[38] and an Ordinance on nature conservation[39]. These two legal texts are pre-forestry code, and are subject to revision projects.

DRC does not have an officially adopted national land use plan, which impedes the development of the forest sector.

Outside the forest/environment sector, other laws may affect the management of forest resources and biodiversity conservation, particularly in the case of mining[40], land tenure[41] and the labor code[42]. It should also be noted that a duality exists between the different codes in force in DRC (Mining Code, Land Code, Forest Code), and customary law for the management of natural resources. Since customary law is most used by local people who often do not know the provisions of the Forest Code, there are potential conflicts between local stakeholders and forest concessionaires who act on the basis of the Forestry Code and modern law.

At the international level, DRC has signed and ratified 9 international agreements and conventions including the African Convention on the Conservation of Nature (Niger), the Convention on Wetlands of International Impor-

[37] The full list of these texts can be found at: www.observatoire-comifac.net

[38] Law N° 82-002 of 28 May 1982

[39] Decree-law N° 69-041 of 22 August 1969.

[40] Law N° 007/2002 of 17 July 2002.

[41] Law N° 93-001 of 2 April 1993.

[42] Law N° 015/2002 of 16 October 2002.

tance (Ramsar), Convention on the Protection of World Heritage (UNESCO, Paris), the Convention on International Trade in Endangered Species (Washington), the Convention on Migratory Species (Bonn), the Convention on Biological Diversity (Rio de Janeiro), the Convention on Climate Change (Rio de Janeiro), the Convention to Combat Desertification (Paris), and the agreement for the conservation of gorillas and their habitats. It should be noted that DRC has not yet ratified the Treaty of the *Commission des Forêts d'Afrique centrale* (COMIFAC).

Institutions and Capacity

The Ministry of Environment, Nature Conservation and Tourism (MECNT) is the main State institution responsible for implementing government policy in the forest/environment sector. The Department has a geographical information system laboratory inside the permanent service for inventory and forest management (SPIAF) as well as three sub-divisions:

- The *Institut congolais pour la Conservation de la Nature* (ICCN), founded in 1975, which aims to: 1) ensure the protection of wildlife and flora in nature reserves or integral reserves; 2) promote scientific research and tourism in these environments in compliance with the basic principles of nature conservation; and 3) managing the so-called capture stations located in or outside of reserves. In 2007, the ICCN employed about 2,700 people (ICCN, 2008);
- The *Institut des Jardins zoologiques et botaniques du Congo* (IJZBC), which deals specifically with the conservation of wildlife and flora resources *ex-situ*;
- The *Fonds de Reconstitution du Capital forestier* (FRCF), should implement the State's re-forestation policy, but is no longer functional and should be restructured in the near future.

In terms of forest and environmental research and training, DRC has a research institute, the *Institut pour l'Étude et la Recherche agronomique* (INERA) established in 1948, and eight other major training institutions (table 7.2). There are numerous institutions in the provinces that are more or less functional, where the environment is featured in their training programs.

Photo 7.2: Part of the xylotheque in Yangambi (DRC).

Table 7.2: Forestry and environmental training institutions in DRC

Institution	Field	Level of training
University of Kisangani	Biology, wildlife, botany, forestry	Undergraduate and post-graduate
Institut supérieur d'Études agronomiques (ISEA) Bengamissa	Forestry, agronomy	Undergraduate
École régionale post-universitaire d'Aménagement et de Gestion intégrés des Forêts et Territoires forestiers tropicaux (ERAIFT)	Integrated management of tropical rural areas (basic forestry concepts)	Post-graduate
University of Kinshasa, Faculty of Science, Environmental Management Department	Environment, natural resource management	Undergraduate and post-graduate
Institut technique agricole (ITA)/Bafwansende	Agronomy	Secondary level (technical diploma)
Institut technique agricole (ITA)/Seke-Banza	Agronomy	Secondary level (technical diploma)

Source: RIFFEAC, 2006.

Forest Logging and the Timber Sector

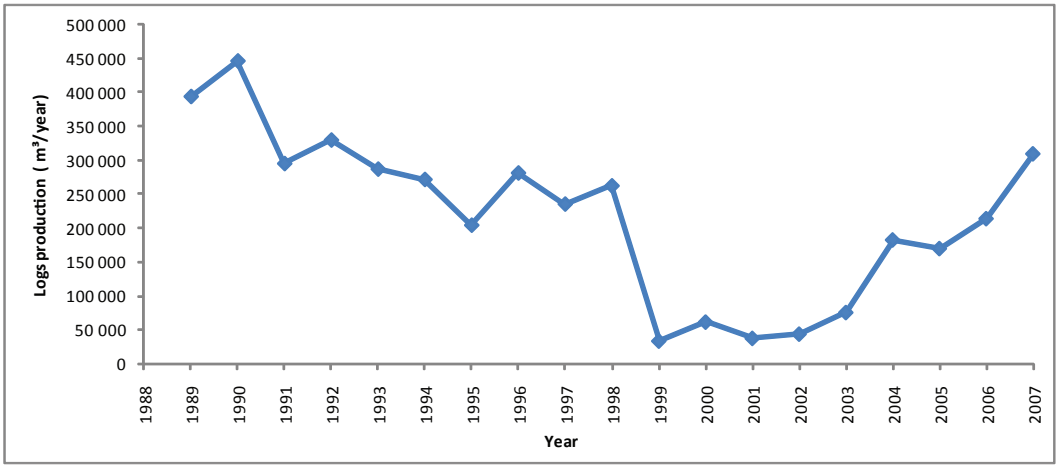
Recent developments in the sector have been strongly influenced by the unrest that has plagued DRC. Forest production fell between 1998 and 2003, to about 50,000 m³ a year. Since then, strong growth has been observed and production has reached levels in 2007 of that before the war. This growth is likely to stop in 2008 because of the impacts of the economic crisis on the market for tropical timber (ITTO, 2008) and the cancellation of some forest titles (conversion process, see above).

Typology of Forestry Titles

DRC is currently transitioning towards the legislative framework described in the new Forest Code of 2002. The legislative framework of DRC provides for several types of logging titles: long-term titles for industrial purposes, and short-term titles for artisanal logging.

Long-term titles established under the former legislation are being converted to forest concessions, as provided for in the Forest Code. This conversion process incorporated a comprehensive review of existing titles to judge their legal validity. Conversion requests were introduced for 156 former forest titles in January 2006, covering just over 22 million ha. After review by the Inter-ministerial Commission appointed for this purpose, 46 titles have been converted for a total area of approximately 7 million ha.

This effort expands the repeal of 25.5 million ha (Debroux *et al.*, 2007) of forest titles in 2003 and 3 million ha in 2007.



Source: DGF.
Figure 7.2: Change in log production from 1992 to 2007

Current production

The vast area of rainforest remains untapped and its timber resources very poorly developed. In comparison with other countries in the Congo Basin and the two other main rainforest blocks (the Amazon and Southeast Asia), formal production is negligible. With less than 300,000 m³ of annual log production, DRC's forest resources are not threatened by industrial operations as currently practiced.

In addition to the fact that DRC's timber resources are considered of poorer quality, the low level of harvesting can be explained by the high costs of evacuating products due to difficult access and transportation. The road network in the central basin, though dense, is impractical for trucks and timber can only be transported as far as Kinshasa (1,500 km of transport from Kisangani) by river. After Kinshasa, the Congo River is no longer navigable, and products must be transported by road to the port of Matadi, which does not have sufficient storage capacity and is frequently congested. At the moment, only the forests near waterways are developed. These forests should be the focus of land zoning, to develop new areas for timber production.

Table 7.3: Main species logged by the industrial sector in DRC in 2007

Species	Volume (m³)	%
1:Sapelli	60,910	19.6
2: Wenge	52,000	16.8
3: Afrormosia	31,140	10.0
4: Sipo	27,000	8.7
5: Tola	24,130	7.8
6: Iroko	24,040	7.8
7: Acajou	13,600	4.4
8: Bomanga	13,400	4.3
9: Tiama	11,000	3.5
10: Tchitola	9,400	3.0
11: Total other species (44)	43,510	14.0
Total (54 species)	**310,130**	**100.0**

Source: MECNT-FORAF, 2008.

Photo 7.3: Dead trees can be used as bridges between banks of a river.

Table 7.3 lists the most industrially harvested species in DRC. Sapelli (*Entandrophragma cylindricum*) is traditionally the main production species and grows throughout the rainforest. Since the end of the armed conflict, Wenge (*Millettia laurentii*) has taken the second place in national production after having been relatively unvalued in the past. Afrormosia (*Pericopsis elata*), third in species production, is found in dense, occasional stands in the provinces of Equateur and Orientale. For the moment, production is not very diversified, especially further from Kinshasa. However, the logging of other species, such as Bomanga (*Brachystegia laurentii*), is growing.

The European Union remains the main timber market for DRC; Asia has only a small market share unlike in other countries in Central Africa.

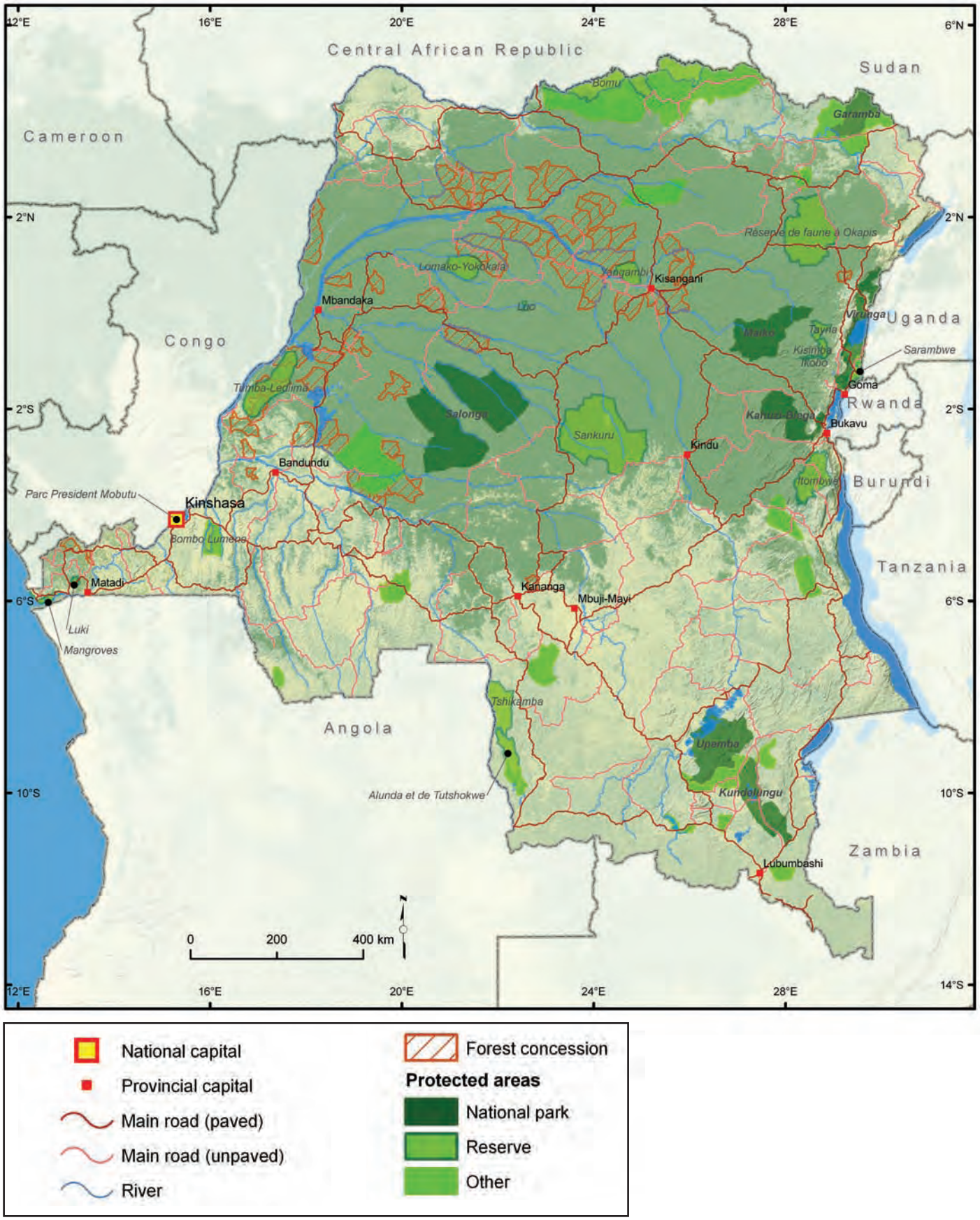
Main Producers

The forestry sector has grown more consolidated, with a reduction in the number of active companies, especially during the 1990s. Table 7.4 shows the 10 main timber-producing companies in DRC in 2007. The four largest producers accounted for more than two thirds of national production. The Danzer Group (currently known as SIFORCO in DRC) has dominated production since the 1970s. NST Group, through its 4 companies (SODEFOR, SOFORMA, FORABOLA and CFT) is second and is present in four provinces. Most logging sites achieve very low production, often less than 2,000 m³ per month, for various reasons including artisanal production, lack of production means, lack of logistics and maintenance.

Table 7.4: Log production of the 10 largest companies in DRC in 2007

Company	Volume (m^3)
1: SIFORCO	65,740
2: SODEFOR	48,699
3: TRANS M	48,442
4: ITB	36,259
5: SEDAF	18,794
6: FORABOLA	17,184
7: SAFBOIS	14,643
8: SOFORMA	14,417
9: BIMPE AGRO	13,794
10: SICOBOIS	8,063
Total	**286,035**

Source: MECNT-FORAF, 2008.



Sources: AWF, WWF, DFGFI, ICCN, SPIAF, UCL, RGC, and FORAF.
Figure 7.3: Forest concessions and protected areas in DRC

Collective Forests

The Forest Code of 2002 does not provide for the creation of collective forests; however, it opens the possibility for decentralized administrative entities to manage permanent production forests (art. 97). Currently no production forest is managed in this manner.

Community Forests

The creation of community concessions, with the aim to develop permanent forest, is provided for in article 22 of the Forestry Code. Discussions on the management of these forests are underway, but so far there are no clear examples of effective development of community concessions. The most advanced thinking is being done through an FAO project to develop and implement community forestry in DRC. The FAO project is working with eight communities in five provinces (Katanga, Equateur, Bas-Congo, Orientale, and Bandundu).

Industrial Timber Processing

Industrial timber processing in DRC can be described based on the following characteristics:

- timber processing is primarily located in Kinshasa, with the notable exception of a large industrial site in Bandundu.

- An important local market, in Kinshasa in particular, which significantly improves the yield of processing plants located there;

- Supply to urban centers outside of Kinshasa is heavily dominated by the informal sector.

-Processing facilities are largely outdated or operating at a very low level of production with many idled or halted timber processing plants.

The industry focuses on sawn timber production (33 sawmills listed, but many are not operational), flooring, peeled veneer (6 units listed), plywood and sliced veneer (2 units, only one of which is operational).

Informal Sector

The volume of timber produced by the informal sector is inherently difficult to quantify. It is considerable in DRC. While products from the industrial sector are generally intended for export, the informal sector is the main source of domestic timber. In addition, the informal sector exports to neighboring countries such as Angola, Zambia, Burundi, Rwanda, and Sudan (Lumbwe, 2001, Baker *et. al.*, 2003; Djiré, 2003). Djiré (2003) found that artisanal loggers produced between 1.5 and 2.4 million m³, which is between five and eight times the production of the industrial sector.

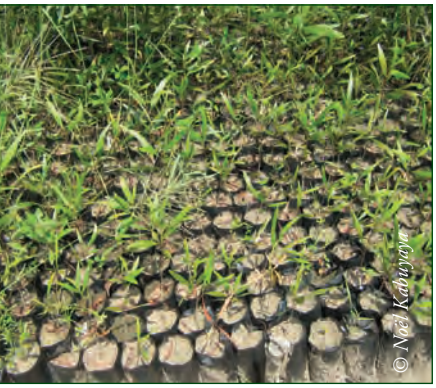


Photo 7.4: Unmaintained tree nursery in the Mampu plantation.

Progress Towards the Sustainable Management of Production Forests

The management of production forests is described in the new Forestry Code of August 2002. For logging concessions, the preparation and implementation of the management plan are the responsibility of the concessionaire. In some cases the process of developing management plans has been delayed by the conversion process and the preparation of implementing provisions for the Forestry Code. With the conversion process, a total of 46 titles were upheld, representing approximately 7 million ha. Companies managing these concessions now have the legal foundation to finalize management plans. Some of these companies had already begun preliminary studies to prepare management plans before the conversion process and five plans have been submitted for validation by the forest administration.

Forest Plantations

Forest plantations are very poorly developed in DRC, with only 345 hectares planted in 2007 by the *Service national de Reboisement* (the national reforestation service). However, there are private or NGO initiatives to establish forest plantations. For example, the carbon sink project IBI Batéké, under the Clean Development Mechanism (CDM), plans to plant 8,000 ha of eucalyptus and acacia between now and 2011, having planted 534 ha in 2007. Another example is a WWF project, which established 200 ha of forest plantations in Luki in Bas-Congo.

Box 7.1: World Heritage sites in Danger

World Heritage sites in Sub-Saharan Africa represent nearly 40 % of properties on the List of World Heritage in Danger, with 12 out of 30 Sub-Saharan sites listed. Approximately 15 % of African properties are included on the List of World Heritage in Danger.

In the Democratic Republic of Congo, the state of conservation of the 5 properties listed as World Heritage has deteriorated from 1994 onwards, resulting in their classification as World Heritage in Danger. The massive surge of Rwandan refugees into Virunga National Park and the start of the conflict in the Great Lakes region in 1996 had considerable impact on the state of conservation of the Congolese sites, four of which are located in the eastern part of the country.

The UNESCO program "Biodiversity Conservation in Regions of Armed Conflict: Conserving World Heritage Sites in the DRC" began in 2000 with financial support from the United Nations Foundation, Belgium and Italy. UNESCO and its partners (ten international conservation NGOs) support the ICCN in preserving the "ecological capital" of natural sites in the DRC that have been identified as World Heritage.

The table below presents, by site, conservation difficulties in the DRC and the UNESCO-initiated solutions to tackle them within the framework of the program mentioned above.

Site	Conservation difficulties	UNESCO intervention
Garamba NP	No trace of the northern white rhinoceros Major circulation of weapons Intensive poaching by national and Sudanese poachers	« Conservation diplomacy » missions Direct support (paying bonuses to guards, buying equipment, etc.) Increased anti-poaching patrols Community conservation
Kahuzi-Biega NP	Presence of armed groups Mining Occupation of the « ecological corridor » Inaccurate site limits	« Conservation diplomacy » missions Direct support (paying bonuses to guards, buying equipment, etc.) Increased anti-poaching patrols... Community conservation
Salonga NP	Presence of armed groups involved in poaching Park/local community conflicts linked to natural resource access Impact of villages on the site	« Conservation diplomacy » missions Direct support (paying bonuses to guards, buying equipment, etc.) Socio-economic surveys Community conservation
Virunga NP	Impact of refugees Occupation of the gorilla sector by rebels Increase in poaching, deforestation and pressure from fisher villages in the park	« Conservation diplomacy » missions Direct support (paying bonuses to guards, buying equipment, etc.) Community conservation
Okapi Faunal Reserve	Population decline in flagship species (elephant, okapi, chimpanzee) Lack of control over migratory movements into the reserve Presence of armed groups Illegal artisanal mining operations	« Conservation diplomacy » missions Direct support (paying bonuses to guards, buying equipment, etc.) Community conservation

Biodiversity Conservation and Development

Biodiversity Components in DRC

Given in part its size and location in the heart of tropical Africa, DRC exhibits high levels of biodiversity at both the ecosystem and species level. The country is geographically located on both sides of the equator and enjoys a warm and humid equatorial climate.

Photo 7.5: Savanna landscapes are common in DRC.

Ecosystems

At the ecosystem level, DRC has 19 major ecosystem types that can be grouped into three classes (*Anonyme*, 2000): forest ecosystems (11), mixed and savanna ecosystems (4) and aquatic ecosystems (4).

Forest ecosystems include: a) swamp forests; b) the Guinea-Congolese rainforests; c) the transition rainforests; d) the Afromontane forest; e) the Afromontane bamboo stands; f) the Zambezian dry forests; g) the Zambezian woodlands; h) the Sudano forest; i) bamboo with *Oxytenanthera abyssinica*; k) evergreen coastal forests; and l) mangroves.

Flora

The State of Biodiversity in the Democratic Republic of Congo Report (MECNEF, 1997) explains that, while not all of the broad taxonomic flora groups of DRC have been described, current knowledge shows a minimum of 10,531 flora species in DRC (including 8,867 spermaphyte species) of which 1,337 are endemic.

Wildlife

Table 7.5 presents a summary of the 4,758 known wildlife species in DRC.

Table 7.5: Wildlife species in DRC

Category	Number of species
Land invertebrates	456
Aquatic invertebrates	1,782 (1,596 freshwater)
Freshwater fish	1,000
Birds	1,099
Mammals	421
Total	**4,758**

Source: MECNEF, 1997 and Christy and Vande weghe,1999.

Photo 7.6: Demidoff's Bushbaby (Galago demidavii) in the Ituri forest.

Table 7.6 provides a list of mammals endangered in DRC (Anonyme, 2000). Moreover, according to the previous source, we observe that some species that used to exist in the country have disappeared. This is the case with *Diceros bicornis* (black rhinoceros), *Lycaon pictus* (lycaon) and the Cape Eland. Other species have disappeared locally from natural biotopes, such as the cheetah (*Acinonix jubatus*), who disappeared from the hunting reserve of Swa Kibula and from Virunga National Park, and the African elephant (*Loxodonta africana*) who disappeared from the forests of Mayumbe.

Table 7.6: Species of endangered mammals in DRC

Species	English name
Ceratotherium simum	White Rhinoceros
Cercopithecus hamlyni	Hamlyn's monkey (Owl-faced Monkey)
Cercocebus galeritus	Tana River mangabay
Colobus badius	Red Colobus
Galago demidovi	Dwarf bushbaby
Galago elegantulus	Western needle-clawed bushbaby
Gorilla gorilla berengei	Mountain or eastern gorilla
Gorilla gorilla graueri	Western lowland gorilla
Kobus leche	Lechwe
Leptailurus serval	Serval
Manis gigantea	Giant pangolin
Orycteropus afer	Aardvark
Pan paniscus	Bonobo
Pan troglodytes	Chimpanzee
Panthera pardus	Leopard
Perodictius potto	Potto
Tragelaphus scriptus	Bushbuck
Tragelaphus spekei	Sitatunga
Taurotragus derbianus	Giant eland
Loxodonta africana	African elephant
Trichechus senegalensis	West African manatee

Source: Anonyme, 2000.

Formal Management of Biodiversity

The formal and institutionalized management of biodiversity in DRC is mainly done through protected areas, which are the focus of efforts from the government, development partners and the national and international public. While the law provides for about ten types of protected area, DRC only had four types of officially classified protected areas as of 2008, covering a total area of nearly 26,314,300 ha (ICCN and WWF-RDC, 2008). Table 7.7 shows the break-down of this area by type of protected area. These protected areas account for more than 11 % of the national territory, close to the objective of 15 % set by the Forest Code (art. 14). None of these protected areas has an officially adopted management plan that could be used as a technical and legal framework to implement activities.

Table 7.7: Protected areas in DRC

Type	IUCN Category	Number	Area (ha)
Integral natural reserve (wildlife reserve, forest reserve, scientific reserve)	I	14	7,679,100
National park, botanical and zoological gardens	II	14	8,618,230
Hunting reserve	VI	22	10,017,000
Total		**50**	**26,314,330**

Source: MECNT-FORAF, 2008.

In addition to protected areas, forest concessions should represent areas where biodiversity is managed in a formal fashion, however, at present the forest concession management process has not yet really started in DRC.

At present, there is no system in DRC for collecting data on ecotourism. Nevertheless, a 2007 ICCN report stated that ICCN had collected earnings of 65,222,711 FC (about $ 118,600) that year (ICCN, 2008). These earnings were slightly below the previous year owing to the worsening security situation in the provinces of North and South Kivu.

Conclusions

The Democratic Republic of Congo has great potential to develop its forest/environment sector. This potential involves both sustainable logging and biodiversity conservation. However, the post-conflict context in DRC makes it impossible to realize this potential at this time. The conflicts of the 1990s led to a collapse of government institutions, which are currently in a mode of restructuring. The legal framework still needs to be finalized and the institutional reforms in the forest/environment sector are not yet complete.

The implementation of sustainable management has not really begun on the ground and DRC is still one of the smallest timber exporters in Central Africa. Likewise, despite major progress in the classification of protected areas, none of the protected areas have officially adopted a management plan. Furthermore, tourism and trophy hunting only make a token contribution to the national economy. Even if infrastructure remains inadequate, DRC will most likely play a growing role in forest resource management at the sub-regional level in the next five to ten years and the end of the conversion process for forestry titles means sustainable management will be able to make quantifiable progress in industrial forest concessions. Similarly, the potential existing in DRC should enable it to take a leadership role in processes linked to climate change during negotiations such as REDD (Reduced Emissions from Deforestation and Degradation).

CHAPTER 8
A New Tool for Sustainable Forest Management in Central Africa: Payments for Environmental Services

Guillaume Lescuyer, Alain Karsenty and Richard Eba'a Atyi

Payments for Environmental Services: Background

Tropical forests represent one of the rare ecosystems able to provide an abundance of products and support a diversity of human practices: from villagers seeking a source of natural products, the state seeking to conserve biodiversity, the timber processor, to the Global Environment Facility, which sees it as a carbon sink, the rainforest is multi-purpose and multi-stakeholder *par excellence*.

First and foremost, the tropical forest provides material support for local populations' way of life: the ecosystem is both their environment, a source of raw materials and foodstuffs, and a land reserve for farming expansion. Most people in the Congo Basin meet basic needs by direct exploitation of their environment: fuelwood, timber, game, non-timber forest products (NTFP) …

Nationally, the rainforest is often viewed as supporting economic development: industrial logging is supposed to generate economic growth, employment and foreign exchange earnings. Most reforms of sub-regional forest policy in the past fifteen years were primarily geared towards improving timber production and processing.

Finally, tropical forests also provide a set of indirect benefits as "natural capital," including the generation of environmental services. The loss of these benefits would diminish the well-being of human societies. Unlike the extractive uses of forest resources, the environmental services provided by tropical forests are not yet incorporated into forest policies, even if all Congo Basin states have signed international conventions on climate change, biodiversity or wetlands. However, as stated in the Millennium Ecosystem Assessment, tropical forests have four functions that cannot be broken down just into the production of material resources.

Photo 8.1: Tropical forests alternate between dense undergrowth and gaps.

Table 8.1: Categories of environmental services provided by forests

Regulatory functions	Productive functions
The forest provides support to economic activities and human well-being by:	The forest provides basic resources, notably:
- climate regulation - hydric regulation - protection against soil erosion - maintaining biodiversity - carbon sequestration - recycling organic matter and human waste	- building materials: wood, lianas... - energy: fuelwood... - food resources: non-timber products, game... - medicinal resources - genetic resources
Physical support functions	**Informational functions**
The forest provides the space and required substrates for:	The forest provides esthetic, cultural and scientific benefits:
- habitat - farming zones - recreational sites - conserved natural spaces	- source of cultural and artistic inspiration - spiritual information - historic, scientific and educational information - potential information

There is currently much scientific uncertainty about how these ecological functions play out as well as their interrelations, especially in tropical forests. After their production roles, attention turns to forests' regulatory functions so these can be better integrated into the sustainable management process. Three environmental services are currently at center of debate - carbon sequestration, biodiversity conservation, and watershed protection - which generate significant economic benefits, as illustrated in the following table, both generally (Pearce and Pearce, 2001), and specifically as in the case of Cameroon (Ruitenbeek, 1990; Lescuyer, 2000, Yaron, 2001).

Table 8.2: Estimation of the main economic benefits derived from tropical forests (in current $ per hectare)

Goods or services provided by the tropical forest	Tropical forest (Pearce and Pearce, 2001)	Cameroon forest: Korup National Park (Ruitenbeek, 1990)	Cameroon forest: forest concession in the East (Lescuyer, 2000)	Cameroon forest: Mount Cameroun (Yaron, 2001)
Timber	200 – 4,400		580	
NTFP	0 – 1,000	60	1	40 - 70
Tourism	20 – 4,700	20		
Genetic resources	0 – 3,000	7		3
Watershed	150 – 8,500	70		270
Carbon sequestration	360 – 2,200		980	2,260
Benefits of non-usage	50 – 4,400			20 - 30

Thus, these environmental services have a positive impact on human well-being, sometimes greater than the impact from lucrative activities. Such estimates depend on both local and analyst assumptions - on methods and on some variables - and are hard to extrapolate (Lescuyer, 2000). Nonetheless, they indicate the potential importance of certain products or certain ecological functions rarely subject to management measures. As they are rarely subject to monetary transactions, environmental services are difficult to incorporate into forest management. For example, unlike the person who fells a tree and sells the timber, there is no payment for protecting the forest, its carbon and biodiversity. But, as true in Central Africa as it is anywhere else, an effective way to change forest managers' behavior is to change the revenues and costs derived from management. A better way to take into account forests' environmental functions involves assigning a price to be paid by the beneficiary of these services which provides an income for the producer/protector of these services. This is the purpose of payments for environmental services (PES).

Implementing Payments for Environmental Services in Congo Basin Forests

The rationale behind PES schemes is simple: external beneficiaries of environmental services make a direct, contractual and conditional payment to the owners or users of the sites if they adopt practices to secure the conservation/restoration of the ecosystem and thereby generate environmental services (Pagiola *et al.*, 2002; Wertz-Kanounnikoff, 2006). In this way, users receive a direct incentive to include environmental services in their land and resource use decisions, which should ideally lead to better resource use than in the absence of such payments. In theory, the PES contractual mechanisms should have five main features: (1) a voluntary transaction where (2) a clearly defined environmental service (3) is "purchased" by (at least) one individual consumer (4) from (at least) one individual supplier, (5) if and only if the supplier guarantees the continued production of the environmental service (Wunder, 2005). In practice, these conditions are rarely met: PES vary significantly by level (competitive markets, or on the basis of profits made by the

ecological service, or based on opportunity costs borne by the actors involved) and by type of financial[1] transfer (in cash or in kind, through taxes, trust funds, bilateral or multilateral compensation,...). Moreover, biodiversity conservation PES employ three broad types of support:

- *schemes based on area*, where the contract is for a particular space in which all or certain uses are prohibited, such as a first-class protected area;
- *schemes based on products*, where consumers pay a "green" premium in addition to the market price for a property that has been produced in compliance with environmental standards;
- *schemes based on use restrictions* which compensate users for limiting their use of resources, without restriction to a particular area, such as preventing great ape hunting or sea turtle fishing.

There is in fact a continuum of PES initiatives ranging from competitive markets to projects to promote environmental services and regulatory approaches using economic incentives (Grieg-Gran *et al.,* 2005). Whichever form the PES takes, the approach is still recent in Central Africa, and not widely implemented. In the early 2000s, Landell-Mills and Porras (2002) conducted a broad review of market mechanisms designed to ensure maintenance of several forest environmental services. The only case study from Central Africa in the report covers the assignment of bioprospecting access rights in Cameroon.

Even today, if we refer to http://www.ecosystemmarketplace.com, a PES discussion and promotion group (Katoomba Group), PES implementation in the African rainforest is addressed in five papers, and even then, only partially. Hence there is currently very little PES activity with regard to the Congo Basin forest.

Yet many sub-regional actors are beginning to pay close attention to this type of mechanism. As for donors, the African Development Bank in 2008 launched the "Congo Basin Forest Fund," with more than $ 110 million, which will be partly devoted to setting up PES, including the fight against climate change. Similarly, the World Bank, with its Forest Carbon Partnership Facility, and the United Nations - UNDP, UNEP, FAO - have significant funding for implementing sub-regional programs for reforestation or avoided deforestation. Finally, the Global Environment Facility has started a "Strategic Program to Support Sustainable Forest Management in the Congo Basin," which is also skewed towards PES.

All this funding is for three main environmental services – carbon sequestration, biodiversity conservation, and watershed maintenance – which are just starting to be implemented in Central Africa.

Photo 8.2: Pitsawing is a common activity on the edge of the forest (near Mitzic, Gabon).

[1] The opportunity cost corresponds to the sum of lost net benefits due to the loss of access to natural resources.

Table 8.3: Some Clean Development Mechanism projects in Central Africa

Country	Cameroon	Cameroon	Congo	Congo	
Project	Alternative to the decline in old cocoa plantations using mixed species, medium growth plantations on humid savanna	« One Parisian, one tree »	Private woodlands on the Batéké plateaux and on degraded lands of the Pool savannas to supply fuelwood to Brazzaville	Cogeneration CIB	
Localization	Plain of Mbam, municipality of Bokito	Western region	Plateaux Batéké and Pool savannas	Pokola	
Period	To start in July 2009	February 2008 - December 2012	Possible 2009	Possible 2009	
Project Perimeter	At full term, 1,670 hectares of cocoa plantations with mixed cropping	Village plantations over 51 ha in November 2008; 500 ha over time	Plantations for fuelwood over 16,500 ha in 30-years	Energy independence, wood drying and electricity for the town of Pokola	
Species	Cocoa association with fruit species, palm oil, coconuts, forest species (frake and fromager)	Fruit trees, timber species or artisanal species, fast growing exotic species	Plantations of species for charcoal (eucalyptus and acacia)	Development of 90,000 t of wood waste/year and substitution of 6 million liters of gas oil/year	
Project Sponsors	ANAFOR, SODECAO, IRAD	Municipalities of Tonga and Foumban	*Ministère de l'Économie forestière* by SNR, City of Brazzaville and region of Pool	CIB Group	
Supervision	FUPROCAM, IRAD	*Syndicat des Communes forestières du Cameroun*, CTFC, ONFi	SNR via *Autorité du Bassin d'Approvisionnement énergétique de Brazzaville*	CIB	
Actors	Individual growers in Bokito affiliated with FUPROCAM	*Communes* of Tonga and Foumban, Community Interest Groups	Private producers (individual and industrial)	CIB	
CDM case instruction	CDM: CASCADe/UNEP (decision January 2009)	CDM: City of Paris	CDM: seeking financing	CDM: PIN/self-funded	
Supporting body	ANAFOR, IRAD	ONFi	SNR, CIRAD and others	CIRAD	

	DRC	DRC	CAR	CAR
	Private woodlands on the Batéké plateaux and degraded lands of Bas-Congo to supply fuelwood to Kinshasa	Carbon sink at Ibi-Batéké	Cogeneration SEFCA	SCAF Plantation on savanna
	Plateaux Batéké and Bas-Congo	Plateaux Batéké	Mambéré-Kadéi and Sangha-M'baéré	Liboko
	Possible 2009	To start in January 2008	Possible 2009	Possible 2010
	Plantations for fuelwood over 112,000 ha in 30-years	Plantations of timber and fuelwood over 8,000 ha in 30-years	Energy independence, wood drying and rural electricity	Industrial timber plantation
	Plantations of species for charcoal (eucalyptus and acacia)	Eucalyptus, acacia and local species	Development of 59,000 t of wood waste/year and substitution of 942,000 liters of gas oil/year	Teck plantation
	Ministère de l'Environnement and provinces of Kinshasa, Bas-Congo and Bandundu	Fondation asbl Novacel sprl	SEFCA Group	SCAF Group
	SNR via *Autorité du Bassin d'Approvisionnement énergétique de Kinshasa*	Novacel sprl and Gi Agro asbl	SEFCA	SCAF
	Private producers (individuals and industrial)	Private company and local community	SEFCA	SCAF
	CDM: CASCADe/UNEP (decision January 2009)	CDM: World Bank (Biocarbon Fund) + CASCADe	CDM: PIN/CBFP- CDM	CDM: PIN/PDD through self-funding
	SNR, CIRAD and others	FRM then ONFi	CIRAD	FRM

Undoubtedly, carbon sequestration represents the most interesting environmental service and the one with the highest expectations. This is linked to the scale of the issue and the funds available. The payment mechanism for maintaining or restoring this service assumes three main forms: Clean Development Mechanism (CDM), Reduction of Emissions linked to Deforestation and Degradation (REDD), and initiatives linked to voluntary markets. None of these mechanisms are operational in the Congo Basin, or registered with the United Nations Framework Convention for Climate Change (UNFCCC). On the other hand, numerous project ideas have come to light in the sub-region in recent years.

First, under the Kyoto Protocol, all Central African states and a number of private actors are initiating afforestation/reforestation projects to benefit from CDM. The following table presents some of these initiatives. Several have been formalized in documents known as PINs (Project Idea Notes) prepared by designated national authorities in sub-regional countries while others are individual efforts. In both cases, the design of a CDM project is long and complex and requires a variety of skills.

Since 2005, a second new approach has been under discussion to include "avoided deforestation" in the collection of Protocol instruments: the famous REDD process, which aims to compensate efforts to prevent deforestation and forest degradation, and thus the release of greenhouse gases at the end of the next post-2012 commitment period, that is, starting in 2018. This tool is the subject of much debate and encounters still unresolved methodological difficulties. The issues regarding this financial mechanism are discussed in detail in chapter 11. In general, all sub-regional countries have drafted documents called R-PINs (Readiness Plan Idea Notes) submitted to the World Bank's Forest Carbon Partnership Facility to develop a national strategy for avoiding deforestation. These R-PIN include roughly the same four headings: consultation with stakeholders, developing a baseline project, drafting the national strategy, and developing a monitoring system.

In addition to these R-PINs, the Congo and DRC have also written papers on PIN REDD initiatives, in both cases to guarantee wood energy supply in Brazzaville, Kinshasa and surrounding areas.

Finally, surfing the wave of climate change, many carbon sequestration/storage initiatives do not originate directly from the Kyoto Protocol. Difficult to identify, these voluntary measures are usually implemented by environmental NGOs with private (often international) funding for their mission. The reforestation project initiated by WWF and MTN (Mobile Telephone Network) in northern Cameroon is such an example. A number of CDM projects currently facing important methodological difficulties will probably switch to the voluntary market, where criteria are less stringent. But unlike CDM or REDD projects, such voluntary measures are not recognized by the UNFCCC and cannot be used to achieve quotas of greenhouse gas emissions. They therefore enjoy a lower price per metric ton of carbon sequestered (Hamilton *et al.,* 2008).

Photo 8.3: Koko leaves (Gnetum sp.) are commonly consumed by rural populations.

In recent years, biodiversity has become the second PES environmental service in the sub-region. There are direct incentives for biodiversity conservation in which compensation depends upon the level of biodiversity. They differ from more conventional approaches which either provide alternative activities to biodiversity exploitation (game farming, micro-development, agricultural intensification ...) or develop profitable but sustainable uses for biodiversity (tourism, recreational hunting, crafts, sale of non-wood products ...). In both cases, the link between financial support and the level of biodiversity is indirect at best (McShane and Wells, 2004). On the contrary, a PES depends directly on conserving the biodiversity we seek to maintain: the degradation or disappearance of the resource means the payment is reduced or cancelled.

There are several initiatives in Central Africa to compensate protectors of biodiversity. There are three types: "freezing" potentially exploitable areas to promote conservation; the labelling of goods produced in compliance with specific environmental standards; and restrictions on practices impacting biodiversity in and around protected areas. Table 8.4 summarizes these initiatives and their implementation in Central Africa.

Conservation concessions represent the most recent approach in the Congo Basin. The objective is to convert areas earmarked for logging into protected areas, the shortfall being offset by domestic and local financial flows, or investment in kind from the conservation concession manager (Niesten and Rice, 2004). No projects have started yet in Central Africa, but WWF and CI have made three proposals: in the special dense forest reserve of Dzanga-Sangha in CAR; for the Ngoyla-Mintom forest area in Cameroon (Usongo *et al.*, 2007); and for a bonobo conservation concession in DRC (Conservation International, 2008). The goal is to conserve the habitat of several major species of large mammals, especially apes and elephants. These conservation concession proposals have yet to convince the national governments to whom the land belongs. The reluctance of public authorities can almost certainly be attributed to the opportunity cost of these conservation concessions - estimated at € 13 million per year for the Ngoyla Mintom forest (Karsenty, 2007), and almost € 10 million for the forest reserve of Dzanga-Sangha (Lescuyer, 2008) - as well as the complexity of national and local institutional arrangements to put in place.

The trend is reversed when we look at the number of FSC-certified forest concessions in the

Table 8.4: Current state of PES for biodiversity in Central Africa

	PES based on area: conservation concessions (proposed)	**PES based on products: FSC - certified forest concessions**	**PES based on restricting usage in/around protected areas**
Country	Cameroon (2007): Ngoyla Mintom (550,000 ha) CAR (2006): Special dense forest Reserve of Dzanga-Sangha (230,000 ha) RDC (2008): Bonobos conservation concession (680,000 ha)	Cameroon: Wijma (2 concessions, 97,100 ha); Pallisco (6 concessions, 341,700 ha); SEFAC (4 concessions, 314,600 ha); TRC (1 concession, 125,500 ha) Congo: CIB (2 concessions, 748,200 ha) Gabon: CEB (2 concessions, 616,700 ha), Rougier (3 concessions, 688,200 ha)	Cameroon: Compensation for halting turtle fishing (Campo Ma'an National Park) RCA: Compensation for reporting poachers (Dzanga and Ndoki National Parks) DRC: Compensation for reporting poachers (Garamba National Park) DRC: Creation of the Tayna Nature Reserve by local communities Equatorial Guinea: compensation for damage caused by wildlife (Monte Alén National Park)
Area (ha)	1,460,000	2,932,000	

sub-region. Most European forest companies are now committed to this process, although few have received final certification. By early 2009, three million hectares of forest should be managed in compliance with the "principles and criteria" of FSC in the Congo Basin. Compliance with FSC criteria requires the demarcation of areas with high conservation value and effective integration of local practices into forest management.

However, there are two reasons why forest certification represents an indirect incentive rather than direct payment for biodiversity conservation. For one, the "green premium" associated with certified products still has little weight today: it is not enough to convince a company to manage its forest and hence biodiversity better. Moreover, the surcharge paid by the final customer can be linked to a number of virtues associated with certified products, with biodiversity conservation being only one among others – legal compliance, empowerment of indigenous peoples ... Thus only a small part of the certification premium can be linked to biodiversity protection.

Finally, PES for biodiversity conservation also takes the form of a contractual arrangement between the protected area manager and local people. People are rewarded for their help in maintaining certain animal populations - such as sea turtles in Cameroon or great apes in DRC - or for their efforts in reducing pressures on biodiversity, including poaching. These types of agreement are still rare in Central Africa.[2] Based on a survey of 30 protected areas in the Congo Basin, Tchiofo (2008) observes that only five instances of direct compensation for users' right restrictions currently exist, even though almost all these protected areas offer indirect and/or semi-direct incentives for biodiversity conservation.

Financing Watershed Protection

Most Central African watersheds are covered with forest, which enhances the quality and regularity of water flows. However, it remains difficult to link forest cover and the quality/quantity of water used in urban centers where most demand takes place. In Cameroon, for example, the water used in Yaounde and Douala does not come from predominantly forested watersheds (Lescuyer and Bravi, 2004). On another scale, Ivindo National Park in Gabon helps ensure the high water quality of the Ivindo River, but it is only a secondary tributary of the Ogooué River, which itself flows through sparsely populated areas. In most Central African cases, access to water resources is not yet a problem. Finally, there are generally still few data on the relationship between forest ecosystems and water resources in Central Africa, which gives rise to much scientific uncertainty about how effective the forest's environmental role is (Bruijnzeel and Critchley, 1994).

Photo 8.4: Water, a valuable commodity, is abundant in the region.

Despite these difficulties, two PES for watershed protection are being developed: one in Gabon and one in Cameroon.

Proposed by WCS to the Global Environment Facility, the project "Sustainable Management of the Mbé River Forested Watershed through the Development of a Payments for Ecosystem Services Mechanism" aims to strengthen the protection of the river Mbé watershed, which is both the main source of drinking water and electricity for Libreville and an area of high conservation value. Located in Monts de Cristal National Park, the Mbé Forest plays several ecological functions, reducing sedimentation of reservoirs used by the power plant, preventing flooding and protecting the mangroves, which are major spawning grounds. The project objective is to test a PES mechanism in 100,000 ha of the Mbé River catchment area to compensate actors for preventing degradation

[2] No example of such a PES is explicitly mentioned in the Landscape presentations.

of forest cover and natural resources. The same logic drives WWF-CARPO to consider creating a PES scheme for Lake Barombi-Mbo, overlooking the town of Kumba in Cameroon. The crater lake has had Forest Reserve status since 1940; however, this has not prevented the area from suffering considerable damage for many years. Yet this lake is a major reservoir of drinking water, an ecological function that is now threatened by the fast disappearance of the surrounding forest. Economically, a PES payment for forest protection in this watershed could be a more viable solution than seeking an alternative drinking water source for Kumba.

These two testing-grounds will only be implemented at best by 2010. It is now clear they raise more issues than they solve. Nonetheless, widespread PES application in the sub-region must first transit through the implementation of such pilot projects. Although PES literature is abundant, there has hardly been any implementation in Central Africa. However, these direct incentive approaches are currently considered a promising solution by many managers. Firstly we need to consider the relevance of, and implementation conditions for, such incentives in the Congo Basin.

PES Issues and Constraints in Central Africa

Is There a Market for Environmental Services from Tropical Forests?

A payment mechanism for producing or protecting an environmental service implies a permanent and solvent demand for this service. Carbon sequestration is a good example as numerous funds and considerable funding exist for such initiatives, even though REDD implementation conditions remain unclear. On the other hand, biodiversity conservation remains fully problematic for two reasons. First, it is not easy to link biodiversity to a specific environmental service with a clear and direct impact on human well-being. As illustrated in the Millennium Ecosystem Assessment (2005), biodiversity helps maintain key ecological services on the planet without any direct connection to producing an environmental good or service. Thus, unlike the more traditional PES for water or carbon for example, users who pay for biodiversity know they are paying for an environmental service that does not directly alter their level of well-being because the biodiversity-ecosystem-human well-being relationship is still poorly understood (Ridder, 2008). Secondly, for a PES to be sustainable, the beneficiaries of environmental services – i.e., potential buyers – often have to be richer than those helping to produce or protect the service. Therefore, payments for biodiversity conservation can only come from companies or the international community, the only solvent and politically acceptable "buyers." The problem is similar for watersheds or carbon. The primary condition is that some actors are willing to finance the PES. To be effective, these funds have to change the behavior of actors in relation to maintaining one or several environmental services. This is the famous criterion of additionality, that says that activities that would have occurred without introducing the PES scheme should not be funded. Specifically, an environmental service must be threatened by human practices to be eligible for a PES. If agents are not capable or do not have the opportunity to clear forests, to impact biodiversity or degrade a catchment area, there is no reason to pay them to guarantee these environmental services as this is what they would have done anyway. Local practices have a clearer impact on biodiversity: the populations of flagship animal species are declining almost everywhere partly because of big game poaching for commercial trade. In most cases, these practices are carried out via local people who continue to manage and control access to hunting areas (Nasi *et al.*, 2008). This is thus an instance where local actors pose a real threat to biodiversity and where a PES would represent a real incentive to change practices (Pagiola *et al.,* 2005). However, if local people are actually involved in the illegal commercial hunting trade, the main beneficiaries are generally poachers from outside. Thus the opportunity cost of curbing the hunting of these species would be relatively modest for local people. Such a context would seem to favor setting up a usage restriction system since modest compensation for local people may be enough to halt these practices and bring local people back into full legality

Compensating actors for conserving environmental services they are used to degrading is equivalent to purchasing some of their user and access rights to natural resources.[3] However, these rights are not always legal even if stakeholders consider them legitimate. In Central Africa, local people commonly practice commercial hunting but the practice is nearly always banned under the Forest Code. The same is true of opening fields/plantations in forest concessions. Yet these legitimate but illegal practices often have a major impact on the state of the forest, and should be modified through economic incentives. But should people who degrade resources illegally receive compensation? Compensation mechanisms may encourage law-compliant actors to resort to illegality to benefit from this compensation, with the risk of spreading a "payment right" claim. However, this risk is lessened when the PES strengthens poorly enforced regulations and is used to partially cover the opportunity costs associated with implementing these regulations. Thus it represents an additional way of enforcing a legal and still credible restriction, for example on the edge of protected areas where there is minimal control of human activities (Arnoldussen *et al.,* 2008). However, this combination of legal repression and economic incentive still requires a change in the way local managers think and in local people's legitimacy in the context of conservation activity.

Photo 8.5: "Collaring" is a common trapping method.

These legitimate user and access rights to resources have the advantage of being generally based on local institutions, which can provide the foundation for creating a PES. Across Central Africa, people have appropriated areas and established key principles for land and resource use (Diaw, 1997). Still we should not have an idyllic view of these institutions as the way they function often has little to do with sustainable and harmonious community management of resources. In general, there is a multitude of flexible and adaptable rules, ambiguous sources of authority, heterogeneous communities ... (Geschiere, 1982; Le Roy *et al.*, 1996). A PES requires a field-level institution or organization capable of becoming a credible partner in such a contract. Two minimum requirements must be met:

1. The institution must have legitimate authority in the eyes of the people concerned, raising the question of how to define a community. Most decentralized management experiences in Central Africa equate the community - social entity - to a village – a geographical unit that, most often, had been created by colonial authorities. This is one of the main reasons why most of these experiments failed (Karsenty, 2008). Despite legal recognition, most villages are made up of a series of lineages or families, which are the real institutions regulating land access and use (van den Berg and Biesbrouck, 2000; Lescuyer, 2006). Thus, legitimate community institutions should be designed at this decision-making level to have any real impact on resource users. Families and lineages have the added advantage of being flexible enough to integrate people originally from outside the community but who have been assimilated through land allocation for example.
2. The institution must be capable of monitoring both internal and external individual rights in the community. Resisting outside pressures generally necessitates legal status to act and carry out sanctions beyond the local level: this can involve legalizing the institution or operating partnerships with influential external actors (NGOs, businesses, administrations, projects ...).

[3] This can be translated by compensating the populations to protect some resources against outside pressures such as poachers, for example. But there again, poacher access to the village hunting grounds is generally considered a legitimate right by people and it is more often than not a reason for remuneration. Paying local people to combat poaching means taking away their right to let poachers enter.

These institutions may also find it tricky to regulate the uses of group members, especially for partial or total restriction (Hackel, 1999). In Central Africa, user rights are acquired and updated through usage of an area or resource, not through maintenance. PES implementation for biodiversity conservation means turning this paradigm upside down. This can only be done through regular payment of adequate compensation in a context of secure but unused rights.

A major problem for decentralized resource management in Central Africa is the lack of local institutions credible enough and able to enter into a contract. It is probably more sustainable to work with established social entities, such as lineages, than to set up more specialized village committees. Several examples show that these local institutions can be strengthened through building capacity so they can finally commit to, and comply with, contracts for natural resource use (Bigombe Logo, 2004).

Ownership of future royalties from PES implementation will undoubtedly be an important issue for forestry sector actors in the years to come. Good governance will be a central issue in future discussions. Will this benefit local "elites" able to capture these new profits or will it be a springboard for a new sustainable development model based on communities? What role will the national governments and its decentralized agencies play? The question remains open and the answers are in the hands of African stakeholders themselves.

PES and Opportunity Costs

Convincing users to surrender some of their rights to protect environmental services requires the proposed compensation to be greater than the benefits users would earn by continuing their practices. In economic terms, the PES must be greater than the opportunity cost borne by the actor if he accepts the PES and subsequently limits his/her practice.

Estimating opportunity costs is a delicate exercise, particularly in Central Africa where, unlike the static vision of low or non-existent technical change over time (Ferraro, 2002; Wunder, 2006), the socio-economic situation in rural areas has experienced important dynamics in recent years: higher prices for agricultural materials, more chainsaws and motorcycles, easier (and illegal) individual logging of timber, restitution of some forest royalties ... There has been a tendency towards higher rural incomes in the last ten years, as evidenced by some recent studies in Cameroon in particular (UNDP, 2006; Toison, 2008). The baseline scenario "without carbon sequestration" or "without biodiversity conservation" is indeed a development scenario, resulting in a progressive, albeit moderate, rise in income and greater forest resource utilization. On a small-scale or project scale, any evaluation of opportunity cost should incorporate income changes that can be objectively expected in Central Africa in the medium and long term. The same is true for a national approach to the REDD mechanism for example, although in practice the current price of a metric ton of carbon leaves little doubt about the ability of the PES to exceed opportunity costs.

Transaction costs to set up and operate a PES may also represent a major brake in Central Africa. These costs are generally estimated at between 5 to 25 % of the operating budget (Ferraro and Kiss, 2002; Grieg-Gran *et al.*, 2005). In Central Africa, where rural populations are dispersed and generally have limited technical capacity, transaction costs are likely to be high. Local monitoring of environmental services often represents a substantial cost, but can also be an effective way for the stakeholders themselves to appropriate the PES. In any case, such a mechanism seems unlikely at present unless a supporting actor absorbs part of the transaction costs. This is the case in protected area buffer zones where managers support local organizations to help local stakeholders become organized and to suggest discussion fora. In addition, a national PES, such as REDD, will undoubtedly help reduce transaction costs, at least after the negotiation, development and learning phases.

Photo 8.6: Pineapples and bananas are consumed daily in Central Africa.

To be effective, a PES must convince buyers that the service is, and will be, effectively provided by the suppliers for the period stated in the agreement. The primary objective of these mechanisms is environmental: the non-delivery of the environmental service means payments will stop. To be effective, the PES should thus target the actual producers of the environmental services and pay them a fair price, i.e., at least the opportunity cost they incur by engaging in this activity. Such an arrangement is more complex when it targets the poor and when the PES is viewed as a means of alleviating poverty (Corbera *et al.,* 2007). A PES will have at least two types of effect on living standards in rural areas: effects on environmental service providers and effects on non-suppliers who live in the same communities.

Photo 8.7: Traditional house in Mount Oku.

Even if the goal is primarily environmental, the PES may actually increase the living standards of the service providers if the proposed income exceeds the transaction and opportunity costs and is based on a baseline scenario for regular development in the area. Thus, the PES must meet stakeholders' legitimate aspirations to increase standards of living consistent with what they could reasonably expect without PES implementation. Can we sustain an effective PES designed solely for environmental service providers in the segmentary societies of Central Africa where egalitarian sentiment is dominant? A compensatory mechanism for only some people might create tensions among community members, and could lead to resource degradation from retaliation. By not bowing to the social community order, the PES could lead to private appropriation of collective resources and the generated funding, ultimately leading to a rejection of the mechanism (Karsenty and Weber, 2004). In addition, in the spirit of fairness, there is no shortage of pro-indigenous voices to defend the principle of equal pay for communities adopting "secular" forest conservation practices.

The distribution of PES benefits is a major issue in Central Africa. One option would be to share these benefits with all community members, irrespective of producers and non-producers of environmental services. But besides the fact that the payment would no longer be an incentive for producers of environmental services, current community organizations in Central Africa which manage such collective income (from community forestry, forest fees, ...) also face difficulties and do not always have a real impact on local development (Oyono, 2005; Assemb Mvondo, 2006). If the PES must increase the living standards of environmental service providers to be accepted, it cannot by the same token be a tool for supporting rural economic development. To remain effective and be socially acceptable, a PES should probably be linked to the introduction of other indirect and semi-direct incentives systems for stakeholders besides providers of environmental services and which share conservation benefits more equally.

Conclusion

Even with few practical examples, PES are of interest to a growing number of stakeholders in the Congo Basin. The probable implementation of the REDD mechanism within a decade (with current indications that massive funding will be available) should lead to an expansion of all PES. But all the REDD structures being considered are not equally favorable to the PES, in particular the balance between carbon and biodiversity. The dominant option at present is to pay governments based on a quantified target for avoided deforestation at national level, in which the national government (not decentralized actors) sells carbon credits on the market. This poses a double constraint for PES promotion in the Congo Basin. For one, it is not clear that governments will use the funds from REDD to launch national PES programs covering biodiversity and watersheds. Furthermore, since "REDD payments" will only start by 2018, bridging in the form of "funds" or voluntary programs will be needed to launch PES. In summary, if REDD really represents a major opportunity for setting up PES for not emitting carbon in Central Africa, existing regional initiatives tend to show that other environmental forest-related services are often mentioned but not incorporated into these projects. PES implementation for biodiversity or watersheds still depends heavily on funding and specific experiences. PES are primarily environmental management tools. However, implementation in Congo Basin countries means their economic efficiency should be linked to relative social equity. Locally, the PES must be estimated on the basis of opportunity costs incurred by people involved in the mechanism. The baseline scenario used to estimate these opportunity costs must reflect the current development of rural economies in Africa and an increase in living standards. However, the PES should not be regarded as the main instrument for poverty alleviation. Even though PES can actually improve the living standards of environmental services providers, they must be combined with other development support approaches to achieve a more egalitarian distribution of benefits within communities. Their effectiveness ultimately depends on careful integration into ambitious sustainable development policies at local and national levels.

CHAPTER 9
Water Resources, Forests and Ecosystem Goods and Services

Randall Brummett, Charles Tanania, Albert Pandi, Julie Ladel, Yolande Munzimi, Aaron Russell, Melanie Stiassny, Michele Thieme, Sue White, and Diane Davies

Among the ecosystem goods and services supplied by rainforests are numerous vital, but often underappreciated, goods and services linked to water resources. The Congo Basin forested region forms part of the Congo Basin watershed that provides its inhabitants with multiple water-related benefits, including water supply, flow regulation and water quality. The watershed is characterized by a dense river system that serves as an important navigation system for Central Africa, plays a large role in food supply and local livelihoods, acts as habitat for a range of plants and animals and has significant hydropower potential. In this chapter we examine some of the goods and services provided by the hydrological system in the Congo Basin and explore the relationship between forest ecosystems and the water resources that provide these benefits. A flexible spatial definition will be applied; the primary focus is on the Congo Basin forested region, but some consideration is given to the entire Congo River Basin and to major coastal cities on rivers outside the hydrological basin that benefit from hydrological goods and services. The chapter begins with an overview of the water system in the Congo Basin, presents a synopsis of select hydrological goods and services, describes the relationship between forests and water resources in large river systems and concludes with a section on the state of knowledge and water resource management in Central Africa.

Photo 9.1: The forest plays an important role in maintaining the quality and quantity of water in the Congo Basin.

The Congo Basin Hydrological System

The forests of Central Africa overlap with several major basins (figure 9.1): the Congo, the Ogooué, the Sanaga, the Cross, and the lower Niger. There are also many smaller basins that drain into the Gulf of Guinea.

The Congo River basin, with annual renewable water resources of about 1.3 billion cubic meters, is the largest of these basins and accounts for about 30 % of the water resources in Africa and was estimated to contain a population of approximately 77 million inhabitants in 2005 (African Development Bank, 2006). It is the largest basin in Africa with an area of approximately 4 million km^2; the Congo River has an annual average discharge at Brazzaville of about 41,000 m^3/s (Nkounkou and Probst, 1987). The Basin includes portions of ten different countries, but 85.3 % of the Congo River basin falls within the largely forested regions of four countries: Cameroon, Central African Republic, the Democratic Republic of Congo and the Republic of Congo. Within the Basin the hydrological network is very dense and includes a complex river network, vast inundated forests and lakes.

Sources: WWF, USGS, SDSU, UMD, Tom Patterson, US National Park Service.
Figure 9.1: Congo Basin Hydrological Watersheds

Source: NASA.
Figure 9.2: Image of the Congo River at Stanley Pool. Taken from the International Space Station on June 6, 2003

The Basin extends from latitude 09°15' N in the Central African Republic to 13°28' S in Angola and Zambia, and from longitude 31°10' E at the Great African Lakes in the East African Rift to 11°18' E on the Atlantic Ocean. The waters of the Congo River originate in the highlands (1,400 m) and mountains of the East Africa Rift, as well as Lake Tanganyika and Lake Mweru (Shahin, 2002) and flows north towards Boyoma Falls. The Upper Congo (Lualaba River) ends at Boyoma Falls where the Middle Congo begins. After the town of Kisangani, the Congo River turns west and southwest following a great curve. The Middle Congo ends at Stanley Pool, where the capital cities of Kinshasa and Brazzaville are located (figure 9.2). There, the river expands some 24 km across and the waters slow down considerably. Between Kinshasa and Matadi, a distance of about 350 km, the river descends some 280 m in elevation and is interrupted by numerous stretches of rapids, the largest and most well known of which are the Inga rapids. The River reaches the Atlantic Ocean between Banana Point in the Democratic Republic of the Congo, and Sharks Point in Angola, from where it continues its course underwater. The length of the Congo is approximately 4,700 kilometers. The major tributaries are: the Luapula and the Lualaba (the two headstreams), the Lomami, Ruki-Tshuapa and Oubangui (the main navigable tributaries of the Congo), the Sangha, and the Kasai.

In the central Basin there are vast areas of flooded forests, characterized by brown humic (acidic) waters that fluctuate with rainfall and seasonal changes in the Congo River level. Figure 9.3 shows the extent of flooded forest in the central Congo Basin.[4]

The Congo River system covers three different climate zones, including an equatorial zone with tropical zones to the north and south and a more temperate zone in the elevated region to the east. The heart of the Basin is within the equatorial climate zone where there is no real dry season. The rainfall in the equatorial region varies between 1,500 and 2,000 mm a year, with an average temperature of approximately 26º C. Average humidity is around 77.8 % and evapotranspiration is around 1,700 mm.

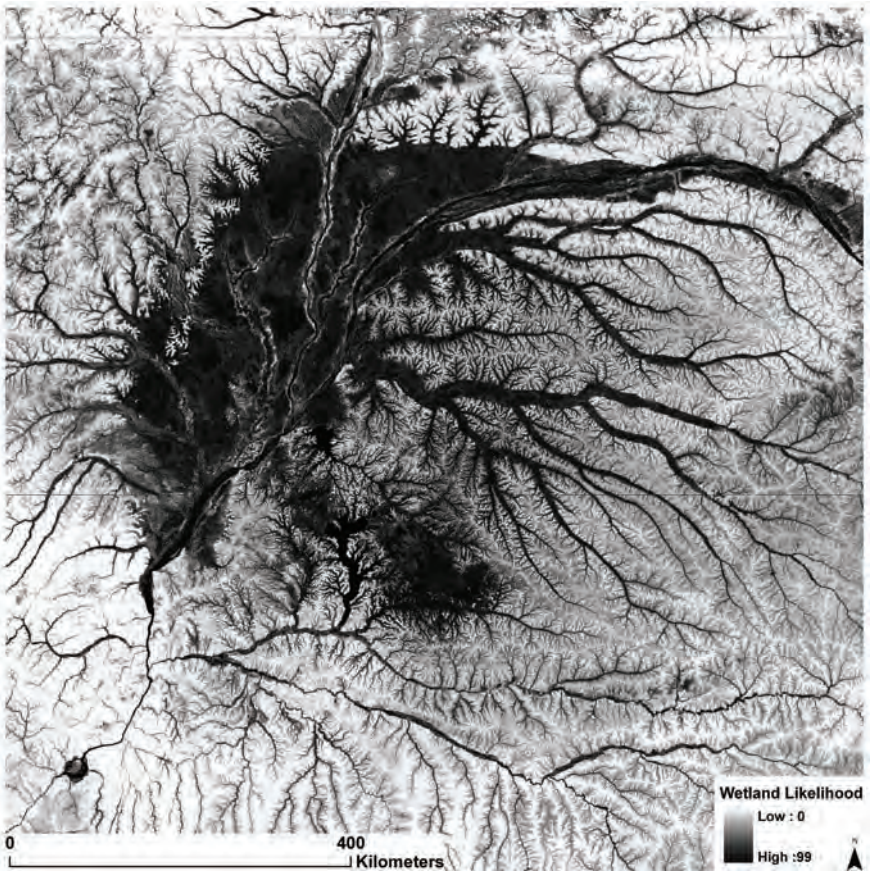
[4] Data used in mapping the extent of flooded forests include: Landsat TM and ETM+ imagery, JERS-1 SAR and SRTM.

The flow of the Congo is influenced by a complex series of factors across the Basin, but overall the Congo is more constant than many other African rivers because large sections of the watershed lie above and below the equator, in the path of the Intertropical Convergence Zone. However there is some inter-annual variability with December being the month of maximum flow and July and August the months of lowest flow. The tributaries from the South, such as the Kasai, have two periods of low water and two of high water each year, but the tributaries from the north, such as the Oubangui, have a single peak causing the regime of the main river to vary from place to place (Shahin, 2002).

Since 1960 there has been a general decrease in flow which coincides with a reported decrease in precipitation from major meteorological stations.

Box 9.1: Wetlands Likelihood in the Cuvette Centrale

A new approach to mapping the wetlands of the Congo Basin has been applied to a 1,175,918 km^2 region centered on the *Cuvette centrale* of the Congo Basin watershed. Mapping challenges include data limitations, vegetative structural heterogeneity, wetland seasonal variability, and limited opportunities for data collection for ground-based training and validation. To overcome these limitations, a multi-source statistical supervised classification approach was undertaken. Passive optical remotely sensed imagery provided by the Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) sensors, JERS-1 active radar L-band horizontal co-polarization imagery, and 3 arc-second elevation data derived from the Shuttle Radar Topography Mission (SRTM) were used as inputs. These data were related to wetland/non-wetland training data through a classification tree algorithm to yield a wetland probability map for the central Congo Basin. Wetland probability was expressed at a spatial resolution of 57 meters. The proportion of wetland cover for the study area equaled 32 %, equivalent to 359,556 km^2. Figure 9.3 shows the results of the study and the fine-scale variation of central Congo Basin wetlands. The unique ecological characteristics of humid tropical forest wetlands merit their mapping and monitoring. Improved wetland mapping can be used by a variety of applications, including hydrological modeling, forest use planning and biodiversity assessments. Future efforts will extend the method to cover the entire Congo Basin and to develop approaches for quantifying changes in wetlands extent over time.



Source: SDSU and CARPE.

Figure 9.3: Wetland likelihood map for the central Congo Basin area.

Photo 9.2: Rainfall is abundant and supplies rivers with large quantities of water.

Hydrological Goods and Services in the Congo Basin

Among the ecosystem services provided by forests in the Congo Basin are hydrological services related to water resources, including the vast Congo River system. Following the classification used by the Millennium Ecosystem Assessment, these services can be categorized into: (1) provisioning services - for example services related to water supply, that can be used through extraction, for purposes such as agriculture and municipal water supplies, and *in situ*, for maintaining freshwater fish production, navigation or hydropower generation; (2) regulating services, including services that help to maintain biophysical processes; (3) cultural services; and (4) supporting services, such as maintaining biodiversity habitat. Hydrological services also include water mitigation services that diminish flood damage, stop in navigation due to low waters, sedimentation of water bodies, saltwater intrusion and dryland salination.

In this section we review several of the provisioning and supporting hydrological services in the Congo Basin, including: navigation, fisheries, hydroelectric power generation, and biodiversity habitat. This section does not review all the ecosystem services provided by water resources in the Congo Basin, but instead serves as an introduction to some of the services of most immediate concern for human populations.

Photo 9.3: Navigation is important in Central Africa, but is sometimes interrupted by waterfalls.

Navigation

Within the Congo Basin, waterways provide a dense navigation system that extends for over 12,000 km and supply a vital means of transportation within and between different countries in the region. This network is the primary means of exchanging goods and services for the bordering communities and is the basis for a regional multimodal transportation network extending outward from the main ports of Pointe-Noire, Matadi, Brazzaville, Kinshasa, Bangui, and Kisangani (figure 9.1).

In the colonial era, rivers were used to transport goods and passengers between the Atlantic and the interior. To bypass the un-navigable falls and rapids three portage railways were built: Matadi to Kinshasa, Pointe-Noire to Brazzaville and Ubundu to Kisangani. All were abandoned at some point due to sabotage and civil war. Since 1997, periodic suspension of the Congo-Ocean Railway, linking Brazzaville to Pointe-Noire led traders to use an overland route through Cameroon. Limited freight and passenger services were resumed in 2000 and 2001 and restoration of the line is being discussed. The line between Matadi to Kinshasa does not work and the line from Ubundu to Kisangani has long since been reclaimed by the forest (Butcher, 2008).

With outdated railways and relatively few roads, the complex system of waterways is vital for local economies throughout the Congo Basin and the revival of the regional economy. Inland, the Congo and the Oubangi rivers form the two main axes suitable for commercial traffic and yet despite the importance of these waterways river traffic has severely decreased. This is partly due to political instability and a decrease in water

level on the Oubangui over the last 30-years. The *Service commun d'Entretien des Voies navigables* (SCEVN) noted an 18 % decrease in discharge since 1985 (figure 9.4). Shallow water levels on the Oubangui River during the dry season prohibit the use of barges for navigation for five months of the year. When water levels are sufficiently high it takes approximately 21 days for a convoy of barges carrying about 1,500 metric tons to complete the 2,360 km round trip from Bangui loading either in Kinshasa or Brazzaville and back to Bangui.

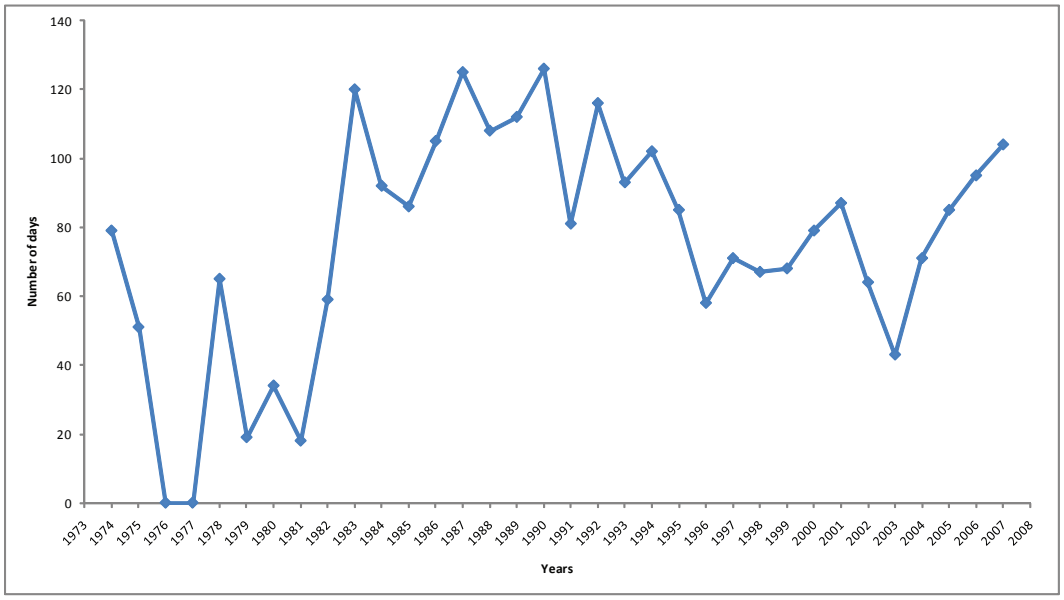
In general the navigation system in the Congo Basin suffers from significant problems: poor maintenance, insufficient beaconing of waterways, modest traffic, lack of regulation, out datedness and insufficiency of transport facilities, as well as additional non physical barriers. Managing navigation on shared waterways is a key objective for CICOS, the International Commission for the Congo-Oubangui-Sangha (box 9.2).

Photo 9.4: Water is a basic necessity; its quality is preserved by the forest.

Box 9.2: CICOS - International Commission for the Congo-Oubangui-Sangha

On November 17, 1999, CICOS, the International Commission for the Congo-Oubangui-Sangha Basin, was created to strengthen trans-border management of water resources between the four riparian countries which together compose 85.3 % of the Congo's hydrological basin: DRC, Cameroon, Republic of Congo and CAR. The original Accord, ratified by the four Heads of State, identified internal navigation as the key objective. On February 22, 2007 an amendment to the Accord supporting the Integrated Management of Water Resources (IWRM) was ratified. The overall aim of CICOS is to manage water resources based on shared strategies that promote trade and economic development, while also controlling pollution and adhering to IWRM principles.

The institutional framework of CICOS is composed of two bodies: (1) the Ministerial Committee, which serves as the decision making body of CICOS and (2) the Management Committee, which acts as the advisory body or steering committee.



Source: Ladel et al., 2008.

Figure 9.4: Number of days with a water height of less than 90 cm required for an economic navigation on the Oubangui River.

Photo 9.5: A "residential" boat on the Salonga River in DRC.

Estimates of annual fish catch from the Congo Basin vary widely and range as high as 120,000 metric tons. In addition to generating the majority of animal protein consumed by rural communities, the value of the catch represents an important proportion of gross national income in the rainforest zones. An estimated 20 % of the adult population living in rainforests are engaged in river fisheries (Brummett and Teugels, 2004). Actual fish yields and their value are unknown but the potential for the fishery in the mid 1980's was estimated at 520,000 tons worth $ 208 million (Neiland and Béné, 2008). Chapman and Chapman (2003) estimate that this value represents only 41 % of the potential total catch in DRC.

There is very little actual or published data on the Congo Basin fisheries. The following descriptions are summarized from an ongoing research by the World Fish Center (funded under CARPE) in lakes Tumba and Mai-Ndombé, the Salonga River and the Lomako River.

The Fishery

The most widely used gear is the traditional basket trap. These come in a wide range of lengths from 30 cm up to 3 m or more. These are placed in streams and shallow sections of main rivers at fish migration routes. They are held in place with stakes, rarely baited and checked daily for fish. Such traps are cheap, being mostly manufactured by the fishers themselves.

A widespread women's traditional fishery or "*écoupage*" is also based on home-made baskets used as the waters recede from the forest during the dry season to capture small and juvenile fishes, crabs and freshwater prawns. The "epoko" is a small, nearly watertight basket that is used to bucket water out of depressions in the swamp forest or from small dams constructed on low-order streams. Usually, 6-10 women, lead by an older and more experienced matron, will work together to share the work.

The most widely used "modern" gear in the commercial (all male) fishery is the "Lubumbashi" style gill net, named after the defunct fishing net factory that produced netting up until 1983. Gill nets are generally placed in parallel with the river current across entry/exit points where fish move between the main river and the flooded forest. Hooks are comparatively rare among the typical fisher, but "professional" fishers (see below) report using baited hook-lines for the preferred *Parachanna obscura* ("*mongusu*") an ambush predator difficult to catch with set nets.

The use of dynamite, chemical poisoning of ponds and burning vegetation have been reported as illegal fishing methods in Salonga National Park (Inogwabini, 2005).

Out of some 1,000 estimated species in the Congo river system (Thieme *et al.*, 2005), only 50 are regularly captured. Due to the inability of most fishers to access deep water or main river channels, many of these are taken only as juveniles while they are feeding and growing in the flooded swamp forest or during (horizontal) spawning migrations between the main river and the flooded forest.

The Fishers

Most fishing occurs during the dry season when the water is relatively low, the swamp forest is relatively dry and fish are concentrated in the rivers. However, some fishing, especially for household nutrition, occurs throughout the year. During the peak fishing seasons, groups of fishers operate from small villages or temporary camps. Fishing is seen as a complimentary activity to agriculture. Most fishers remain dependant upon a larger village where they cultivate land for agriculture.

Despite well-known village boundaries, the fishery is open-access with people fishing pretty much wherever they please. Most fishers are, nevertheless, from the village on whose land they are situated, which permits them to retain traditional property rights to any agricultural plots they manage. All of the interviewed fishers insisted that newcomers are welcomed and that there are no constraints put on fishing access and no requirements to seek permission from traditional authorities.

Fishing is seen as a complimentary activity to agriculture and many fishers are only fishers because of a lack of capital and markets needed to undertake traditional agriculture on a larger scale. When asked specifically what they would do if they had "enough money," fishers indicated that they would go back to the village, build a house and obtain a plot of land to farm. These fishers operate an average of about 13 nets (approximately 50 m wide) and a few dozen hooks and manage to capture 20-30 *valises* (3-5 kg) of dried fish per year.

There are a minority of fishers who are considered professionals. These people usually bring manufactured goods (e.g., clothing, sandals, mosquito nets, torches, batteries, fishing gear) from outside to barter for fish as well as doing their own fishing. The typical professional fisher operates about 100 nets plus 1,000-1,500 hooks and catches 60-100 *valises* per year. Once they have enough fish to fill their pirogue, they go to town, sell their catch, replenish their supply of consumer goods and return. These trader-fishers tend to move around and compete with each other for a presence in the best fishing camps.

The Fishery Value Chain

It is estimated that fishers keep about 1 kg per family (avg ~6 persons) per day for household consumption. The rest is destined for market. These are usually smoked in a single layer over an open hot fire using dry wood for a period of about 6 days. This results in a product that is charred on the outside but poorly preserved on the inside. The typical practice is to store these fish throughout the dry (fishing) season until prices rise in the following rainy season, meaning that most fish are held for at least 2-3 months, and sometimes up to 6 months prior to marketing. Smoking is often repeated monthly during storage to combat insect infestation and mould. The process leads to dry matter losses estimated by the fishers at between 30 and 50 %.

Salting and sun drying produces a higher quality product, but relies on expensive salt that has to be brought in from either Kisangani or Basankusu. The high cost of salt, approximately 10,000 Congolese Francs per 20 kg (roughly $ 20 in 2008), encourages fishers to try to brine their fish in lower-than-optimal concentrations, reducing quality. Although the data collected on fish are sparse, observations indicate that the relative return on salted fish has the potential to be double that of smoked fish, and may possibly surpass that of fresh fish due to its longevity.

The catch from the women's *écoupage* fishing is primarily consumed by the household, but in times of abundance may be marketed locally. Women are heavily involved in the smoking of the men's commercial catch, cleaning the fish, gathering firewood and tending the fires. In the "professional fisher/trader" camps, all processing and trading is done exclusively by the women, leaving the men to spend more time fishing.

Fish are marketed in a variety of baskets and basins. The smallest unit is the "*valise*" which holds about 30 smoked fish (estimated 5 kg dry weight, 10-20 kg wet weight). A "*basket*" contains 5-6 *valises* while a "*suzuki*" in turn holds some 3-4 baskets. None of the above units are standardized, so one often hears of a "small *valise*" or a "large *suzuki.*" Salted fish are transported on open "*paniers*" that hold roughly 10 fish. *Écoupage* catches are transported either in the small *epoko* used in the *écoupage*, but more frequently in large baskets called "*corbeilles*" that equal roughly four *epoko* in volume. In more accessible camps fish can be kept alive for several days in 15 L plastic basins for sale as fresh fish, and contain between 120-140 fish. Price is a function of the size of the unit, species and condition of the fish.

From a study in Basankusu a *valise* of the most valuable species, *P. obscura ("mungusu")* in good condition sells for about 3,000 Congolese Francs (roughly $ 6). At the other extreme, the least preferred *Malapterurus sp* ("*neena*") in bad condition sells for about 1,000 Congolese Francs per valise ($ 2). Overall, prices vary by 30-50 % according to the state of the fish and supply in the market.

Photo 9.6: The waters of Central Africa are rich in fish species.

Table 9.1: Indicative enterprise budget (in Congolese Francs*) for a fishing family working the two main fishing seasons on the Lomako River

			Low market		High market	
	Quantity	**Units**	**Unit price**	**Total**	**Unit price**	**Total**
Nets	13	50-m	3,000	39,000	3,000	39,000
Transport	2	2 oarsmen	7,000	14,000	7,000	14,000
Food and accommodation	14	days	500	4,200	500	4,200
"Taxes"	25	*valises* x 2 ports	2,000	50,000	2,000	50,000
Total cost				**107,200**		**107,200**
Fish sales	25	valises	2,500	62,500	5,000	125,000
Profit/loss				**-44,700**		**17,800**

Exchange rate $ 1 = 500 Congolese Francs

As markets can be distant and expensive to reach, marketing tends to be opportunistic. It has been reported that many fishers sit in their pirogues along the main channel waiting to sell small quantities of fresh fish, or occasionally *valises* of smoked fish to passing boats. A minority of fish is sold this way, most likely to the professional fisher-traders.

Most fishers choose to go to market when they need money or when the fishing is poor, rather than waiting until there are enough fish to make a full load. This means that most of the fishers travel to markets around the same time, after the end of the dry season, when the fishing starts to get worse, and when people need money to invest in clearing land for farming.

Overall, lack of market access, poor quality and illegal taxes levied arbitrarily by government officials render fishing a subsistence activity. Under the right conditions, aquaculture could make a significant contribution to food security and economic growth (Brummett *et al.*, 2008).

Hydropower Potential

The varied hydrological arrangement associated with the topology of the river courses in the Congo Basin offers numerous opportunities for hydropower development. At the end of 2005, most of the installed capacity for generating electricity in the Congo Basin was from hydropower. The total installed operational capacity of hydropower was reported at 6,490 MW, 39 % (2,540 MW) of which is located in DRC (see table 9.2).

The installed capacity represents only a small fraction of the estimated hydropower potential in the Congo Basin. Studies examining the potential for hydropower generation, point to the Congo Basin, and the Inga rapids in particular, as the most important potential source of hydropower development on the African continent. Currently, the Inga hydropower station comprises a 358 MW plant (Inga I) that was commissioned in 1972 and a 1,424 MW plant (Inga II) that began operating in 1982 (both are currently reported to be operating at less than half their installed capacity). The overall hydropower generating capacity of the Inga site has been estimated at 44-60 GW and the interest to build a third Inga site (Inga III) and develop a pan-Africa electricity exporting project has long existed. Plans are currently underway with Westcor (Western Power Corridor (PTY) Limited) to begin construction for Phase I of Inga III in 2010, with full commissioning of Phase I anticipated in 2015 at a base power of 5,000 MW. An ambitious undertaking, this project is at the center of the NEPAD Infrastructure Program and represents a serious potential source of revenue for potential shareholders, including an estimated $ 424 million annually for the government of DRC after payment of capital debts during years 1 to 5. Revenues are expected to increase to $ 594 million and finally to $ 678.8 million in subsequent years (Westcor, 2008).

Other hydropower (proposed and actual) developments of note are:

- The Imboulou hydropower dam on the Léfini River in the Republic of Congo. Construction of the facility began in 2005 and was expected to take 5 - 6 years. It is expected to have an installed capacity of 120 MW.[5,6]

[5] http://www.mbendi.com/indy/powr/af/co/p0005.htm (accessed 24 Feb. 2009)

[6] http://www.fwt.fichtner.de/php/main/page/php/referenzen.php/ukat_id/6/kat_id/3/idc1/27/z1/2/map/1/sprache/e/li/0re (accessed 24 Feb. 2009)

Table 9.2: Hydropower capacity in the Congo Basin at the end of 2005

	Net installed capacity of electric generating plants		Production of hydropower electricity.
	Total (all types) MW	Hydropower MW	MWH
Angola	525	390	1,747
Burundi	33	32	99
Cameroon	875	805	3,913
CAR	43	22	84
ROC	93	92	355
DRC	2,573	2,540	7,395
Gabon	420	175	814
Rwanda	39	35	130
Tanzania	549	329	1,778
Zambia	2,260	2,245	5,834
Total	**6,990**	**6,490**	**21,335**

Source: United Nations, 2005. All figures are estimates by the Statistics Division of the UN Secretariat.

- The Belinga dam, Gabon. The Kongou Falls, on the Ivindo River have been earmarked as the site for this dam (Stella, 2007). The proposed Belinga dam would generate power for the Belinga Iron Ore Project. Environmental groups are concerned that if the dam is constructed at the Kongou Falls in Ivindo National Park, it will have a negative impact on the biodiversity and natural resources and have requested the dam be moved instead to Tsengué-Lélédi Falls. Civil society groups are also concerned about the imbalance of benefits for the Gabonese people. Currently Gabon's primary hydropower sites are located at Tchimbélé, in Monts de Cristal National Park (69 MW) (supplying electricity to Libreville) and Kinguélé (58 MW) on the M'Bei River.[7]
- The Ruzizi III dam in DRC would be situated 25 km downstream from Ruzizi I and II, already located at the outlet from Lake Kivu. Ruzizi I and II are operated by a tri-national company (Burundi, Rwanda and DRC). Electricity production is insufficient to meet the needs of the adjacent areas. A further dam, Ruzizi III, is planned to meet the shortfall
- The Lom Pangar dam in Cameroon. The two main hydro stations, Song-Loulou (384 MW) and Edéa (264 MW) located on the Sanaga River, have experienced significant reductions in power generation due to reservoir sedimentation, poor maintenance and dry seasons exacerbated by drought (Hathaway and Durrell, 2005). Construction of the Lom Pangar dam would help regulate flow of the Sanaga and increase and secure constant power output from two downstream dams. This would be the fourth dam built to help regulate the Sanaga River. The project has been delayed due to pressure from environmental groups who claim it will submerge part of the Deng Deng Forest Reserve, a refuge for endangered animals such as chimpanzees, elephants, gorillas, and black rhinoceros. Concern has also been expressed about Cameroon's heavy reliance on hydropower when drought is already an issue.[8,9]

Climate models for Africa are far from clear (Schiermeier, 2008) and so too are the effects that climate change will have on large hydropower schemes. Mukheibir (2007) is of the opinion that an increase in the average annual rainfall in the Congo Basin would lead to increased generation potential but notes this could also have negative impacts of increased flooding and associated large sediment loads which would be detrimental to large dams. By contrast Paeth and Thamm (2007) modeled climate scenarios for Africa and indicate that there could be a reduction in precipitation in the Congo Basin by up to 500 mm (20-40 % of the annual sum) which could seriously limit the hydropower potential of the region.

Although Africa's great rivers are considered "under-dammed" by global standards, many of the big dams constructed have been built at the expense of rural communities and important ecosystems. In response to such concerns, guidelines and improved practices for decision making and risk assessment have been put forward by the World Commission on Dams and the Dams and Development Project.[10]

[7] http://www.internationalrivers.org/en/africa/belinga-dam-gabon (accessed 24 Feb. 2009)

[8] http://africanpress.wordpress.com/2008/02/02/delay-in-construction-of-lom-pangar-dam-slows-project-to-upgrade-aluminium-smelter/ (accessed 24 Feb. 2009)

[9] http://www.internationalrivers.org/en/africa/drought-could-cripple-cameroon %E2%80%99s-hydro%E2%80%93heavy-energy-sector (accessed 24 Feb. 2009)

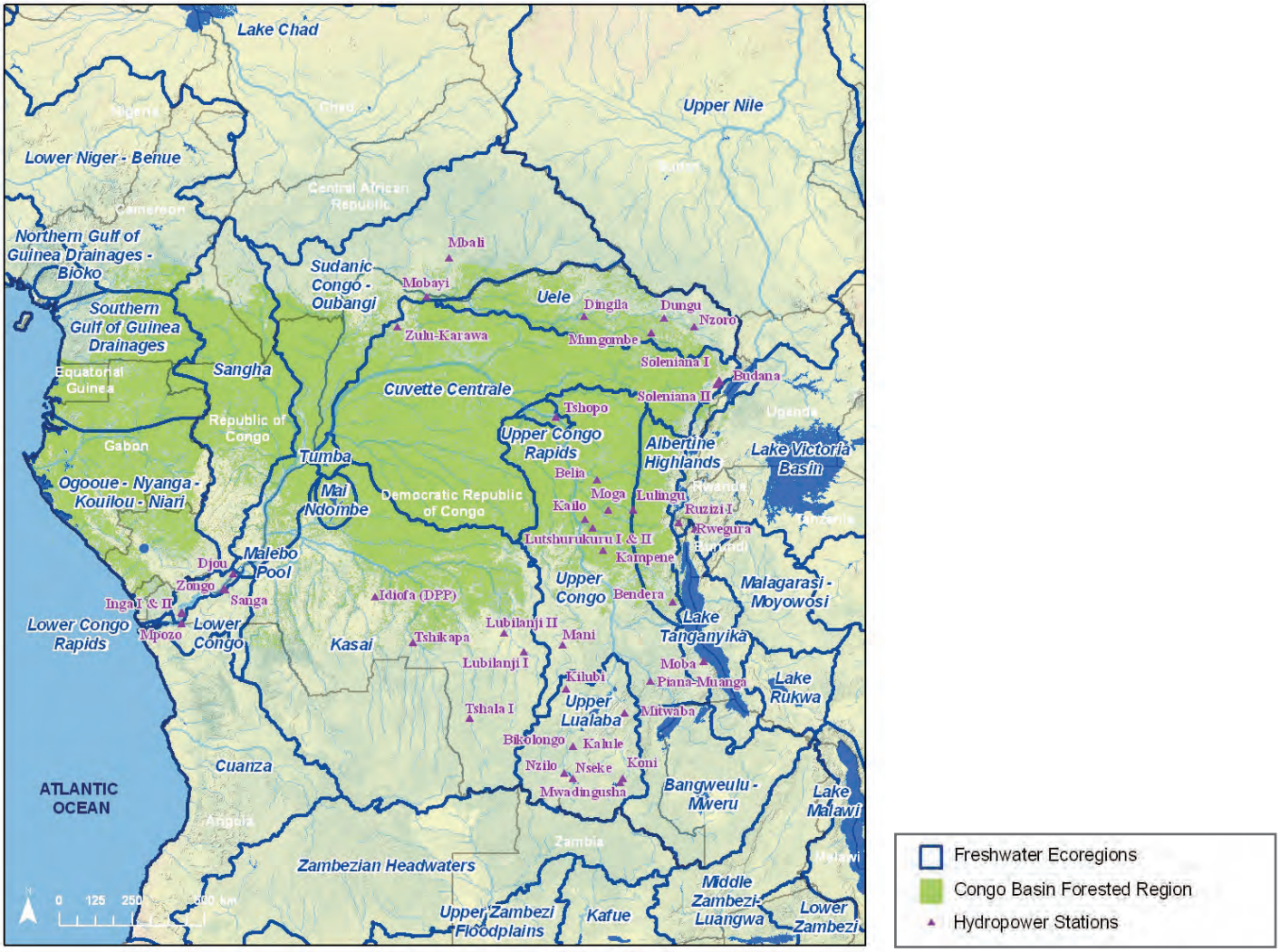
[10] http://www.dams.org/.

The forested region of Central Africa is characterized by a large diversity of freshwater system types and habitats, from the large delta of the Niger River, to the extensive swamp forests and associated lateral lakes of Central Congo, to the powerful rapids of the Lower Congo, to the web of marshes and lakes along the Upper Lualaba.

Several authors have defined freshwater biogeographic provinces for Africa based on freshwater fish (Lévêque, 1997; Roberts, 1975; Thieme *et al.*, 2005). Each province encompasses freshwater systems sharing a relatively similar fish fauna. The boundaries largely correspond with the catchments of major river systems, which provide the natural routes for gene flow for freshwater fishes (Stiassny *et al.*, 2007). The major ichthyofaunal provinces in the region are the Congo, Lower Guinea, and Nilo-Sudan. These provinces are further subdivided into freshwater ecoregions, which also largely follow river basin divides and are intended to describe broad patterns of species composition and associated ecological and evolutionary processes (figure 9.5; Abell *et al.*, 2008; Thieme *et al.*, 2005).

The diversity of habitats in the region is matched by high species diversity. However, taxonomic surveys are lacking for much of Central Africa and new species are continually being discovered (Lévêque *et al.*, 2005; Lundberg *et al.*, 2000). For fish species, it is considered the third richest tropical river basin, following the Amazon and Orinoco Basins. Over 550, 700, and 150 fish species are currently described from the Lower Guinea, Congo, and Niger Delta, respectively; with new species being described every year (Stiassny *et al.*, 2007; Teugels and Guégan, 1994; Thieme *et al.*, 2005). The rivers and streams of Lower Guinea and the Congo have high levels of fish endemism (estimated at 50 % and 80 %, respectively). About fifteen strictly aquatic mammals live in the waters of Central Africa; including several that are endemic (e.g., the aquatic genet (*Osbornictis piscivora*), Ruwenzori otter shrew (*Micropotamogale ruwenzorii*), and giant otter shrew (*Potamogale velox*)). The region also has a rich herpetofauna – upwards of 280 aquatic frogs, and about twenty aquatic snakes, turtles and crocodiles are known. Data on aquatic invertebrates are particularly scarce; however, available data suggests that the region harbors areas of high invertebrate biodiversity. Kalkman *et al.*, (2008) identified the Guinean-Congolian region as having the greatest diversity and number of range-restricted species of Odonates (dragonflies) in Africa. The richest areas for dragonflies are the Cameroonian highlands and Lower Guinean lowland forests (Kalkman *et al.*, 2008). Diversity of freshwater crabs appears to be highest in the lower parts of the Congo Basin and the upper reaches, including those draining from Rwanda and Burundi (Groombridge and Jenkins, 1998). Southeast Nigeria, southern Cameroon, and Gabon also host three endemic genera and more than 10 endemic species of freshwater crabs (Cumberlidge, 1998). Aquatic mollusks are very poorly known - about 100 snails (gastropods) have been described from the Congo Basin, of which about half are considered to be found only there (Brown, 1994); a contemporary region-wide estimate of aquatic mussels does not exist, though there are historical and more recent syntheses for parts of the region (e.g., Graf and Cummings, 2006; Pilsbry and Bequaert, 1927).

Despite the lack of reasonably comprehensive georeferenced species data, several studies have highlighted freshwater biodiversity hotspots in the region (Groombridge and Jenkins, 1998; Kamdem-Toham *et al.*, 2003; Thieme *et al.*, 2005). Common among these are the Lower Congo rapids for their rheophilic and endemic fish and mollusks; the *Cuvette centrale* and associated marshes and swamp forest for high fish richness and endemism; floodplain lakes and marshes of the plateau region of the Upper Lualaba for fish endemism; several crater lakes in Cameroon with highly endemic aquatic faunas; several rivers of the Lower Guinea province including the Ogooué, Kouilou-Niari, and Cross Rivers for high richness and endemic fish and crabs; and the Niger Delta with five monotypic fish families. Additional areas will be added and the boundaries of existing hotspots will be modified as new data on the biodiversity of the region become available.



Sources: WWF, TNC, SDSU, CICOS.
Figure 9.5: Freshwater ecosystems

Photo 9.7: Riparian forests have specific floral compositions.

Box 9.3: The Lower Congo River

In 2005 the American Museum of Natural History's Congo Project received funding from the US National Science Foundation to undertake an ichthyofaunal survey and inventory of the lower Congo River (http://research.amnh.org/ichthyology/congo/index.html). The project which is an ongoing international, multidisciplinary collaboration is combining traditional taxonomy and survey methods and the latest molecular techniques with state-of-the-art remote sensing technologies and *in-situ* geomorphological analysis. Results to date reveal the lower Congo River to be a site of unexpectedly high fish biodiversity forged by an uniquely complex physical regime. By integrating analyses of hydraulic conditions and channel morphology with metapopulational analyses of fish species in the lower Congo the project aims to elucidate the underlying processes driving speciation and diversification in the river.

Near the twin capitals of Kinshasa and Brazzaville, the lower Congo River spills out over a rocky sill at the southern edge of Stanley Pool and cascades down through the gorges of the Crystal Mountains. This relatively short stretch of the river, fed by a discharge of 23,000-50,000 m^3/s is punctuated by some of the most spectacular rapids, pools and runs on Earth. Unlike most of the rest of the river, the lower Congo downstream of Pool Malebo to the port town of Matadi, is highly channel-constrained with a peculiarly complex hydrology that appears to have isolated it from the remainder of the Basin. Channel topology itself is highly heterogeneous, punctuated by underwater canyons of extreme depth. Water velocities are also extreme, even in areas without surface rapids, and recent measurements taken with pirogue-deployed Acoustic Doppler Current Profilers (ADCP) have revealed complex flow patterns within the water column including shifting counter directional flows and descending and ascending "walls" of fast moving water. Analysis of remotely sensed data provides an additional view of the numerous macrohabitats and channel features that characterize this hydrologically complex stretch of river. Using the latest remote sensing technologies, and with intensive on-the-ground sampling and analysis, a much clearer picture is beginning to emerge of how the geomorphological template of the river has played a major role in isolating fish populations.

To date the project has documented the presence of over 300 fish species and of these upward of 80 appear to be endemic to the lower Congo region. These are unexpectedly high levels of species richness and endemism for a 350 km stretch of river, by way of comparison the entire Upper Nile from its headwaters to the junction with the Blue Nile at Kartoum, a stretch well over 1,400 km in length, harbors around 115 fish species of which only 16 are known endemics. Clearly the lower Congo, with its unique hydrological regime, represents a model system for exploring the interplay of complex hydraulic conditions, channel features of extreme depth, and patterns of species richness and drivers of local endemism.

Relationship between Forests and Hydrological Goods and Services

Forest Cover and Watersheds

Water resources are regional services that are strongly influenced by their ecosystem. Vegetation is often the primary influence of these ecosystem effects on hydrological services (Brauman *et al.*, 2007). In a forest ecosystem, forests influence the hydrological cycle by regulating the quantity and timing of water and nutrients being added to the system. The extent to which ecosystems are affected is dependent on the size and distribution of different ecosystems within a catchment system as well as the frequency, duration and intensity of climatic events. Andreassian (2004) argues that larger forests, such as the Amazon or Congo Basin play a critical role in both controlling the quantity and quality of water circulating in a watershed or river basin as well as influencing climate at the global level. In the following section we examine local and regional interactions between forests and water resources.

The Role of Forests in the Congo Basin Water Balance

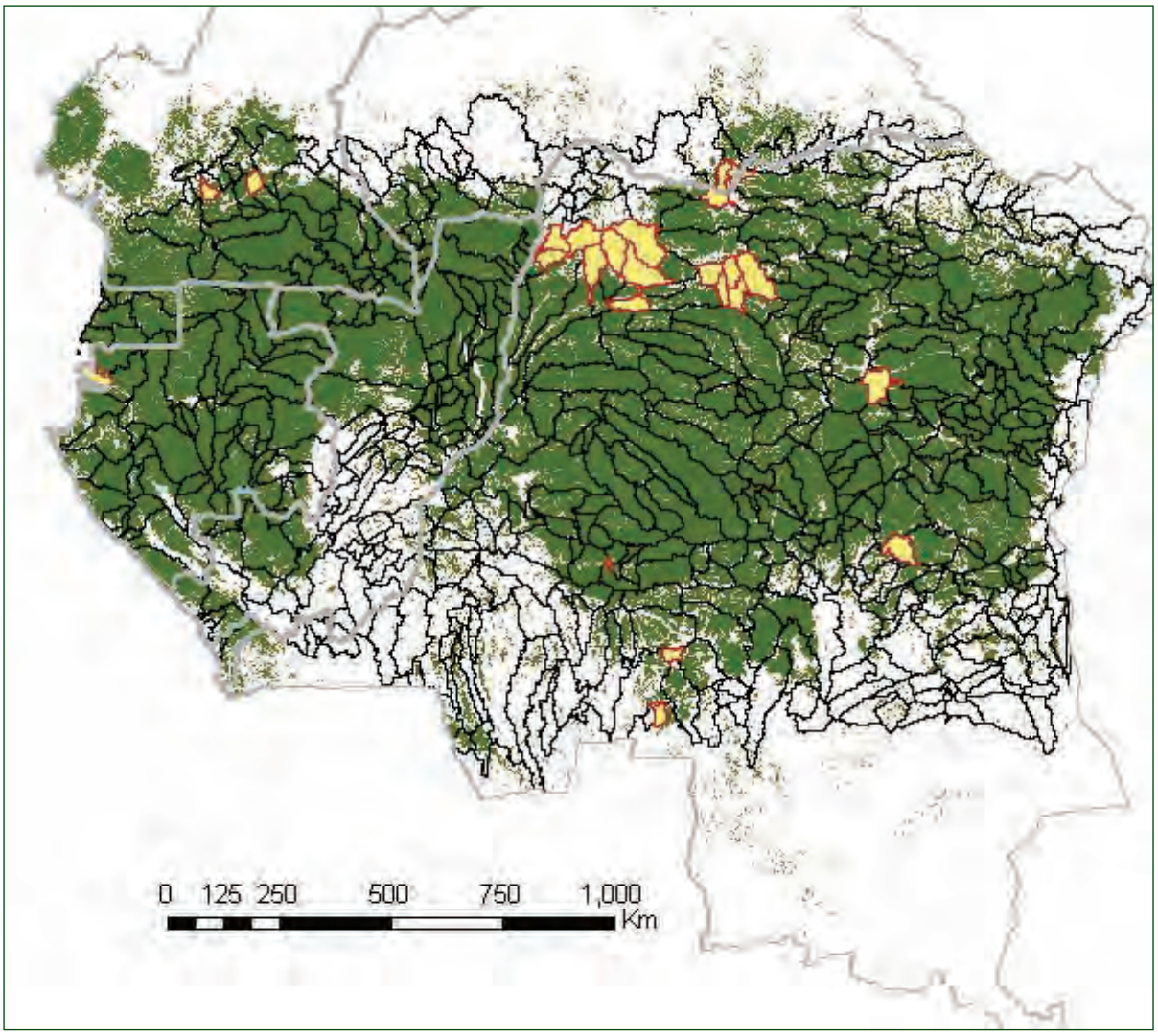
Relative to other comparable forested regions, far less research has gone into understanding the relationship between forests and water in the Congo Basin (box 9.4). However, studies from other areas can provide insight into how forest cover may affect water systems. The common perception is that "forests are good for water," acting like sponges to absorb high rainfalls and releas-

ing water slowly through drier periods. While it is generally accepted that forests improve water quality, moderate peak flows and sequester carbon dioxide, trees can also use more water than other vegetation types and so the net water balance may mean that less water is provided to downstream areas than for other land covers (Dudley and Stolton, 2003; Bruijnzeel, 2004; Brauman *et al.*, 2007). This increased water use is due to the larger rooting depth of trees (compared with grassland or agricultural crops) allowing them to access water from a greater portion of the soil profile, and sometimes even from the sub-soil. Forest also presents a rougher surface than shorter crops, thus increasing the efficiency of gas exchanges with the atmosphere (Brauman *et al.*, 2007).

Evidence of the greater water use of forests has been accumulated mainly from studies where forests have been cleared and net water supply has increased, albeit in a much more irregular flow distribution pattern. These studies are almost exclusively for montane forests. No reported declines in annual streamflow totals following lowland tropical forest removal have been found in the literature. For montane forests controlled experiments comparing water yield before and after deforestation, show that in all cases the removal of more than 33 % of forest cover results in significant increases in overall annual streamflow during the first 3-years, with changes in water yield roughly proportional to the fraction of biomass removed (Bruijnzeel, 2004). The reverse effect has been observed: in a review of 14 comparative experiments in the tropics to find that after afforestation or planting trees in agricultural fields there was approximately a three-fold increase in water infiltration. Elsewhere it has been shown that afforestation will reduce local water yields and flow, but these effects are likely to be small unless the area reforested is large (Van Dijk and Keenan, 2007). In studies on smaller tropical watersheds, deforestation has been shown to increase discharge and runoff (Sahin and Hall, 1996).

Mature tropical rainforest deforestation has the potential to degrade the regulation of hydrological flows through changes in evapotranspiration, canopy interception, surface runoff and groundwater recharge. Reductions in evapotranspiration (the process of direct evaporation and transpiration by plants that transfer water to the atmosphere) with increasing deforestation can impact hydrological flows by warming the surface, inhibiting convection and changing regional precipitation and cloud cover. Most evidence of these impacts has been witnessed in smaller river basins, where in many cases the effects of land cover change on hydrological processes are not measurable until at least 20 % of a catchment has been converted, although this threshold may vary between 15 to 50 % (Stednick, 1996). The effects of land conversion on evapotranspiration may be less for conversions between primary and secondary forests, as opposed to cropland or shrub land.

The results of local, short-term studies provide important information but can not necessarily be extrapolated to the larger scales and time frames of relevance when discussing vast river systems like the Congo Basin. A study by Costa *et al.*, (2003) in a large Amazonian river basin found that changes in land cover had a significant impact on discharge, although not precipitation. In the Congo, the effects of deforestation on rates of evapotranspiration are expected to be particularly significant because a large portion of rainfall, (between 75-95 %), comes from recycling moisture from the region's forests (Brinkman, 1983). A recent study mapping forest clearing over the last decade for the entire Congo Basin (Hansen *et al.*, 2008), at a spatial resolution that allows forest clearing to be examined on a per watershed basis, will provide important data for future studies (figure 9.6).



Sources: SDSU, USGS.

Figure 9.6: Watersheds with more than 50 percent forest cover in circa 1990 and a 5 percent loss in forest cover by circa 2000 are highlighted in yellow

Box 9.4: State of Knowledge

Compared to other vast river systems in the world, little information and research is available for the Congo Basin. Quantitative data on water resources within the Congo Basin has always been limited. The collection and management of information on water resources are difficult for numerous reasons, including:

- The dilapidated state, and low density, of data collection sites for hydrological, limnimetric or meteorological information.
- Few stations are operational, most are manual and they are usually limited to large freshwater areas.
- The discontinuity in the hydroclimatological data series in the vast majority of hydroclimatological stations across the Basin. Very few continuous data sets, where continuous refers to constant data collection since pre-1960, exist. Even rarer are meteorological or hydrological stations with a continuous series of data for the past 100 years. The data that is most frequently presented have been collected through remote sensing.
- The lack of coordination between different sectors concerned with water resource management in all the riparian countries.

However some historic data are available for: the Congo from 1902 (station in Kinshasa), 1907 (station in Kisangani), and 1912 (station in Kindu); from 1911 for the Oubabgui (station in Bangui) and from 1948 on the Sangha river (at Ouesso). Daily water levels are measured at Bangui, Ouesso, Brazzaville and Kinshasa. The three organizations charged with monitoring flow in the Congo Basin are:

- The *Régie des Voies fluviales* (RVF) in DRC for the middle and upper portions of the river.
- The *Régie des Voies maritimes* (RVM) in DRC for the lower Congo.
- The *Service commun d'Entretien des Voies navigables* (SCEVN) in CAR and ROC for the Congolese section of the River and the Oubangui.

The African Monitoring of Environment for Sustainable Development program (AMESD; www.amesd.org/www.cicos.info) in Central Africa aims to develop a monitoring system for water resources in the Congo Basin. Implemented by CICOS for Central Africa, AMESD will utilize existing meteorological satellite data receiving stations in seven Central African countries, install additional environmental receiving stations in key organizations and built the capacities of regional experts with the aim of providing regular information on water levels and the water cycle (rainfall, runoff and evapotranspiration will be measured) (Ladel *et al.*, 2008). Two operational services will be developed: one to alert on low waters for navigation, and one to monitor the impact of deforestation and climate change, initially on the Oubangui sub-basin water resources.

Water Resource Management

The Congo Basin has abundant water supplies and great potential to develop further in the areas of hydropower, irrigation and navigation. In the past a piecemeal approach to water management focused solely on satisfying immediate demands for energy, agriculture or urban water supply. And in doing so it failed to take into account the potential environmental, social or long-term financial impacts. Conflict, lack of regulation and mismanagement has left more than half the rural population in Congo and DRC without access to clean drinking water and adequate sanitation facilities[11]. The need to improve water management in the Basin is widely recognized both within individual countries and across the Basin as a whole.

In response to this need, an Integrated Water Resource Management (IWRM) approach has been adopted (box 9.5) by CICOS. This approach to planning and implementation simultaneously works to balance society's long-term needs for water, essential ecological processes and economic benefits. It is centered on maintaining the environment while also promoting sustainable development and encouraging democratic participation in governance. A better understanding of the relationship between forests and water resources, as well as an appreciation for the economic value of forests based on the water-related services they provide (see box 9.6) can be used to increase the incentive to maintain healthy forest ecosystems and conserve forest watersheds. Although a comprehensive economic assessment of the goods and services provided by water resources has never been attempted in the Congo Basin, it is clear that the economic value of water resources in the Congo Basin and the dependence of human populations on these resources are great.

[11] http://www.unicef.org/infobycountry/centralafrica.html

Box 9.5: Integrated Water Resource Management (IWRM)

The history of IWRM stems back to the United Nation's Mar del Plata Conference in 1977 which called for increased coordination between different sectors concerned with water management. In 1992, the International Conference on Water and the Environment reiterated the need for a more holistic approach to assure the sustainable use of water resources. The 2000 Millennium Development objectives called for IWRM to go further to incorporate interactions between surface water and underground water resources, as well as taking into consideration the limits of the environment and managing the demand for water.

IWRM is a process that promotes the co-ordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare on an equitable manner without compromising the sustainability of vital ecosystems. It is based on the following four Rio/Dublin principles:

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
3. Women play a central role in the provision, management and safeguarding of water.
4. Water has an economic value for all its competing uses and should be recognized as an economic good.

Photo 9.8: The Congo River in Kinshasa.

Understanding the role forests play in providing these benefits will support adopting an ecosystem approach to managing forests that involves evaluating the "trade-offs" between alternative management schemes. This can be complex because it is often difficult to assess the long-term impacts of actions such as deforestation or carbon sequestration on the ecosystem or the services it provides (Foley *et al.*, 2007; Jackson *et al.*, 2005). The variation in geographic scale of ecosystem services further adds to this complexity, with some services extending to cover whole watersheds. Additional research is needed to further explore the intricate relationship between changes in land cover and water resources in the Congo Basin, specifically from the perspective of the goods and services provided by water resources at different space and time scales. In addition to local and national governments there are two principal organizations concerned with managing the Congo Basin's water resources: CICOS (see box 9.2) and the Authority of Lake Tanganyika.

CICOS recognizes that the management of vast river basins is dependant on many factors, including: the ecological nature of the basin, demographic and socioeconomic conditions, the historical context of the Basin, partnerships, regulating texts and laws, the engagement of governments, financial factors and planning. Given all of these different variables it is difficult to provide a comprehensive strategy of resource management for water resources in the Congo Basin; however, CICOS has identified some underlying principles that are necessary to implement effective resource management:

- implementation of a political process of transboundary cooperation between all the riparian countries;
- increased availability of pertinent data and information on water resources;
- application of institutional agreements for issues such as the division of costs, environmental regulations, environmental standards, etc;
- a clear definition of the role of the organization in charge of Basin management;
- strong leadership within the governing organizations;
- strong implication of stakeholders, including the public, in the development of management plans and the implementation of policies.

With funds from GTZ and the African Development Bank[12,13] CICOS has been tasked with the preparation of a strategic action plan for integrated management of the Basin's water resources. As part of this plan activities are likely to include the rehabilitation of an *in situ* hydrological network within the Basin (complementary with the AMESD satellite monitoring system), the creation of an information management system within the CICOS Secretariat and capacity building to implement activities in accordance with the principles and strategies agreed with the riparian countries. It is hoped that this approach will promote well-coordinated policies at the national, regional and transnational scales that seek to balance long-term water needs, essential ecological processes and economic gains.

[12] http://www.engineeringnews.co.za/article/development-bank-funds-project-to-support-management-of-congo-river-2007-06-22 (accessed 24 Feb. 2009)

[13] http://www.gtz.de/en/themen/umwelt-infrastruktur/wasser/18950.htm (accessed 24 Feb. 2009).

Box 9.6: Payment for Watershed Services

The ecosystem services delivered by a particular geographical location and habitat will provide benefit both to the location itself and to others at a distance. In current market conditions and governance structures, the costs of protecting these ecosystem services, in terms of proactive management or lost opportunities to carry out other activities, falls predominantly on those in the provider location. It is thus important when considering the ecosystem service of an area to identify the flows of benefits, so that the full value, in ecological terms, can be assessed. So, for example, forests provide services at the global level (regulating climate, sequestering and storing carbon dioxide, biodiversity, as a source of medicinal plants), at the national/regional level (e.g., timber resources, opportunities for eco-tourism), at the river basin level (e.g., clean water, regulated river flows (less floods, higher dry season flows), reduced sediment supply) and at the local level (e.g., timber, firewood, water, non-timber forest products).

Forests in many areas of the world are under pressure primarily due to the clearance of land for food production or timber extraction. There is much evidence that such activities cause the loss of a whole range of ecosystem services at all levels from global to local. Therefore, it is argued that those who would benefit from the protection of such services should contribute financially to their protection. This is one of the underlying principles of the global carbon market (although this also allows swapping of damaging behavior in one location for carbon storing actions in another). The idea of ecosystem service beneficiaries paying managers of the land elsewhere to protect those services either proactively, or through not taking some action (such as forest clearance for agriculture) is the concept behind payment for Environmental services (PES)(see also chapter 8 on PES in this report). At the watershed, or river basin level, this is often called payment for watershed services (PWS), although it can be argued that this is only a partial picture of the services delivered predominantly through transfers of water and mass (sediment, nutrients, contaminants).

It is now recognized globally that with ever increasing population and standards of living, the environmental resources of the planet are becoming stretched to, and sometimes, beyond, their limit; climate change is the obvious pressing example. Many governments, NGOs and scientists are now starting to advocate ecosystem approaches and PES schemes to protect and restore the environment to address such concerns.

CHAPTER 10
The Contribution of Biodiversity to the Maintenance of Forest Goods and Services

Conrad Aveling

Introduction

For this chapter the term biodiversity is defined as the variability among living organisms in the terrestrial and aquatic ecosystems of the Central African humid forests. This includes diversity within and between species and among ecosystems types (Hooper *et al.*, 2005).

Biodiversity provides ecosystem goods and services in two ways. Firstly, it is used as a source of food, fiber, fuel, and other extractable resources. Secondly, it plays a key role in regulating ecosystem processes such as pollination, nutrient cycling, erosion control, water cycling, climate regulation etc...

Goods and services provided by the forest are generally categorized as follows (Kettunen and ten Brink, 2006; Millenium Ecosystem Assessment, 2005):

- ***provisioning services***: food, fiber, fuel, bio chemicals, fresh water, ornamental resources;
- ***regulating services:*** benefits obtained from the regulation of ecosystem processes, such as the regulation of climate, floods, erosion, disease, water quality, carbon sequestration, pollination, biological control of pests, fire tolerance;
- ***cultural services***: recreation, aesthetic and spiritual values, tourism;
- ***supporting services***: services that are necessary for the production of all other ecosystem services, such as photosynthesis, primary production, soil formation, nutrient cycling.

Although the links between biodiversity and ecosystem processes are extremely complex there is a broad consensus within the scientific community on many aspects of the relationship (Hooper *et al.*, 2005). In particular there is general agreement that ecosystem processes are influenced by functional diversity. Functional diversity is a measure of how individual species contribute to the working of an ecosystem by, for example, reducing erosion, improving soil fertility through nitrogen fixation, and ensuring plant regeneration through pollination or seed dispersal. In other words species composition and characteristics, including the effects of keystone species (species that have a disproportionate effect on their environment relative to their abundance) are central to the maintenance of ecosystem processes and services (Hooper *et al.*, 2005; Kettunen and ten Brink, 2006). Species richness (a measure of the number of species in an ecosystem) is also important for the maintenance of ecosystem processes. Having a range of species that respond differently to different environmental perturbations can stabilize the effects of these disturbances (e.g., resilience to exotic species invasion).

Hooper *et al.*, (2005) summarize current knowledge of the effects of biodiversity on ecosystem functioning as follows:

- Species' functional characteristics strongly influence ecosystem properties. Relative abundance alone is not always a good predictor of the ecosystem-level importance of a species, as even relatively rare species (e.g., a keystone predator) can strongly influence pathways of energy and material flows.

Photo 10.1: The canopy houses a unique and poorly known biodiversity.

- Alteration of biota in ecosystems via species invasions and extinctions caused by human activities has altered ecosystem goods and services in many well-documented cases. Many of these changes are difficult, expensive, or impossible to reverse or fix with technological solutions.
- The effects of species loss or changes in composition, and the mechanisms by which the effects manifest themselves, can differ among ecosystem properties, ecosystem types, and pathways of potential community change.
- Some ecosystem properties are initially insensitive to species loss because a) ecosystems may have multiple species that carry out similar functional roles, b) some species may contribute relatively little to ecosystem properties, or c) properties may be primarily controlled by abiotic environmental conditions.
- More species are needed to insure a stable supply of ecosystem goods and services as spatial and temporal variability increases, which typically occurs as longer time periods and larger areas are considered.

In view of the extreme complexity of ecosystem processes, and the far reaching effects that degradation of these processes can have on the food and health security of human populations and on climate change in general, placing economic values on the services that they provide remains a highly inexact science. The ecosystem service of food production, for example, contributes by far the most to economic activity and employment globally. In 2000, the market value of food production was $ 981 billion, or roughly 3 % of gross world product, but represented 24 % of total GDP in countries with per capita incomes less than $ 765 (the low-income developing countries, as defined by the World Bank) (MEA, 2005). The demand for ecosystem services is so great that trades-offs among services are constantly made. A country can increase food supply by converting a forest to agriculture, for example, but in so doing it decreases the supply of services that may be of equal or greater importance, such as regular rainfall, clean water, timber and non timber forest products, flood regulation ... Very little reliable information exists on the economic value of ecosystem goods and services provided by the Central African humid forests. However since the overall net annual deforestation rate in the Congo Basin, estimated at 0.16 % for the period 1990 and 2000 (Duveiller *et al.*, 2008), is half that of South America and four times lower than Southeast Asia, the economic value of forest services in the Congo Basin are likely to be comparatively important. A more detailed analysis deforestation rate estimates is given in chapter 12.

Overview of Products and Services Provided by Central African Forests Biodiversity

This section describes the goods and services provided by the forests according to the four categories mentioned in section 1: provisioning services, regulating services, cultural services, supporting services. Climate change, carbon sequestration, watershed protection and fuel wood are not covered in detail as they are treated more fully elsewhere in this report.

Provisioning Services

More than 90 % of the people of the Congo Basin depend to varying degrees on natural resources, including agriculture and non-timber forest products, for food, medicine, income, and timber (Clark and Sunderland, 2004). The Central African forests provide a very wide range of non timber forest products, NTFP, (FAO, 2001) and these make a significant contribution to the livelihoods of the rural poor (Ndoye, 2005). Several categories of plant and animal NTFP are recognized. Animal NTFP include: bushmeat (mammals, birds, reptiles, fish, insects); skins and trophies (ceremonial, decoration, fetish); live animals (pet trade); wild honey and wax; raw materials for traditional medicines; raw materials for colors. Categories of plant NTFP include foods (fruits, vegetables, nuts, spices); browse for livestock; traditional medicines and aromatic preparations; raw materials for colors and dyes; tools, arts and crafts and construction materials; ornamental plants; exudates (saps, oils).

Bushmeat (which is generally used to denote mammal meat but in fact also includes other vertebrates such as reptiles and birds) and fish are the most commonly exploited animal NTFP, followed by edible insects and honey. The forests of Central Africa contain about 270 species of mammals (Vande weghe, 2004). Virtually all of the large- and medium-bodied species (about 120 species, Kingdon, 1997) are consumed and at least 80 small-bodied mammal species (rodents, insectivores, bats) are also taken. Where faunal assemblages are relatively intact, ungulates, particularly forest duiker (*Cephalophus spp*) and small primates are the most commonly consumed animals. Certain rodents, such as the brush-tailed porcupine (*Atherurus africanus*) and the cane rat (*Thryonomys swinderianus*), are also favored species, particularly in situations where faunal assemblages are depleted. It has been estimated that bushmeat contributes between 30 and 80 % of the protein intake of forest-based communities in the region (Wilkie, 2001).

Photo 10.2: The pangolin, a common animal in the African forest.

Fish diversity and endemism is very high in the Congo Basin (over 700 species with 80 % endemism) and new species are being discovered with every expedition (Mamonekene, 1998; Stiassny *et al.*, 2007). Fresh water fish form an extremely important part of rural populations' diets. For example in the north of the Congo Republic freshwater fish make up an average of 41 % of rural populations' household protein depending on the season (Poulsen *et al.*, 2007) and can rise as high as 60 % depending on the season (Banque Mondiale, 2006).

Insects are also an important component of rural populations' diets. A review of the literature in Hoare (2007a) identifies at least 110 species traded in Central African markets including 82 species of caterpillars and larvae, 20 species of cricket and grasshopper and 8 species of termite. Caterpillars belonging to the moth genus *Imbrasia*, many of whose host plants are commercially important timber species of the Meliaceae family such as *Entandrophragma cylindricum* (sapelli), are particularly sought after during the hatching season. Beetle larvae, such as *Rhynchophorus phoeonicius* collected from raphia and oil palms, are also commonly eaten and traded.

A few animal species from Central Africa are collected for the pet trade. African grey parrots (*Psittacus erithacus*) are exported from Cameroon. BirdLife International (2006) reports that between 1994 and 2003 over 359,000 wild-caught birds were reported in trade by CITES Parties, of which 86 % came from Cameroon, Congo and DRC. Freshwater fish for the aquarium trade, and butterfly specimens for collectors (particularly from CAR) are also traded internationally but no reliable data on the level of the trade are available. Brummet (2005) suggests that a large number of fish species (from 13 genera) in the Central African rainforest rivers and lakes, where levels of endemism are particularly high, have potential as ornamentals and wholesale at an average of $ 2.43 per fish. The difficulty of capturing, holding and transporting these fish explain the high prices. Natural fecundity forest river species is very low, and breeding has also proved extremely difficult because they rarely reach sexual maturity outside of the special and complex rainforest ecosystem. The excessive or uncontrolled extraction of ornamental fish is considered to be a problem in all countries bordering Lake Tanganyika (EC, 2008).

Plants

Some 65 million people are estimated to live in, or in proximity to, the forests of Central Africa and use plant NTFP to varying degrees (Mala, 2008; Hoare, 2007a) for food, medicines and materials. The bulk of vegetable calories come from cultivated agricultural products. Most wild NTFP species are probably only used occasionally, the vast majority of use coming from a relatively small number of species which are used for essentially subsistence purposes. Many of the wild plants and mushrooms collected are rich in micronutrients, proteins and, in the case of seeds, fats. They therefore serve as important dietary supplements to the traditionally cultivated agricultural crops. Many species are used for multiple purposes including commercial timber. For example 61 % of the main commercial timber species exported from Cameroon have non-timber values and are used by local communities and poor urban households (Ndoye and Tieguhong, 2004).

It is estimated that 80 % of Africans use plant NTFP for medicinal purposes (Mala, 2008). They are readily available and are much cheaper than pharmaceutical equivalents, an important consideration at a time when medical services in Central Africa have collapsed. Many thousands of species are probably involved. For example, for the treatment of malaria alone, the Metafro–Infosys database[14] in the Royal Museum for Central Africa in Tervuren, Belgium lists over 500 plant species in sub-Saharan Africa. The Central African forests contain about 10,000 species of vascular plants (Mittermeier *et al.*, 2002) and an extensive scientific literature on Central African plant NTFP reveals that many hundreds of these species are used for medicinal purposes. For example in Cameroon alone, over 500 species are reported to be used for medicinal purposes (Mala, 2008). However it is important to underline that the widespread use of NTFP for medicinal purposes in Central Africa probably has much more to do with their cheapness than their real effectiveness in treating illnesses. For example malaria continues to kill untold thousands of people in Central Africa, despite so many different plants being used to treat it. The biochemical properties of only a handful of Central African plant species have been exploited for use in the international pharmaceutical industry, in particular *Prunus africana* and *Pausinystalia johimbe* for the treatment of prostate hypertrophy and sexual impotence respectively.

While most NTFP use can be considered to be for essentially subsistence purposes a small number of plant species are collected and traded on a large scale both regionally and internationally. Well known examples of these include:

- leaves: Marantaceae (packaging) and *Gnetum sp* (vegetable) ;
- barks: *Prunus africana* (treatment of prostate conditions), *Annickia chlorantha* (treatment of hepatitis), *Pausinystalia johimbe* (treatment for sexual impotence), *Garcinia cola* (stimulant, and bitter additive for palm wine) ;
- fruits and seeds: *Cola acuminata*, *Dacryodes edulis*, *Ricinodendron heudelotii, Irvingia gabonensis, Baillonella toxisperma, Piper guineensis, Xylopia aethiopica,* (fruits, seasoning, oils);
- saps: *Raffia* palms for palm wine ;
- canes: *Laccosperma spp* (rattan furniture).

Photo 10.3: The forest offers a wide variety of consumable goods.

[14] http://www.metafro.be/prelude/plant_collection

Box 10.1: NTFP in the Congo Basin

Across Central Africa, over 74 plant species and 67 species of animals (primarily mammals, birds, snails and lizards) have been recorded as sources of nutrition (FAO, 2007). The majority of these species are unevenly distributed across the Congo Basin and their use for sustenance varies widely based on accessibility, as well as culture, socioeconomic status, price and to an extent, especially for bushmeat species, legal regulation. The greater part of data on the use of NTFP in the Congo Basin concerns the use of NTFP as food, with studies showing the percentage of NTFP harvested for food in the range of 65% of NTFP for the whole of the Central African Republic to 88% for Baka communities in Cameroon. The second most common use for NTFP is medicinal: up to 80% of the African population is estimated to use NTFP for medicinal purposes. This number is as high as 91% of the population in the Democratic Republic of Congo. Over 500 different species of medicinal NTFP have been recorded in Cameroon. With several medicinal species traded internationally, notably *Prunus africana* and *Pausinystalia yohimbe*. A wide variety of other uses for NTFP has been also been documented, including construction materials (e.g. *Raphia spp.*, *Elaeis guineensis*), cosmetics and as wrapping for food products (*Afromomum spp.*).

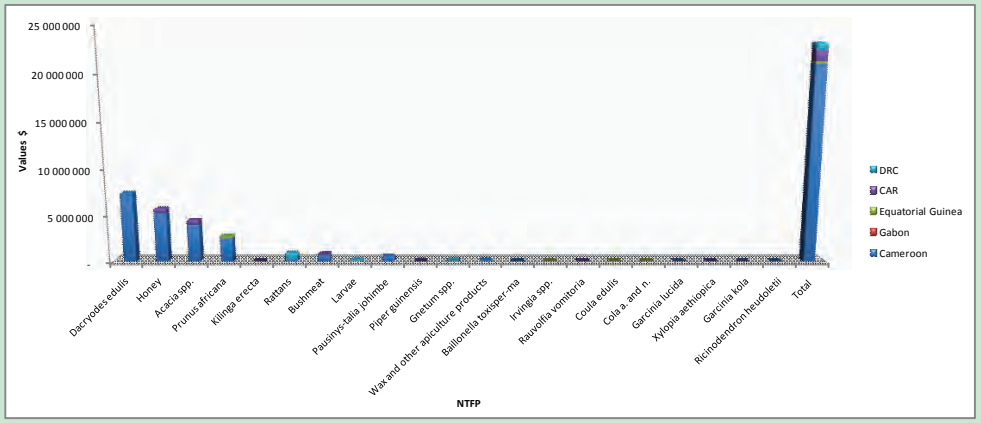


Figure 10.1: Market values for Congo Basin NTFP

More in-depth analytical data exist for certain NTFP, with over 30 studies in the last decade reporting on both individual NTFP and/or the variety of NTFP used in specific regions. The majority of information has been gathered in Cameroon. Although consistent and comparable data from across the Basin are inexistent, a literature review by CIFOR (CIFOR, 2008) reports that the annual market value of 21 specific NTFP amounts to approximately $ 23 million annually. This figure is likely the tip of the iceberg, as most of the studies included in the review focus on one of two types of species: (1) high value international products (39 % of all studies), such as acacia species for gum arabic or the highly regulated species *Rauvolfia vomitoria*, *Prunus africana* and *Pausinystalia yohimbe*; or (2) products with significant and well known national markets (36 % of the studies), such as Rattan, honey, *Irvingia spp.*, *Gnetum spp.* and *Cola spp.* Nearly all NTFP traded on national markets are unregulated. If harvesting quotas exist, they are not founded in scientific understanding. Seventy –eight percent of studies on NTFP are concerned with plant species, whose regulation is under the authority of Ministries concerned with forests and environment. However, for some animal products, such as honey in Cameroon, the authority is the Ministry of Livestock. International NGOs and other organizations such as, SNV, IUCN, and CIFOR, often coupled with international and national research institutions, have been the primary organizations documenting the NTFP trade in Central Africa to date. NTFP markets across the region are often characterized by high numbers of small scale actors, who often have a low level of organization. In addition there are often a wide range of intermediaries between the forest-based collectors and eventual processing, transformation or the end consumers in national urban and international markets.

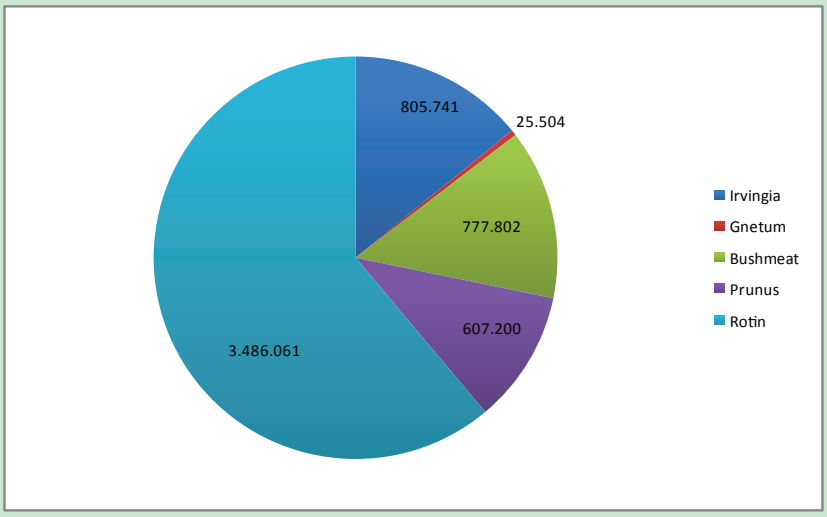


Figure 10.2: High value NTFP in the Congo Basin (in $)

In Cameroon, the markets for bush mango, Ndjansang, Eru, honey, Cola, Safou, bushmeat, Pygeum, Moabi oil, gum arabic, and rattan have a total annual value of sales of approximately $ 21,872,000. In Equatorial Guinea, *Prunus africana*, bushmeat, rattan, *Piper guinensis*, Irvingia, *Cola spp.* and *Coula edulis* amount to $ 187,000. In CAR, bushmeat and estimates for *Piper guinense*, *Xylopia aethiopica*, *Kilinga erecta*, *Rauvolfia vomitoria*, honey, rattans, and gum Arabic, amount to $ 1,210,000 per year. In DRC, Gnetum, larvae, caterpillars and rattan amount to some $ 842,000. The highest value products are listed in figure 10.2.

Verina Ingram

Regulating Services

Tropical forests affect cloud formation, rainfall and temperature by absorbing high levels of solar energy and producing high rates of evapotranspiration. They also affect global climate processes. However while there is growing evidence to show that deforestation (the consequence of which is biodiversity loss) affects global climate processes (Stern, 2006; Shem and Dickinson, 2006; Maniatis, 2007; Hoare, 2007b), there is little if any empirical evidence to demonstrate to what extent the biodiversity in itself has a direct influence on climate patterns and other ecosystem services (Myers, 1996). Nevertheless since the vegetation structure and biomass of tropical forests is largely determined by its biodiversity (functional diversity, species richness) there may indeed be a relation between biodiversity and the regulating services that the tropical forests supply. However biodiversity is only one of several parameters, including species composition, nutrient supply and disturbance that influence ecosystem structures and processes (Tilman, 1999).

In the Congo Basin most of the rainfall comes from recycling of moisture by the forest (Brinkman, 1989), in contrast to other monsoon regions where much of the rainfall comes from the water vapor accumulated over the oceans. Loss of forest cover is therefore likely to cause a reduction in local rainfall and this has been confirmed by some modeling studies (Shem and Dickinson, 2006). There is also evidence that deforestation in the Congo Basin will affect weather patterns in distant parts of the world through its affect on large-scale atmospheric circulations (Avissar and Werth, 2005). However it should be remembered that much of the research is based on modeling which is limited by the quality of data available from the Congo Basin and the use of oversimplified scenarios for deforestation (Nasi, 2005). The current knowledge of the role of tropical forests on rainfall patterns and hydrological services is discussed in greater depth in chapter 9.

Biomass in tropical humid forests is much greater than in other types of forest so they are important reservoirs of carbon. Of the total car-

bon pool found in the terrestrial biosphere about 17 % is contained in tropical forests (Locatelli and Karsenty, 2004). An estimated 46 billion metric tons of carbon are stored in the Congo Basin of which 60 % are stored in evergreen lowland forests which cover only 35 % of the area (see chapter 12). The dense humid forest of the Congo Basin is therefore an extremely important reservoir of carbon. However global rates of deforestation are such that tropical forests during the 1990s accounted for 25 % of total anthropogenic emissions of greenhouse gases (Houghton, 2005), although reliable estimations of carbon fluxes for the Congo Basin, where deforestation rates are much lower than in the Amazon or Southeast Asia, are hampered by lack data. A more detailed analysis of carbon stocks and their variations in the Congo Basin is given in chapter 12.

Provisioning and supporting hydrological services provided by the Congo Basin forests include navigation, fisheries and hydroelectric power generation. These aspects are dealt with in detail in chapter 9. Here again however there appears to be little if any empirical evidence to show the extent to which biodiversity in itself contributes to these services. A monodominant *Gilbertiodendron* forest is likely to be just as effective for water flow regulation, for example, as a more diverse mixed forest.

Essential ecosystem functions of the Central African forests such as pollination and seed dispersal are highly dependant on animal biodiversity. It is estimated that two thirds of the world's flowering plants require animals, largely insects, for pollination (FAO, 2007). Pollination is known to be a central component in the evolutionary process of plant and animal communities but remarkably little is actually known about pollinators of wild plant species in Central Africa. Their role in agriculture is also of enormous importance. This is well illustrated by the weevil *Elaeidobius kamerunicus* which is the natural pollinator of the African oil palm *Elaeis guineensis*. When large-scale oil palm plantations were first established in Southeast Asia production was very poor. It was only after researchers in Cameroon discovered the pollinating role of *E. kamerunicus* that production could be increased by importing the weevil into Malaysian plantations (FAO, 2007). Central African forests are probably also important reservoirs of many predators and parasites of agricultural plant pests although here again very little is known.

Up to 80 % of tropical forest plants rely on animals to disperse their seeds (Vande weghe, 2004). In the Congo Basin large- and medium-sized fruit and seed-eating mammals, particularly apes, monkeys, ungulates (duiker, wild pigs), and elephants are known to play a key role in the regeneration of the forest. Seeds eaten are widely disseminated in the dung and passage through the digestive system is often a precondition for successful germination. Large keystone species such as the elephant can have a particularly important impact on these processes because of the large variety and quantity of fruits consumed (a dung pile can contain several hundred seeds from more than a dozen plant species), the distances they move (forest elephants can have home ranges up to 2,300 km²) and the physical impact that these large-bodied animals have on the structure of the forest as they move through it feeding (Blake, 2006).

There are also links between biodiversity and human health. Intact ecosystems maintain a diversity of species in equilibrium and can provide a disease-regulating effect if any of these species are directly or indirectly involved in the life cycle of an infectious disease. Disease agents with much of their life cycle occurring external to the human host, such as water- and vector-borne diseases, are subjected to environmental conditions, and it is these diseases for which most linkages to ecosystem conditions have been found (Patz and Confalonieri, 2005). Changed environmental conditions resulting from deforestation have been implicated in the upsurge of several diseases in Central and West Africa including malaria, onchocerciasis (river blindness) and yellow fever. The increased contact between wildlife and humans as a result of human-induced forest loss and the large-scale trade in bushmeat and live animals also brings the risk of emerging diseases from cross-species transmission since 61 % of a list of 1,415 known human pathogens are zoonotic – i.e. capable of infecting humans (Taylor *et al.*, 2001). HIV, monkey pox, Ebola and Severe Acute Respiratory Syndrome (SARS) are recent examples (Karesh *et al.*, 2005). Cross-species transmission can also work in the opposite direction – from humans to wildlife. For example the rare mountain gorilla, *Gorilla gorilla berengei*, in the Bwindi forest and the Virunga volcanoes could be at risk from close contact with humans through ecotourism (Robbins and Williamson, 2008).

Photo 10.4: Bushmeat hunting (duikers shown here) feeds urban markets

Cultural Services

Cultural services provided by forests in Central Africa include sacred forests and consumptive and non consumptive tourism.

A sacred forest is a place that is venerated and reserved for the cultural and/or religious expression of a community. Access and management are often governed by traditional power structures. Sacred forests are found throughout Central Africa. They serve a variety of functions including religious activities, protection of ancestors' spirits, secluded sites for cult or initiation ceremonies, forest cemeteries for particular members of the community who may have died in unusual circumstances. In areas where human activities have led to extensive forest degradation, the sacred sites are often harbors of biodiversity although they are generally rather small in size (0.5 to 5 ha) and are therefore unlikely to be important for biodiversity maintenance over the long term. Where they contain water sources sacred sites can play a role in protecting village water supplies in the dry season.

Box 10.2: Evaluating Protected Area Management and the RAPAC Pilot Action Program (PAP)

In 2007, RAPAC carried out an assessment of 40 protected areas distributed across 7 ecological complexes in the sub-region to assess management effectiveness. Using PAMETT (Protected Areas Management Effectiveness Tracking Tool), developed by the World Bank/WWF to monitor progress in forest conservation, the evaluation was based on thirty questions covering broad elements of protected area management. From now on, RAPAC will carry out this appraisal every two years. The next appraisal in 2009 will be extended and standardized across all protected areas in Central Africa. Moreover, information collected will be systematically inserted into the RAPAC database through collaboration with partner databases.

Results

Threats and enforcement

Among the ten threats indexed in PAMETT, poaching represents the main threat to protected areas in Central Africa and monitoring is the primary activity (in nearly 72.5 % of protected areas).

It appears that all protected areas have a decree announcing their creation, but there are still problems regarding the exact limits of some protected areas.

In nearly half of the protected areas, there are mechanisms to monitor unsuitable land use and illegal activities. However, effective implementation of these mechanisms raises major problems. Logistical and financial problems hinder the surveillance process and human resources are generally lacking compared to the IUCN norm of 1 person/5,000 ha.

In 70 % of the cases, the staff is sufficiently skilled to enforce laws and regulations, but some issues remain, especially in terms of staff numbers and staff retraining. Increased collaboration with legal agencies and the acquisition of more suitable equipment are required to improve the enforcement of regulations.

Environmental knowledge

Overall there is well-documented information on sensitive habitats, species, cultural values, and the potentialities of protected areas. Inventories are often implemented when partners are funding them and are inexistent otherwise. Generally, the available data and information is sequential and scattered, which hampers its capitalization.

In thirteen protected areas, there are integrated programs for inventory and research. For eight protected areas, the results of the research programs still need to be validated. In the remaining protected areas, these activities are sporadic and carried out by lone researchers or students.

Protected areas do not have any monitoring-evaluation strategy or regular collection of information.

Management efficiency

Effective implementation of desired objectives and activities is limited by insufficient financial and human resources. Poor local participation is another obstacle. Moreover, the absence of management plans for most Central African protected areas represents a weak point. Four protected areas were found to have management plans under implementation (Korup, Lobéké, Bénoué and Campo Ma'an in Cameroon).

Operations

No protected area was found to have an adequate budget, and funding from governments is insufficient to meet management needs. Protected areas that have acceptable levels of funding are those with partner support. The parks of Los Altos de Nsork, Corisco and Elobeyes, and Caldera de Luba have no budget. Nearly a quarter of protected areas have no basic equipment and infrastructure. Often there is no maintenance plan and equipment maintenance is sporadic.

Sensitization and local involvement

Education and sensitization programs were found to be targeted and limited in scope, and rarely part of a broader plan. Exchanges with public and private actors operating in the areas around protected areas are few and far between, although there is informal contact between protected area managers and tour operators. When local communities or indigenous peoples take part in management discussions, they do not participate in decision making.

With few exceptions (Pongara - Gabon, Dzanga-Ndoki - CAR, and Korup - Cameroon), visitor infrastructure is non-existent and, while provisioned for, access fees and taxes are generally not paid. On the other hand, the protected areas of Dzanga-Ndoki, Binder Léré, Monte Alén and Obô provide good examples of how income generated from protected areas can be redistributed.

Realization of opportunities

To date and across the board, the essential biodiversity values of protected areas have not been severely damaged and the partially degraded zones are found on the outskirts of the protected areas. At the same time, protected areas have neither compromised nor promoted local economies and employment opportunities have only benefited a few individuals.

Pilot Action Program (PAP)

In light of that assessment, RAPAC launched a request for applications for a Pilot Action Program in April 2008. The main goal of this Program is to improve the effectiveness of protected area management in Central Africa. Since the pilot actions that were financed would act as a "showcase" for RAPAC at the field level, priority was given to projects that best met the following criteria:

- innovative in character and replicable;
- located in or on the periphery of a site, in a transborder zone or in a marine protected area;
- implementing a participatory management model;
- working to improve livelihoods;
- potential to serve as a source of experiences and of tools that could be shared with other protected areas in Central Africa.

A total of CFA 188 million was provided to support fifteen projects through national organizations, and one of these projects (PROTOMAC, a project on turtles) has a regional scope. Each RAPAC member country (Cameroon, Congo, Gabon, Equatorial Guinea, CAR, DRC, Sao Tomé and Principe, and Chad) benefited from at least one project.

Because of its unique assemblages of tropical forest species the Congo Basin has considerable potential for two types of tourism - consumptive (sport hunting) and non consumptive (wildlife viewing). In both cases however the potential is based not so much on biodiversity, but rather on the presence of a few charismatic mammal species. Furthermore with the exception of tourism in the Great Lakes region, both forms of tourism remain relatively under-developed for various reasons. These include the high transport and living costs in Central Africa, the political and economic instability of the region, the logistical difficulties of access to many of the best sites, and the absence of reliable local operators capable of meeting the standards required by international tour operators. Non consumptive tourism has been most successful in sites where viewing of spectacular charismatic species such as gorillas, forest elephant and bongo, can be guaranteed (Wilkie and Carpenter, 2002). Mountain gorilla viewing in the Great Lakes region (Virunga volcanoes and Kahuzi-Biega) brings in millions of dollars annually for the three countries that share their range (Languy and Demerode, 2006). Demand is so high that parks authorities are able to charge up to $ 500 per person per day for gorilla viewing permits. The economic value of this species is undoubtedly one of the main reasons that this species remains relatively well protected despite the ongoing conflict. Indeed even after the gorilla sector of DRC's Virunga National Park was taken over by rebel forces in 2008 it is reported that they continued to organize gorilla viewing visits for tourists[15]. However elsewhere in the Congo Basin wildlife tourism is much more difficult to organize because of the difficulties of access to the few sites where wildlife viewing can be guaranteed. Gorilla viewing has been developed in Congo, Gabon and CAR where forest clearings (*bais*) provide ideal conditions for observing gorillas, as well as several other charismatic large mammal species such as elephants, buffalo, bongo, sitatunga and giant forest hog. In the early 90's (before the Rwandan and Congolese wars), the Rwandan and Congolese sectors of the Virunga volcanoes ecosystem were each receiving between 6,000 and 8,000 visitors per year (ORTPN, 2004; Aveling, unpublished

[15] http://gorilla.cd/2008/03/09/our-position-on-engaging-with-the-rebels/

Photo 10.5: There is high insect diversity in DRC: a Longhorn beetle from the Cerambycidae family.

data) for gorilla viewing, compared with a range of between 290 and 1,120 visitors per year between 1992 and 2006 in Dzanga Sangha in CAR (Blom, 2000; Blom, unpublished data).

Safari hunting in the Congo Basin also has considerable potential to generate revenues because of the presence of a few charismatic tropical forest species. The forested areas of Cameroon and RCA are the main areas where safari hunting is currently organized. Trophy hunters are particularly interested in forest elephant and bongo but the smaller, typically Central African, forest species such as duiker and sitatunga are also marketable. As with gorilla viewing this type of tourism targets the high end of the market. In Cameroon a 16-day safari currently sells for up to € 25,000[16]. High-paying, low-volume tourism is probably the most suitable form of tourism for the forest milieu because of the difficulty of approaching and observing forest species and the logistical difficulties of access. It has the potential to make a significant contribution to livelihoods of local communities and sustainable management of wildlife resources if partnerships and revenue-sharing agreements are established within the framework of community-based wildlife management structures, such as the ZICGC (*Zones d'Intérêt cynégétique à Gestion communautaire*) in Cameroon.

With the exception of the special case of gorilla viewing, non consumptive and consumptive tourism in the Central African forest is unlikely ever to be able to compete with logging in terms of financial spinoffs for local populations. However it can play an important role in achieving buy-in for conservation measures from local populations (Blom, 2000).

Supporting Services

Gross primary production of tropical forests is very high because of the high light intensities, high temperatures and abundant rainfall. However tropical forest soils, including those of the Congo Basin, are often poor because of leaching due to the high rainfall. Tropical forests have therefore developed efficient nutrient cycling systems which ensure that nutrients from the plants, in the form of fallen vegetation and other organic matter of plant and animal origin, are rapidly reabsorbed by the roots and recycled into the plants. A huge diversity of soil fauna (essentially invertebrates), fungi and microbes ensures that organic matter is rapidly broken down in the hot humid conditions of the forest floor. The nutrient cycle is therefore an essentially closed one with the majority of nutrients being stored in the plants themselves rather than in the soil. The efficiency of this system is due in large part to the high biodiversity of the tropical forests and the functional diversity of the different ecosystems. For example the vast areas of swamp and riverine forests, by filtering the water draining from *terra firma* forests, play a vital role in conserving "escaped" nutrients from these forests (Vande weghe, 2004). Loss of this diversity, through forest clearance, is therefore likely to impact negatively on the efficiency of the nutrient cycling processes in the Congo Basin. Nutrients will be lost and annual production will decrease.

The Impacts of Biodiversity Loss on Forest Products and Environmental Services

General Remarks

Poor people in tropical ecosystems rely on ecosystem services more than do wealthy people (Reid and Huq, 2005). To meet their daily needs they tend to have multiple livelihood activities based on access to common property forest products such as bushmeat, fish and plants. Some food species are used on a daily basis while others are exploited as an alternative when staples are in short supply. Rural peoples' access to these products is therefore severely affected when the forest is degraded through deforestation and biodiversity loss. At a more general level, as we have seen in a previous section, ecosystem services such as pollination, seed dispersal, climate regulation, nutrient and water cycling, primary production, soil formation and retention, and human health regulation are also affected by biodiversity. The well-being of rural populations in the Congo Basin is thus directly linked to the state of conservation of the ecosystem (Biringer *et al.*, 2005).

This section looks briefly at some of the implications of harvesting of forest products and biodiversity loss in relation to the environmental services provided by the Congo Basin forests.

[16] http://www.huntineurope.com/usa/hunting_AFRICA.asp

Harvesting of NTFP

In species-rich forests most species are rare or patchily distributed and occur at relatively low densities. This means that commercial exploitation of most species of value to humans can easily lead to overharvesting. The "bushmeat crisis" has received much attention in the international press over the past decade. No reliable data exist for overall quantities of bushmeat consumed in the Congo Basin because the trade is conducted almost entirely within the informal sector and is therefore very difficult to monitor. Bushmeat is traded and consumed in both rural and urban settings and figures of up to 1.1 million tons consumed annually are quoted by the Bushmeat Crisis Task Force (BCTF, 2006). Opening up of the forest through road building and industrial extraction activities (particularly timber) are known to facilitate the bushmeat trade and the received wisdom is that the markets in the large cities are the principal drivers of this trade. However recent evidence suggests medium-sized towns and rural villages may play a much more important role in the trade than was previously thought. For example in Gabon 50 % of bushmeat is consumed in rural areas and it has been shown that the value of bushmeat as income in villages is more important than its value for consumption, and its income value is greater in remote villages than in more wealthy ones which have easier market access for alternative products (Starkey, 2004; Wilkie *et al.*, 2005). What is clear however is that sustained hunting pressure significantly alters the structure and composition of wildlife populations and there is now a growing body of evidence to show that the bushmeat trade is leading to unsustainable levels of harvesting, particularly with respect to large-bodied, slow-reproducing mammals. This effect is particularly marked closer to urban centers where depletions, and even extinctions, have been reported (Starkey, 2004; Colishaw *et al.*, 2004). Where local extinctions of keystone species, such as the forest elephant or seed-dispersing ungulates, occurs this can have a disproportionate effect on ecosystem processes (Nasi *et al.*, 2008). Sheil and Salim (2004) observed a marked difference in forest composition and structure in two forests in Uganda, one with elephants and one where elephants had disappeared.

However some small-bodied fast-reproducing species, such as the blue duiker, brush-tailed porcupine and cane rat appear to be able to resist high levels of off-take. Colishaw *et al.*, (2004) have coined the phrase "post-depletion sustainability" for areas where intense hunting over many years has eliminated large-bodied slow-reproducing mammals and the bushmeat trade is confined to robust small-bodied species that can sustain heavy exploitation. However in terms of animal diversity these forests are impoverished, even if the off-take of the small-bodied species appears "sustainable." This impoverishment is likely to be particularly acute because the loss of all large-bodied mammals, several of which may be keystone species, impacts the functional diversity of the forest. In many areas however, particularly around large towns and cities, bushmeat species have been essentially eliminated and people have switched to domestically-reared livestock.

Although most plants NTFP are collected mainly for subsistence purposes several species are harvested intensively (Mbolo, 2006) and in some cases this may be at unsustainable levels (Ndoye and Awono, 2005; Hoare, 2007a). Most are collected from the forest, in general from secondary or early successional forests. A few, for example the African plum tree *Dacryodes edulis* and the wild mango *Irvingia gabonensis,* have been integrated into the agricultural systems and would perhaps be better described as crops rather than NTFP. As with animals, the scale of harvesting is difficult to monitor precisely because it is mainly confined to the informal sector. Also the impact of harvesting on the survival of the plant is very difficult to asses as it varies according to the part of the plant that is collected. Harvesting of reproductive parts (fruits, seeds) or vegetative parts whose removal kills the plant (bark, roots) has a greater impact on the survival of the plant populations than harvesting of leaves, saps and resins.

© Jaap Van der Waarde

Leaves of Gnetum (*Gnetum africanum* and *G. buchholzianum*), rattan canes (*Laccosperma spp*), kola nuts (*Garcinia spp*), wild mangos (*Irvingia* sp), and African plum (*D. edulis*) are some of the most widely traded both within the region and internationally. Trade in rattan canes, which is harvested exclusively from the wild in Central Af-

© Reto Kuster

Photo 10.6: Bosman's Potto (Perodicticus potto) in the Ituri forest in DRC.

Photo 10.7: Display of honey and other products extracted from the forest.

rica, is considerable and rivaled only by bushmeat (Sunderland *et al.*, 2002). There is also a large trade in *D. edulis*. A study in Cameroon estimated its annual worth at $ 7 million in-country and $ 2.2 million for the African diaspora in Europe and North-America (Awono *et al.*, 2002).

There is abundant evidence for overharvesting of some species. For example *Gnetum* is becoming rare in some areas (Ndoye and Awono, 2005; Bikoue and Essomba, 2007) because of the large quantities harvested and the destructive methods used which involve cutting the vine at the base to pull it down and remove the leaves. Plants such as *Garcinia*, which are used for both food and medicinal purposes, are particularly at risk of overexploitation (Guedje and Fankap, 2001). In this case destructive collection methods include ring barking and felling for collection of the roots. Barking and felling of *Prunus africana* trees for the multi-million dollar international pharmaceutical trade has also led to the virtual disappearance of this species in many areas particularly in the montane forests of Cameroon (Stewart, 2003) and eastern DRC.

As with bushmeat the open access nature of most plant NTFP is an important factor contributing to overharvesting. However, unlike wild animals, possibilities exist for integrating certain species into existing agroforestry systems (van Dijk and Wiersum, 1999). For example a study in Cameroon (Tchatat, 2002 cited in Bikoue and Essomba, 2006) showed that up to 40 % of the plant species used for NTFP occurred at higher densities in habitats modified by human activities (secondary forest produced by slash-and-burn agriculture, cocoa plantations) and that farmers apparently make a deliberate effort to preserve species of particular value when they clear the forest.

Biodiversity Loss, Rainfall and Climate Patterns

As noted earlier most of the rainfall that falls on the Congo Basin is thought to be generated from the Congo Basin itself so it is likely that rainfall patterns will be affected by changes in forest cover. The Congo Basin rainforests are considerably "drier" than the Amazon and Southeast Asian rainforest blocks. Average rainfall over most of the Congo Basin fall within the range of 1,200 to 2,000 mm while in the central Amazon and Southeast Asia averages generally fall within the 2,000 to 3,000 mm range (Cutrim *et al.*, 1999; UNEP, 2006; Globalis web site[17]). The rainfall threshold for the maintenance of dense humid forest in Central Africa is low at around 1,350 mm, and only if the dry season does not exceed 3.5 months (Jacobs, 1981 referring to the work of André Aubréville). If average annual rainfall over the Congo Basin were to drop slightly for whatever reason (forest fragmentation, global warming), or the dry seasons were to extend beyond 3.5 months this might bring large areas of the Congo Basin below the threshold level for maintenance of humid forests, thus accelerating the process of forest loss, and hence biodiversity loss. Evidence for a significant decrease in rainfall in the Lac Tumba area of DRC, resulting in a drop in the water level of the lake, has been reported by Inogwabini *et al.*, (2006). They argue that these changes, which they suggest may be attributable to the global climate change phenomenon, will have important ecological consequences on the adjacent forest ecosystems. They also point out that lack of long term meteorological data in Central Africa is a major constraint to understanding the effects of climate fluctuations on the Congo Basin forests.

Biodiversity Loss and Nutrient Cycling

As mentioned above the efficiency of tropical forest nutrient cycling is closely linked with its biodiversity. It follows that loss of biodiversity through forest clearance will lead not only to a massive loss of the nutrients stored in the plants themselves but also to the loss of the litter and upper soil layers, where all the nutrient cycling takes place, through erosion. Traditional farmers in the Congo Basin have long understood this process and have developed an itinerant form of slash-and-burn agriculture with, until relatively recently, sufficiently long fallow periods (>20 years) to allow soils to recover. Unfortunately increasing human populations is leading to a significant shortening of the fallow periods in the Congo Basin (Ngobo *et al*, 2004) and this is having adverse effects on soil fertility, forest regeneration and, ultimately, biodiversity.

[17] http://globalis.gvu.unu.edu

Photo 10.8: Basket making is an activity that relies on forest products.

Biodiversity as a Gene Pool for Crops and Pharmaceuticals

Although about 7,000 plant species have been cultivated for food since agriculture began about 12,000 years ago only about 200 have been domesticated and today about 15 plant species and eight animal species supply 90 % of our food. Many traits incorporated into these modern crop varieties came from wild relatives to improve their productivity and tolerance to pests, diseases and growing conditions. Wild relatives are therefore an insurance for the future (UNEP, 2007) but human food production currently rests on the tips of pyramids of biodiversity, leaving the majority of species little-used and undomesticated (DFID, 2002). It should be remembered however that, with the notable exception of the oil palm and two species of *Dioscorea* yams, almost all other crops grown in the Congo Basin originate from Central-South America and South Asia or from African regions outside of the Congo Basin (e.g., coffee from Ethiopia).

Similarly 25 % of modern prescription drugs contain at least one compound derived from, or patterned after compounds derived from, higher plants (Duke, 1993) but the majority of plant species remain untested. The genetic diversity of the Congo Basin therefore constitutes a reservoir of potentially useful compounds waiting to be discovered although care should be taken not to raise expectations about the likelihood of major new discoveries being made and the scale of economic spinoffs that these might bring. Simpson *et al.*, (1996) consider that the conservation incentives provided by biodiversity prospecting are, at the most, modest. So far only a handful of species have been commercially exploited by pharmaceutical companies for their medicinal properties, the most well known examples being *Prunus africana* and *Pausinystalia johimbe*. However this has involved the export of large quantities of plant parts and has lead to unsustainable harvesting levels. In recent years there has been a move towards a more systematic process of bioprospecting of Central African plants to identify active compounds. Where this is conducted by reputable interna-

tional scientific research institutions, working with private research labs within the framework of transparent agreements with host countries, intellectual property rights and national interests can be safeguarded. The Missouri Botanical Gardens[18] and the United States National Cancer Institute have been running such a program in tropical Africa and Madagascar since 1986 and a number of promising compounds have been discovered from this program, including the anti-malarial korupensamines from the recently discovered liana *Ancistrocladus korupensis*.[19] The Biodivalor program, implemented by the NGO Pro Natura International in collaboration with IPHAMETRA (*Institut de Pharmacopée et de Médecine traditionnelle*) also undertook bioprospection work in Gabon between 1997 and 2001 and established contracts with several pharmaceutical and cosmetic companies (Dior, Aventis, Fabre, Novartis-Syngenta) for the commercialization of locally-transformed products. The results in terms of economic spinoffs nationally and locally appear to have been disappointing (Lescuyer, 2006), although this may be more to do with institutional failings rather than a lack of genetic potential of the Gabonese forests.

Conclusion

The relationships between biodiversity, ecosystem function, climate patterns and human well-being are highly complex and tightly intertwined and clearly cannot be treated exhaustively in a chapter of this length. This chapter has attempted to provide a broad overview of the ways that biodiversity contributes to the maintenance of some of the key forest goods and services in the Congo Basin and highlights, within the limits of current knowledge, the most likely impacts of biodiversity loss on these goods and services. Although empirical data on these impacts are sketchy to say the least, there is general consensus among scientists that the genetic and functional diversity of the Congo Basin is of exceptional global importance. It provides essential food, fiber, medicines and water for the majority of the inhabitants of the Congo Basin and has global impacts through its effects on global climate patterns. Biodiversity loss in tropical forest ecosystems is an insidious process which is likely to go unremarked until it is too late to reverse the slide. There is therefore an urgent need for wise management of the Congo Basin forests so that sufficient forest cover is preserved to maintain these essential goods and services. Given the relatively slow rate of forest loss in the sub-region, the countries of the Congo Basin still have a rich and abundant heritage of forest resources and are in the enviable position of being able to react before it is too late.

[18] http://www.wlbcenter.org/bioprospecting.htm

[19] http://www.wlbcenter.org/discoveries.htm

CHAPTER 11
Congo Basin Countries and the Reduced Emissions from Deforestation and Degradation (REDD) Process

Building the COMIFAC Position within the Framework of International Negotiations

Vincent Kasulu Seya Makongai, Joseph Armathé Amougouii and Olivier Hamel
Text approved by Etienne Massard Kabinda Makagai, Adélaide Itoua, Aline Malibangar, and Déogracias Ikakanzamio

Brief Reminder on the Kyoto Protocol and the Clean Development Mechanism

During negotiations on the so-called "flexibility" mechanisms enshrined in the Kyoto Protocol (KP), to facilitate compliance with commitments to reduce greenhouse gas emissions (GHGs) from the North[20], many discussions centered on the relevance of carbon related to "Land Use, Land Use Change and Forestry"(LULUCF). Opponents feared that efforts to reduce domestic emissions in Northern countries would be diverted by the opportunity to invest in cheaper (but unsustainable and difficult to monitor) carbon sequestration projects in land ecosystems in Southern countries. These debates and controversies were provisionally laid to rest upon adoption of the decisions known as the "Marrakesh Accords" in December 2001 (COP-7).

Broadly speaking, the Clean Development Mechanism (CDM) is the only flexibility mechanism concerning Southern countries.[21] The CDM is governed by the same general principles for all projects, whether they pertain to reducing emissions from GHG "sources"[22] or to carbon sequestration by "sinks."[23] The Accords state that all projects to reduce fossil fuel consumption and GHG emissions are eligible for the first commitment period of KP 2008/2012 if project boundaries are clear; the baseline scenarios are solid; strict measurements of emissions are possible; and if periodic/regular checks can be performed in the future. In contrast, if the methodologies are unreliable and inconsistent with the rigor and accuracy of the "source" projects' methodologies, carbon sequestration projects in ecosystems (forest, agricultural or livestock production ecosytems) are not eligible, except for afforestation and reforestation projects.

Thus, the only LULUCF activity approved under the KP is the establishment of plantations on agricultural or non-forested lands, but not the improved management of existing ecosystems to store more carbon. The improvement in natural forests management (i.e., the management of forests for production or conservation) and the improvement of pre-existing agricultural, livestock or plantation production systems are therefore not eligible under the first commitment period. Concerns of abuse in the utilization of "sinks" induced the creation of land eligibility rules for CDM plantations, requiring a standardized national definition for "forest"[24]. To limit the use of this flexibility, the Marrakesh Accords set a cap in equivalent sequestered CO_2 corresponding to 1 % of the 1990 GHG emissions of the purchasing country.

However, negotiations for a possible expansion of eligibility for future commitment periods were planned with the understanding that these negotiations could begin simultaneously with those planned under the KP on post-2012 reduction commitments for Northern countries, that is to say, for 2005.

Photo 11.1: The forest is also present in areas of rugged relief.

[20] Annex 1 countries in the Kyoto Protocol

[21] Non-annex 1 countries in the Kyoto Protocol

[22] Projects to lower fossil energy consumption or to lower GHG emissions

[23] Land Use, Land Use Change and Forestry

[24] Definition of « forest »: 0.05 ha ≤ minimal surface area ≤ 1 ha; 10 % ≤ tree cover ≤ 30 %; 2 m ≤ height at maturity ≤ 5 m

Post-Kyoto 2012 Negotiations

Preparatory Phase to the Official Post-Kyoto 2012 Negotiations

a – COP-10, Buenos Aires, December 2004 → 22nd SBSTA Session, Bonn, May 2005

The Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Buenos Aires introduced the post-Kyoto 2012 question at a first seminar of governmental experts at the 22nd session of the Subsidiary Bodies in May 2005 in Bonn. During that seminar, Papua New Guinea and Costa Rica launched the idea of an initiative on incentives to reduce emissions from deforestation in developing countries by highlighting the magnitude of emissions caused by anthropogenic deforestation compared to world emissions, and by emphasizing the necessity of Northern countries' cooperation to meet Article 2 of UNFCCC.[25] Since then, Latin American countries (except Brazil) and some Congo Basin countries were approached to support this initiative.

b – COP-11, Montreal, December 2005: Submission from Papua New Guinea and Costa Rica[26]

The Kyoto Protocol having come into force in February 2005, the 1st Meeting of the Parties to the Protocol (CMP-1), was held simultaneously with the COP-11 in Montreal in December 2005. The submission from Papua New Guinea and Costa Rica, supported officially by eight countries including four from Central Africa (CAR, Republic of Congo, DRC, and Cameroon), recalled that the Convention, by targeting reduced emissions from all "sources," automatically incorporated deforestation,[27] and highlighted that in the absence of compensation for the environmental services provided by forests, the KP offers no economic incentive mechanism for Developing Countries (DC) to commit to reducing this deforestation (even though the annual gross loss is about 15 million ha)[28]. They added that remote sensing technologies now enable deforestation to be detected and mapped, opening up possibilities for more concrete assessments.

To take this emission "source" into account, two approaches suggested in this submission were: (i) to adopt an Optional Protocol under the Framework Convention that would specifically test this approach (with countries volunteering from the North and the South) to build a future global regime; or (ii) to expand the Marrakech Accords in post-Kyoto 2012, to include deforestation in compliance with article 12 of the KP. It was then suggested that SBSTA initiate a dialogue, using a project approach and in line with national baseline scenarios based on criteria of additionality (by setting national baseline deforestation rates), of checks on potential leakage, of permanence to cover the risks, and of monitoring based on affordable remote sensing techniques.

Upheld during the session by many countries, including Cameroon and Gabon, the COP took that submission officially into account and invited the Parties to submit their views on it by March 31, 2006 so that the 24th SBSTA session in May 2006 could prepare a workshop on the subject for late August 2006 in Rome and a report for the first session of the 25th session in November in Nairobi. The final recommendations were then submitted to the 27th session in December 2007 in Bali (COP-13) to decide on the inclusion or not of this mechanism on the agenda. The international agenda having been set, the French Facilitation of the Congo Basin Forest Partnership (CBFP) decided to take charge of the consultations of Congo Basin countries in order to support the COMIFAC submissions related to deforestation[29].

c – First Structuring of the Congo Basin Countries' Position in Preparation for the Rome Workshop

The first consultation meeting between the "climate" focal points from major Congo Basin countries took place in March 2006 in Libreville. Based on the outline of a workshop organized in New York by the RainForest Coalition and on the Latin American countries' discussions in Lima, the first COMIFAC submission was developed. The submission[30] highlighted the specific nature of the Congo Basin by emphasizing that this new mechanism should integrate both deforestation (from changes in land use) and forest degradation (from logging), and should take into account the sustainable management process already underway in the sub-region through the implementation of compulsory forestry management plans.[31] For COMIFAC countries, there was no question

[25] "The ultimate goal … is to stabilize … GHG emissions in the atmosphere to a level which prevents any dangerous anthropic disruption to the climate system."

[26] FCCC/CP/2005/MISC.1

[27] UNFCC article 1.9; 3.3; 4.1 (c) and 4.1(d)

[28] FAO Global Forest Resources Assessment 2000, Executive Summary

[29] In the framework of the « Post Kyoto 2012 » component of the project CBFP-CDM

[30] FCCC/SBSTA/2006/MISC.5

[31] 55 % of the forest concessions (or 23 % of the total production area) were under management in Africa (ATIBT: *"Formation en aménagement forestier"* July 2006 FRM - TEREA)

that countries that had not yet made the financial effort to manage their forests should enjoy a tailor-made mechanism that would only value reductions in future emissions,[32] and it was therefore necessary to find a fair and equitable mechanism which would consider *a posteriori* the consequences of previous efforts.

In that submission, key principles were affirmed, such as true benefits for the climate, common but differentiated responsibilities, state sovereignty when it comes to sustainable development, principles of fairness at local, national and inter-state levels, additional resources, and an urgent call for action while respecting preexisting mechanisms (in particular, that Northern countries focus on reducing domestic emissions). But the contribution also stressed the need to take into account innovative policies that integrate national specificity, the participation of the private sector and local communities, and the adoption of financial incentives at regional, national and local levels to provide training, transfer of technology, consolidation of protected area networks and sustainable forest management. It was also suggested that discussions on methodological, technical and political aspects take place in parallel to provide overall consistency. Finally, a sectoral approach encompassing a stratification by biome was also being planned.

The position of the Congo Basin countries was therefore similar to that of the "RainForest Coalition." However, the fact that Congo Basin countries highlighted the need to consider forest degradation on the same footing as deforestation in the proposed mechanism and the fact that they insisted that past forest management efforts should be recognized shows strong nuances which characterize the Central African position.

During the 24th session of the Subsidiary Bodies in May 2006, taking into consideration all contributions, it was noted[33] that, to achieve the final objective of the Convention, Parties felt that «it was necessary to study the issue of reducing emissions from deforestation in developing countries as part of efforts aimed at mitigating the effects of climate changes ». Thus, Parties were asked to present their experiences at the Rome Workshop, to analyze the scientific, socio-economic, technical and methodological questions contained in their proposals, and to assess the methods and needed resources.

To prepare a presentation covering the specificities and the proposals of the Congo Basin, a second consensus-building meeting of "climate" focal points and national forest experts was held in Libreville in early August 2006 to find elements of common ground for Congo Basin countries. The meeting culminated in a presentation which highlighted both the exemplary regional partnership through COMIFAC and the original donor commitment within the CBFP, and which stressed the very low deforestation rates in the Congo Basin (0.27 % for gross deforestation against 0.36 % according to the FAO) and the implementation of ambitious forest management policies (20 % of the area under management), as well as certification and conservation policies. The presentation also stressed the facts that the doubling in size of the population by 2050, its associated poverty, and strong Asian demand for raw materials would have a considerable impact on deforestation rates. Congo Basin countries were favorable to the creation of this potential mechanism on avoided deforestation and degradation under a KP-type "binding carbon market," the only way of ensuring sustainable funding. However, this requires much research in order to quantify the GHG flows and stocks in equivalent CO_2.

Photo 11.2: The logging town of Loundoungou.

Photo 11.3: Boards directly processed from logs in the forest.

[32] A refusal that some countries could « have their cake and eat it »

[33] FCCC/SBSTA/2006/L.8 articles 1 and 3

Photo 11.4: Training and field visits are essential for understanding the future of the African forest.

For this reason, until the conditions for establishing such a rigorous mechanism are met, Central Africa proposed the immediate establishment under UNFCCC of an incentive fund for the Reduction of Emissions from Deforestation (FRED), which acknowledges forests' role in regulating climate through the allocation of "responsibility subsidies" to countries, weighted by the estimated rate of deforestation in unmanaged and non-certified forests, and which rewards management efforts (forest sustainability) by allocating a "management grant" proportional to the area of managed forest in the country (see box 11.1).

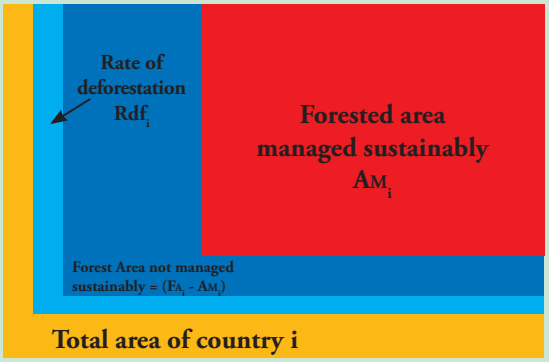
Box* 11.1: Proposals from Congo Basin Countries Made During the Rome Workshop in August 2006: *Mechanism for Allocating a Transitory Incentive Fund for the Reduction of Emissions from Deforestation (FRED) or for a Forest Stabilization Fund

While remaining convinced that market dynamics are preferable in the long run to a specific fund to finance efforts equitably over a long period of time, and despite IPCC methodologies, Congo Basin countries are aware of the scientific and methodological difficulties and workload to overcome in order to translate unit areas of avoided deforestation into metric tons of GHG not emitted, with a level of uncertainty comparable to that found in the Kyoto-type carbon market.

In order to remove methodological snags and adopt a market system, if possible within the KP/CDM framework, Congo Basin countries wish to create a support fund to strengthen national capacity, especially scientific and technical programs. In addition, awaiting the establishment of rigorous methods, they suggest the immediate creation of an incentive Fund for the Reduction of Emissions from Deforestation (FRED) within the UNFCCC framework but outside of the Kyoto Protocol.

Climate regulation, notably by the conservation of carbon stocks in forests, gives Southern countries a differentiated responsibility according to surface area, pedoclimatic conditions and the country's forest management history. Moreover, « a halt to deforestation » does not mean that logging stops, and thus, is not a synonym of « halting GHG emissions ». To encourage countries to reduce their deforestation rate and promote sustainable forest management, COMIFAC countries propose that the incentive, or stabilization fund, be structured around the recognition of the country's responsibility in regulating climate and conserving biodiversity in proportion to its forest area, both managed and unmanaged. Efforts undertaken to manage forests sustainably and the deforestation rate should be taken into account in the fund allocation mechanism, penalizing bad behavior.

The concrete translation of these principles into a fund distribution mechanism is as follows.



- Recognition of the country's responsibility for climate regulation can result in a country responsibility bonus i ($\mathbf{R_{G_i}}$). It would be proportional to the area of existing forest not managed sustainably: $\mathbf{R_{G_i} = [(F_{A_i} - A_{M_i}) / F_{A_T}] * Fd}$

$\mathbf{F_{A_i}}$ being the total forested area for country i,

$\mathbf{A_{M_i}}$ being the forested area managed sustainably in country i,

$\mathbf{F_{A_T}}$ being the total forested area of Parties not included in Annex 1,

Fd is the total funding volume allocated by FRED.

- For each country, the incentive to reduce the deforestation rate is thus built upon granting a country incentive bonus i ($\mathbf{E_{G_i}}$) based on adjusting the $\mathbf{R_{G_i}}$ such that the country's rate of deforestation is taken into account and bad behavior is penalized:

$$\mathbf{E_{G_i} = R_{G_i} / [\lambda * Rdf_i]}$$

$\boldsymbol{\lambda}$ is the coefficient modulating the incentive (example: $\boldsymbol{\lambda}$ =10) and Rdf_i, the rate of deforestation in the country i.

Thus, E_{G_i} is equal to: $\mathbf{E_{G_i} = [(F_{A_i} - A_{M_i}) / F_{A_T} * Fd / [\lambda * Rdf_i]}$

- Greater recognition for country i of the impact of forest management in climate regulation translates into a management bonus $\mathbf{M_{G_i}}$ (Sustainable forest management grant for country i), proportional to the sustainably managed forested area: $\mathbf{M_{Gi} = [A_{Mi} / F_{AT}] * Fd}$

A_{M_i} is the forest area managed sustainably in country i.

The total consolidated bonus $\mathbf{O_{G_i}}$, overall grant allocated to country i, which integrates both forests' role in climate regulation weighted according to deforestation rates and which rewards sustainable management efforts, is thus equal to:

$$\mathbf{O_{G_i} = M_{G_i} + E_{G_i}}$$

or

$$\mathbf{O_{G_i} = [A_{M_i} / F_{A_T}]* Fd + [(F_{A_i} - A_{M_i}) / F_{A_T}]* Fd / [\lambda *Rdf_i]}$$

Conclusion

A fund to promote forest cover stabilization would recognize the impact of forest cover in climate regulation and the responsibility of Southern countries in maintaining this cover despite economic and social constraints. The allocation of bonuses would assign financial value to forests' environmental services and would partially compensate for the economic imbalance that exists between forest profitability and agro-industrial speculation of the same land. By weighing up the bonus according to the deforestation rate at any given moment, this instrument encourages the maintenance of forest cover, or the reduction in the deforestation rate, without speculating on the exact decrease in the deforestation rate. With regards to conventional rules, the originality of this fund is that, overall, it values existing forests (and thus, indirectly, the global carbon stock in place) and not the increase in forested areas, whether managed or not (which would translate into an increase in carbon stocks). This incentive and transitory fund, which would compensate (outside the carbon market) both environmental services and carbon stocks, was designed to save time and ward off emergencies in anticipation of a more functional mechanism.

The strength of this proposal is that the bonus is based on surface area measurements without looking at it in terms of biomass, and thus without measuring the sequestration of equivalent CO_2. Hence it is easier to implement and it addresses concerns of immediateness and transition, without trying to put a value on the real impact of biomass-based carbon sequestration on climate stabilization. This temporary instrument cannot thus be part of the KP or « carbon » market system, but it is consistent with UNFCCC. It also has the advantage of presenting complete equity between humid and dry zones and suggests that forest management is as difficult to implement in humid zones as in dry zones.

Fund allocation using this instrument should be « mechanical » and not subject to outside arbitrage. Hence the importance of finding a fair system.

This allocation mechanism can be expanded by introducing an assessment of equivalent CO_2 sequestration instead of surface area. This could be done, notably by using IPCC methods for adapted forest stratification, but this could result in the introduction of similar difficulties faced by other proposals and would delay its implementation.

Remainder of the Funds

This fund allocation mechanism entails the non-distribution of a sizeable portion of the fund. The basis for distribution is the forested area of the country in proportion to the forested area of non-Annex 1 countries. Whereas protected areas or managed forests are entitled to an unmitigated share of the fund unmanaged forests are entitled to compensation likely to be strongly reduced by the deforestation rate. That is why the factor λ is used to accentuate the impact of a bonus according to deforestation.[34] As managed forests are mainly in the minority, there will be a sizeable fund balance which could be managed by the international community to develop conservation programs targetting particularly vulnerable regions and strongly disadvantaged countries, or to strengthen sub-regional capacity and research.

[34] Example: in the simulations carried out the value was λ = 10.

Taking into account the problems in conserving forests in densely populated countries

Simulations were carried out to address the criticism from small, densely populated countries that this proposal did not do enough to promote their forest domain. These simulations showed that the "proportionality" to actual forested area is consistent, but that the distribution mechanism of the fund (which is finite and outside the market system) may lead to an unattractive (modulated) dilution for smaller countries if the application of this mechanism is generalized.

One weakness of this mechanism is the fact that it does not take into account the problems densely populated countries must overcome to conserve or manage their forests sustainably compared to less populated countries.

To address this weakness while maintaining FRED principles, all or part of the bonus can be modulated by population density per km^2. To maintain fairness among Southern countries, this population density cannot be compared to the country's total surface area but to the forested area (FAO or CDM) estimated, for example, in 2005.

The pivot population density (P_D) for modulating the bonus could be the average population density of « non-Annex 1 countries » compared to the forested area of the same « non-Annex 1 countries ».

Thus, for country i with population density $\mathbf{D_i}$:

→ if $\mathbf{D_i = P_D}$ no bonus modulation occurs.

→ $\mathbf{D_i > P_D}$ the $\mathbf{O_{G_i}}$ has more value;

→ $\mathbf{D_i < P_D}$ the $\mathbf{O_{G_i}}$ bonus decreases.

With regards to the distribution key $\mathbf{O_{G_i} = M_{G_i} + E_{G_i}}$, the balance of $\mathbf{D_i / P_D}$ could come into play either in terms of both parts of the equation, or just one.

Fgi being the final grant allocated to country i:

→ Global application on $\mathbf{O_{G_i}}$: $\mathbf{F_{G_i} = O_{G_i} * D_i / P_D}$

→ Application on $\mathbf{M_{G_i}}$: $\mathbf{F_{G_i} = M_{G_i} * D_i / P_D + E_{G_i}}$

→ Application on $\mathbf{E_{G_i}}$: $\mathbf{F_{G_i} = M_{G_i} + E_{G_i} * D_i / P_D}$

Discussion are still ongoing but it seems reasonable to apply this weighting to the targeted bonus for $\mathbf{M_{G_i}}$, as management is always more difficult in densely populated environments. But other weighting scenarios can be considered.

Photo 11.5: Typical log pile from industrial exploitation.

At the Rome workshop (August 29 to September 1, 2006) each Party presented its experience and position in a constructive fashion. Besides COMIFAC's presentation on bonuses for sustainable forest management and the principle of weighting the bonus for climate change responsibility according to the deforestation rate (encouragement from "virtuous" countries to countries caught in a deforestation cycle), the following presentations were the most significant:

- Papua New Guinea introduced a proposal for a new type of carbon unit exclusively targeting deforestation, and generated by changing the rate of deforestation in a country (involved in the system on a voluntary basis) compared to a baseline level established on a national scale;
- Costa Rica presented its program of Payment for Environmental Services (PES) to reverse the high rate of deforestation observed in the 1980s;
- Bolivia submitted its pioneering project showing that it is possible to develop CDM-type methodologies for avoided deforestation projects at sub-national levels;
- Brazil introduced similar ideas to Papua New Guinea, but differed by rejecting the "market" part in favor of a fund provided by Northern countries disconnected from their commitments to reduce emissions.

Overall, workshop presentations focused on the following sensitive points:

- definitions, including the relationship between deforestation and forest degradation;
- availability and quality of data;
- relevance of scale;
- rate of deforestation and determining factors;
- estimates of changes in carbon stocks, forest cover and their related uncertainties;
- permanence of emission reductions and displacement of emissions (leakages);
- promotion of sustainable forest management;
- capacity building.

The workshop was concluded by suggesting a more detailed discussion before the COP-12 in Nairobi on the two or three main options for reducing emissions from deforestation, expanding on the levels of activity and the positive incentives that could be implemented to use the funds or generate new funding.

d – From Rome to Cairns: Latin American/Central African and Intra-COMIFAC Consultations

To prepare the contribution for COP-12 in Nairobi, a COMIFAC representative[35] took part in the REDD consultation meeting for Latin American countries in Sao Paolo in October 2006 and took this opportunity to present the Congo Basin countries' position. The 3rd consultation meeting of Congo Basin countries took place subsequently in Yaoundé in October 2006.

COMIFAC's position was furthered by renewed insistence on the following points:

- It is vital for Congo Basin countries to take into account the notion of conservation and sustainable forest management (managed and certified forests, and protected areas) in the incentive distribution mechanism;
- The baseline for GHG emissions should not penalize countries which took early measures. A baseline using historical deforestation rates significantly penalizes Congo Basin countries. Mechanisms for adoption should not penalize virtuous countries;
- Congo Basin countries stress that the financial mechanism being considered should be binding in nature to ensure sustainability (mandatory fund or market mechanism linked to Northern country commitments);
- Central African countries want a support fund to be set up urgently in order to strengthen capacity and research and to strengthen scientific and technical programs so that the methodological hurdles can be overcome;
- Given the diversity of situations in Southern countries, the mechanisms to be adopted should be flexible in nature;
- Despite scientific uncertainties and technical constraints in estimating stocks from different biomes, it is necessary to work on carbon stock estimates (CO_2 equivalents) according to the different types of vegetation/biome;
- Incentives should recognize countries' responsibility in stabilizing the climate, in proportion to carbon stocks present in their forest ecosystems;
- Country efforts in terms of conservation and sustainable forest management (managed and certified forests, and protected areas) should also be taken into account.

COP-12 Nairobi provided no decisive elements to the deforestation discussions. Parties agreed to continue the process and confirmed the negotiations schedule for FCCC/SBSTA/2006/L.25 on November 13, 2006. The highlights were (i) an invitation by the Parties to submit comments on issues related to deforestation, and the organization of a second workshop in early March 2007 in Cairns, Australia to study the issues; and (ii) SBSTA review and compilation of all this information at its 26th session in Bonn in May 2007.

To prepare these meetings, the "Coalition of Rainforest Nations" and the Government of Costa Rica proposed that its members and interested countries meet in January 2007 in San José (Costa Rica) to work on a joint submission. The four Congo Basin country members of the coalition (Gabon, CAR, DRC, and Congo) and Cameroon were invited. COMIFAC took advantage of this gathering to organize the 4th consultative meeting of Congo Basin countries in Turrialba. Thus, two regional seminars were held following the Coalition meeting, one for Latin American countries and one for COMIFAC.

Twenty five countries including eleven Latin American and eight African countries (five from the Congo Basin, plus Madagascar, Ghana and Kenya) attended the Coalition meeting. This was preceded by technical seminars in New York, on the basis of which a submission proposal was discussed by Coalition members.

Finally this contribution distinguished four distinct mechanisms:

- The CDM mechanism (in place) for afforestation/reforestation activities;
- A REDD mechanism to finance actual reductions from deforestation in developing countries using a national approach;
- A stabilization fund, specifically for countries with low deforestation rates, to fund policies for maintaining forest cover;
- An activation fund, to be set up immediately, to strengthen countries' capacities (remote sensing, inventories, diagnostic of the deforestation situation, policies to implement) and the setting up of "pilot projects."

The contribution prepared by COMIFAC at its consultative meeting, however, specified certain other points:

- The mandate produced by the COP-12 mentions only deforestation and not degradation, which theoretically shuts out degradation processes. The COMIFAC also emphasized that the translation of the REDD acronym must be "Deforestation and Forest Degradation" and not "Deforestation in Developing Countries."

[35] Mrs Aline Malibangar, CAR "climate" focal point

Regarding the REDD approach, COMIFAC did not voice a preference between an Optional Protocol under the Framework Convention for deforestation and degradation, and an expansion of the Marrakesh Accords, which favors the CDM project approach. This indicates that openness and flexibility are preferred for the time being both for the financial instrument, with or without market mechanisms, and for the implementation scale (regional, national, sub-national, or project). COMIFAC also confirms the Coalition's position on a baseline scenario based on a historical emissions rate incorporating a prospective development adjustment factor (DAF).

- The stabilization fund in the Coalition's submission is based on COMIFAC's proposal to set up a fund to reduce emissions from deforestation. The fund targets countries with low deforestation rates that will not benefit from REDD: countries that have always managed to preserve their forests (e.g., Gabon, CAR); or countries that are in the process of regenerating their forest cover after its sharp reduction (e.g., Costa Rica, Uruguay). This fund would encourage forest cover stabilization, with an allocation formula based on the Rome COMIFAC proposals to prioritize forest areas, deforestation rates and areas under sustainable management.
- The activation fund involves supporting the launch of three types of voluntary strategies for developing countries: 1. instruments without free market mechanisms based on a fund; 2. instruments based on market mechanisms; 3. support for stabilization so that a positive incentive system can operate as soon as the Convention incorporates the process.

Upon reading the Coalition and COMIFAC proposals, some differences can be observed. These differences relate to (i) a less obvious desire for one than for the other to include degradation in the mechanism; (ii) the scale of implementation, which is national for the Coalition whereas COMIFAC does not want to favor any specific approach, and (iii) how to integrate sustainable development efforts into the mechanisms under discussion. Conversely, Latin America's position (excluding Brazil) is more in tune with COMIFAC's on all these points.

Congo Basin participation in the technical workshop in Cairns in March 2007 was limited to Gabon, Congo and CAR. However, this workshop pointed out the proponents for a national approach underpinned by IPCC-type methodologies, and those who challenge the exclusivity of a single approach (subject to compatibility between carbon accounting and between approaches). These quarrels would seem to mask political manoeuvering in anticipation of the fungibility or not of such a mechanism in a Kyoto-type market.

e – World Bank Initiative (Forest Carbon Partnership Facility - FCPF) and the G8

Following the Cairns meeting and just before the 26th SBSTA session in Bonn, the G8 summit was held in Heiligendamm (Germany) in June 2007 to address climate change issues. A series of workshops were organized in which the World Bank (who wanted G8 support) presented its new initiative entitled the "Forest Carbon Partnership Facility (FCPF)." This initiative was requested at the G8 summit in Gleneagles in July 2005 in Britain and constitutes one of the four guiding principles of the Global Forest Alliance (GFA), which is the World Bank's strategic framework of action for forests.

The ultimate goal of this initiative is to provide a series of innovative tools and methods that can be used by the Climate Convention. The objective of avoided deforestation is delimited at the national level in order to benefit from economies of scale and to reduce the risks of "leakage;" and emission reductions are compensated by "non-Kyoto carbon" credits underwritten by the World Bank.[36] In due time, this mechanism will be developed and compensation from other services incorporated, such as biodiversity protection and water protection.

The project is structured around two concepts: (i) the "Carbon Finance Mechanism," designed to compensate reductions in the net rate of deforestation in five pilot countries, using an "innovative" market system outside the Climate Convention and the KP; and (ii) the "Readiness Mechanism" to prepare project dossiers (establishing emission baselines and an emission monitoring facility) for 25 to 30 developing countries wishing to enter the FCPF. Among the issues raised in this initiative, apart from questions about the links between FCPF and the Climate Convention that were not clearly expressed, are: (i) the future integration of "pilot country" operations into the future United Nations mechanism, (ii) the terms for redistributing incentives to the final beneficiaries, and (iii) taking into account forest management.

Broadly speaking, this initiative is supported by G8 countries, provided it does not preempt United Nations negotiations. In its final state-

[36] ERPA = "Emissions Reductions Purchase Agreement".

Photo 11.6: Shifting cultivation is one of the primary causes of forest clearing in the Congo Basin.

ment, the G8 encourages the World Bank for its "pilot initiative for capacity strengthening, creating and evaluating performance-based instruments to reduce emissions from deforestation in developing countries, as an extension of, and without prejudice to, ongoing negotiations within the United Nations."

f – Preparation of the 27th Session of SBSTA, COP-13 and COP/MOP-3 in Bali - December 2007

The 5th COMIFAC consultative meeting (Douala, August 2007) analyzed and modified the SBSTA decision project of May 2007 and drafted a new REDD proposal for the 27th session in Bali in the framework of COP-13. This contribution[37] takes up the main points of the position of Congo Basin countries.

- "An essential priority for Congo Basin countries is that degradation should be taken into account on the same basis as deforestation."
- "It is important that the choice of approach and pertinent action level be flexible." The scale may go from national to local, going through sub-national levels corresponding to administrative territories with relative management autonomy for land use planning (States of a Federation (e.g., Brazil), Provinces (e.g., DRC), Regions/ *Départements*, Rural communities/territories, etc).
- "The historical trend baseline (for a national, sub-national or local approach) should be complemented by an adjustment factor integrating development and taking into account national and international circumstances."
- "Only the carbon market mechanism can generate the necessary financial resources for REDD and ensure sustainable funding."
- "Congo Basin countries propose setting up a stabilization fund to compensate standing carbon stocks with a distribution scheme in compliance with FRED."

The 6th consultative meeting (Douala, October 2007) was devoted to preparing negotiations for the 27th session of SBSTA and COP-13 in Bali. On this occasion, participants tried on the eve of the Bali meeting to draft a schematic table (table 11.1) reflecting positions of the main influential parties on the five main issues linked to REDD.

[37] FCCC/SBSTA/2007/MISC.14.

Table 11.1: Outline of the position of the major Parties regarding the five major REDD issues, as perceived by Congo Basin countries

	Degradation/ definition of forest	Sustainable management and stabilization fund	Baseline scenario	Funds/REDD market	National/ project
Brazil	No	No	Historic (to be developed)	Voluntary fund	National
Latin America	Possibly	-	-	REDD market	National + project
Indonesia	Yes ++		Historic + DAF	Market	National
India	Yes +	Yes and reforestation			
China	Yes	Yes and reforestation			Project
Coalition	Yes but flexible	Stabilization fund for countries with low deforestation rates	Historic + DAF	REDD market	National
COMIFAC	Yes +++	Funding of sustainable management/stabilization fund	Historic + DAF	REDD market	National + project
EU	Not too keen except Germany, Belgium, France	Yes, in a second phase	Leaning towards historic with possibility of modifications	Leaning towards REDD market but hesitant	National, while waiting for evidence
Japan	Yes ++	Leaning towards yes and reforestation	Leaning towards historic but?	Leaning towards market	Leaning towards national but…?
USA	Yes	Leaning towards yes	Not really tackled	Fund, as outside Kyoto Protocol	National + project
WWF	Yes ++	Agreement in principle but to be reviewed according to the modalities	Historic and + DAF	Market but with limits	National - projects with national commitments

COP-13 faced an important challenge as the goal was to begin a formal negotiation process between UNFCCC Parties to conclude a global agreement on climate between that point in time and COP-15 in Copenhagen (December 2009), to be ratified before the deadline of the first KP commitment period at the end of 2012.

After intense debate and many new developments, the Conference finally adopted the "Bali Action Plan"[38], which launches and defines the negotiation process and "invites" Parties to reach an agreement within two years. While this plan makes no mention of any numerical target for long-term emission reductions, it provides a framework, organizes upcoming negotiations, and guarantees that Parties will have a productive discussion on a long-term objective. This text is important since it involves the USA and emerging countries. This plan does not explicitly refer to reduction commitments for developing countries, but taking into account actions (measurable and verifiable) carried out in these countries could be a prelude to other forms of commitment from the major emerging countries.

The great innovation of this plan in terms of international climate negotiations is that it proposes taking into account political approaches and positive incentives "in everything concerning the reduction of deforestation and forest degradation in developing countries; as well as the role of sustainable forest management and conservation, and strengthening forest carbon stocks in developing countries".

The plan also explicitly mentions the need to consider "sectoral approaches to enhance implementation of article 4, paragraph 1, subparagraph c of the Convention". This provision invites all Parties to cooperate in order to facilitate technology transfer and implementation of all practices and technologies that control, reduce and prevent greenhouse gas emissions in all sectors, including energy, agriculture, forests and forest management, thereby opening up the prospect of taking into account "bottom up" type approaches.

Decision 2/CP-13, specifically dedicated to incentive measures to reduce deforestation in developing countries, mentions that "forest degradation also leads to emissions and this must be taken into account in reducing emissions from deforestation." The preamble recognizes that "initiatives and measures to reduce deforestation and to conserve and maintain forest carbon stocks in developing countries are already underway," which could be considered as an explicit reference

[38] Decision 1/CP.13.

to management efforts carried out by Congo Basin countries, and goes on to acknowledge that "new measures to reduce emissions from deforestation and forest degradation in developing countries could help the Convention achieve its ultimate goal."

The efforts of COMIFAC countries have thus paid off. The debate on incorporating forest degradation and on the recognition of sustainable management efforts has come to a close. REDD with a D for deforestation and a D for degradation has been definitively adopted. However, the Bali Plan remains cautious on the question of whether conservation, sustainable forest management, and carbon stocks sequestered during afforestation and reforestation should be taken into consideration for the purpose of mitigation. However, the experimental phase launched under decision 2/CP-13 more or less covers public and private initiatives implementing activities to reduce deforestation and forest degradation, with the prospect of seeing their efforts rewarded through the mechanism to be adopted.

This decision and the experimental phase provide the flexibility requested by Congo Basin countries, without prejudice to scale (national or sub-national) or implementation modalities. They also are not prejudiced towards a future financial mechanism, but still lean towards a "carbon market," since decision 1/CP-13-1-bv specifies that "all steps should be envisaged, including the option of using markets to improve the cost-effectiveness of mitigation measures and to promote them." Thus, in terms of expectations, Congo Basin countries are satisfied with the outcome of Bali. However, they remain attentive to future developments in order to preserve the sub-regional coherence of the COMIFAC position and the flexibility they wish to maintain between national and sub-national approaches.

Photo 11.7: Forest roads improve the accessibility of remote areas.

Series of Official Post-Kyoto 2012 Negotiations

a – Technical Meetings Directly Concerning the Congo Basin (Paris, March 2008)

During the week of March 11th to March 14th, 2008, three successive meetings were held in Paris at AFD headquarters. The first brought together international experts to discuss the problematics around REDD in COMIFAC countries; the second meeting was about the Steering Committee of the CBFP-CDM project and finally the third one (7th consultative meeting of Congo Basin countries) was aimed at preparing a new submission for the 28th SBSTA in Bonn.

The technical REDD-COMIFAC meeting's goal was to establish the technical and scientific bases for monitoring and recording greenhouse gas emissions from deforestation and forest degradation, with a view towards carrying out the REDD pilot activities endorsed in Bali. In addition to COMIFAC representatives, the workshop gathered together international experts, representatives from the French and German cooperation agencies, international institutions and governmental agencies, NGOs and associations, research organizations, and the private sector.

Once the IPCC best practice guidelines for measuring and recording the specific impacts of deforestation and degradation were presented, available technologies for remote sensing and forest inventory were discussed in the light of experiments carried out in the Congo Basin. The FORAF[39] project presented the setting up of the *Observatoire des Forêts d'Afrique Centrale* (OFAC), placed under the aegis of COMIFAC, and OFAC's results on deforestation rates[40] in the sub-region. Consulting firms presented their experiences with performing *in situ* inventories relating to forest management. Finally, the research sector assessed how logging has degraded forests in Central Africa by trying to translate available data from management plans and research facilities into carbon figures. REDD experiences and methodologies from around the world (India, Australia, French Guyana, South-East Asia, Madagascar, and Cameroon) and REDD methodological tools developed by the BioCarbon Fund were also presented for possible replication in the Congo Basin.

In conclusion, it became clear that (i) deforestation and forest degradation in the Congo Basin are historically low and that it will be difficult to reduce them significantly; (ii) conservation and forest management play a clear role in forest preservation and thus justify compensation; (iii) finally, forest management fulfills the triple functions of conservation, economic growth and poverty alleviation, which must be strengthened. Finally, it was noted that well-planned and controlled logging does not automatically lead to degradation in the long term in terms of reduced carbon stocks. It was stressed that IPCC methodologies may provide information on degradation linked to other human activities (agriculture, bushfires, mining activities, overexploitation of forests for energy, or

[39] Project funded by the European Commission: www.observatoire-comifac.net

[40] Rate of 0.19 % in line with the results from the CARPE program.

illegal timber logging), but not on impacts from logging operations conducted under sustainable management.

In line with this REDD workshop, the CDM-CBFP project steering committee, which took place right after, validated the projects presented by the DRC and Congo on "REDD Hot Spots" targeting wood energy supply zones[41] for the urban areas of Kinshasa and Brazzaville as "sub-national" REDD pilot projects. These projects address the concerns of decision 2/CP-13 from Bali. Following the workshop recommendations, the steering committee also expanded on the measures to be implemented to increase knowledge of the region and to facilitate implementation of pilot activities.

The 7th consensus-building session of the Congo Basin formulated a submission addressing the requirements of decision 2/CP-13-7a. Perfectible data exist to assess deforestation and to translate it in terms of GHG emissions, but human and technical capacities should be strengthened to characterize data specific to the Congo Basin. To take into account sustainable forest management, it is proposed that emissions from sustainable forest management not be considered, but that reduced emissions or an increase in stocks caused by better management should be. At the national level, the baseline scenario should incorporate future development requirements and the methodology can be defined at the regional level. At the sub-national level, general principles should allow for integration of local conditions and dynamics. The definition of degradation under IPCC should be finetuned to differentiate temporary stock declines from logging operations carried out as part of sustainable management. Flexibility in national or sub-national approaches is vital. The sub-national approach should precede the national approach and should not be limited to the 2008-2012 experimental period. Finally, the criteria for evaluating effectiveness depend on the adopted approach and the specific contexts. The criteria will depend on pilot projects, technology transfer and technical, institutional and material capacity building. It is also reiterated that only the carbon market can sustain REDD financing, but Congo Basin countries continue to request that a stabilization fund be set up to compensate forest environmental services (cfr. the Rome workshop proposal). That fund could be fed by taxes on emission permits and taxes on the "carbon footprint" of products and services collected by Annex 1 countries.

b – The First Meetings of the "Ad Hoc Working Group on Long-term Cooperative Action under the 2008 Convention"

These sessions (in April in Bangkok, in June in Bonn, in August in Accra, and in December in Poznan) are part of the Bali Action Plan and prepared the program of work to be adopted by COP-14 in Poznan (December 2008) to reach post-Kyoto agreement in 2012 on the occasion of COP-15 in Copenhagen (December 2009). The aim is to build a framework for negotiations and identify issues that are the subject of consensus and those requiring negotiations. The actual negotiations will be held in 2009, when the new U.S. administration will be in place.

The first formal session (AWG-LCA-1) on the post-Kyoto 2012 regime took place in Bangkok from March 31st to April 4th 2008. It was a laborious but strategic first discussion, since interpretations of the Bali roadmap had to be harmonized around five identified negotiation blocks, namely shared vision, mitigation, adaptation, technologies, and financing. The sectoral approach issue (North-South technological strengthening in different economic sectors) has often been at the heart of the debate, because developing countries suspect that developed countries are trivializing their status and are leading them to binding commitments without explicitly saying so. Furthermore it should be noted that the World Bank/FCPF project was widely criticized by developing countries who feel that it has no clear connection with international financing structures.

The 5th session of AWG-KP was held in parallel with AWG-LCA, only for Parties to the Kyoto Protocol, and aimed at improving the efficiency and implementation of Northern commitments through mitigation measures. The forest and land use session helped rank issues on which there was consensus and those where there was debate. It appeared that there was post-Kyoto 2012 consensus on (i) taking into account the forest sector including agriculture, (i) keeping already approved general principles, (iii) improving accounting rules, and (iv) the stimulation of CDM afforestation projects in developing countries. The issues that remain under discussion include (a) the distinction between anthropogenic and natural causes of forest carbon stocking, (b) the accounting of carbon stored in timber products, (c) taking into account the effects of climate change (fires, storms, insects ...), (d) the promotion of sustainable forest management, and (e) the effects of bio-fuels. All these issues are important because they will complement the collection of « carbon » mechanisms relating to CDM and REDD.

[41] Expanded to the limits of the concerned provinces or *départements*.

During the AWG-LCA-3 session in Accra, a major step forward was taken in the "forest" dossier. An agreement in principle was reached on the mechanisms to be adopted for tropical forests that go beyond the Bali Action Plan. These mechanisms will apply not only to combating deforestation and degradation but also to human activities promoting "conservation," "sustainable forest management," and afforestation and reforestation. Brazil made this breakthrough possible by removing its objections to the inclusion of "conservation." Thus, from Bangkok to Accra, Brazil has successively altered its position on degradation and conservation, permitting the whole range of forest activities to be covered.

An important debate took place in Accra on "differentiation," which confirms the North-South divide, but which was discussed openly for the first time. The idea was to agree on a set of criteria to determine each country's obligations according to GDP or *per capita* GHG emissions. Delicate subject, because emerging countries feared that this discussion would pave the way to include reduction commitments in a post-2012 agreement while also breaking up the block of non-Annex 1 countries.

At the parallel session of the AWG-KP-5 in Accra on improving the flexibility mechanisms' functioning and on expanding options, the creation of a "sectoral CDM" was discussed. This "sectoral CDM" would complement the current "CDM project." It would allow a Southern country to receive financial support if it enforced regulations limiting GHG emissions in a sector of its economy. This opening could be interesting but, emerging countries in particular, for sovereignty reasons, are reluctant to have to include their public policies in a treaty in order to obtain financial compensation. Congo Basin countries could obtain financial assistance if more stringent regulations were implemented which could help reduce emissions in the forest/timber sector (e.g., limiting log exports to promote national processing capacity). Other policies affecting energy consumption patterns in the country could also receive support in function of the emission reductions that they would generate.

Discussions have begun on the permanence of REDD type reductions and the compatibility between fossil fuel emission reduction certificates and REDD certificates, and thus the type of financial mechanism. Proposals are open to suggestion. Specifically, the proposals consistent with a market system range from the proposal to set up a dual market (Greenpeace) divided into a « fossil fuel » market and a « REDD-type » market for part of the commitments, to a system similar to that governing the CDM afforestation project, which caps the acquisition of certificates for countries subject to reduction commitments to a percentage related to emissions from a baseline year.

c – Steering Committes of FCPF/World Bank: Paris, July 2008 and Washington, October 2008

The World Bank FCPF initiative on REDD continued. The launching workshop was held in Paris from July 8th to July 10th, 2008. Following a call for proposals from the Bank for pilot initiatives in line with a national REDD approach, 39 Southern countries, including all of the Congo Basin countries, expressed the desire to take part in the FCPF mechanism. Among them, 18 countries (including Gabon, DRC, Congo, and the CAR) submitted a fact sheet (R-PIN) stating their willingness to participate and describing the status of existing data and available means. The selection process for these proposals was organized by a steering committee (made up in equal number by contributors and recipient countries) in charge of selecting pilot countries. The steering committee was held during the workshop to launch the FCPF and it finally selected 14 countries including six from Africa, two of which were from the Congo Basin (Liberia, Ghana, Madagascar, Kenya, DRC, and Gabon). The Republic of Congo and CAR were invited to re-submit their fact sheets (R-PIN) at the next selection meeting to be held in October 2008 in Washington, while Cameroon and Equatorial Guinea were to submit theirs for the first time. The selected countries will receive a grant of $ 200,000 to prepare national plans. Once the plan is approved, up to $ 3.3 million may be allocated to implement the national « readiness » plan. After the plan has been carried out, five pilot countries will be selected to carry out the exercise to its end. They will receive a compensation that will depend on the reduction in the net deforestation rate under the "Carbon Finance Mechanism," through an "innovative" market system outside the Climate Convention and outside the Kyoto Protocol.

The 8th COMIFAC consensus-building meeting enabled Congo Basin countries to reaffirm their wish to participate in this initiative in solidarity, without questioning/undermining their need to experiment with sub-national approaches. An uncompromising objective analysis of the FCPF initiative selection results was also made to try to incorporate all Congo Basin countries in upcoming selection phases. Congo Basin countries have also defined a REDD strategy to assess the state of affairs and to prepare the baseline scenario definition and policy strategies to combat deforestation and degradation (see the Congo Basin strategy in table 11.2).

Table 11.2: Mechanisms to reduce GHG emissions from deforestation and degradation (REDD)

Components	Sub-Components	Activities	Implementation
1. State of deforestation and degradation			
	1.1 Study on the causes of deforestation and degradation		
		Developing a State of the Forest synthesis specifically on DD causes	R
		Studies on the causes of deforestation and degradation at the national level	N, RS
		Assessment of areas: cf. cross-cutting component on emission monitoring	
	1.2 Analysis of policies implemented in the country and impact on DD		
		Synthesis of recent studies adapted to the needs of REDD Focal Points and identification of missing analyses/studies	N
		Formulation of terms of reference; additional studies	N
		Preparing national studies	N
		Synthesis of studies from countries at the regional level	R
	1.3 Evaluation of GHG emissions associated with historic and current DD		
		cf. cross-cutting component on emission monitoring	
2. Baseline scenarios of emissions relative to DD			
	2.1 Preparing baseline scenarios		
		Formulation of terms of reference for national and regional studies	R
		Phase 1. Diagnostic study on methodologies/choice (modeling)	R
		Phase 2. Diagnostic of the future drivers for DD and modeling future DD pressure	R, N
		Phase 3. Defining possible reference scenarios	N, RS
	2.2 Evaluation of associated GHG emissions		
		cf. cross-cutting component on emission monitoring	
3. Analysis and definition of potential strategies to combat DD			
	3.1 Defining the different policy options		
		Improving existing policies	N
		Defining new policies	N
	3.2 Comparative study of these policies based on impact modeling		
		Evaluation of associated avoided GHG emissions	N
		Evaluation of resulting constraints	N
		Economic, social and environmental analysis (opportunity costs)	N
		Study of alternatives to reduce emissions in other sectors	N
	3.3 Consensus-building and validation		
		Consensus-building and validation	N
		Official adoption by governments	N
4. REDD implementation framework			
		Defining the national scale articulation - projects/implementing a national carbon registry	N
		Setting up the mechanism for distributing the revenues/incentives from REDD	N
		Defining the legal carbon framework	N
		Defining the financial management and marketing mechanism for REDD credits	N

Components	Sub-Components	Activities	Implementation
Cross-cutting components			
1- Measures to monitor GHG emissions (counting and monitoring)			
	1.1 Forest cover monitoring mechanism		
		Summary of existing data	R
		Study on image availability	R
		Evaluation of national capacity (infrastructure and images)	N
		Initial scoping studies for a mobile receiving station	R
		Study for creating a receiving station	R
		Choice of a monitoring methodology	R
		Installing a receiving station	R
		Image pre-processing	R
		Installing/strengthening national GIS units	N, RS
		Image processing and interpretation	N
	1.2 Measuring carbon stocks		
		Diagnostic study of existing actors and data	N
		Formulating terms of reference for studies	R
		Preparing national studies – carbon stocks/allometric equations	N
		Synthesis of studies carried out in countries at the regional level	R
		Platform for exchange of technical data between countries	R
		Setting up/strengthening national forest inventories	N, RS
	1.3 Reporting GHG emissions from DD using IPCC guidelines		
		Strengthening inventory capacity/training	R, N
2 – Institutional environment			
	2.1 Installing REDD coordinating bodies at the regional level		
		Setting up a regional consensus platform between partners	R
		Setting up a regional REDD scientific committee	R
		Strengthening the COMIFAC REDD Working Group	R
		Supporting REDD coordination at regional level	R
	2.2 Installing REDD coordinating bodies at the national level		
		Operationalize national REDD committees	N
	2.3 Involving and consulting the public		
		Preparing the public consultation plan for the entire process	N
		Implementing the consultation plan	N
3 – Support to negotiation			
	3.1 Support to negotiators from Central African countries		
		Organizing consensus-building meetings	R
		Preparing technical orientation documents	R
		Strengthening country participation in major negotiation meetings	R
	3.2 Support to carrying out strategic studies		
		Preparing an impact study of REDD mechanisms on countries' policies	R
		Evaluation of different countries' positions on REDD	R
	3.3 Development of technical exchanges		
		Organisation of technical and scientific workshops at regional and international level	R
		Exchanges with negotiators from other regions	R

R = regional, N = national, RS = regional supervision

During the second meeting of the FCPF Steering Committee held in Washington (October 2008) members of the fund's decision-making body were appointed. Africa secured four seats among the ten members of the "beneficiary" group, including two countries from outside the Congo Basin (Madagascar and Ghana), and two from the Congo Basin (DRC and Gabon). The initial endowment of $ 100 million for "preparatory funds" was planned for 20 beneficiary countries and the initial selection, held in July, designated fourteen countries, including DRC and Gabon. The second selection, held in October, designated six new countries including Cameroon. In order to incorporate ten additional countries, the idea of increasing the endowment fund by $ 50 million was put forward, subject to approval by the Bank's Board of Directors. Already five countries have been selected, including the Republic of Congo. Thus there are still five countries to be designated under the next and final selection. Despite the efforts of Central African countries to promote a regional "Congo Basin" approach, CAR and Equatorial Guinea have not yet been incorporated. To show their discontent and reassert their commitment to a united regional approach, Congo Basin countries left the meeting. This led to the decision to draft a presentation specifically for a regional approach in time for the next steering committee meeting in March 2009 in Panama.

d – The European Union Position on the Eve of Poznań

While waiting for the USA to redefine its position regarding post-Kyoto 2012 negotiations, the European Union is playing a major role among Annex 1 countries. EU internal debates on how to implement its "Energy and Climate" policy package through concrete North-South policies are interesting because they reflect its eventual negotiation margins.

To date, the European Commission has always been reluctant to introduce carbon credits from the forest sector. Thus, temporary CDM afforestation credits were not allowed in the European EU-ETS 2008/2012 carbon market (and so this type of credit developed poorly). In line with this position, the Commission has so far not proposed using REDD credits that would permit industrial entities or member states to meet their commitments.

Negotiating pressure has brought about a change. From mid-October 2008, the Commission indicated that it did not support the inclusion of REDD credits in the "carbon" market for the 2013 to 2020 period, but was open to proposals for the post-2020 period. For the period 2013/2020, the Commission proposed setting up a public fund to compensate this kind of credit so that the results of pilot experiments could be considered.

The Commission also proposed that the modalities of the "Emission trading system" (EU-ETS), which is the basis for the European carbon market, be revised and that national emission allowances for certain industries not be allocated freely but put up for auction. Furthermore, it suggested that at least 20 % of the revenue from these auctions be used to support emission reduction and climate change adaptation policies, including avoided deforestation and adaptation in developing countries.

This cautious approach is disputed by the European parliament[42] which proposed in its amendments that at least 50 % of the income from allowance auctions be transferred to a community or international fund for countries that ratify the upcoming international agreement. A quarter of the funds would be allocated to forestry projects, another quarter to reducing emissions and technology transfer, and half to climate change adaptation. This international fund would facilitate the transfer of up to € 10 billion a year (including € 2.5 billion for REDD) to countries ratifying the future agreement. Another amendment proposes that European companies that are under the National Quota Allocation Plan (NQAP) can use the credits from forestry activities in Southern countries up to a limit of 5 % of the required emission reductions.

These amendments were not adopted by the Council of Europe as some countries complained to the Commission about restrictions on national earnings. But the ideas of a financing structure, allowance allocation and a partial connection to the carbon market were retained. This kind of structuring is also being discussed in the US Congress.

Nonetheless, in its « environment » session of December 4th, 2008, the European Council undertook its transition. The Council took note of the Commission's suggestions to set up a global mechanism for carbon forestry, and estimated that between € 15 and 25 billion per year were required to halve deforestation by 2020. They highlighted that current negotiations for the "energy-climate" package within the EU will contribute to this funding, while recalling that Member States should determine how revenue generated by the auctioning of quotas within ETS will be used to combat climate change in the EU and in developing countries.

In addition, the European Council stressed that afforestation and reforestation activities should continue to be taken into account during the 2013-2020 period, and invited the Commission to as-

[42] ITRE Commission report (11 September 2008) and Doyle report of the ENVI. Commission (7 October 2008)

sess the impact of credits generated under a REDD mechanism, under appropriate conditions, to see if they might already partially meet government commitments, while being open to the idea that the EU ETS could serve as an additional instrument in the medium to long term.

Finally, the Council asked that the mechanism be implemented based on results in terms of avoided emissions from gross deforestation and forest degradation, while promoting the conservation, sustainable management and enhancement of forest stocks. The Council also suggested that an implementation strategy at the national level covering the whole forest sector is required to reduce the risk of leakage inside a country.

The change in stance within the European Union is positive, although the national approach and some of its theoretical benefits should be demystified with regards to the benefits that may accrue when the sub-national level approach is used within administrative boundaries. This approach would indeed lead to compatibility between the two approaches, carbon accounting with no risk of double benefits for the same avoided emission, and an inter-provincial leakage control as effective as an inter-state leakage.

e – Poznań, December 2008, 29th SBSTA Session, COP-14 and COP/MOP-4

As predicted, this COP was only an intermediate step/juncture between Bali and Copenhagen. Hence no progress was made as to the legal nature of the post-Kyoto agreement or the scale of emission reductions. The European Union announcement of a 20 % reduction in its member-state emissions from now until 2020[43] received mixed reactions from Southern countries, because the IPCC felt that the reduction should be between 25 to 40 %. The planning for 2009 negotiations was refined without any major modifications. A project agreement summarizing the proposals should be provided by the presidency for the 30th SBSTA.

Brazil and Mexico have announced national climate plans, while India and China are firmly rejecting any attempt to reduce emissions. Southern countries have obtained direct access to the adaptation fund, but conversely, Northern countries have not, for now, expanded the financial resources of the fund which still come solely from the collection of 2 % from the CDM, without any similar agreement with regard to other flexibility mechanisms.

More positive confirmations were made than new advances concerning the mechanisms or the expansion of existing mechanisms, including those directly relevant to forests. However, studies are urgently required to simulate how these innovations may impact the sustainability of the whole system. However, Brazil is still against including non-anthropogenic forest carbon in the accounting system for preparing inventories, because it fears that a huge influx of forest carbon units would reduce prices and harm future sectoral investments. However, Brazil is now accepting that national inventories be open to independent and external reviewed which it previously refused.

Basically, while waiting for the new American administration to take office, each Party prepares for the crucial negotiations of 2009, without revealing its strategy.

Photo 11.8: Clearing vegetation using fire is common before planting.

Photo 11.9: Shifting cultivation along the edge of the forest.

[43] However, the EU indicates that if other partners (USA but also emerging countries) made similar commitments, the EU reduction rate would increase to 30 %.

Conclusion

Congo Basin countries, gathered in COMIFAC, are aware that the size and quality of their forests represent a huge responsibility both vis-à-vis their own people and the whole planet. The future of this forest is not limited solely to carbon sequestration or environmental services that are essential to the future of the planet; in addition, the human and economic dimensions of this area are inescapable. Under these circumstances, Congo Basin countries consider that REDD and its ramifications represent an essential, structural and cross-cutting, approach in their development strategies.

Achieving these goals involves coordinating all initiatives in Congo Basin countries to make the whole process consistent. To this end, the Ministers of Environment and Forests of COMIFAC countries met in Bangui in September 2008, calling to mind the fact that "only a sub-regional collaborative and coordinated approach by Central African governments with the support of bilateral partners can integrate sub-regional interests into post-Kyoto climate negotiations." To determine a range of development scenarios based on the causes and extent of deforestation and forest degradation requires a preparatory phase for Central African countries. But all current and future initiatives should be integrated into the common work program prepared by Congo Basin countries.

In the "pre-economic crisis" world, Northern institutional partners strongly supported "structural readjustment" to allow the unrestricted development of the liberal economic model, a model that supposedly would address all mutations and accidents.

The financial market crisis has shown the weaknesses of self-regulation of this system, even in countries where the rule of law is beyond dispute. On another level, a major weakness of the liberal economic model is the mismatch between market globalization and its logic of sustained growth, as well as safeguarding the ability of the planet to sustainably provide environmental services while ensuring the renewal of natural resources. Since the causes and consequences of the financial and economic crisis are tackled on such a voluntary and massive scale, the same should happen for the environmental imbalance.

Given that Northern and emerging countries have exploited natural resources without restraint for their economic revolution and given that these rights are now heavily regulated, a new development model should be designed. In a liberal, even if regulated, system, natural ecosystems can be saved permanently only if the environmental services (public goods) they provide are financially developed to rival local or national benefits obtained from agricultural or agro-industrial speculation that would occur instead. REDD and other CDM-type mechanisms that take into account the impact of sustainable management (through production or conservation concessions/management units/land use planning) will help increase the value of standing timber. But a fund is also required (outside the post-Kyoto 2012 "carbon" markets) to stabilize forest cover in order to finance investments from the state and from communities in and outside the forestry sector.

This fund should be separate from the climate change adaptation fund and could be financed through "carbon" taxes levied by Northern countries on their borders to penalize products with carbon footprints not meeting recognized United Nations standards. Thus, carbon markets and carbon taxes become complementary levers to combat climate change while contributing to "cleaner" development in Southern countries, whether in humid or dry regions. For democracies in developed countries, environmental concerns only made their imprint on the democratic way of life once their peoples stopped worrying about tomorrow and started thinking about the day after tomorrow. However, in Congo Basin countries, most people survive on a day-to-day basis. In this context, no democratic governance can sustain environmental conservation measures without providing clear alternatives that benefit people. Moreover, although a decentralized local democracy may benefit from transferring its natural resources management to the municipal level, this would only worsen local or ethnic rivalries if there was not also strong central governance to promote solidarity.

Many people in Central Africa in both urban and rural areas depend directly or indirectly on forest resources, and all village communities in rural zones and forested areas are concerned with the development of a REDD mechanism.

Further, all links in the development and good governance chain should be consolidated simultaneously to face multiple and contradictory solicitations, from Northern countries influenced by a greater environmental awareness to emerging Southern countries mobilized in the search for raw materials and new markets.

CHAPTER 12
A First Look at Carbon Stocks and their Variation in Congo Basin Forests

Robert Nasi, Philippe Mayaux, Didier Devers, Nicolas Bayol, Richard Eba'a Atyi, Antoine Mugnier, Bernard Cassagne, Alain Billand and Denis Sonwa

Introduction

The Kyoto Protocol allows for only afforestation and reforestation under its Clean Development Mechanism (CDM). The rules and modalities established under the Marrakech Accords allow developing countries to sell CDM certified emission reduction to developed countries up to a limit of 230 millions metric tons of carbon dioxide (CO_2) during the period 2008-2012 (about 45 million metric tons of CO_2 per year on average). At the same time the Intergovernmental Panel on Climate Change (IPCC) estimates that 1.7 billion metric tons of CO_2 are released annually to the atmosphere because of land use change and largely from tropical deforestation, dwarfing the possible impact of possible forest CDM projects. The magnitude of the emissions from deforestation not included in the Kyoto Protocol triggered the Conference of Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC) to initiate a two-year process to address issues relating to reducing emissions from deforestation in developing countries. This process peaked during the COP13 in Bali in December 2007 with the Decision 2/CP.13 "Reducing emissions from deforestation in developing countries: approaches to stimulate action." It is interesting to note that it took more than 10 years for the international community to accept that reducing emissions from deforestation or sequestering carbon from standing forests is more effective than through planting trees and reintroduce this topic to the international climate negotiations. It will probably take another five years to have the rules and modalities in place but some countries and donors are eager to get an early start.

Put simply, without entering the innumerable arguments ongoing about baselines or financial mechanisms, the idea behind the concept of reduced emissions from deforestation and forest degradation (REDD) is to provide financial incentives to help developing countries voluntarily reduce national deforestation rates and associated carbon emissions below a baseline. Countries that demonstrate such reduced emissions would be able to sell carbon credits on the international carbon market or receive financial compensation in one way or another for their good behavior.

No matter which final REDD mechanism is chosen, we will need to know as accurately as possible how much carbon (C) is:

- stored in different standing vegetation types (especially forests) and soils;
- released through AFOLU (agriculture, forestry and other land use) activities.

In this chapter we will try to bring the best possible answers to these two questions without entering into much scientific complexity, but at the same time avoiding oversimplification. We will start with some definitions and explanation of terms. To determine the existing C stocks by vegetation type we will present the respective area and C content per hectare of each vegetation type. Then to have an estimation of past and present human activities, we will give estimates of deforestation and degradation linked to agriculture, forestry (logging) and other land uses. We will briefly expose the state of knowledge about C fluxes through ecological processes and what we can reasonably deduce for Congo Basin forests. Finally we will conclude with a note of caution describing the uncertainties in the estimations presented in this chapter.

Definitions[44]

Forest lands include all land with woody vegetation consistent with thresholds used to define forest land in the national greenhouse gas inventory. They also include vegetation types that, *in situ,* could potentially reach the threshold values used by a country to define the forest land category (like regenerating stands).

For the purpose of the Kyoto Protocol, Parties should select a single value of crown cover, tree height and area to define forests within their national boundaries. Selection must be made using the following ranges:

- minimum forest area: 0.05 to 1 ha matching the two following criteria;
- potential to reach a minimum height at maturity *in situ* of 2 to 5 m;
- minimum tree crown cover (or equivalent stocking level): 10 to 30 %.

At the time of writing the only published nationally selected minima for Congo Basin countries are the ones for the DRC, which are: minimum forest area 1 ha, minimum height at maturity 5 m and minimum tree crown cover 30 %. These values however were only agreed upon for the purpose of the Kyoto Protocol and CDM and might be revised for a future REDD mechanism.

Deforestation is the long-term or permanent conversion of forest land to other non-forest uses. The UNFCCC (Decision 11/CP.7) defines it as: "...the direct, human-induced conversion of forested land to non-forested land." Deforestation is therefore a reduction in crown cover below the nationally defined threshold (e.g., for DRC deforestation would not be recorded until the crown cover was reduced below 30 %). If forest cover passes below the threshold only temporarily due to say logging, and is expected to grow again above the threshold, then this is not considered deforestation. Based on AFOLU land use classes, there is deforestation when "forest lands are converted to crop lands, grass lands, settlements, wetlands or other lands".

Degradation is defined as a loss of carbon stocks in forests impacted by human activities but still remaining forests according to the three criteria defined above. There is no accepted quantitative definition of the term, which can seriously complicate monitoring of how much is emitted by "degrading" forests or could be kept sequestered by reducing degradations. To develop a monitoring system for degradation, it is first necessary that the major causes of degradation (extractive industries, agriculture…) are identified and the likely impact on the carbon stocks assessed. Furthermore, degradation by fire, through fuelwood harvesting or because of invasive species, all also important causes of degradation, is likely to be more complicated to monitor with remote sensing. In AFOLU terms a decrease in carbon stocks of "forest lands remaining forest lands" will be equated to degradation.

In the "climate" negotiations and for REDD purposes, deforestation and degradation are only considered in terms of carbon stocks, without proper attention to biodiversity and other forest functions. Knowledge on forest ecology (Dupuy, 1998; Zobi, 2002; Gourlet-Fleury *et al.,* 2004) shows that significantly reducing the stand basal area of a dense rainforest (e.g., from 30 m^2/ha to below 20 m^2/ha) can induce a profound change in the forest dynamics and jeopardize recovery both in term of diversity and biomass. Such a change in basal area can happen before the crown cover is reduced below 30 %. This implies that land use practices, not technically considered as immediate deforestation (leaving 30 % of crown cover), may cause straightforward deforestation in the short term. Similarly, repeated entry into the stand, accompanied by selective logging of shade intolerant timber trees, will greatly reduce forest basal area and can sequentially eliminate timber species from the forest while keeping the overall cover above the 30 % threshold, resulting in a degraded forest where no future crop trees exist.

The IPCC Guidelines refer to two **basic inputs to calculate greenhouse gas inventories**.

- "Activity data" in the case of deforestation and forest degradation refers to area change data (e.g., the area of forest land converted to other land use).
- "Emission factors" refer to emissions/removals of greenhouse gases per unit area (e.g., metric tons of CO_2 emitted per hectare of deforestation).

Among the three possible approaches (see table below) for representing the change in area of different land categories it is likely that only the third Approach, which involves tracking of land conversion between categories using spatially-explicit land conversion information, can be used for REDD implementation.

[44] Definitions used in this chapter are extracted from the GOFC-GOLD Sourcebook (GOFC-GOLD, 2008).

Photo 12.1: Light availability in the forest is often a limiting factor for the growth of seedlings.

Approach for activity data: area change
1. total area for each land use category, but no information on conversion (only net changes)
2. tracking of conversion between land use categories
3. spatially explicit tracking of land use conversion

Emission factors are derived from assessments of the changes in carbon stocks. This information can be obtained at different "Tier" levels (see table below) independently of the "Approach" selected. Tier 1 uses IPCC default values, Tier 2 requires some country-specific estimates (i.e. inventories, permanent plots) while Tier 3 requires inventory-type data of carbon stocks in different pools and assessment of any change through repeated measurements or modeling. Accuracy, complexity and cost of monitoring increase from Tier 1 to Tier 3.

Tiers for emission factors: change in C stocks
1. IPCC default factors
2. Country specific data for key factors
3. Detailed national inventory of key C stocks, repeated measurements of key stocks through time or modeling

Estimation of Land Use and Land Cover Change

Vegetation and Land Cover Types

In the IPCC "Forest" category, different ecological types correspond to different carbon stocks. In order to provide the most accurate figures of carbon stock and change for Central Africa, we will detail the areas and the carbon associated with the main forest types using the GLC2000 map[45]. For each GLC2000 class, we analyzed the tree cover (from MODIS data) and the floristic domain (White, 1983). Results are summarized in table 12.1 and are given with the "ecological" equivalents of land cover classes.

Table 12.1: Major landcover classes and equivalent vegetation types in the Congo Basin

Land cover class derived from low resolution satellite imagery (% tree cover)	Equivalent vegetation types and ecology	Floristic domain
Dense humid forests		
Swamp and riparian forests (>70 %)	Evergreen inundated forests, fresh water swamps characterized by *Uapaca, Guibourtia, Hallea, Raphia*	Gu-Co
Closed evergreen lowland forests (>70 %)	Evergreen and semi-deciduous forests below 900 m a.s.l.; high floristic diversity	Gu-Co
Sub-montane forests (>70 %)	Transition forests between lowland and true montane forests (900 and 1500 m a.s.l.)	AfMo
Montane forests (>70 % - variable)	Evergreen montane forests (1500-2400 m a.s.l.) and alpine vegetation (>2400 m a.s.l.) characterized by *Alangium, Linoceira, Olea, Prunus*	AfMo
Mangroves (10-60 %)	Coastal evergreen forests on marine alluvium, brackish waters; little tree species diversity, dominated by *Rhizophora, Avicennia, Brugueria*	Azonal
Closed deciduous forest (>40 %)	Open forests, wet Miombo characterized by *Brachystegia* (Zam), *Julbernardia* (Zam) and *Isoberlinia* (Zam/Sud)	Zam/Sud
Mosaic forest/croplands (20-60 %)	Correspond quite closely to shifting cultivation areas (mix of crop lands, fallows, plantations, young secondary forests) located around transportation axes and human settlements; tree layer is often dominated by pioneer species (*Musanga*, *Macaranga*)	Gu-Co
Mosaic forest/savanna (30-60 %)	Humid savannas and gallery-forests; the savannas correspond to the "derived savannas" (*sensu* Keay, 1959) or Guinean savannas; they constitute fire climax savannas; the palm *Borassus aethiopium* is often common; the forests are similar to closed evergreen forest class	Gu-Co
Deciduous woodland (10-40 %)	Woodland, dry Miombo characterized by a perennial grass cover and open tree layer; Combretaceae and Leguminosae families are very common	Zam/Sud
Shrubland and grassland (<10 %)	Herbaceous dominated vegetation with scattered treelets, included in the dense forest mass. Grasslands correspond to the Plateau Batéké and Adamaoua regions; shrublands are found in the Niari-Nyanga-Ngounié region (Gabon-Congo) and in DRC	Zam/Sud

Gu-Co: Guineo-Congolian; AfMo: Afromontane; Zam: Zambezian; Sud: Sudanian. Modified from Mayaux et al., 2004

The two principal land uses in the Congo Basin sub-region are logging concessions (595,380 km^2) and protected areas (444,970 km^2). The third largest land use, shifting cultivation, is not easily detected using low resolution satellite imagery, but could be estimated as a first approximation at 438,801 km^2 (sum of the two land cover classes Croplands (embedded in "other") and Mosaic forest/croplands of table 12.2).[46]

[45] A full description of the land use/land cover types described in this chapter is available in Mayaux *et al.*, 2004.

[46] That number is probably an underestimation as some cultivated areas are located inside logging concessions or protected areas and have not been included in the figure listed here.

Table 12.2: Area estimates by land cover classes and allocation (protection, logging) in 2006

Land cover class (LCC)	Total area (km²)	% sub-region	Protected area (km²)	% land cover class protected	Area allocated for logging (km²)	% land cover class allocated for logging
Closed evergreen lowland forest	1,421,834	35	187,880	13	481,680	34
Sub-montane forest (900-1,500 m)	63,100	2	23,290	37	1,530	2
Montane forest (>1,500 m)	9,754	0.2	7,870	81	20	0
Swamp forest	123,264	3	10,280	8	28,570	23
Mangrove	1,926	0	240	12	20	1
Total humid forests	**1,619,879**	**40**	**229,580**	**14**	**511,830**	**32**
Mosaic forest/croplands	370,123	9	13,000	4	45,860	12
Mosaic forest/savanna	588,011	15	49,870	8	16,280	3
Closed deciduous forest	304,808	8	16,220	5	4,720	2
Deciduous woodland	630,890	16	64,350	10	1,680	0
Open deciduous shrubland, sparse trees	301,220	7	46,070	15	10,780	4
Other	233,540	6	25,910	11	4,220	2
Sub-region total (Congo Basin)	**4,048,470**	**100**	**444,970**	**11**	**595,380**	**15**

Source: GLC 2000, FORAF.

Photo 12.2: The canopy is a complex structure of various species.

While forest areas are derived from coarse resolution satellite images with high observation frequency, changes in area are better measured by the analysis of fine spatial resolution satellite images taken at two dates. Two recent studies (Duveiller *et al.*, 2008; Hansen *et al.*, 2008a), based on different methods, have produced reliable and consistent estimates on the deforestation in the humid domain between 1990 and 2005.

Table 12.3[47]: Basin-wide and national figures for annual deforestation (humid forests) and degradation rates between 1990 and 2000

Country	Net deforestation (%)	Net Degradation (%)
Cameroon	0.14	0.02
Gabon	0.09	0.07
Congo	0.02	0.01
CAR	0.06	0.02
DRC	0.20	0.12
Central Africa	**0.16**	**0.09**

Source: figures adapted from Duveiller et al., 2008 and Hansen et al., 2008a.

For the 1990-2000 period the annual gross deforestation rate for Central Africa's tropical forest is estimated at 0.21 % per year, with an annual reforestation rate corresponding to 0.05 % and net degradation rate estimated at 0.09 %. The net deforestation rate for the 10-year period is therefore 1.6 %, which means that the humid forests of the Congo Basin lost about 29,000 km^2 from 1990 to 2000. National estimates are also provided in table 12.3, with less reliable figures for Cameroon and Gabon given the paucity of available data due to quasi-permanent cloud coverage over these two countries.

The first estimates of forest change between 2000 and 2005 are derived from a combination of multi-temporal and multi-resolution satellite data (Hansen *et al.*, 2008b). The authors report a forest loss rate of 0.76 % for 5 years (0.15 %/yr), which is very close to the 0.16 %/yr reported for 1990-2000 and represents an area of about 14,000 km^2.

In summary, from 1990 to 2005, around 43,000 km^2 of humid forests have been deforested in the Congo Basin.

These observed forest-cover change rates are by far the lowest of the pan-tropical belt, with a net deforestation rate two times higher in South America and four times higher in South-east Asia. It is important to note however that deforestation is not a uniform process. Some areas (figure 12.1) show a dramatic increase of deforestation due to agricultural encroachments, particularly in regions affected by human conflicts (e.g., Kivu) and at the fringes of the Basin (Northern Equateur, Kasaï), whereas others remain almost untouched.

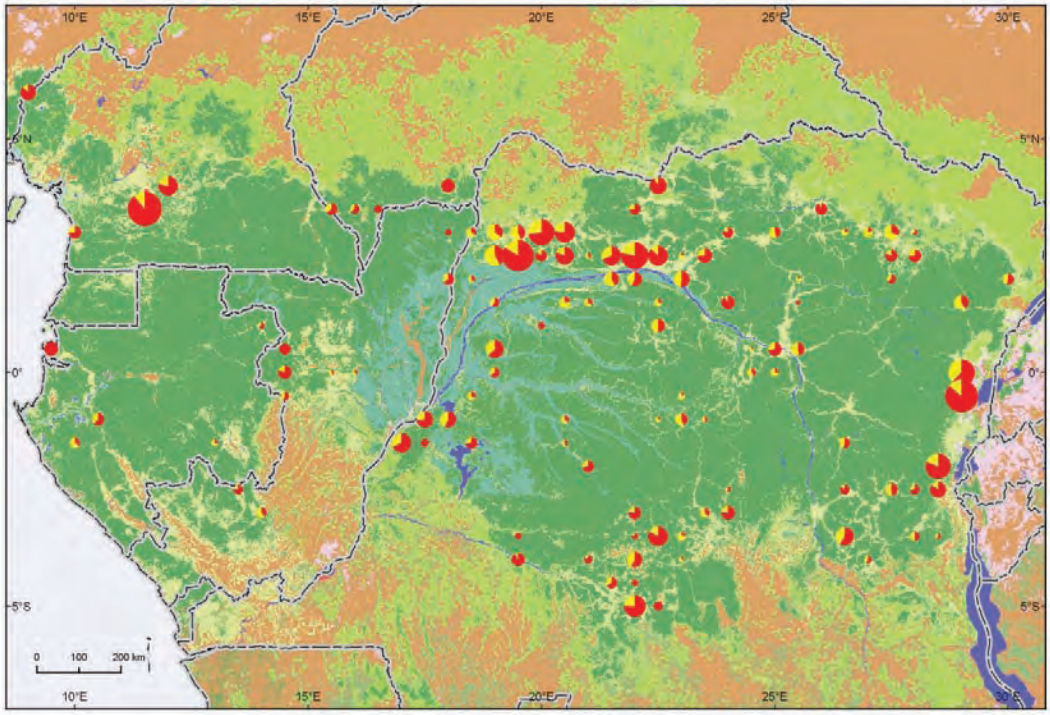
[47] Three land use classes are considered in the Duveiller *et al.*, study: dense forest, degraded forest and non-forest. The class "degraded forest" is composed of dense forest perforated by mid-size (2-5 ha) clearings or crop fields, while the GLC2000 mosaic forest-croplands class belongs to the non-forest class. The degradation produced by selective logging cannot be detected by satellite imagery at the 30-m spatial resolution currently used in regional studies of forest-cover change, and current degradation figures do not account for this.

Estimation of Carbon Stocks

The estimation of C stocked in forest ecosystems requires estimates of the following C pools:

- aboveground (AG): trees, lianas, understory vegetation, litter and dead wood;
- belowground (BG): roots and soil carbon.

Carbon stocked in woody plants (C_w) is linked to the biomass (B_w) expressed in dry matter by unit of area Mg/ha or t/ha). It is estimated by a simple relation: $C_w = k.B_w$ with $k \approx 0.47$. Estimating carbon stock or biomass is therefore equivalent.



Each circle represents a 10 x 10 km sample. The size is proportional to the total area affected by deforestation and degradation, while the two colors provide information on the relative importance of the two processes.
Source: Duveiller et al., 2008.

Figure 12.1: Spatial distribution of deforestation (red) and forest degradation (yellow) in the humid forests of the Congo Basin

Aboveground Carbon Pools

To estimate the aboveground biomass (AGB) of a given forest stand, one needs first a biomass equation (allometric relation between the biomass of the vegetation –with or without the roots - and some easily measured parameters like diameter at breast height or total height). Such an allometry is built using destructive methods: an area or a sample of individuals is measured then clear-cut and all the components (stumps, stems, branches, leaves, logs…) are oven-dried and weighed; the resulting data is then used to build a biomass equation model: AGB = f(diameter, height, wood density) for the given tree of the stand. This is the most precise solution if the sample is adequate but this method is very time-consuming and labor intensive. It should be noted that this allometry is only valid for the location where it was designed and for a given range of diameter or height. The only local aboveground biomass (AGB) equation for the Congo Basin seems to be the one developed by Ibrahima *et al.*, (2002) for an evergreen forest based on 93 trees spanning 1 to 79 cm in diameter at breast height (D) but with only one tree over 50 cm.

Global biomass models based on extensive samples spanning several topical regions (Brown *et al.*, 1989; Brown, 1997; Chave *et al.,* 2005) have also been developed. The best available global models (Chave *et al.*, 2005) so far are based on 27 sites and 2,410 trees (none from African forests) using diameter and specific wood density (ρ):

- 1500-3500 mm annual rainfall, 1-4 months dry season:

$$AGB_{trees} = \rho e\ (-1.499+2.148\ ln(D)+0.207(ln(D))^2-0.0281(ln(D))^3$$

- >3500 mm, no seasonality:

$$AGB_{trees} = \rho e\ (-1.239+1.980\ ln(D)+0.207(ln(D))^2-0.0281(ln(D))^3$$

AGB_{trees} *in kg; D in cm;* ρ *in g/cm*^{3}

The other aboveground carbon pools have received less attention because in tropical forests it is generally estimated that trees above 10 cm diameter represent more than 75 % of the biomass.

The available biomass equations are then applied to census data (from permanent sample plots or using data from forest inventories) to es-

timate the biomass of a stand or a forest type. A review of the existing literature on plot-based biomass estimates using equations and/or destructive sampling is summarized in annex 1 and from inventory-based estimates in annex 2. Some authors (annex 3) have used GIS modeling techniques to extrapolate stand values of biomass to entire regions or entire biomes and to build biomass maps using reasonable but largely unchecked assumptions. The most recent of these biome-wide estimates provides carbon stocks for the whole of Sub-Saharan Africa (Gibbs and Brown, 2007) accounting for anthropogenic disturbances and using a rule-based GIS analysis to spatially extrapolated forest inventory data.

From the overall literature review and using the best available data both from plot, inventory and GIS approaches (annexes 1, 2 and 3), we obtain the following C stock estimates by land cover classes (table 12.4) using 0.47 as the 'biomass to carbon' conversion factor.[48]

Photo 12.3: Forest measurements and inventories are essential for the quantification of forest carbon.

Table 12.4: Aboveground carbon (Mg/ha) in vegetation by land cover classes

Land cover classes	Aboveground carbon		
	Plot-based (annex 1)	**Inventory-based (annex 2)**	**GIS-based (annex 3)**
Deciduous woodland	**21** (2-43; 20)	-	-
Closed deciduous forest	**42** (22-68; 6)	-	36
Closed evergreen lowland forest	216 (146-275;15)	**126** (63-174;55)	178 - 211
Swamp forest	-	**85** (-; 1)	-
Sub-montane forest	-	-	**68**
Montane (moist) forest	-	-	**68**
Mosaic forest – cropland	**54** (3-141;29)	-	-
Mosaic forest – savanna	**14** (4-22;2)	-	-

Values in table: average (range; number of observations).
Sources: see annexes 7,8 and 9.

[48] All figures have to be taken with all the caveats and possible sources of errors listed in the section "A note of caution…" at the end of this chapter.

In the case of inventory-based estimates, an observation is a group of inventory plots located in the same forest strata. The total number of inventory plots is bigger than the given figures.

For closed evergreen lowland forest, inventory-based figures are slightly lower than FAO estimations (2006), FAO gives an average of 155 tC/ha (from 30-35 cm dbh, depending on the countries). These differences may be explained by:

- Different sample representativity at the sub-regional scale: for example, the opened forests of DRC and northern Congo are overrepresented in the inventory-based estimations.
- Uncertainities linked to some of the assumptions made in the calculations.

Bold values indicate values selected for the present document (even though C stocks estimated from inventories appear lower than from plot-based or GIS estimates, we believe that they are a better estimate of the reality because they are based on much larger samples).

Belowground Carbon Pools

Belowground biomass (BGB) consists in roots. It is considered the most difficult pool to assess and the very few data available in the literature for Central Africa (see Annex 1) have to be used with extreme caution as they come from limited, small size, samples. For this reason using a root/shoot ratio (R/S) has become a core method for estimating root biomass from the more easily measured shoot biomass: BGB= AGB * R/S

Mokany *et al.*, (2006) provide a very useful critical review of the literature on root/shoot (R/S) ratios and derived values for various vegetation types (table 12.5) recommended in IPCC (2006). No data are available for Africa and all the samples used in this table have been measured in other regions.

Photo 12.4: The transportation of logs can be disrupted by the poor quality of the road network.

Table 12.5: Root/shoot ratio values

Vegetation type	Shoot biomass(t/ha)	R/S median	Min.	Max.	Sample size
Tropical moist forest	<125	0.205	0.092	0.253	4
	>125	0.235	0.220	0.327	10
Tropical dry forest	<20	0.563	0.281	0.684	4
	>20	0.275	0.271	0.278	2
Tropical moist woodland		0.420	0.292	0.548	7
Tropical dry woodland		0.322	0.259	0.710	6
Tropical grassland		1.887	0.380	4.917	15

Modified from Mokany et al., 2006.

For the "average" tropical forest (with a tree biomass generally higher than 125 t/ha), it is estimated that the roots represent 23.5 % of the aboveground biomass. This value however increases for more arid ecosystems and the roots represent 42 % of the aboveground biomass of woodlands. It is important to note that these values are derived from a very limited number of cases (e.g.,14 for tropical moist forests and 6 for tropical dry forests) and that they need, consequently, to be treated and used with caution.

The other pool of belowground carbon is found in soils. Soil organic carbon (SOC) plays an important role in the ecology of terrestrial ecosystems through the moderation of cation exchange capacity (CEC)[49], water holding capacity, soil structure, resistance against erosion, etc. The assessment of SOC and its dynamic is the subject of many studies, largely out of the scope of this paper. Lal (2005) considers that all other soil parameters being equal, SOC is similar in tropical and temperate soils but that tropical SOC is subject to faster rates of decomposition. Some local estimates of SOC (annex 4) exist for Central Africa[50], or for similar ecosystems in West Africa, but are subject to the same caveats as root carbon estimates. Based on annex 9 and additional literature datasets we obtain the SOC values (tC/ha) summarized in table 12.6. From this table it appears that there are no significant differences between the various land use types, which means that we can use the overall weighted average (38 tC/ha) as a first approximation for the sub-region.

Table 12.6: Soil organic carbon (SOC) in metric tons/ha

Land use	Avg	StD	Median	Min.	Max.	N	Sources
Dry miombo fallow	45	14	45	20	74	28	Williams *et al.*, 2008
Chromolaena fallow	39	14	37	21	58	6	Palm *et al.*, 2000
Cocoa agroforest	42	8	41	33	53	6	Palm *et al.*, 2000; Sonwa, 2004
Humid forest crop	35	15	38	18	56	5	Palm *et al.*, 2000
Forest	52	14	49	37	75	7	Palm *et al.*, 2000; Jaffré *et al.*, 1983
Humid forest fallow	53	20	47	30	89	18	Palm *et al.*, 2000; Jaffré *et al.*, 1983
Wet miombo	83	23	NA	NA	NA	5	Walker and Desanker, 2004
Wet miombo fallow	52	17	NA	NA	NA	6	Walker and Desanker, 2004
Wet miombo crop	49	11	NA	NA	NA	11	Walker and Desanker, 2004
Dry miombo	NA	NA	58	18	140	28	Williams *et al.*, 2008
Overall weighted average	38			18	140	120	

Avg: average; StD: standard deviation; N: number of observations

An Estimate of the Carbon Stored in Congo Basin Ecosystems

Based on the abovementioned data on land cover classes and carbon stocks, table 12.7a gives an estimate of 46 billion metric tons for the C stored in the Congo Basin. Closed evergreen lowland forests represent 60 % of the carbon stored in the sub-region, while only covering 35 % of the area.

Table 12.7b gives the estimation at country level and compares our estimates with some published values from the literature.

[49] In soil science, cation exchange capacity is used as a measure of fertility, nutrient retention capacity and the capacity to protect groundwater from cation contamination (Wikipedia).

[50] An interesting new development is the use of SOTER (Batjes, 2008) to map the soil carbon stocks of Burundi, Rwanda and the Democratic Republic of Congo.

Table 12.7a: Total carbon stock estimates for the Congo Basin

Land cover classes (LCC)	Area (km²)	Carbon pools (t/ha)				Total C
		AG C	R/S	SOC	C	(million metric tons)
1. Closed evergreen lowland forests	1,421,834	125	0.235	38	192	27,299
2. Swamp forests	123,264	85	0.235	38	143	1,761
3. Sub-montane forests (900-1,500 m)	63,100	68	0.235	38	122	770
4. Montane forests (>1,500 m)	9,754	68	0.235	38	122	119
Dense humid forests (1-4)	**1,617,952**	**147**			**185**	**29,949**
Closed deciduous forests	304,808	42	0.275	38	92	2,791
Mosaic forest/croplands	370,123	54	0.275	38	107	3,955
Mosaic forest/savannas	588,011	14	0.42	38	58	3,403
Deciduous woodland	630,890	21	0.322	38	66	4,149
Grassland, shrub land, sparse trees		5	0.42	38	45	1,770
Congo Basin sub-region	4,048,470					46,016

AG C: aboveground carbon; SOC: soil organic carbon: R/S: root/shoot ratio

Table 12.7b: Total carbon stock (million metric tons) estimates for the Congo Basin by country

	Cameroon	Congo	Gabon	Eq. Guinea	CAR	DRC
1. Closed evergreen lowland forests	3,162	2,762	4,029	379	886	16,082
2. Swamp forests	0	501	2	0	0	1,000
3. Sub-montane forests (900-1,500 m)	39	0	2	4	0	857
4. Montane forests (>1,500 m)	2	0	0	0	0	117
Total humid forests (1-4)	**3,203**	**3,263**	**4,033**	**383**	**886**	**18,056**
Mosaic forest/croplands	414	534	287	57	167	1,945
Mosaic forest/savanna	628	145	20	3	2,437	3,059
Closed deciduous forest	6	73	10	0	54	1,625
Deciduous woodland	684	6	2	1	1,658	1,812
Open deciduous shrubland, sparse trees	108	199	31	0	258	760
Total per country (this chapter)	**5,043**	**4,219**	**4,383**	**445**	**5,460**	**27,258**
Total per country (Gaston *et al.*, 1998)	**3,131**	**2,822**	**3,892**	**349**	**3,740**	**16,316**
Total per country (Gibbs *et al.*, 2007)	**3,454-6,138**	**3,458-5,472**	**3,063-4,742**	**268-474**	**3,176-7,405**	**20,416-36,672**

Emissions from Deforestation and Degradation

A First Estimate for the Basin

Based on the estimation of deforestation between 1990 and 2005 (about 43,000 km^2) and on the average C stock of dense humid forests derived from table 12.7a (147 tC/ha without considering the fate of the SOC), we can estimate that the region has released approximately 0.63 billion metric tons of C in 15 years.

This is of course a crude estimate that does not take into account the exact life cycle of wood carbon.

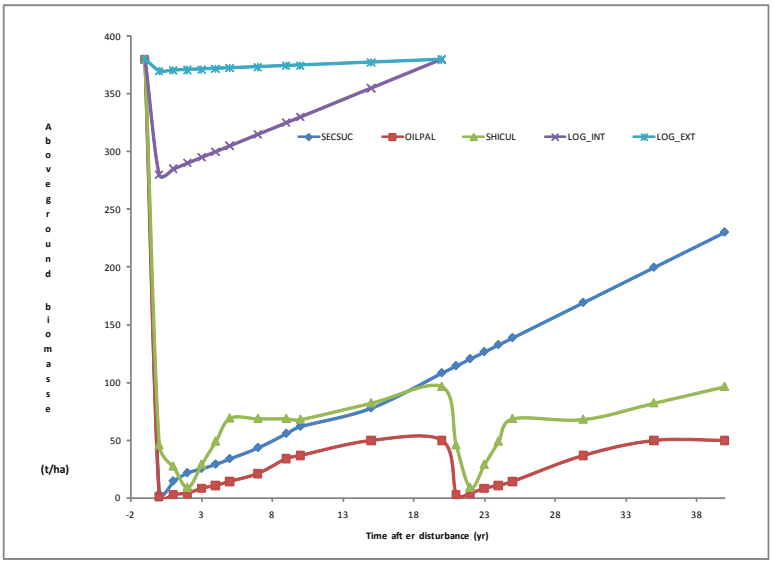
Some Specific AFOLU Examples

No matter which REDD mechanism is adopted we will need to be able to assess carbon changes linked to specific AFOLU classes. This is still largely impossible in the Congo Basin due to the lack of comprehensive studies on the effects of land use changes on carbon stock pools. Some preliminary and pioneer studies, however, do exist that provide us an idea of the relative magnitude of the primary potential cases. Using published (Jaffré *et al.,* 1983; Palm *et al.,* 2000; Ibrahima *et al.,* 2002; Kanmegne, 2004; Brown *et al.,* n.d.) and unpublished data (Gourlet-Fleury) we have been able to plot variations of C from aboveground living biomass pools for five land use systems:

- LOG_EXT: high-grade selective logging (one species, *Entandrophragma cylindricum*, constituting 95 % of the logged individuals) in a semi-deciduous rainforest managed with a 30-year rotation.
- LOG_INT: intensive selective logging in a large-scale permanent sample plot, same forest type as in LOG_EXT but with a higher logging intensity.
- SECSUC: secondary succession in an area that was slashed and burned to plant dry rice, abandoned and reverted to 40-year old secondary forest (South of Ivory Coast).
- OILPAL: oil palm plantation (130 plants/ha), with re-planting every 20 years.
- SHICUL: complete 20-year shifting cultivation cycle in Southern Cameroon (slash-and-burn; *Cucumeropsis melo* – plantain field; pure plantain field; short *Chromolaena odorata fallow*; mixed crop field, groundnut – cassava; long fallo*w).*

Figure 12.2 clearly shows that except for selective logging and secondary succession after 20 years, the overall aboveground living biomass following disturbance remains below 100 Mg/ha. This does not take into account the dead wood and litter carbon pools but these are small (except for the *Cucumeropsis melo* field where many unburned logs remain on the forest floor) and come essentially from the aboveground tree C pools. Oil palm plantations and shifting cultivation, unless abandoned and left to revert to forest, represent a loss of about 70-90 % of the original forest C stock.

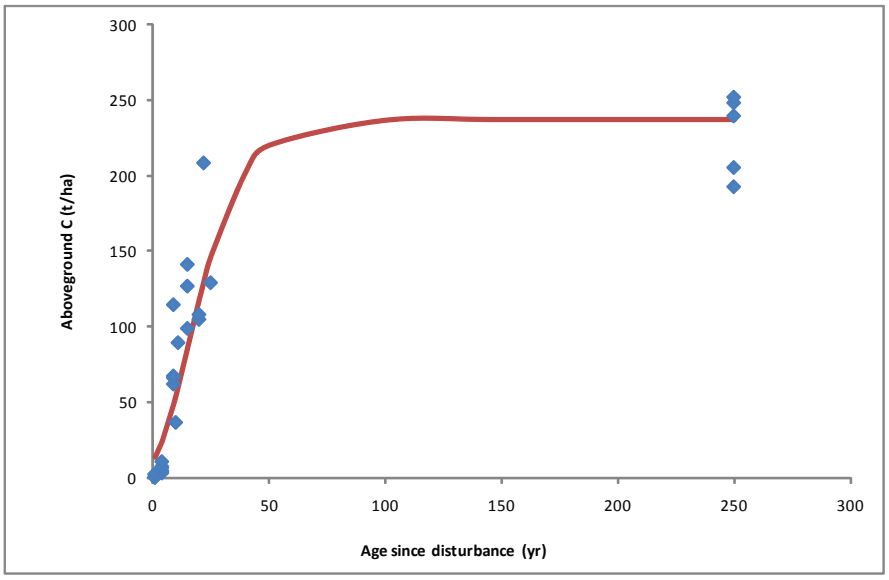
Photo 12.5: Sawn timber ready for export.



Sources: Jaffré et al., 1983, Palm et al., 2000; Ibrahima et al., 2002; Kanmegne, 2004; Brown et al., n.d.; Gourlet-Fleury, unpub. data.

Figure 12.2: Temporal evolution in aboveground living biomass of different land use systems

To better understand the time needed for these systems once abandoned to recover the original C stocks we used the dataset collected by the ASB (Alternatives to Slash-and-Burn) initiative in Cameroon (Palm *et al.*, 2000a) and fitted (r^2= 0.95) a Gompertz sigmoid (S-shaped) growth curve to the data (figure 12.3). The data shows that the original aboveground biomass could be recovered in less than 50 years after abandonment. The two logging examples show a full biomass recovery in about 20 years. This does not mean however that the C stock will have reconstituted to the same level, as some of the growth could be composed of fast growing light-demanding trees with lower specific densities or of smaller-size shade-tolerant species. It also does not imply that forest quality will have fully recovered after 30 years, as forest composition, structure and functioning will still be recovering after such a time period. Moreover, these two examples do not take into account the fact that in some places the forest is totally and permanently destroyed during the first logging operation (e.g., for permanent roads or camp infrastructure).



Source: Palm et al., 2000a.

Figure 12.3: Carbon accumulation curve (slash-and-burn clearing of intact forest)

These examples demonstrate the magnitude of C-pool variations to be expected for the most frequently encountered land use systems in the Congo Basin region. Agriculture, traditional or modern, seems to be by far the biggest potential emitter of C as opposed to selective logging as practiced in the region.

These limited datasets are not only the only ones available for the sub-region but they are also not the most pertinent as they are not concerned with the main zones where carbon fluxes are likely to occur (e.g., forest margins). If the region is to embark seriously in REDD, then there is a pressing need to carry out more studies of this type to enable the use of higher IPCC tiers and approaches for C stock accounting. Without this work, it will be impossible to know whether emissions are truly being reduced because of less deforestation and degradation or if it is simply a case of generating "hot air."

A Note of Caution: Data, Errors and Uncertainties

Now that we have shown the importance of the Congo Basin forests (and of other tropical forests) in the global C cycle, and their unique potential to offset some of the CO_2 released in the atmosphere by human activities, a word of caution is warranted regarding data errors and uncertainties; there is still an immense amount of work to be carried out to really accurately assess the C stored, sequestered and released annually by the Congo Basin forests.

Estimates of Biomass Based on Field Studies

Most of the estimates of C stocks in living vegetation are calculated on an unacceptably small area of permanent sample plots (probably less than 300 ha for the whole region) or calculated by allometric equations derived from an even smaller sample of destructive biomass studies and extrapolated to use extensive forest inventories, which were never designed to assess biomass but instead commercial volume. The stocks and exchanges in the soil both from roots or soil biology are even less well known.

Photo 12.6: Access to forests is facilitated with the creation of permanent trails.

The uncertainties in building a biomass equation from destructive sampling of trees and other vegetation components are:

- errors in the measurement of tree parameters (diameter, height, specific density) necessary to build the model;
- sampling uncertainty, related to the number and diameter range of measured trees;
- error due to the construction of the allometry.

To develop an allometric model to predict the biomass of a tree from other easily measured parameters like diameter or height, each species or group of species should have its own equation, based on a destructive study of a large sample size. This is still largely unrealistic for tropical forests. The existing allometric models for tropical trees are constructed from limited samples, applied beyond their valid diameter range and seldom include wood-specific gravity. They are also generally based on harvests from a single forest. We should add that none of the existing models, even the most recent ones, use data from African tropical forests.

The uncertainties in deriving biomass using a set of permanent sample plots are:

- error in the estimation of individual tree aboveground biomass because of measurement errors and construction of allometry;
- error due to the choice of allometric models to derive biomass from other parameters;
- sampling uncertainty, related to the size of the plot(s);
- landscape scale representativity of the plot(s).

The uncertainties in deriving biomass estimates from classical forest inventories are the same as those using permanent sample plots plus:

- sampling uncertainty, related to inventory design (intensity of sampling, size of the plots, *a priori*/*a posteriori* stratification…);
- error linked to the minimum diameter limit for the inventory (30 or 40 cm dbh in past inventories, now 10-20 cm dbh);
- errors linked to the use of expansion factors to convert volumes above the minimum diameter limit to volumes above 10 cm dbh, and to convert stand volume in biomass.

It is even more complicated to estimate the propagation of these errors from one stage of the biomass evaluation process to another and to the final result. One thing is sure, this is not a simple relation and it is likely that most errors are additive or multiplicative and that, even though some of these errors might be compensated without generating biases, the confidence interval of any biomass estimation is very likely to be disturbingly large. It is largely out of the scope of the present chapter to provide a detailed review of these errors and uncertainties. Instead we are simply providing a table that gives an idea of the relative scale of the possible errors based on existing literature (table 12.8).

Photo 12.7: The mobile saw "Mighty Might" is used to cut logs on site (Gabon).

Table 12.8: Some biases, errors and uncertainties in biomass estimation

	Source of error/uncertainty	Error (of mean, in %)	Parameter
Building a biomass equation	irregularly shaped and hollow trees		
	if dbh >50 cm	+30	BA stand
	if dbh <5 cm	+11	BA stand
	measure of trees (dbh, H, density)		
	if dbh >10 cm	±17	AGB tree
	if dbh <10 cm	±23	AGB tree
	sampling error (5, 100, 300 trees)	±10, 5, 3	AGB stand
	allometry error		
	if dbh >10 cm	±31	AGB tree
	if dbh <10 cm	±55	AGB tree
Estimating biomass using a set of permanent sample plots	tree-level AGB estimate		
	if dbh >10 cm	±47	AGB PSP
	if dbh <10 cm	±78	AGB PSP
	allometric model (with/without corrections)	±22 to 11	AGB PSP
	PSP size (0.1, 0.25, 1 ha)	±16, 10, 5	AGB PSP
	landscape representativity of set of PSP	±11	AGB landscape
Estimating biomass using an existing forest management inventory	minimum diameter limits for census		
	30 cm	-30	VOB FMU
	45 cm	-55	VOB FMU

PSP: permanent sample plot, BA: basal area, AGB: aboveground biomass, VOB: volume over bark, FMU: forest management unit

Source: modified from Chave et al., 2004; Feldpausch et al., 2006; Nogueira et al., 2006.

From the above table, the minimum adequate samples or values appear to be:

- 100 – 150 weighted trees spanning a wide diameter range to build a biomass equation;
- 0.25 ha individual plot area for dendrometric parameters estimates;
- 10 cm minimum diameter for censuses.

Estimates of Forest Biomass and Forested Areas Using Remote Sensing Technologies

The use of satellite data has undoubtedly increased the accuracy of forest maps and of forest-cover change estimates. However, some uncertainties remain in the current datasets and affect the overall accuracy of estimations of carbon stocks and fluxes. These uncertainties in estimating forest areas from maps derived from remote sensing are:

- errors due to the coarse spatial resolution (1 km) of forest-cover maps;
- approximations in the legend adapted to the spectral signature of vegetation types, which are not necessarily directly related to carbon content, and inconsistency in the forest land definition with the definitions used in the Kyoto protocol;
- uncertainties due to the lack of data in regions under nearly-permanent cloud coverage, such as the coastal part of Gabon, Cameroon and Equatorial Guinea.

New techniques and datasets have been used to reduce these errors but these techniques are still in the research domain. Regional forest maps are currently based on an accumulation of Landsat images (30-m spatial resolution), but the resulting forest typology is less detailed than the ones computed by using daily images. Radar sensors present the advantage of being independent of cloud coverage, but their sensitivity to the terrain at a meso-scale, to the soil and vegetation moisture conditions, to the roughness of the surface (canopy, soil), and to the structure of the leaves preclude their use for any reliable assessment of forest types and carbon stocks.

Forest cover changes occur at a very fine scale and requires the use of time-series of fine spatial resolution images. Two main information extraction techniques are available:

- the spectral difference between images on wall-to-wall datasets, which produces a simple deforestation map of the entire area;
- the delineation of many transition types based on image segmentation techniques on a sampling of sites, which produces a more complete change matrix but on a limited number of sites.

Both methods can be affected by several sources of errors:

- the lack of satellite images at the right year or the right season;
- the underestimation of subtle changes (degradation, forest recovery…) by purely spectral techniques;
- the sampling density that affects the precision and the confidence interval of the estimates.

Underestimation of subtle changes by spectral techniques is difficult to evaluate but sampling uncertainty has been already assessed in the Congo Basin. A minimum of 30 samples of 10x10 km is necessary for estimating the deforestation rate at a regional level (country, province), with an optimum of 50 samples. Increasing the sample size or of the number of samples can reduce this sampling uncertainty, as is the case for the OFAC estimates (20x20 km squares every half-degree (+/-55 km), with a sampling intensity of 16 %). For assessing the degradation area induced by selective logging, indirect techniques combining forest management documents and reports and the detection of logging roads could be applied, but with huge uncertainties.

The direct assessment from remote sensing of carbon stocks of dense humid forests currently suffers from major errors due to the absence of clear and understandable relationships between parameters influencing the carbon amount and the spectral and backscattering properties in the optical and radar domains. Although these relationships have been demonstrated in the savanna domain with low to medium biomass, the radar signal saturates at high biomass levels and the other parameters influencing the spectral properties of the vegetation (moisture, slope, leave structure…) lead to significant instability in carbon estimates. New techniques such as LIDAR can improve the quantification of carbon stock changes during logging operations, but there is still a need for more investigation before that technology may provide reliable figures.

Box 12.1: Are Congo Basin Mature Forests Absorbing or Releasing C?

About 8 billion metric tons of C are produced annually by human activity (6.3 from fossil-fuel emissions, 1.7 from land use changes - mainly deforestation in the tropics). Studies of the global C cycle show that about 3.2 billion metric tons remain in the atmosphere and 2.1 and 2.6 billion metric tons are sequestered by marine and terrestrial (forests) carbon sinks respectively. It was estimated that as much as 2.4 billion metric tons of this carbon was sequestered in boreal and temperate forests and marginally in tropical vegetation (Clark, 2004; Lewis *et al.*, 2005). However, in 2001, assessments of C exchanges in northern regions were only able to account for about 0.7 billion metric tons (Myneni *et al.*, 2001). There was therefore what was called a "missing sink" of about 1.9 billion metric tons sequestered in terrestrial ecosystems.

Two options are possible for the role of land use changes in the tropics in releasing C in the atmosphere:

- a large release of C through land use changes (especially deforestation and forest degradation) compensated by a large sink in undisturbed tropical vegetation;
- a smaller release through land use change with little or no sink in undisturbed vegetation.

The first option seems the most probable as sequestration of C by undisturbed tropical forests seems to be confirmed by the results of recent analyses of sets of permanent sample plots throughout the tropics showing an estimated net C sink of about 1 billion metric tons. As forester's conventional wisdom says that a mature undisturbed forest is at equilibrium, what would explain such a large accumulation of C (equivalent to growth) in undisturbed tropical forests?

Two main hypotheses are currently in favor:

- there is an increase of net primary productivity very likely to be caused by the rising CO_2 concentration in the atmosphere. Tropical forest dynamic is changing with faster growth and turnover (recruitment, mortality), and replacement of shade-tolerant slow-growing species by light-demanding fast-growing ones. The current environment with higher CO_2 is, for the time being, favorable to tropical vegetation (Lewis *et al.,* 2005);
- there is no real increase of net primary productivity. Tropical forests are recovering from disturbance hence a significant increase in aboveground biomass and a shift towards slow-growing species at the expense of fast-growing species. The global occurrence of natural disturbances in untouched forests suggests that they are growing in an increasingly hostile environment (Chave *et al.,* 2008).

In 2007 (Stephens *et al.*), a comprehensive study of atmospheric samples apparently confirmed that tropical forests absorbed about 1 billion metric tons more C than previously estimated (with respectively northern mid-latitude forests absorbing 0.9 billion metric tons less than assumed in 2001).This would weigh in favor of the first hypothesis but as of today it is yet not possible to reach a definite conclusion on this matter. Both hypotheses might be true, but only locally. Forests of eastern or western Amazon, coastal or inland Central Africa, continental or insular South-East Asia, Australia … are most likely following one or the other hypothesis, or a mix of both, depending on local conditions and short-term climate variations. The resolution of this issue is important in modeling scenarios for the future. Tropical forests sequester C but for how long? Will they become net sources if the temperature continues to increase? What will be the impact of more frequent global disturbances (El Niño, drought, floods…)?

R. Nasi 2008

CHAPTER 13
Peri-Urban Forests and Wood Energy: What Are the Perspectives for Central Africa[51]?

Jean Noël Marien

Introduction

At the beginning of the twenty-first century, the city/forest relationship is a major issue for sustainable land management in many countries, particularly in inter-tropical zones. In Africa, especially Central Africa with all its ecological, social and economic diversity, wood as a domestic energy source will continue to play a dominant role for decades to come. Over the last 20 years, uncontrolled urbanization has impacted all Central African countries to varying degrees. There has been no adaptation in terms of infrastructure and energy consumption patterns to cope with this sharp rise in urban population (European Commission, 2007; CBFP, 2006; UNEP, 2008).

Forests, most notably peri-urban forests, play a key role in providing fuelwood and charcoal. Supply zones for wood and wood products are often laid out in concentric rings around cities. Informal supply chains frequently develop over time, with few instances of sustainable timber resource management. Peri-forest degradation affects not only the largest cities (e.g., Kinshasa) but also all major cities and towns in areas dominated by savanna (Matadi in DRC, Nkayes in Congo). Medium and small cities and village populations in forest areas are barely affected, for the time being, by the wood energy issue and are not of immediate concern.

The dynamics of growth, availability and management of the timber resource are often unknown; especially since suburban areas are frequently without official status and do not possess even the most basic management tools. In many cases, the management of timber resources is only one aspect of land management and therefore the management of wood as it relates to energy is often disrupted by other external considerations.

Africa's demographics and rapid urbanization have radically transformed the social context for urban people, but domestic energy consumption patterns have not kept pace. Linked to ever-increasing and persistent urban poverty, wood energy consumption remains the main cooking method (and/or heating) in many Central African cities. The issues in terms of gender, health and employment for the weakest members of society are often not resolved or even ignored. In these conditions, it will be difficult to reach the Millennium Development Goals. The predominance of wood energy supply to cities is also underpinned by a sizeable informal economy, in which fragmented and disjointed organizations develop as needed. They provide labor and are pivotal in redistributing income from the forest to urban markets.

Photo 13.1: Transportation of charcoal ("makala") in DRC.

The wood energy sector is growing in a very diverse institutional context. Some countries have adopted dynamic policies of energy and taxation, resulting in a drastic change in consumption patterns and a replacement of wood by alternative energy sources (often fossil fuels). Other countries, in contrast, are characterized by poor governance. Purposefully or not, insufficient land management is allowing the private sector to establish itself and to adapt to local conditions, without anticipating or planning for future trends. Finally, uncontrolled collection of resources often exceeds

[51] This chapter is based on the regional African report prepared by JN Marien (CIRAD) for the FAO Conference on urban and peri-urban forestry « Trees connecting people: In action together » held in Bogotà (Colombia) from July 28th to August 1st, 2008. We would like to thank FAO for allowing us to use this work for the State of the Forest 2008 report.

the recovery potential of forest stands especially given the short distance from peri-urban forests to urban markets. The environmental impacts of forest degradation and deforestation, can become critical and effect climate change, biodiversity, desertification and/or carbon-related processes. These impacts are found at all levels of spatial integration from the single plot to the global arena. The objective of this chapter is not to revive the old debate of the 1970s and 1980s regarding the fuelwood crisis, which was long awaited and then mainly forgotten. Instead, this chapter aims to provide some understanding and reflection on an oft-underestimated subject, but one with considerable impact on Central African forests.

The latest data show that wood energy in Central Africa is a fundamental cornerstone of the forest economy and household energy budgets (Nash and Luttrell, 2006). This raises interesting new questions:

- Do recent and projected human and social changes in Central Africa (e.g., demography, urbanization, livelihoods, conflicts, governance) necessitate modifying the traditional view of the wood energy sector?
- Are these changes compatible with a sustainable wood energy sector?
- Can alternative energies be integrated fast enough to decrease pressure on rural and forest spaces?
- Are wood energy resources and networks able to adapt to changing needs?
- Can they find their place in the sustainable management of Central African forests?
- Can they contribute to the conservation of degraded ecosystems and hence combat deforestation?

A Major Factor in Forest Degradation

Fast-Growing Consumption

Wood energy in Africa represents over 80 % of total domestic energy consumption across all countries. The same sector is also responsible for more than 90 % of total timber harvesting in forests and woodlands. Finally, in most countries in Africa, population growth and rapid urbanization do not go hand in hand with poverty alleviation or changes in energy consumption patterns, with the exception of a transition from wood to charcoal if living standards permit or if supply distances become too great. Fuelwood conversion into charcoal is accompanied by a significant loss in energetic power (European Commission, 2005; Debroux *et al.*, 2007; Binzangani, 2004).

Africa is the only continent where wood energy use for household consumption (particularly urban) should continue to grow in the coming decades. With an annual population growth rate above 3 %, the number of African cities with more than one million inhabitants will rise from 18 (1990) to 70 (2020), with some cities meeting or exceeding ten million inhabitants (Drigo, 2001; FAO, 2007a).

Annual *per capita* consumption of wood (firewood and charcoal) in urban Central Africa is equivalent to 0.99 m^3, almost twice that of West Africa with 0.58 m^3 (table 13.1) (FAO, 2007b).

Compared to drier areas of Africa, the low population density (usually rural), combined with an abundance of natural resources and a highly dynamic system of regeneration, have masked the importance of wood energy harvested from forests. In fact, this sector is accountable for a higher level of harvesting than logging (formal and informal) (Van de Ven, 2008).

Table 13.1: Basic data on the wood energy sector in Africa

Africa (FAO classification)	Central	East	South	West	North
Country					
Area (millions ha)	529	399	590	503	940
Population (millions inhab.)	105	200	120	252	184
Forests					
Area (millions ha)	236	77	171	74	77
Area (%)	45	19	29	21	8
Area (ha)/inhabitant	2.2	0.4	1.4	0.7	0.4
Change 2000-2005 (%)	-0.3	-1.0	-0.7	-0.6	-0.7
Standing stock					
Volume (m^3/ha)	194	58	36	91	18
Total volume (millions m^3)	46,760	4,351	6,102	6,254	1,390
Biomass (m^3/ha)	315	172	99	175	51
Total biomass (millions m^3)	74,199	13,006	17,015	12,039	3,880
Carbon (t/ha)	157	86	50	85	25
Total carbon (millions t)	37,099	6,503	8,507	5,875	1,939
Production					
Wood energy (x1,000 m^3)	103,673	194,816	55,908	145,291	46,371
Industrial timber	12,979	10,526	26,356	17,128	3,458
Sawnwood	1,250	1,296	2,905	3,145	200
Some calculated ratios:					
Consumption of wood energy (m^3/inhab.)	***0.99***	***0.47***	***0.47***	***0.58***	***0.25***
Production of wood energy/total woody production (%)	***90***	***95***	***67***	***88***	***92***

Source: FAO – FRA, 2007.

Table 13.2: Relative importance of wood harvesting in DRC

	Annual volumes (x 1,000 m^3/an)	%	Economic value (x 1,000 $/an)	%
Source	1		2	
Formal timber sector	500	1	40,000	4
Informal timber sector	5,000	9	50,000	5
Wood energy	50,000	90	1,000,000	91

Sources: (1)Van de Ven, 2008; (2)Debroux, 2007.

Table 13.3: Annual wood production in Central Africa (in x1,000 m^3)

	FAO	COMIFAC countries
Wood energy	103,673	83,920
Industrial timber	12,979	11,876
Sawnwood	1,250	1,080

Source: FAO – FRA, 2007.

In the absence of strategies and management plans, these facts translate into the degradation of natural woodlands, forests, parks, trees and shrub savannas, which is particularly acute in the supply basins of cities and megacities. This degradation of wooded ecosystems can lead to deforestation, with well-documented and disastrous ecological, economic and social consequences.

Photo 13.2: Forest strips near cities are under great pressure.

Paradoxically, there is a lack of recent studies and data on wood energy in Central Africa and existing initiatives are often relatively unknown or underdeveloped. Nevertheless, several case studies illustrate the diversity of situations regarding supply and consumption that exist in Central African cities.

Bangui (Central African Republic)

The greater Bangui, capital of the CAR, has about 800,000 inhabitants and is growing at an annual rate of almost 3 %. Uncontrolled urbanization (in 2007, it covered 10 times the surface area of 1960) is mainly linked to poverty and insecurity (4 times higher in rural areas than in towns). The development of urban poverty is also worthy of mention. The city is diffuse and there are still plenty of open spaces and partially rural areas. Firewood represents 92 % of household energy. Energy sources depend on poverty level: more affluent people use more coal and gas. Annual consumption ranges between 280,000 to 500,000 metric tons of wood, representing an informal turnover of CFA 2 to 3 billion. Finally, urban attitudes are heavily influenced by rural lifestyles, including wood energy use. A UPF–FAO project aims to build support for a local strategy aimed at making wood energy resources and networks more sustainable in Bangui (FAO, 2008).

Cities in the Democratic Republic of Congo

Despite the Inga dam (one to two turbines operate out of eight), only 5 % of DRC's population have access to electricity. As a result, wood energy production accounts for 85 % of total energy consumption. Lubumbashi, for example, uses 1 million bags of coal per year. Wood energy resources are estimated at 70 million tonnes of oil equivalent (TOE), but wood energy production is predominantly careless, unplanned and not ecologically sound, with growing rings of deforestation around cities. Surveys in several cities in DRC showed a sizeable population of woodcutters and a strong migratory phenomenon from cities to areas where felling continues. Rural and urban poverty causes uncontrolled harvesting for subsistance. Wood energy is the main product transported by road (European Commission, 2005; Debroux *et al.*, 2007; Binzangani, 2004).

Kinshasa (Democratic Republic of Congo)

The megacity of Kinshasa (8 to 10 million inhabitants) is located on the Batéké Plateaux in a forest-savanna mosaic environment. Wood energy supply is 5,000,000 m^3/year, almost exclusively from informal harvesting of degraded forest galleries within a radius of 200 km. Gallery forests are the most affected by degradation from wood harvesting. It is estimated that more than 60,000 ha are used annually by village communities, both for slash-and-burn agriculture and for wood energy harvesting. Traditional lengthy fallow rotations are becoming shorter. There is a gradual degradation of forest ecosystems within a radius greater than 200 km, and total deforestation in the peri-urban areas (50 km). Unresolved issues that contribute to the sector's lack of sustainability include: management and restoration of degraded forest ecosystems; agroforestry; land tenure security and the revitalization of village communities; gender and health issues; carbon issues; and sectoral economics. Mampu acacia plantations (8,000 ha near Kinshasa) play a valuable role and should serve as an example for developing a sustainable resource. These plantations are currently managed in blocks of 25 ha, combining crop rotation and wood energy plantations.

Goma (Democratic Republic of Congo)

For several decades, the eastern part of DRC has faced a situation of acute conflict. This situation has given rise to serious crises, including humanitarian crises due to the displacement of over one million refugees in the Goma area and ecological crises from the deforestation of Virunga National Park, the last refuge of mountain gorillas (more than half of the surface area has been deforested to date).

To deal with an estimated annual demand of 500,000 m^3 of fuelwood for Goma (300,000 inhabitants, 97 % with no alternative energy source) and more than 200,000 metric tons for refugees (600 metric tons per day, or 0.6 kg per person per day), multiple projects have been developed over the past 20+ years (EC, WWF, UNHCR). These projects have different objectives (ecosystem conservation, humanitarian assistance), but typically involve establishing community plantations of fast-growth exotic species (eucalyptus, acacia) to increase resources and reduce pressure on residual natural ecosystems. Ongoing and recurring instability in the region represent a challenge, which, unfortunately, is not unique to Goma in Central Africa (UNHCR, 2008; WWF, 2007).

Libreville (Gabon)

Located in a distinct forest environment, Libreville is growing fast (about 600,000 inhabitants in 2006). Traditionally, wood energy availability has not been problem; however, recent periurban deforestation has occured (e.g., urban development speculation). As a gas and oil producer for many years, Gabon has implemented a policy to support the natural gas sector. This has resulted in a subsidized domestic market for gas with gas cans available for most of the population (urban and suburban). Furthermore, hydropower is a reality and hydroelectric stations, either operational or planned, should supply most of the energy needed once electrical infrastructure is established in urban and peri-urban areas. Overall, wood energy represents only a small proportion of domestic consumption (Anonymous, 2008; CAEMC, 2009; DGEG, 2005).

Pointe-Noire (Republic of Congo)

A city of 1 million inhabitants, Pointe-Noire is a port and an industrial city located on the edge of a forest savanna mosaic. Located in the heart of an oil production zone, domestic energy consumption is paradoxically based around wood energy. Consumption (500,000 m^3/year) is divided equally between: (1) by-products of industrial plantations of eucalyptus (40,000 ha) under the management of the Eucalyptus Fibers Congo (EFC) firm and (2) informal harvesting in gallery forests. For plantations, the supply radius is less than 40 km; it is 80 km for natural forests. There is no deforestation process and degradation of natural ecosystems is relatively weak and limited thanks to the plantations, which serve both as a buffer against forest galleries and as a substitute for wood from natural ecosystems. Like elsewhere, the sector is largely informal.

The sustainable management of industrial plantations (genetics, soil x plant relations, socio-economic impacts), the dynamics of territorial integration, the economics of plantations versus natural forests, taking into account new carbon markets, and the feasibility of alternative energy are all points underpinning the sustainability of the domestic energy supply in Pointe-Noire. Fuelwood comes primarily from near-by eucalyptus plantations (20 to 40 km). Charcoal comes from further afield (40 to 50 km) and mainly from gallery forests, due to considerations of cost and transport. Transporting fuelwood requires 5 times as many people as charcoal (mostly carried on foot). The eucalyptus plantations account for 53 % of total wood energy, but production is concentrated around a few villages (5 villages account for 80 % of the total production) (Nkou, 2008).

Photo 13.3: Construction of a charcoal furnace in the Mampu plantations (DRC).

Pokola (Congo)

The *Congolaise industrielle des Bois* (CIB) concessions are located in the heart of the dense humid forests in northern Congo, in Pokola. CIB manages a concession of 1,300,000 ha of dense forest, under a management plan and is already FSC-certified for two FMU out of five. Given the low number of inhabitants in the region (15,000 inhabitants on the site and approximately 50,000 including the city of Ouesso), domestic consumption of wood energy is not a major issue. The CIB operates an annual volume of 350,000 m^3 and this leaves a significant amount of logging residue (left on the floor after felling) and sawmill waste (sawdust, flitches...). Sawmill waste (a total of almost 100,000 m^3) is at present mostly made available to private charcoal traders and a processing sector has developed. The charcoal produced is used in Pokola and neighboring towns, but also sometimes sent to Brazzaville (1,200 km by barge on the Sangha and Congo Rivers) where the energy situation is very acute. The establishment of a cogeneration unit from sawmill waste is being finalized and will save almost all of the energy (oil) being purchased and transported at great cost to Pokola.

The wood energy sector has found a new place in the economy of Central African countries, without impacting the dynamics of the concerned natural forests. Production potential (logging residues, primary and secondary processing wastes) and the networks' economics (charcoal, cogeneration) are points that need validation.

What Discriminating Criteria Characterize the Wood Energy Sector?

The descriptions above illustrate the complexity of wood energy supply for Central African cities.

A Complex Issue to be Analyzed at Continent Level

This complexity is not unique to Central Africa, as witnessed almost everywhere in Africa. Some cities (Rabat, Cape Town) have gradually become free of the need for wood energy through proactive and voluntarist national policies. Others (Antananarivo) are experiencing a relatively favorable situation with large-scale production of wood and wood products from planted peri-urban forests (industrial or private). Although in dry zones, some cities (Bamako, Ouagadougou) have relied heavily on developing domestic energy strategies and markets to formalize, at least in part, the sectors, but without ensuring resource sustainability. In Mahajanga, a proposal was put forward to transfer the management of peri-urban timber resources to local communities with generally good results. In some cities in transition (Conakry), the problems of wood energy supply are still manageable, but the situation will change rapidly if nothing is done. Medium-sized cities may experience specific situations. Ifrane, for example, benefits from both sizeable local resources and a demand reoriented to other types of energy. In contrast, located in an area of violent conflict and scarce resources, Abéché has seen its energy balance disrupted by the massive presence of refugees. Finally, some cities (Abuja) are in very delicate situations, with sharp increases in urban populations due to conflicts and rural poverty, and with considerable ecosystem degradation in all their suburban supply basins. Together these examples make it possible to identify the main criteria for managing timber resources for wood energy.

Energy Subsitution Policies

Some countries have introduced policies to substitute wood energy sources for other sources, mostly fossil fuels (e.g., subsidizing natural gas or developing power plants). This substitution is essential to meet domestic energy needs and helps relieve pressure, at least in part, on timber resources.

Unfortunately there are few examples of this kind of voluntarism in Central Africa, where some countries are oil and gas producers and possess considerable hydroelectric potential.

Management of Existing Resources

Management systems for wood energy production forests are highly variable. They range from unmanaged informal extraction systems to management by public bodies, or even private stakeholders (industrial or not). These systems take into account the nature and degree of land and forest ownership by local stakeholders.

In Central Africa, peri-urban land is rarely secure in the long term. This situation makes it difficult to develop suitable sylvicultural practices and to implement private projects to create a dedicated resource.

Size of Urban Centers

The complexity of the sector and the quantification of the population's needs, especially urban populations, are proportional to the size of cities and the speed at which they are changing. In Central Africa, most cities are growing strongly, rapidly and in an uncontrolled fashion. In addition to natural growth, extreme poverty in rural areas and numerous armed conflicts periodically bring about significant population displacements. These abrupt changes cause major and immediate changes in the demand for wood energy.

Origin of the Resource

Wood energy resources can come from natural or planted forests. It can also come from by-products of logging (e.g slash, waste).

In Central Africa, most resources come from informal harvesting of the natural forests. Planted forests are still in a minority and the recovery valorization of logging by-products is still relatively unknown. Hence harvesting has maximum im-

pact on natural areas, leading to degradation of fragile and often fragmented ecosystems, particularly in peri-urban areas.

Supply/demand

Unlike fossil fuels or electricity, wood energy resources cannot be relocated. The supply distance is a very important factor in terms of availability and costs, and conditions the supply-demand relationship.

In Central Africa, supply is usually abundant in the forest zone, but insufficient in savanna areas, even for small towns. A demand greater than supply involves an increase in the supply distance, faster degradation of the close resources and a rise in cost. Refining these criteria, it is possible to define a comprehensive typology, that is still qualitative and provisional. This typology allows efficient segmentation of cases encountered in the field. Then for each type of situation, it would be possible to ask the most important questions and propose the most relevant response. The benefit of this approach is to integrate information that is often fragmentary and apparently not correlated. Figure 13.1 shows an example of a segmentation based not only on the examples cited for Central Africa, but also on the analysis of situations in other regions and cities of Africa.

Photo 13.4: Brick manufacturing is an activity that also consumes wood energy.

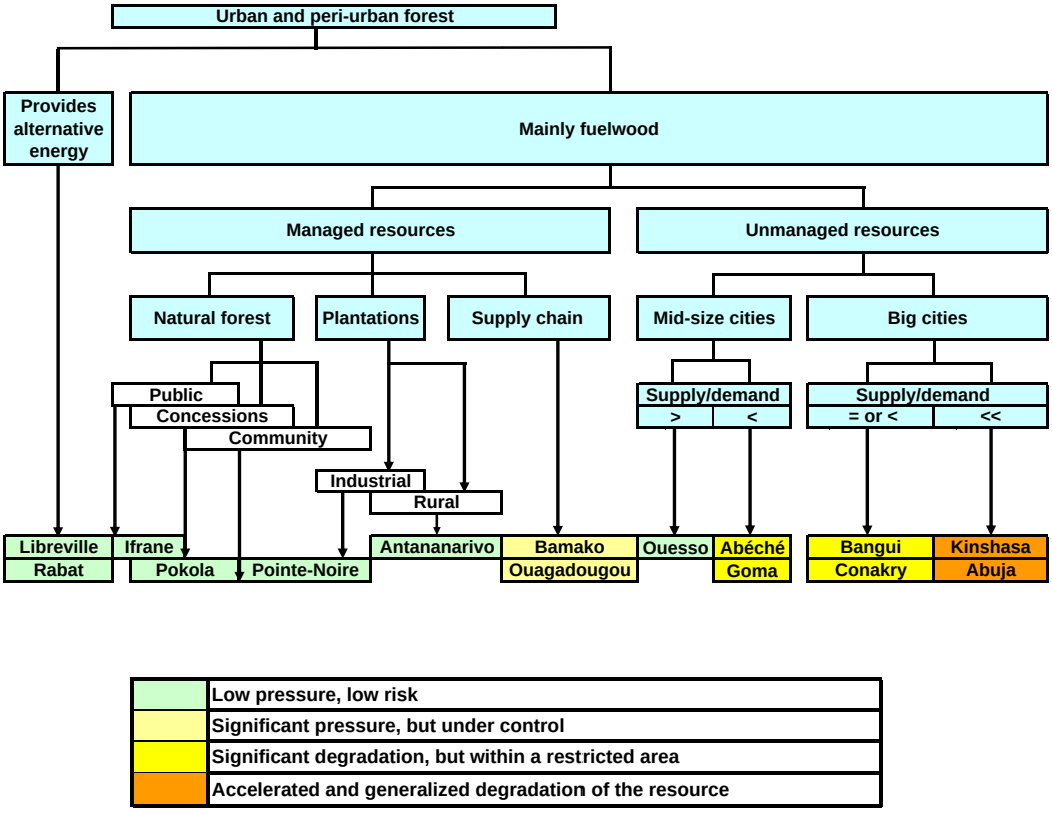


Figure 13.1: Discriminative typology of the wood energy situation applied to some cities in Central Africa

Multiple Impacts of the Wood Energy Sector in Central Africa

The wood energy problem is becoming acute in Central Africa. Besides a complex background and some alarming observations, we should ask the question whether new perspectives and opportunities could modify current trends. While some could be risky, others may alleviate the worsening situation, or even reverse the trends in areas of negative change. These new opportunities are in no way a substitute for better governance and a coherent and rational management of peri-urban areas, especially in terms of the socio-economic and institutional aspects.

A Major Contribution to Carbon Balances

Regardless of its connection to slash-and-burn shifting cultivation, the wood energy sector is the primary factor for global carbon balance and forest degradation in Africa. While many efforts have focused on forest management in concessions, very little has been done in this sector and its impacts. Taking into account the carbon/wood ratio traditionally used by FAO (0.50) and distribution of products (see table 13.4), we calculate the following global balance for Central Africa.

Table 13.4: Carbon stocks global balance for Central Africa and C flows according to wood usage

(x1,000 tonnes C/an)	Total exploited	Remainder on the plot (humus)	Exported from the plot (life cycle C+ long)	% of total C exported from forests by logging
Energy	57,563	5,756	51,807	82
Industry	8,110	1,216	6,894	11
Sawmill	6,250	1,785	4,465	7
Total	**71,923**	**8,757**	**63,166**	**100**

Source: Marien et al., 2008.

Wood energy accounts for more than 80 % of carbon exports from forest exploitation in Central Africa.

Africa currently represents only 3 % of the global carbon market. Hence there is considerable margin for improvement. This challenge can be addressed in a reasonable time-frame as basic skills and project identification resources are introduced gradually through ongoing activity.

However, is there a true carbon market for wood energy in Africa? The wood energy sector (plantations or natural forests) is considered neutral in terms of carbon volume. This only applies for forest renewal which mirrors harvesting (carbon storage = timber production = wood export = carbon emission from combustion) and without inputs likely to induce carbon costs or, on the contrary, better storage or improvement of yields throughout the sector. But the international situation is changing rapidly. The Bali Conference (2007) endorsed the concept of avoided deforestation and degradation (REDD). It is a complementary process to that established in Kyoto (1997) for plantations. Through a market mechanism, the process aims to promote activity to prevent natural forest degradations. However, analysis of past events, like for the CDM, suggests that this process, if it comes to fruition, will take a long time to develop and will be restrictive. Finally, the opportunity costs of the REDD process need clarification (Kasulu and Hamel, 2008; Mallet and Marien, 2008).

A Major Contribution to Forest Degradation

Fuelwood collection is often associated with an unsustainable system of fallow and/or slash-and-burn. The fallow period leads to localized deforestation, but in Central Africa, the natural dynamics allow natural forest resilience since the rotation period is sufficient. The fires mainly affect the fallow and shifting agricultural zones, which are the major areas for wood energy production.

Inseparable in many cases from shifting cultivation, wood energy harvesting is an important factor in degradation, and even deforestation. In Central Africa (COMIFAC zone), areas subject to management (mainly concessions and protected areas...) represent only 46 % of the total forested area of the Congo Basin. Traditional, individual or community management methods do not resist once anthropogenic pressures begin to increase considerably. This is particularly the case in all outlying forests that are not subject to management plans. These forests bear the brunt of pressure to supply fuelwood to local people (CBFP, 2006).

Substitution by Alternative Energies

It is commonplace to state that the cost of fossil fuels has fast become one of the major development drivers for world economies.

If wood energy is considered neutral vis-à-vis the carbon balance, there is a risk that air pollution will be aggravated if combustion efficiency is not improved. Forest residue utilization is underdeveloped but growing demand and the recovery of all residues could negatively impact soil, diversity… We are moving towards global competition between the energetic and industrial valorization of wood, especially resources from plantations, and a gradual increase in resource prices. The choice between agriculture for energy and for food is more an economic choice than a food security choice. Wood energy helps ease the pressure on agricultural areas and the forseeable increase in prices (one to two comparisons between wood energy strategy and cereal energy strategy). The combination of wood energy and crops (agroforestry, integrated cropping, and forest plantations) should therefore be promoted.

Large-scale biofuel cultivation will also compete for land access (agricultural conversion, deforestation, forest management). For example, there are large-scale palm oil plantations in DRC but the social and environmental impacts are relatively unknown. However, the potential development of biofuel crops should not have a major direct impact on peri-urban forestry and wood energy availability as the areas needed for their implantation are outside supply basins. According to FAO, developing countries, including Central Africa, should prioritize the better management of wood resources, leaving energy crops on the backburner (risks for access to land and for food security).

Energy Cost and Access to the Resource

Wood energy is rarely in competition with other energy sources in Central Africa. Unfortunately, it is often the only source of energy available, especially for domestic consumption. Only cities where gas is subsidized have seen a real change in consumption. Little is known about how wood energy cost and price are structured. The informal nature of the sector makes calculations difficult and the few examples of thorough analysis refer mainly to African drylands (Mali, Burkina Faso). Furthermore, there is low price elasticity for consumption as urban demand often exceeds supply.

However, price changes can be seen in the markets. In the dry season, charcoal prices tend to drop since the process is easier to carry out and access trails to production areas are more practicable. Charcoal from dense forest species or acacia is more valued than other species (eucalyptus). On the other hand, the transport distance does not impact purchase prices on urban markets, but affects the "roadside" purchase price and therefore the income of woodcutters and producers (Horgan, 2002; Ouedraogo, 2008).

Photo 13.5: A charcoal furnace, which can operate for several weeks at a time.

Food and Domestic Energy

Urbanization in Africa is in transition. The new urban dwellers, mostly former rural dwellers, retain certain habits. They grow plots on the immediate outskirts of the city or have a small herd.

Urbanization is accompanied by an increasingly strong demand for agricultural commodities. Farming and market gardening are thus galvanized by demand and develop often on peri-urban wooded areas. However, can we talk about competition between the food and energy uses of peri-urban forests? The surface areas involved cannot be compared. Wood energy supply for a city of one million inhabitants in Central Africa (nearly 1 m^3/inhabitant per year) represents annual harvesting of 10,000 ha of productive plantation (100 m^3/ha on average), and up to 100,000 ha of degraded natural forests, according to stands' natural productivity and land use pattern. For the same number of people, only several thousand ha of correctly managed market plots are required to meet fruit and vegetable needs in the same urban area. On the other hand, extensive agriculture and itinerant livestock production on the periphery of Central Africa represents a competition risk for wooded peri-urban areas. Slash-and-burn cultivation is everywhere in Central Africa. Areas are alternately assigned to agriculture and relatively long tree fallow, providing a sizeable share of urban wood energy supply. Fallow duration is the key point in this type of land management and determines whether the system is sustainable. As growing tension surrounds products supply, rotations become shorter and soils become more depleted (Trefon, 1997; Trefon, *et al.*, 2007).

Payments for Environmental Services

Periurban forests provide a range of products and services both locally and globally. The sustainable development of a peri-urban forestry mainly for wood energy will help maintain and even strengthen or create many services, particularly environmental ones. Often non-monetary, these environmental products and services are most often common goods that are essential for both rural and urban communities nearby.

Some forest products (NTFP, such as leaves, fruits, lichens, game, resins, fodder...) have a clear monetary value. These products can be quantified and integrated neatly into the calculation of global forest value.

Other products and services (often of significant environmental value) are equally important but it is more difficult to assess their value. Soil protection, erosion control or siltation control, space structuring, leisure, water quality, treatment of wastewaters and bioremediation, biodiversity and ecosystem conservation, are all examples of these non-monetary environmental goods and ser-

vices (see chapter 8). These products and services have strong (but unquantified) global value and long-term worth for urban people. Unlike many rural communities who understand and manage their land sustainably, urban people are unable to sufficiently influence change to modify the observed trends. Wood energy represents a considerable asset for monetizing peri-urban forests and promoting sustainable management. It is easy to quantify the value of the forest and all the levels of the wood energy supply chain for cities. Several countries have shown that the development of a resource dedicated to wood energy competes directly with other land uses. It is also necessary that the benefits of these measures be attributed to the stakeholders involved in their management. This is only possible with well-established boundaries, authorities and measures for the public and private spheres. Most Central African countries now have appropriate legislation. The concrete application of these laws, fiscal transparency and land tenure security are essential links in building a virtous dynamic.

Photo 13.6: Bundles of wood along the road, ready for sale.

Land Management in Peri-Urban Zones

Peri-urban woodlands are a key source of wood energy, and the sustainable management of these woodlands is a major issue for people in cities and towns of Central Africa, especially the poorest people and women, those most affected by concerns of access to wood energy. Indeed, interventions should aim at combating poverty and insecurity among the urban poor. Diversifying income and employment to peri-urban rural populations is a major challenge for authorities in order to maintain a rural fabric, limit uncontrolled migration to cities and suburbs, and help reintegrate people to their local environment.

Forests are one of many elements that make up the peri-urban space. The implementation of a sustainable management approach for peri-urban areas, including forests and woodlands, can only be achieved with an appropriate strategy. Certain principles of this strategy can be defined by integrating the wood energy issue into urban and peri-urban planning. Wood energy resources are mobilized within a given territory, in which spaces and plant formations have a variety of functions (production, soil and water protection, fallow periods for fertility restoration, forests, land for settlements and infrastructure….) and are appropriated under different, even contradictory conditions. A strategy to develop forest plantations and manage degraded forests sustainably needs to take these different functions into account and development should not conflict with other important functions in the area. The initial aim is not to prepare a management plan for peri-urban areas *stricto sensu*, but rather to develop criteria and indicators to assess the relevance of places and conditions for developing wood energy resources sustainably. A comprehensive spatialized framework for intervention both at global level and with a "landscape" approach will allow the drafting of a Master Plan for the sustainable management of peri-urban areas where wood energy resources are managed.

Is Wood Energy Compatible with Sustainable Forest Management in Central Africa?

Developing Voluntary Public Policies

Public policies in Central Africa are most likely to change the situation, and even reverse the trends observed on the ground. Support for alternative energy, tax incentives, land tenure security, establishment of regulated markets, improving infrastructure, training... are all elements directly under state jurisdiction. Unfortunately, with very few exceptions, wood energy is largely ignored in public policies. A quick look at the few lines on the subject in laws and forestry codes confirms this.

A clear institutional environment and secure tax rules are conducive to the emergence of long-term forest development projects in the public sphere, especially in the private one. Their investment capacity and responsiveness mean private stakeholders can react quickly to development and forest resource management opportunities for wood energy production.

Improving Energy Processing

Much has been written and many projects have been initiated; however, traditional techniques are still the rule despite poor yields. This point certainly deserves more attention because the blockages are not technical and the costs for developing better technologies (charcoal, cooking) are not prohibitive. For example, a simple improvement to the carbonization wheels (not to mention the metal kilns or other more expensive equipment) could already double the performance. The problem therefore lies elsewhere. Wood energy is not rare enough in Central Africa to have a considerable and lasting impact on sales prices. In addition, the fragmentation of the profession and a largely informal sector are not conducive to setting a baseline pricing structure (especially for labor costs) or clear competition on urban markets.

Sustainable Management of Natural, Degraded Peri-Urban Forests

Wood and biomass energy supply to cities is directly related to the presence of a resource at a distance compatible with the economics (even informal) of the sector. Besides planted forest and urban parks, almost all supplies come from natural forests, regardless of land, administrative or territorial status. Anthropogenic pressure and the lack of woodland and natural peri-urban forest management generate significant negative impacts: economic (rural income, costs for urban dwellers), social (employment and rural exodus, poverty, ethnic and gender, post-conflict situation) and ecological (environmental goods and services, land-use competition). The concept of sustainable forest management (and certification) mostly applies to private forests (mostly industrial plantations), concessions or protected areas, and parks and areas with special status. However, the main production areas for woody biomass energy are in peri-urban forests and savanna located in the supply basin of target cities and where no rational management is implemented. There are often multiple and confusing reasons for the lack or even the absence of management.

The overall degradation of peri-urban forests poses numerous and fundamental questions to be addressed before envisaging proposals for suitable and viable management systems. For example, we still know little about ecosystem dynamics and resiliency, community and traditional management systems, territorial and social dynamics or the restoration and rehabilitation of forests mechanisms and tools. Once these bases are better defined, it will be possible to define the principles of adaptive management, which could be termed as "simple management plans." The goal is to manage the forests, gallery forests and riparian forests ... in question, sustainably, with progressive appropriation by local communities, the only guarantors and beneficiaries of a sound implementation. This process will take a long time, if only because of the lack of basic knowledge. However, it is undoubtedly the greatest challenge facing peri-urban forestry in both dry and humid zones of Africa (Smektala, 2003). New projects should help us better anticipate the reality and feasibility of this type of management, still widely unknown (e.g., the "Makala" project for Kinshasa and Kisangani, 2009-2013). New projects should help us better anticipate the reality and feasibility of this type of management, still widely unknown (eg the "Makala" project for Kinshasa and Kisangani, 2009-2013).

Developing Peri-Urban Forest Stands Solely for Wood Energy

If forest plantations were of interest to international investors and institutions a few decades ago, results are mixed, particularly in Africa (Mallet and Marien, 2005):

Industrial plantations of fast-growing species (eucalyptus, acacia, pine) were concentrated in a few countries where conditions are favorable. They are most often backed by corporations or large groups and facilitated the development of large internationalized branches, especially for paper pulp. South Africa, Congo and Morocco are examples. These plantations benefit from new technologies (genetics, forestry...) and are regarded as crops. In this case, local people only use the harvesting residues unless these are left on the ground to maintain soil fertility and plantation sustainability. Rising energy costs also leads to the development of a domestic valorization in

the form of cogeneration, for example. Thus there will probably be not be significant volumes available for people in cities near the plantations. Conversely, these industrial plantations or rather the way they are established, can sometimes present conflicting problems in terms of social management and relations with local people who derive no particular benefit.

Suburban private plantations of fast-growing species only develop if there is land security, a promising local market and a favorable institutional environment. In Madagascar (Antananarivo), the dynamics are completely private and develop without outside intervention. In DRC (Kinshasa-MAMPU), the private sector partially took over international funding and the success now encourages local people to develop the plantations themselves based on the initial plantations (plantations with an additional agricultural component). The profitability of this type of wooded area is often good to very good because the rotations are short, productivity is high and prices attractive. These plantations often do not benefit from modern technology and thrive in a mostly informal framework. And yet this is one of the best solutions for addressing wood energy needs (and timber) in cities.

Agroforestry plantations and parks often develop in peri-urban areas and are also the result of private and community initiatives. They are found in many countries, particularly in dryland Africa. Conflicts between livestock producers and farmers have led to scarcity of available rural areas, strong pressure and accelerated degradation of resources and ecosystems. These fallow lands, tree-covered parks and agroforestry systems (especially fruit trees), produce a growing proportion of the wood energy consumed in urban areas (Harmand and Bale, 2007; Peltier *et al.*, 2007).

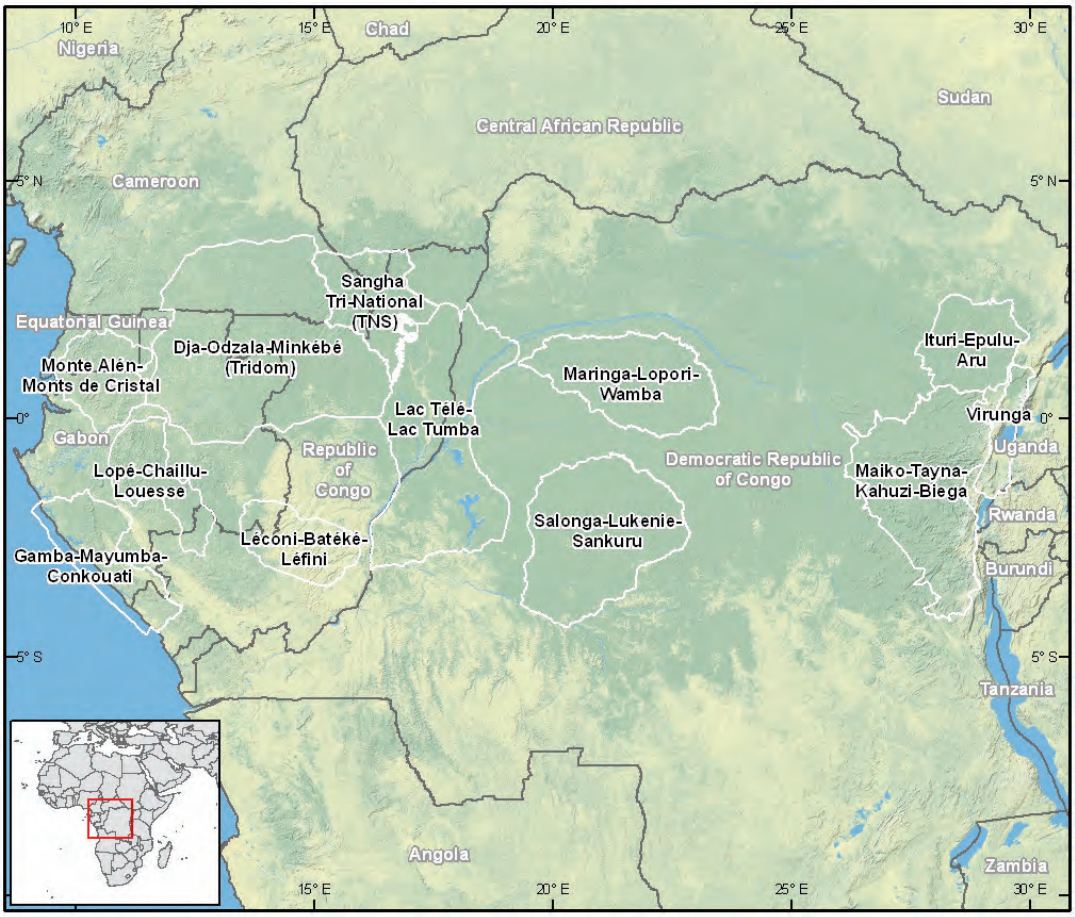
Traditional forest development projects, launched in many countries in the 1960s and 1970s often turned out to be half-successes or failures, and provided a negative image of the very principle of forest plantations for a long time. These large-scale plantation projects were set up under the authority of state forestry services using international co-funding (grants or loans). If the diagnosis was mainly carried out properly (soil restoration, demand for wood and wood products, peri-urban afforestation ...), the achievements sometimes lacked realism. Some critical factors for such half-successes can be identified with hindsight: t**echnical** factors, badly understood or unsuitable techniques; **ecological** factors, introduced species unsuited to plantation areas; **economic** factors with short-term planning, costs out of line with expectations or widely overestimated balance sheets; **institutional** factors with relatively ineffective or absent state management; and, in particular, **social** factors, with poor land control (public or collective), leading to claims and conflicts with both local and herder populations.

However, these woods still continue to provide wood energy in peri-urban zones of some African cities. It is therefore important to learn from these half-successes and boost production on a cleaner, more modern basis. If the public sector does not have the vocation to be the management operator for these plantations, it should provide support in terms of technology (seed quality, extension...), territory (land security) and fiscal support (clear taxation) in order to promote the development of private peri-urban plantations with guaranteed profitability from ever-growing demand and higher energy costs.

CHAPTER 14
The Congo Basin Forest Partnership (CBFP) Priority Landscapes

Alice Altstatt, Alejandra Colom, Paya de Marcken, and Fiona Maisels

The 12 CBFP landscapes were presented in detail in the 2006 State of the Forest report. The following 12 chapters build on the previous presentations to provide the current state of the landscapes (figure 14.1). Updates are provided on a select set of topics and indicators, including: land use planning, land cover monitoring, large mammal and human impact monitoring, and human activities. These topics are introduced below.



Sources: UMD-CARPE, FORAF, Tom Patterson US National Park Service.
Figure 14.1: The CBFP Landscapes

Land Use Planning

The purpose of land use planning is to develop management and governance strategies that reflect scientific understanding of natural and social systems as well as changing societal conditions and values. Ideally, it is a process in which stakeholders (community members, scientists, government representatives, private businesses, traditional authorities, etc.) come together to debate and discuss how to manage lands for the benefit of current and future generations and to ensure ecological sustainability of lands and resources. Effective planning processes promote decisions that are informed, understood, accepted and capable of being implemented.

Photo 14.1: In Cameroon, the forests are an important source of both timber and non-timber forest products.

There are two levels of planning involved in the CBFP landscape land use planning process: the landscape level scale and the macro-zone scale. Landscape level planning assesses broad, wide-ranging trends, influences, and impacts at a large scale, incorporating and integrating multiple protected areas with resource-use zones. A large scale perspective facilitates the identification of resource use opportunities that provide economic and social benefits while promoting ecological sustainability. Experience has demonstrated that planning for ecological sustainability requires this large scale integrated approach.

The macro-zones are areas within the landscape. They are zoned for differing uses and levels of resource protection, and are created to support the landscape desired conditions and objectives. Three types of macro-zones are delineated within the Landscapes: protected areas (PA), whose predominant purpose is the conservation of the natural state of the flora, fauna and other natural resources; community-based natural resource management (CBNRM) areas in which communities have some form of natural resources use rights; and extractive resource zones (ERZ) which include forest concessions, large-scale private plantations, mines, safari hunting zones, and energy and transportation infrastructure.

Central to planning is the recognition that in most cases not all desired data on the landscape and its resources will be available in detail. Even the best plans need to be altered to adjust to improving data and information; changing social, economic or other conditions; evolving threats; or feedback from monitoring efforts. Therefore, these plans are adaptive in nature and amendments or entire revisions are expected.

Sound strategies for landscape planning incorporate multiple opportunities for involvement and concurrence by local communities, government, relevant industry, and other stakeholders. Creating a sense of ownership among local community members and a wider audience of stakeholders by involving them in planning discussions and decision-making, improves the likelihood that the plan will be supported and its implementation will be successful. Without true legal governance authority, the only authority landscape leads have to implement management plans is that which they obtain through consensus. The maps in the following landscape sections are not legal administrative maps, but represent the different approaches to natural resource management as embodied in the macro-zones.

Land Cover Monitoring

Photo 14.2: In forest areas, settlements often develop around extractive industries, such as logging or mining.

Monitoring land cover and land use is essential for successful natural resource management within the Landscapes. Satellite data provides the most cost effective and synoptic means of land cover monitoring. Landsat satellite data is particularly suited for monitoring forest cover and change in the Congo Basin because its spatial resolution is sufficient to detect the small scale deforestation characteristic of the Basin, and because Landsat data have been acquired since 1975. Thus Landsat data can be used to make baseline estimates of forest cover and rates of forest loss and to consistently and accurately monitor forests going forward. The forest cover extent and loss estimates in the accompanying landscape chapters were derived by an automated method using MODIS (Moderate Resolution Imaging Spectroradiometer) data and Landsat data (Hansen *et al.*, 2008; Lindquist *et al.,* 2008). Forest cover and loss are provided for circa 1990, 2000 and, where available, 2005.

Most of the deforestation that occurs in the Congo Basin is a result of clearing associated with small scale agriculture, particularly along the corridors of the existing road network. Commercial logging also impacts forest cover, but this logging is highly selective and is usually only detectable in satellite images as expansion of the road network. Forest cover captured by remote sensing data is based on biophysical and structural traits, and floristic detail can only be provided by *in situ* data. Likewise, although remote sensing data reveals the condition of the forest canopy, assessment of forest ecosystem conditions must incorporate ground-based monitoring of flora and fauna.

Large Mammal and Human Impact Monitoring

Since the early 1990s, it has been recognized that hunting, not deforestation, is the most serious threat to wildlife biodiversity across most of the Congo Basin. Most species are targeted for meat; and elephants primarily for ivory, although they have more recently been hunted for their meat as well. The bushmeat is destined for three main sets of consumers: the local rural communities, laborers working in logging and mining concessions within the forest, and the increasingly important urban markets. Much of the ivory eventually goes to the Far East, especially China.

The species which best indicate whether an ecosystem is intact in the Central African rainforests are generally the larger-bodied, slower breeding mammals. If a forest is being unsustainably hunted, these species are the first to be depleted. This is because they are (i) selected for by hunters, as they give the best rate of return (in terms of kilograms of meat) per unit effort; (ii) generally occur at lower density than smaller species and (iii) because of their slower reproductive rate, are harvested faster than their rate of replacement. Among the larger mammals there are two major groups which are of particular concern: the great apes and elephants. Both take over a decade to reach reproductive age and, even then, have a long interbirth interval (four years). They are the only seed dispersers for an important set of tree species, and elephants are also important in opening up the understory, facilitating seed germination and sapling growth. Elephants are usually the very first species to become locally extinct, or at least very rare, when a forest is unsustainably hunted. These species have therefore been chosen as the animal indicators for "the state of the forest"; in other words they indicate an intact ecosystem where seed dispersion and regeneration are still taking place. It should be noted that a strong positive relationship between large mammal abundance and forest inaccessibility has been observed. Much of the previously inaccessible forest of the Congo Basin, outside national parks and other protected areas, is becoming vulnerable to unsustainable hunting due to the construction of logging roads (Blake *et al.*, 2007, 2008).

Photo 14.3: Two species of doves (Columba unicincta and Treron calva) in a forest clearing in the Okapi Faunal Reserve (Edo).

In most cases, direct observation of animals in the forest is not possible, either because of poor visibility or the animals are nocturnal or uncommon, therefore proxies are used instead of the animals themselves. These proxies are animal signs, especially those which are produced and degrade at predictable rates. These signs are much more abundant than the animals themselves, which facilitates more precise density or distribution estimates. For example, the average chimpanzee produces a nest every night; each nest takes about three months to degrade completely, so at any one time there are about 90 times more chimpanzee nests in an area than there are chimpanzees. For calculating density of apes, therefore, the proxy used is the number and distribution of night nests. Dung is also a useful proxy for other large mammals, particularly elephants. Where density cannot be calculated directly, encounter rate (number of signs per kilometer walked) is a useful proxy for animal abundance. Finally, for monitoring human impact, all signs are generally used as indicators, but these are classified into indicators of hunting, farming, illegal logging, etc. Their encounter rate is the metric used to detect change.

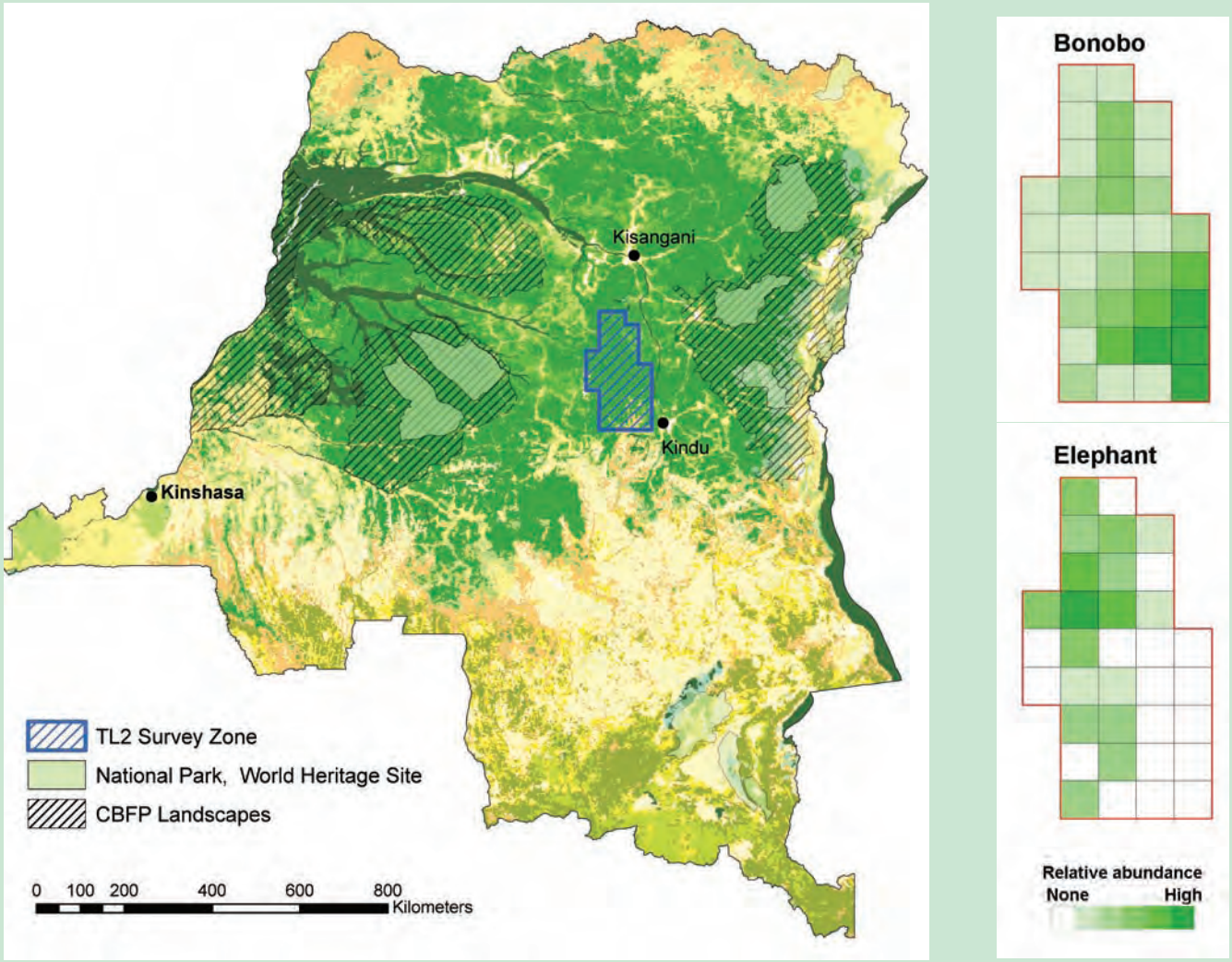
Photo 14.4: Elephants extracting salt from a bai in Dzanga-Ndoki National Park.

Box 14.1: Biodiversity of the TL2 Landscape in Central DR Congo

The conference that led to the delineation of the CBFP landscapes (Libreville 2000, WWF) drew an imprecise outline in the center of DR Congo indicating a totally unexplored area of possible but unknown importance. It was not until 2007 that scientific teams explored the forested basin of the middle Lomami River, from the Upper Tshuapa to the Lualaba (TL2).

The unexpected biodiversity of the area comes not only from range extensions of some of Congo's major endemic fauna but also the discovery of new taxa. Known ranges have been extended throughout the TL2 landscape for bonobo, okapi, blue monkey and numerous bird species. Genetically distinct forms of several species are associated with the cross-hatch of north-south running rivers (Ruiki, Kasuku, Lomami) overlaid by large east-west running barriers of infertile swamp forests. The southern forest is broken by north-south bands of edaphically specialized savannas with a distinctive flora.

Bushmeat from TL2 forests is an important food resource for local communities, but large quantities are now exported to the urban markets of Kindu and Kisangani whose neighboring forests have been emptied of large mammals. Both protected species, species endemic to the landscape and newly discovered taxa are targeted by hunters putting the biodiversity of this landscape in danger.



Source: John Hart, www.bonoboincongo.com.

Figure 14.2: TL2 localization and inventories result

Selected biodiversity discoveries are listed in the table below:

Common name	Scientific name	Observation
Bonobo	*Pan paniscus*	Range extended east of the Lomami River to 3 degrees South, large population in the southern savanna ecotone.
Okapi	*Okapia johnstonii*	Range confirmed east of the Lomami River, and extended south to the forest ecotone, west of the Lomami River.
Forest elephant	*Loxodonta cyclotis*	At the exception of the Salonga´s population, this is the last remaining elephant population of at least 500 in Congo's central cuvette.
"Lesula"	*Cercopithecus sp.*	Newly discovered, known by its vernacular, restricted to forest between the middle Lomami and upper Tshuapa rivers.
Heyman's Blue Monkey	*Cercopithecus mitis heymansi*	Abundant and widely distributed both east and west of the Lomami River.
Blue Monkey unnamed form	*Cercopithecus mitis ssp*	A morphologically distinct, undetermined form with wide distribution both east and west of the Lomami River.
Elegant Mona Monkey	*Cercopithecus wolfi elegans*	Restricted to the Kasuku River Basin, in both forest and savanna ecotone.
Central African Red Colobus	*Piliocolobus oustaleti parmentierorum*	Restricted to forest west of the Ruiki River between the lower Lomami River and the Lualaba.
Tshuapan Red Colobus	*Piliocolobus tholloni*	Major population between the middle Lomami and Upper Tshuapa south to the savanna ecotone.

For more information: www.bonoboincongo.com

Human Activities

Human populations across the Congo Basin are characterized by their heavy dependence on local natural resources for their subsistence and as principal, and often only, source of income. Agriculture, collection of non-timber forest products, hunting and fishing are widespread activities closely tied to the current state and future transformations of the basin's forests. While agriculture and collection of non-timber forest products are important subsistence activities for almost every household (WWF 2006), fishing and hunting are often the sole sources of revenue and protein for the poorest rural populations (Bennett *et al.*, 2007, Nasi *et al.*, 2008).

The bushmeat trade has been identified as an important threat to biodiversity and ecosystem function, as described above. This activity is easily observable, as bushmeat traders are seen daily at principal and secondary river ports and in markets in every city. Quantifying the impact of this trade, however, continues to pose major challenges. Harmonized data sets are difficult to find, information is often site-specific and collected over short periods of time. Also, while market surveys are helpful, interviewing merchants alone provides little light on the actual origins of bushmeat and much less on the conditions under which it was obtained (local versus foreign hunters, levels of local controls, within or outside protected areas, etc.). Bushmeat markets need to be placed within a larger picture that includes the characteristics of the demand (urban areas, mining towns, previously depleted zones, etc.), the economic alternatives to those populations located in and near principal sources of bushmeat as well as other actors and the specific political and economic dynamics between the source and the end markets. These actors include middlemen, transporters, local civilian authorities, and the military.

Even though standardized indicators on local economic activities for the Basin do not exist yet, looking at the principal species of bushmeat traded, purchase and retail prices, and shifts in principal markets can help compare and understand the differences and similarities across landscapes. Other qualities of local trade, such as available infrastructure and distance between sources and principal markets can help understand the role of bushmeat in local economies as well as the possibilities and limitations of alternative economic activities, such as agriculture.

Photo 14.5: Black Legged Mongoose (Bdeogale nigripes) caught in a snare in the Epulu forest.

Box 14.2: UNESCO's Programme on Man and the Biosphere (MAB) and the Biosphere Network in the Congo Basin

UNESCO's Programme on Man and the Biosphere (MAB) aims at providing the basic scientific knowledge needed to effectively address sustainable development and natural resource management issues. This program is present on the ground through a worldwide network of biosphere reserves. In 2008, there were 531 biosphere reserves in 105 countries and five continents, totaling 400 million hectares of land and aquatic habitats. There are 12 biosphere reserves in 6 Central African countries, including Rwanda, of which 5 are located within the landscapes of Gamba-Mayumba-Conkouati, Dja-Odzala-Minkébé (Tridom) and Virunga.

The biosphere reserves are designed to address one of the most important questions faced by the world today: how to reconcile the conservation of biodiversity, the improvement of economic and social conditions and the continuance of associated cultural values? Adopted by the UNESCO General Conference in November 1995, the Seville Strategy and the Statutory Framework for the World Network of Biosphere Reserves stipulate the conditions and game rules for efficient management of the world's biosphere reserve network (http://www.mab-france.org/fr/publi/scan/seville_fr.zip).

Biosphere reserves are both a concept and a tool. As such, each biosphere reserve is characterized by a well-designed zoning system representing a gradient between: (I) one or more core zones dedicated to biodiversity conservation (conservation aspect); (II) a clearly delineated buffer zone surrounding, or close to, the core zones, to be used as a laboratory for collaborative activities compatible with ecologically viable practices such as environmental education, leisure, ecotourism and basic or applied research (development aspect); and (III) a transitional zone with more flexible limits to accommodate various agricultural activities, human settlements and other uses, and in which local communities, administrative organizations, scientists, nongovernmental organizations, cultural and economic groups and other entities from the private sector work in partnership to manage and sustainably develop the resources of their territory (logistical aspect).

Between 1976 (when the first biosphere reserve was created) and 1984, only 23 % of the biosphere reserves had adopted the three-tier zoning system (core zone, buffer zone, transition zone). Today, however, no fewer than 98 % of biosphere reserves strive to reconcile conservation and local economic development by using this zoning system, as well as by supporting local people's participation in the sustainable management of natural resources.

In February 2008, the third World Congress of Biosphere Reserves held in Madrid (Spain) approved the Madrid Action Plan (http://unesdoc.unesco.org/images/0016/001633/163301f.pdf). In a context of worsening and accelerating global changes, poverty and inequality, this Plan has been designed to take advantage of the Seville Strategy and to turn, at the international level, the biosphere reserves into important sites for sustainable development in the first decades of the 21st century. Based on nearly forty years of experience managing biosphere reserves since the MAB program was launched in 1970, the Madrid Action Plan aims to highlight the biosphere reserves and their role as «learning and implementation laboratories for local and regional sustainable development.»

Based on the broad strategic guiding principles of this Plan, the African Network of MAB, "AfriMAB," is planning to take steps to expand the coverage of biosphere reserves to coastal and marine ecosystems – ecosystems characterized by the presence of mangroves, which are not only highly diverse and fragile habitats, but also densely populated. In addition, UNESCO/MAB, ERAIFT (*École régionale post-universitaire d'Aménagement et de Gestion intégrés des Forêts et Territoires tropicaux*), RAPAC (*Réseau des Aires protégées d'Afrique centrale*), and CAWHFI (Central Africa World Heritage Forest Initiative) have decided with the support of partners to strengthen their collaboration and target the Central African forests as the ideal environment to develop a network of biosphere reserves, including transnational reserves, that will serve as: i) sites of excellence for the sustainable future of the Congo Basin; (ii) drivers of change; and (iii) catalysts for new ideas through the testing of innovative development approaches.

For this reason, the Tridom, which saddles three countries and encompasses three biosphere reserves [Dja (Cameroun), Minkébé/Makokou (Gabon) and Odzala (Congo)], as well as the Mayombe project which aims to create a transnational site between the biosphere reserves of Dimonika (Congo), Luki (DRC) and the area of Cabinda (Angola), is a priority for AfriMAB. Within the framework of this initiative, the GRASP partnership (Great Apes Survival Project) promotes the idea of using large primates as ambassadors of peace while encouraging the integration of environmental problems into transnational "peace-building" operations and conflict resolution.

Table 14.1: Ecological characteristics of the Congo Basin Biosphere Reserves

Biosphere reserve	Country	Date of creation	Principal ecosystem	Main habitats	Elevation (m)	Total area and (core zone)[1] (ha)
Waza	Cameroon	1979	Tropical rainforest	Tropical deciduous rainforests *Anogeissus leiocarpus* forests on sandy soils *Acacia spp.* wooded savannas on clay soils Shrubby savannas Herbaceous savannas with *Lannea humilis* Flooded prairies	+300	170,000 (nc)
Benoué	Cameroon	1981	Tropical rainforest	Wet deciduous tropical forests Tropical dry open forests Wooded savannas	+800 to +1,100	180,000 (nc)
Dja	Cameroon	1981	Tropical rainforest	Tropical evergreen rainforests with *Afrostyrax lepidophyllus, Anopyxis klaineana* and *Anthonotha ferruginea* *Gilbertiodendron dewevrei* forests Swamps Old secondary forests Cocoa and abandoned coffee plantations	+400 to +800	526,000 (nc)
Odzala	Congo	1977	Tropical rainforest	Tropical rainforests with *Entandrophragma utile, E.cylindricum* and *E.candollei* Marantaceae forests Logged forests Savannas with *Hymenocardia acida, Annona arenaria* and *Hyparrhenia diplandra*	+400 to +600	110,000 (nc)
Dimonika	Congo	1988	Tropical rainforest	Tropical rainforests on plains Secondary forests Savannas	+85 to +810	136,000 (nc)
Ipassa Makokou	Gabon	1983	Tropical rainforest	Tropical evergreen rainforest with P*olyalthia suaveolens, Panda oleosa, Plagiostyles africana* and *Dacryodes buettneri* Agro-ecosystems	+450 to +500	15,000 (10,000)
Basse-Lobaye	CAR	1977	Tropical rainforest	Semi-deciduous wet tropical forests with *Ulmaceae, Sterculiaceae, Meliaceae* and *Sapotaceae* Young forests with firm undergrowth Forest galleries	<+500	18,200 (nc)
Bamingui-Bangoran	CAR	1979	Tropical dry forest	Semi-deciduous dry tropical forest Forest galleries Wooded savanna with *Terminalia spp.*, *Anogeissus spp.* and *Isoberlinia dokae* Shrubby savannas Edaphic savannas Prairies	+350 to +450	1,622,000 (nc)

Biosphere reserve	Country	Date of creation	Principal ecosystem	Main habitats	Elevation (m)	Total area and (core zone)[1] (ha)
Yangambi	DRC	1977	Tropical rainforest	Tropical evergreen rainforest with *Brachystegia laurentii* and *Gilbertiodendron dewevrei* Semi-humid deciduous tropical forests with *Scorodophloeus zenkeri* Semi-deciduous secondary forests with *Pycnanthus angolensis* and *Fagara macrophylla* Saltwater marsh forests Insular valley forests Regrowth forest Flooded plains	+490 to +530	235,000 (160,000)
Luki	DRC	1979	Tropical rainforest	Tropical rainforests with *Gossweilerodendron balsamiferum, Gilletiodendron kisantuense* and *Terminalia superba* Secondary forests with *Terminalia superba* Tree savannas Herbaceous savannas Agro-forestry systems Agro-ecosystems	+150 to +500	32,968 (6,816)
Lufira	DRC	1982	Tropical dry forest	Tropical humid forests "Muhulu" Miombo open forests open with *Cassia singueana, Psorospermum febrifugum* and *Afzelia quanzensis* Wooded savannas Forest galleries with *Khaya nyasica, Chlorophora excelsa* and *Parkia sp.* Flooded prairies with *Leersia spp., Oryza spp., Typha spp.*and *Phragmites spp.* Agro-ecosystems Pastures	+1,200	14,700 (2,800)
Volcanoes	Rwanda	1983	Montane forests	Low, medium and high elevation forests sheltering a mountain gorilla population (*Gorilla beringei ssp. beringei)* Forests with *Neoboutonia spp.* Bamboo forests (*Arundinaria alpina)* Forests with *Hagenia abyssinica* Prairies Pastures Marshes Swamp Small-sized lakes	+2,400 to +4,507	12,500 (nc)

1 Core zone area – nc = not communicated.

CHAPTER 15
Monte Alén-Monts de Cristal Landscape

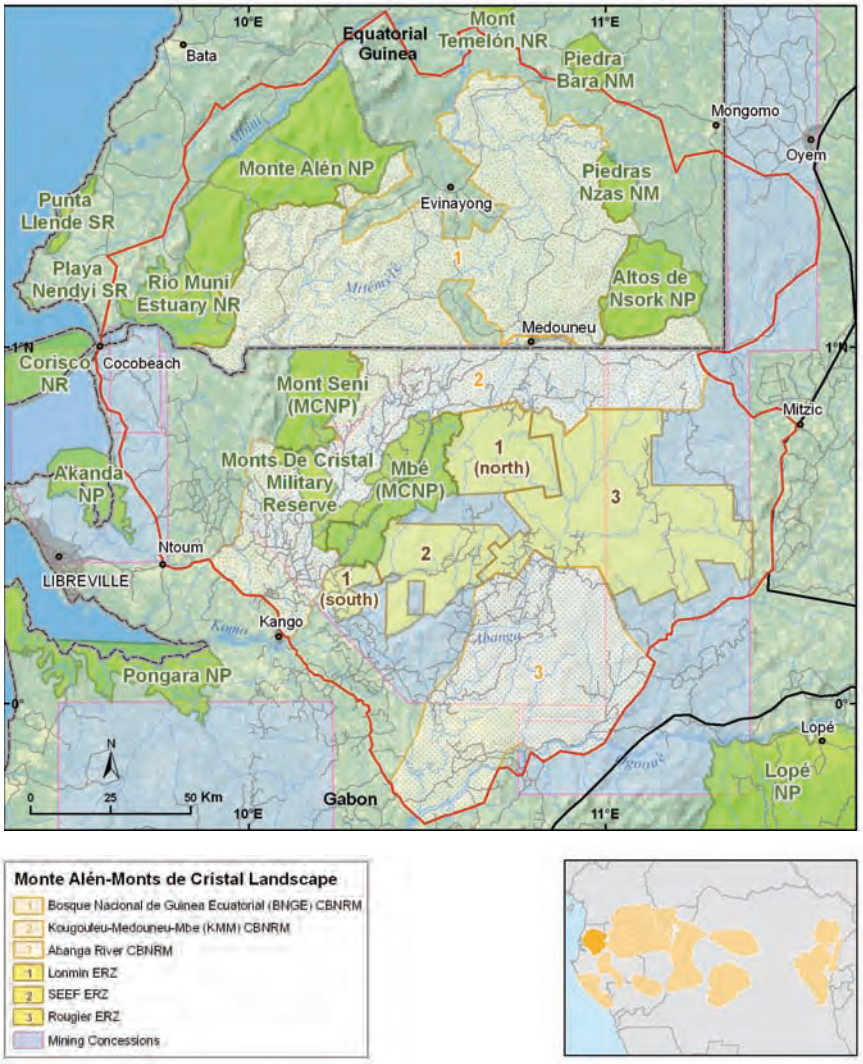
Christopher Kernan and Patrick Mehlman

Land Use Planning

In the Monte Alén-Monts de Cristal Landscape (MA-MC), land use planning is beginning to exert an influence on forest and natural resource management. A landscape land use plan has been designed. In addition, land use plans for the Monte Alén National Park (PNMA), Altos de Nsork National Park (PNAN), Monts de Cristal National Park (PNMC), *Réserve Militaire Monts de Cristal* (RMMC), Bosque Nacional Guinea Ecuatorial (BNGE), Abanga River (AR), Lonmin, Rougier, and SEEF macro-zones are in various stages of being designed, adopted or implemented The Rougier extractive zone land use plan, although a private document unavailable to the public, is fully convened, designed and being implemented on schedule.

In the Monte Alén segment of the landscape, a land use plan for PNMC is the highest priority objective of ECOFAC, which will accomplish this by contracting an external consultant to work with the PNMA planning team. ANDEGE, an Equatorial Guinean environmental NGO, leads a PNAN land use planning team that has drafted a PNAN land use plan and in 2009 will present, discuss, and revise the plan with the participation of PNAN stakeholders.

The BNGE planning team has developed management objectives and guidelines for a BNGE land use plan. The declared purpose of BNGE is to support both biodiversity conservation and viable economic opportunities for local communities using natural resources sustainably. The BNGE planning team has proposed BNGE boundaries that would protect three large forest blocks. The team will present these boundaries and the land use plan to stakeholders in a series of community meetings in 2009 and will revise both in response to their participation. The BNGE planning team will then prepare legal and technical documents needed for Equatorial Guinea's parliament and the government to create formally BNGE. As supporting sustainable economic activities will be a management focus of BNGE, CI and ANDEGE have begun organizing forest product cooperatives associated with BNGE community forests *("Reservas de Poblados")* and working with these cooperative to develop sustainable harvesting plans.



Sources: CI, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson US National Park Service.
Figure 15.1: Macro-zones in the Monte Alén-Monts de Cristal Landscape

Land use planning in the Monts de Cristal segment of the landscape is evolving and gradually bringing formal land use planning to more areas of the landscape. WCS is supporting the Gabonese government in establishing a military

Photo 15.1: The main axis of the Mbé sector of Monts de Cristal National Park is formed by the Mbé River basin and its principal tributary, the Abangassa River.

reserve in the PNMC buffer zone (RMMC). This is a new category of PA that will have distinctive land use planning objectives and guidelines. WWF is developing a CBNRM stretching from populated areas along the lower Abanga River north to the isolated forest of the Abanga's headwaters. WCS, WWF, and MBG have been working with botanical data to define strictly protected high biodiversity micro-zones within ERZs and CBNRMs. As a result of this work, Rougier and SEEF have created several of these micro-zones within their timber ERZs.

The most problematic component of the MA-MC landscape land use planning remains a formal mechanism to coordinate land use plan design, adoption, and implementation in the two segments. So far, landscape coordination has been through landscape consortium cooperation, IUCN/CARPE focal point contacts or Gabon-Equatorial Guinea technical exchanges within COMIFAC. The land use planning team has proposed that the Comisión Nacional del Medio Ambiente (CONAMA) is the appropriate body to represent Equatorial Guinea in a formal coordination mechanism, but CONAMA cannot become functional until contradictions and conflicts in Equatorial Guinea's current laws are resolved, which will not happen soon. Equatorial Guinea and Gabon have taken their dispute about the border that runs through the MA-MC landscape to the United Nations.

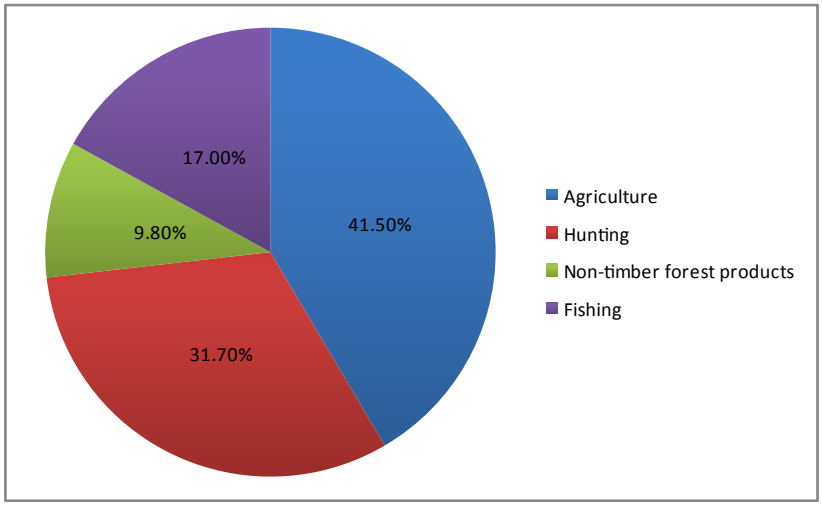
Human Activities

ANDEGE field work in the Monte Alén segment of the Landscape shows that 58.5 % of livelihood activity time requires contact with the forest (Figure 15.2).

The inhabitants of the Monte Alén segment frequently complain of crop damage from forest animals, most often mentioning elephants, gorillas, wild pig, and mandrills. A ban on hunting within protected areas, and a complete ban on hunting primates, appears to these rural people as a particular injustice. They voiced to ANDEGE a demand that an external entity provide a solution. It is evident that forest animals can destroy an individual agriculture plot, but there are no quantitative data to map or calculate the significance of these crop losses.

Monte Alén villagers generally understand that protected areas maintain natural resources and usually they voice support for this goal. These rural residents, however, want viable economic alternatives to recompense any restrictions on their use of the forest. Few rural livelihoods can compete with cash-paying jobs in Bata and Malabo and many villagers of working age have already moved to these urban centers. Easy travel between villages and cities on new, all-weather roads mean that even rural residents are increasingly part of the urban economy rather than one based on direct exploitation of the forest or the soil. In Sendje, for instance, most bushmeat hunters now work in Bata, which is only 30 minutes away on paved roads.

ANDEGE has proposed boundaries for the mixed use Equatorial Guinea National Forest (BNGE) that exclude corridors along roads and urban centers (ANDEGE, 2008a). Table 15.1 provides a synopsis of the human population and timber concessions that fall within these boundaries. Population numbers rely on official records and overestimate residents. Sixteen percent of the area is in swidden agriculture or villages; the rest is heavy forest, 38 % within timber concessions. The BNGE is working to design a BNGE land use plan that balances competing land use demands for the area.



Source: Benito Mba Medja, ANDEGE, 2008.

Figure 15.2: Distribution of time spent on alternative economic activities in rural communities of the Monte Alén segment.

Table 15.1: Socio-economic characteristics of the proposed Equatorial Guinea National Forest.

Block	Area	Population	Number of villages	Km of roads	Timber concessions (area)	% forest cover
Block 1	300,000 ha	~10,000	30	215	None active	85
Block 2	138,100 ha	~7,500	15	105	Shimmer Int (47,000 ha) Shimmer Int (10,000 ha) Samage (23,000 ha)	69
Block 3	162,500 ha	~7,500	21	34	Semasa Shimmer (65,350 ha) Shimmer Mongola (39,000 ha) Chilbo (5,500 ha) Mari Luisa Chilbo (2,000 ha)	95
Total	**600,600 ha**	**~25,000**	**66**	**354**	**191,850 ha**	**84**

Source: ANDEGE.

Hunting remains an important human activity in the MA-MC landscape. Bushmeat is a source of nourishment for rural residents and hunting pressure influences the size and distribution of prey populations. WCS recce data suggest that hunting has influenced the distributions of large mammals. Elephants and apes were most abundant in the remote lowland forest of eastern Mont Mbé NP where signs of hunters were scarce. By contrast, northern Mont Seni NP had very few signs of apes, elephants, monkeys or ungulates, but many signs of hunters. Abandoned elephant paths in this sector suggest that elephants had been present in the recent past, but had either been hunted or had moved away. Abandoned elephant paths around the Kinguele area in southern Mont Seni NP suggest a similar effect.

The main road from Libreville to Medounou runs through the Mbé River valley between Mont de Seni and Mont de Mbé. WCS found almost no elephant signs in this area but did find many signs of hunting, especially near Song, Asseng Assala, and nearby villages. WCS found evidence that hunters from Equatorial Guinea were active in Gabon, especially in northern Seni. Most Gabonese people living along the main road, however, did not appear to hunt much further than 5 kilometers from their village.

On 27 October 2007, Equatorial Guinea issued a decree banning the killing, possession, sale, transportation, and eating of any primate species. Awareness of the ban is widespread in the Monte Alén segment. The number of primates for sale in the main bushmeat markets of Bata and Malabo has dropped to one or two animals per week since the ban.

Photo 15.2: Many forest products can be found in African markets.

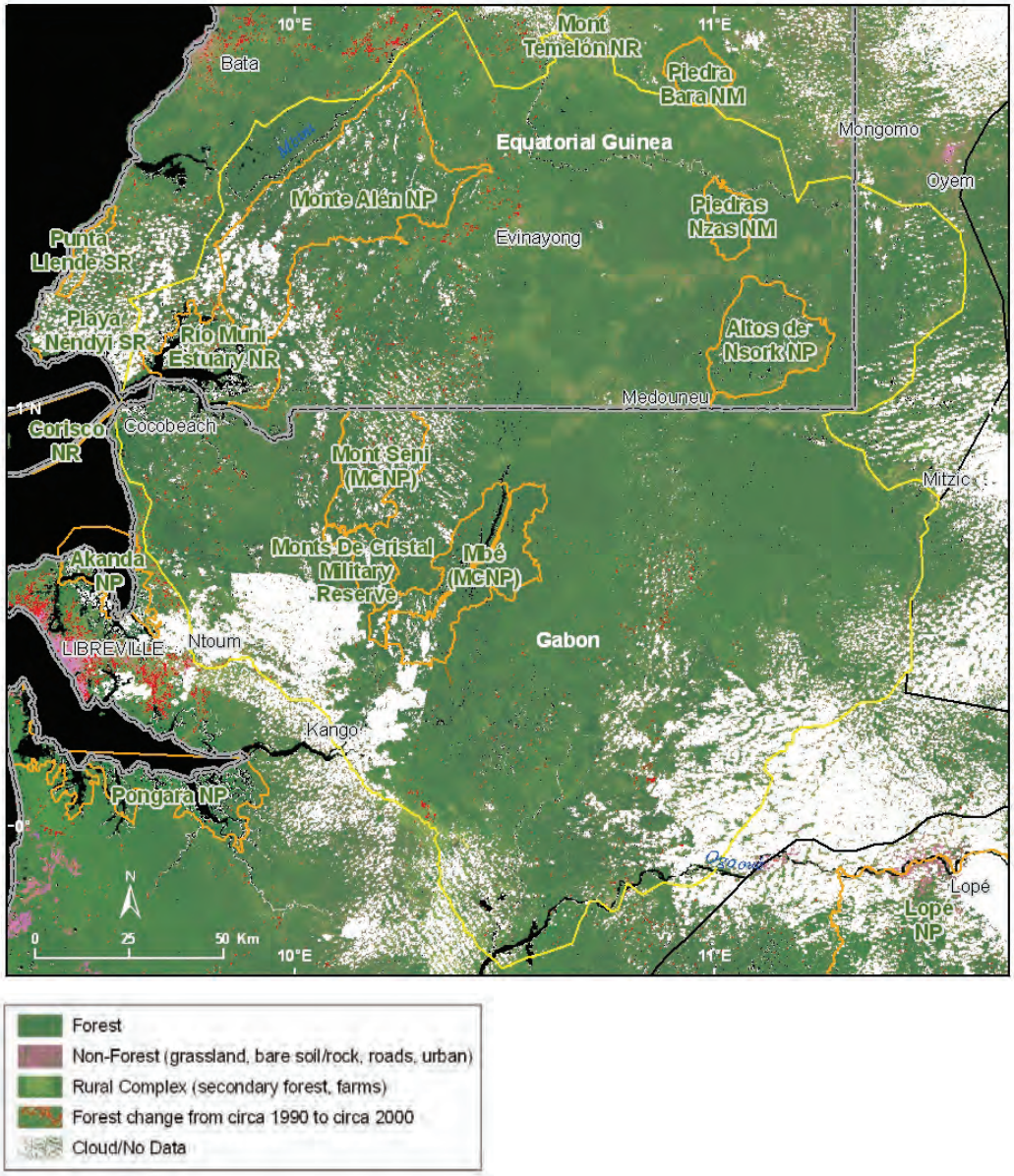
Table 15.2a: Important agricultural products in the Monte Alén segment of Monte Alén-Monts de Cristal Landscape

Agricultural product	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Yucca	Bundle	0.88	Bata, Evinayong, Nsork, local markets in EG, local markets in Gabon	Mar-June 2008	Interviews with village residents producers	ANDEGE, 2008b
Banana	Hand (20)	6.25	Bata, Evinayong, Nsork, local markets in EG, local markets in Gabon	Mar-June 2008	Interviews with village residents producers	ANDEGE, 2008b
Malamba	Liter	0.50	Bata, Evinayong, Nsork, local markets in EG, local markets in Gabon	Mar-June 2008	Interviews with village residents producers	ANDEGE, 2008b

Table 15.2b: Bushmeat trade in the Monte Alén segment of Monte Alén-Monts de Cristal Landscape

Bushmeat species	Unit	Purchase price/ unit ($)	Primary destinations	Date	Data collection	Sources
Brush tailed porcupine *(Atherurus africanus)*	Whole	2.50	Malabo, Bata, and Ebibeyin	Nov 2007-Mar 2008	Interviews in the villages of Sendje I, Mitom, Emangos, Ncoho, Mitong and Kuma; Market surveys of bushmeat for sale in Malabo, Bata, and Ebibeyin	ANDEGE, 2008c
Blue duiker *(Cephalophus monticola)*	Whole	17.50	Malabo, Bata, and Ebibeyin	Nov 2007-Mar 2008	Interviews in the villages of Sendje I, Mitom, Emangos, Ncoho, Mitong and Kuma; Market surveys of bushmeat for sale in Malabo, Bata, and Ebibeyin	ANDEGE, 2008c
Emin's pouched rat *(Cricetomys emini)*	Whole	10.00	Malabo, Bata, and Ebibeyin	Nov 2007-Mar 2008	Interviews in the villages of Sendje I, Mitom, Emangos, Ncoho, Mitong and Kuma; Market surveys of bushmeat for sale in Malabo, Bata, and Ebibeyin	ANDEGE, 2008c

Forest Cover



Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 15.3: Composite Landsat satellite image of the Monte Alén-Monts de Cristal Landscape

Table 15.3: Forest cover and forest loss in the Monte Alén-Monts de Cristal Landscape from 1990 to 2000

	Forest area			Forest loss			
Landscape area	1990 (km^2)	2000 (km^2)	2005 (km^2)	1990-2000 (km^2)	1990-2000 (%)	2000-2005 (km^2)	2000-2005 (%)
26,606	26,229	26,101	N/A	128	0.49	N/A	N/A

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

Table 15.4: Vegetation cover and vegetation loss in Río Muní, Equatorial Guinea in 1997

Vegetation type	Original area (ha)	1997 area (ha)	Percentage of original area	Percentage of 1997 area
Lowland moist forest	2,397,662	347,832	92.16	13.37
Degraded lowland moist forest		1,250,000	0.00	48.05
Montane forest	200,538	91,068	7.71	3.50
Degraded montane forest		20,600	0.00	0.79
Secondary forest		546,200	0.00	20.99
Heath and grassland	3,500	3,500	0.13	0.13
Cultivation/settlement		342,500	0.00	13.16
Total	**2,601,700**	**2,601,700**	**100**	**100**

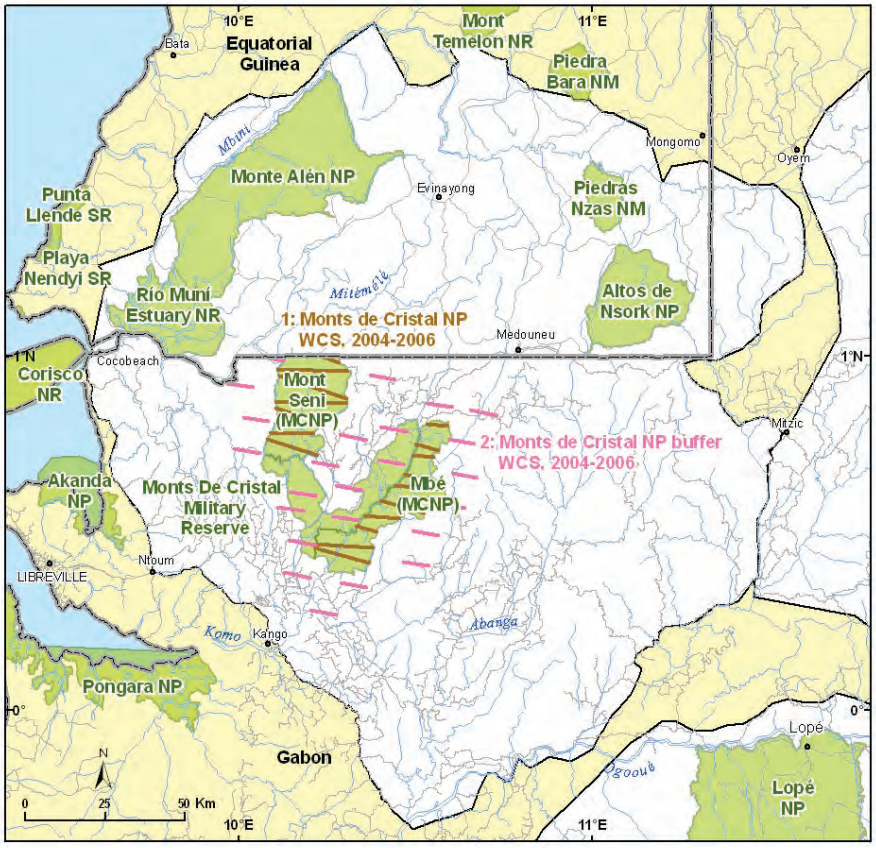
Source: CUREF.

A field verified analysis of forest cover change based on recent, satellite imagery has not been completed for the landscape but Figure 15.3 and table 15.3 show forest cover and loss based on satellite imagery from circa 1990 to 2000. The estimates in table 15.4 are based on a forest ecosystem classification developed by CUREF *(Conservación y Utilización Racional de Recursos Forestales)* and land use maps of the continental part of Equatorial Guinea (Río Muní) derived from a 2001 field-verified interpretation of a 1997 Landsat image.

Table 15.4 includes areas in Equatorial Guinea outside of the MA-MC landscape that are much more heavily deforested than within the Monte Alén segment. The Monts de Cristal segment of the landscape is also less deforested than the Río Muní average. With economic changes occurring in Equatorial Guinea, the rural population is decreasing and forest area may have increased since 1997. The same trend of rural depopulation and forest regrowth may be occurring in the Monts de Cristal segment.

Photo 15.3: The spatial distribution of the liana Duparquetsia orchidacea (family of leguminous plants) is limited to the wettest forests around the Gulf of Guinea. It is a very old species that differentiated before the separation of major sub-families like papilionoïdea, mimosoïdeae and cesalpinioïdeae.

Large Mammal and Human Impact Monitoring



Sources: CI, WCS, UMD-CARPE, OSFAC, FORAF.

Figure 15.4: Biological surveys conducted in the Monte Alén-Monts de Cristal Landscape

Table 15.5: Biological survey results from the Monte Alén-Monts de Cristal Landscape

Survey	Site name	Survey date	Lead organization(s)	Total km of recces	Elephant presence	Elephant dung pile encounter rate	Ape presence	Ape nest group encounter rate	Human sign
1	Monts de Cristal NP, Gabon	Dec 2004-Jan 2006	WCS	222	Yes	2.97/km	Yes	0.45/km	0.54/km
2	Monts de Cristal NP, Gabon	Dec 2004-Jan 2006	WCS	185	Yes	3.56/km	Yes	0.53/km	0.95/km

Source: Aba'a Nseme, 2006.

WCS completed 407 km of recces surveys in PNMC and its buffer zones (including part of the Kougouleu-Medouneu-Mbe (KMM) CBNRM) from December 2004-January 2006. Field workers recorded and georeferenced all signs of humans and large wildlife. Overall, the encounter rates for signs of large mammals or hunters were not statistically significant between the parks and their buffer zone. Mont de Mbé NP, however, had significantly more ape nests, elephant paths and duiker dung than Mont de Seni NP.

Elsewhere in the landscape, the MA-MC consortium has informally surveyed knowledgeable biologists, local community members, and hunters on the status of the MA-MC indicator species in the landscape.

Elephant densities in the Niefang range are known to be some of the highest in Central Africa (Smithsonian Institution, undated). Elephants are present in much of the Monts de Cristal segment with several areas of high density in remote forests, for instance, the Rougier ERZ and the Abanga Forest Block. But there are also areas where elephants are rare perhaps due to hunting pressure or the disturbance of human presence. Local people report gorillas and chimpanzees present in all of the landscape's less accessible forest with gorillas more common than chimpanzees. Recent visits to falls of the Río Wele documented healthy populations of Goliath frogs; reports of populations on the lower Ntem are several years old. In the last year Guineans have reported manatee in the Estuario Río Muní, Río Mbini, and Río Campo. WWF has documented manatee in the Abanga River.

Special Interest

Missouri Botanical Garden (MBG) research has discovered traces of climatic change in the Monte Alén-Monts de Cristal Landscape's remarkable botanical richness and has used this information to recommend changes in the design of the landscape's system of protected areas.

The area of African wet forest has expanded and contracted several times. Today's natural extent is less fragmented and larger in area than it was several times during the Holocene and Pleistocene, but smaller in area than occurred 8,000 years ago.

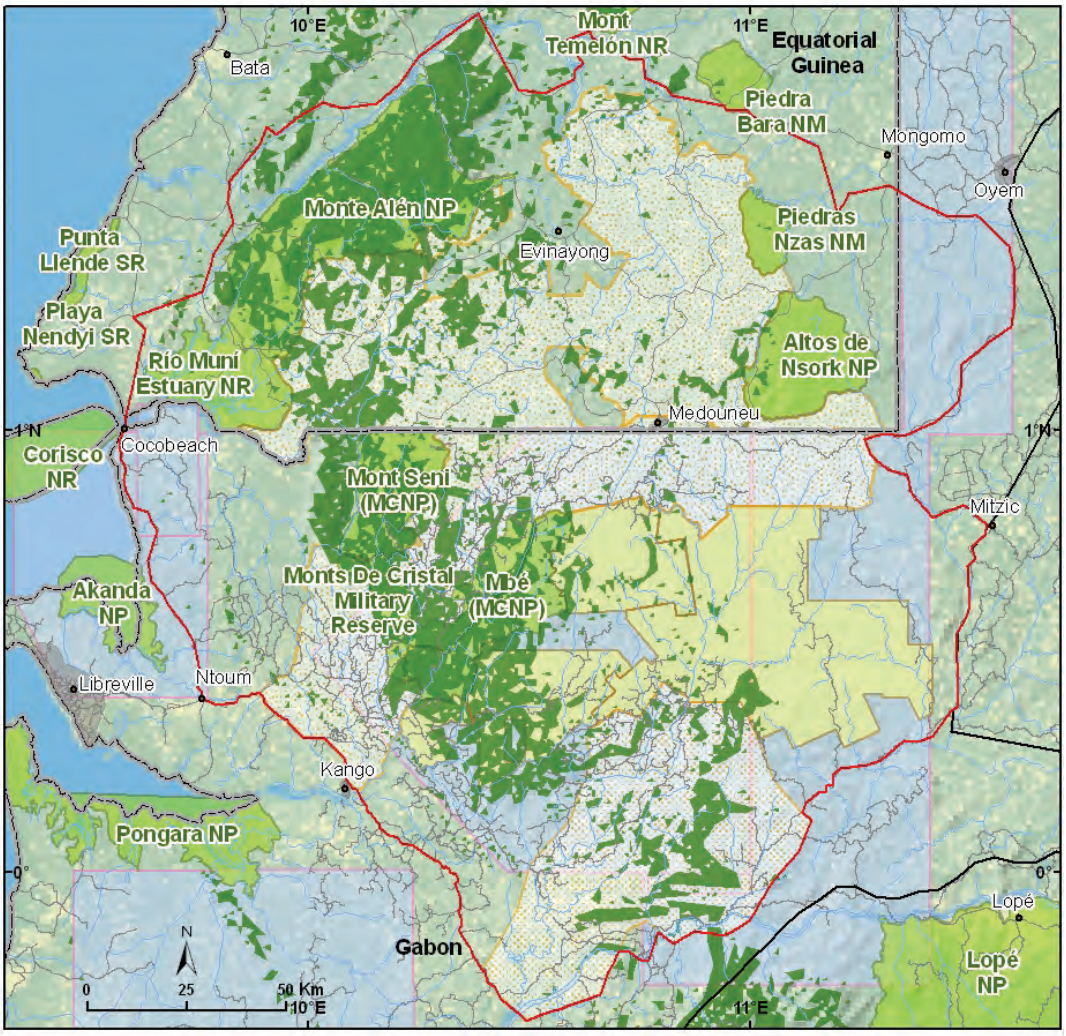
These climatic cycles have greatly influenced MA-MC's patterns of plant richness and endemism. As wet forest disappeared, many plant species retreated to semi-isolated ecological islands of wet climate, conditions that also favored speciation. When the climate turned wet again, these refugia were the centers of forest expansion. Conversely, when wet forest expanded, dry vegetation species retreated to their own climatic refugia and expanded from these in drought phases.

The MA-MC landscape includes both types of refugia. A large area of climatically stable forest (CSF) never completely lost its wet forest. Inselbergs were refugia for drought-adapted species.

Global warming and economic development are now re-fragmenting and reducing the area of wet forests. CSF is again becoming critical for the regional survival of wet forest species. Inselbergs are potential centers of dry-adapted vegetation expansion. MBG has pointed out that mapping and protecting the integrity of CSF and inselbergs in the landscape is a long-term climate change strategy for the landscape. MBG has been detecting the locations of CSF embedded in the landscape's general forest matrix through careful floristic mapping.

Photo 15.4: To the north-east of Monts de Cristal there are many inselbergs, clusters of granite rock that formed about 2.5 billion years ago.

Photo 15.5: The understory abounds with small streams that originate from steep slopes.

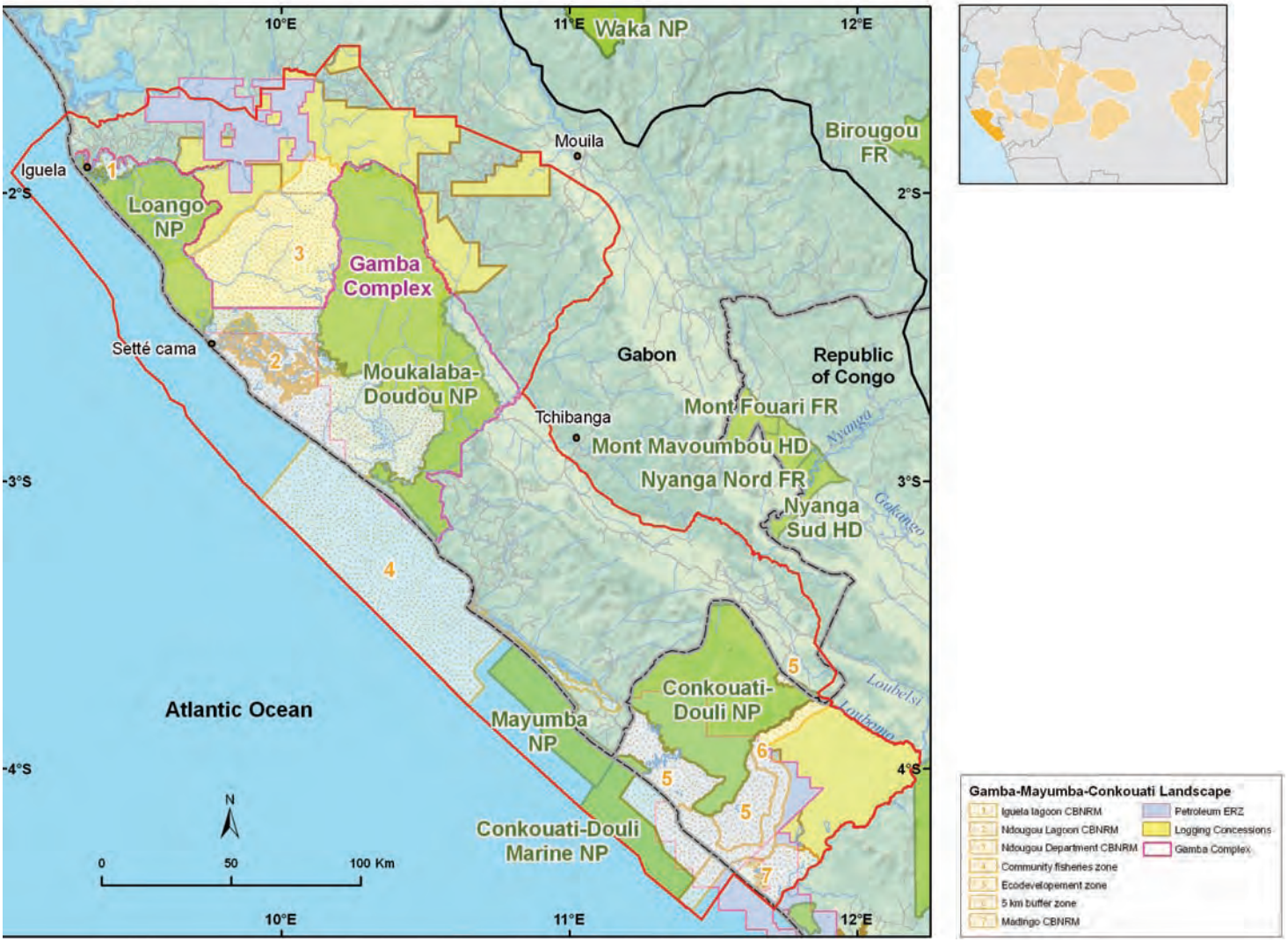


Sources: MBG, CI, UMD-CARPE, OSFAC, IUCN, Tom Patterson US National Park Service.
Figure 15.5: Climatically stable forest in the Monte Alén-Monts de Cristal Landscape

CHAPTER 16
Gamba-Mayumba-Conkouati Landscape

Bas Huijbregts, Stéphane Le Duc Yeno, Hilde Vanleeuwe, Richard Parnell, Ruth Starkey, Bas Verhage, and Benoit Demarquez

Land Use Planning



Sources: WWF, WCS, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.
Figure 16.1: Macro-zones in the Gamba-Mayumba-Conkouati Landscape

Since 2006, coordinated land use planning has shown a considerable degree of advancement. Key stakeholders in the Landscape, including park wardens of all four national parks, international conservation organization representatives, and resource persons from key technical ministries have held technical meetings in Mayumba, Libreville and Brazzaville resulting in the establishment of a formalized Technical Management Committee (TMC). The TMC working agenda has crystallized around the following key themes: (i) regional coastal surveillance and oil pollution surveillance and response; (ii) transboundary protected area management and creation of a bi-national protected area; and (iii) turtle protection.

Currently, in the framework of the Landscape land use plan, a coastal fisheries and oil pollution surveillance strategy is being finalized. Regarding fisheries surveillance, concerted action with technical ministries, including the department of fisheries, has focused on training, the building of onshore and boat-based surveillance, intervention capacity and lobbying the Departments of fisheries to actively address illegal fishing.

Our approach to coastal management and control has generated great interest from the US Navy. A training program for coastal sector employees (including Navy and fisheries boat pilots, ground surveillance staff, administration staff, etc.) was held by US Navy trainers in Mayumba in February 2008. Follow-up training programs, including assistance with regard to remote sensing of fishing vessels in waters beyond the range of current patrol vessels, are being developed. Terrestrial surveillance posts have been set-up in Conkouati (three), Mayumba (two), Sette Cama and Iguela. A fisheries support program funded by the African Development Bank for Gabon will further increase coastal surveillance capacity in two sites. Since July 2007, 35 reports of illegal offshore fishing have been compiled, which together with articles in the popular press, have led to increased public awareness of the problem of illegal fisheries in the region.

In April 2008, the first Pilot Committee meeting was held with all stakeholders from the Republic of Congo section of the Landscape. Given the global rise of oil and gas prices, oil and gas exploration and production activities continue to increase rapidly throughout the Landscape. Since 2006, on- and off-shore seismic campaigns have been carried out in several areas, including Loango National Park (by Sinopec) and Conkouati National Park (by Maurel & Prom and Perenco). An important effort in Gabon has been WCS/WWF involvement in the development and audit of the environmental and social management plan of the oil company Sinopec with regards to their exploration activities in Loango National Park in 2006 and 2007. A coastal sensitivity map is being finalized by Landscape partners. Lobbying is focused on delaying proposed seismic acquisition in the Dussafu Marin PSC offshore permit, currently scheduled during the upcoming humpback whale migration. Upcoming scheduled exploration activities for onshore permits between Loango and Moukalaba-Doudou national parks are being monitored.

Particular attention continues to be given to the monitoring and protection of marine turtles, and in particular to leatherbacks, for which the beaches of the Gamba-Conkouati Landscape constitute the world's most important nesting site. During the turtle nesting period (September – April) beaches were extensively monitored by dedicated field teams in Conkouati, Mayumba, Gamba and Iguela. In order to reduce accidental by-catch of turtles, Landscape partners worked with the United States National Oceanic and Atmospheric Administration (NOAA), with additional support from the Marine Turtle Conservation Fund, administered by the United States Fish and Wildlife Service (USFWS) to organize the first ever Turtle Excluder Device (TED) workshop in Gabon in September 2007. This workshop, organized by the Department of Fisheries, saw full participation of government and private sector, and included an 'at-sea' trial. Further TED trials will hopefully lead to legal requirements for TEDs in trawling fisheries.

Lastly, a draft bi-lateral Landscape collaboration agreement, based on existing COMIFAC models in Tridom and TNS, was presented during the Central Africa World Forest Heritage (CAWHFI) steering committee meeting in Brazzaville in March 2008. Overall agreement was reached that given the particular challenges unique to this Landscape (oil and gas and fisheries), Landscape partners will for now focus on the establishment of specific thematic agreements on Landscape oil and gas response, fisheries and the development of a bi-national protected area.

Photo 16.1: The Rhizophora and their stilt roots are characteristic of mangroves.

Photo 16.2: Community fisheries, both in lagoons and at sea can be adversely affected by illegal trawling.

Box 16.1: CAWHFI

The Central Africa World Heritage Forest Initiative (CAWHFI) is the product of a collaboration between the UNESCO World Heritage Centre and its national government and international non-government partners. Its main objective is to improve the management of a select number of natural sites in the Congo Basin that have been recognized for their exceptional value to the world and to further the integration of these sites into their surrounding ecological landscapes.

The protected areas selected by the Initiative are located in three different Congo Basin landscapes: the Sangha Tri-National Landscape, the Dja-Odzala-Minkébé (Tridom) Landscape and the Gamba-Mayumba-Conkouati Landscape.

Despite the growing recognition of the importance of these sites by national governments, national park authorities often have to make do with limited resources. The signature of the *Déclaration de Yaoundé* by most countries of the region, in 1999, clearly indicates their commitment to improving the situation and working towards a more sustainable management of these ecosystems. In collaboration with other members of the Congo Basin Forest Partnership (CBFP), CAWHFI is well integrated into this process and contributes significantly to the COMIFAC Convergence Plan.

CAWHFI is financially supported by the United Nations Foundation, the *Fonds français pour l'Environnement mondial* (FFEM) and the European Commission.

Protected Areas

In Gabon, the Law on National Parks was adopted in September 2007, and the national parks Agency (ANPN) created a month later. The overall management framework document for Gabon national parks *(Plan Cadre de Gestion)*, also adopted in 2007, sets out the overall strategy for the development of Gabon's national parks for the period 2006-2020. Also, the long expected Gabon biodiversity support program funded by the Global Environment Facility (GEF) and administrated by the World Bank was launched in December 2007, and service contracts were signed between the government of Gabon and WCS and WWF. Two-year work plans for Loango, Moukalaba-Doudou and Mayumba National Parks were adopted by ANPN in June 2008.

These long awaited events have created a strong momentum for the finalization of the park management plans, all of which are expected to be endorsed by the end of 2010. In the Republic of Congo, the awaited new agreement between the Government of Congo and WCS regarding Conkouati Douli National Park (CDNP) was signed in January 2008.

Photo 16.3: Since 2001, the logging company CBG has been actively working to assure the long term sustainable development of its concession areas in the northern sector of the Landscape.

Extractive Resource Zones

In Gabon, a collaboration agreement between the Ministries of forestry, the logging company CBG *(Compagnie des bois du Gabon)* and WWF was signed by the Minister in June 2008. The agreement sets out the roles and responsibilities of these partners in the development and implementation of a wildlife management plan for all CBG forest concessions in the northern sector of the Landscape. A draft plan has been submitted by WWF to CBG, for completion by CBG and the Ministry of Forest (MEFEPA) and endorsement during the first semester of 2009.

In the Republic of Congo, a strategy document has been developed for the Madingo-Kayes macro-zone. The zone includes logging concessions of Quator and Foralac and the forest plantations *Eucalyptus Fibre du Congo* (EFC). Maurel & Prom signed an agreement with the CDNP Conservator to pay for 5 surveillance guards in September 2007. Since then, Maurel & Prom has financed 5 of the current 28 guards at CDNP. In the same way, EFC will sign an agreement with the conservator to finance 10 surveillance guards in 2009.

Community-Based Natural Resource Management Areas

Photo 16.4: The Hartlaub's Duck (Pteronetta hartlaubi) is common to the wetlands of Loango National Park and Lake Kivoro - a favorite place for waterfowl of the coastal basin of Gabon.

In Gabon, development of participatory fisheries management plans for communities in the Banio, Ndogo and Iguela lagoons is advancing well. However in the Republic of Congo, the government continues to permit semi-industrial fishing offshore fishing by an Asian fleet, having designated its vessels as "improved dugouts". In Gabon an "After Oil Development Vision" has been developed for the Ndougou Department.

Human Activities

With the continued rise of global oil prices, both onshore and offshore oil and gas exploration and production projects have significantly increased within the Gamba-Conkouati Landscape since 2006. In Gabon, most of the long outstanding exploration permits have now been attributed, and seismic exploration activities started. Abandoned "marginal" fields and wells are being brought back into production by companies specialized in these niche markets. New land use planning issues have arisen. Several oil and gas permits overlap with protected areas as well as with sustainable forest management concessions leading to conflicting land use objectives, as well as to negative impacts, such as increased number of recorded oil spills and an increase in levels of bushmeat hunting.

The explosion of new oil and gas development activities continues to augment local employment opportunities within the Landscape, especially for unskilled temporary labor (road construction, construction of oil and gas pipe lines, pumping stations, base camps, etc.). It is also attracting a specialized workforce from outside the area. Construction of new roads and maintenance of existing roads due to oil activities, combined with an increase in river and lagoon transport, leads to increased mobility of people in the Landscape, and also to an increase in long distance transport of bushmeat.

In Gabon, the impact of the oil industry on human livelihoods in the Landscape is apparent when comparing oil towns such as Gamba, and to a lesser extent, Omboué, with urban areas such as Tchibanga that are outside oil and gas influence. The influx of people attracted by the oil industry has increased the demand for bushmeat and agricultural products. High salaries in this sector also have led to local inflation of commodity prices and salaries in non-related sectors. Attractive oil-related job opportunities furthermore lead to a decrease in local agricultural production. In Con-

go, several sustainable agricultural micro-projects were abandoned in favor of short-term employment during oil and gas exploration.

Community fisheries, both at sea and in lagoons, continue to be adversely affected by the abuse of fishing zones by industrial trawlers. Most illegal trawling in and around Mayumba marine National Park now goes on under the cover of darkness in order to avoid detection and apprehension by the local authorities, who have been quite successful in reducing daytime trawling. In the Republic of Congo, several dozen commercial trawler fishing boats, primarily Asian, declare themselves to be improved dugouts and thus continue to be allowed to fish within the six-marine mile zone reserved for local fishermen.

The pressure from illegal trawlers impacts the sustainability of coastal and lagoon fisheries that support local communities. The long-term impacts are likely to be economic, social and ecological if these trawlers activities are not swiftly brought under control.

Table 16.1: Important agricultural products in the Gamba-Mayumba-Conkouati Landscape

Agricultural product	Unit	Purchase price/unit* ($)	Primary destinations	Date	Data collection	Sources
Cassava (*Manihot esculenta*)	One kwanga	0.55 (village)/ 1.7 (city)	Village/ Pointe-Noire	Sep-07	Household surveys, Kondi, KM4 and Mpella villages	Michelle Wieland, unpublished data
Sardines (dried)	Bowl (~3kg)	6.67 (village)/ 11.11 (city)	Village/ Pointe-Noire	May-08	Permanent WCS employee (ex-poacher), socio-economic team	Guy-Noël Tchitiamouna, unpublished data
Split wood planks	Packet of 10 planks	2.22 (village)/6.66 (city)	Village/ Pointe-Noire	May-08	Permanent WCS employee (ex-poacher), socio-economic team	Guy-Noël Tchitiamouna, unpublished data
Plantain *(Musa paradisiaca)*	100kg/bunch (*régime*)	44.44 /7.77 + CFA500 per additional bunch	Inside Landscape	May-08	Survey of Mayumba market	Mayumba NP ecoguards
Cassava *(Manihot esculenta)*	Stick (*baton*)	0.44 or 0.55 per "*baton*"	Inside Landscape	May-08	Survey of Mayumba market	Mayumba NP ecoguards
Taro *(Colocasia esculenta)*	Sack (usually re-sold by pile) Weight of sack unknown	33.33	Inside Landscape	May-08	Survey of Mayumba market	Mayumba NP ecoguards
Cassava *(Manihot esculenta)*	Sack 50-100kg (exact weight of sack varies)/ 10 sticks (*batons*)	22.22-27.77/ 5.55	Gamba	Jun-08	Market survey	WWF and Loango NP ecoguards
Plantain *(Musa paradisiaca)*	Per kg/pile of 4 fingers	0.77/ 2.22	Gamba	Jun-08	Market survey	WWF and Loango NP ecoguards
Taro *(Colocasia esculenta)*	Sack 50-100kg (exact weight of sack varies)/ 10 sticks (*batons*)	66.66	Gamba	Jun-08	Market survey	WWF and Loango NP ecoguards
Cassava *(Manihot esculenta)*	10 sticks (*batons)*	6.66	Omboué	May-08	Market survey	WCS and *Eaux et Forêts* Iguela team
Banana (sweet)	One bunch (*régime)*	6.66	Omboué	May-08	Market survey	WCS and *Eaux et Forêts* Iguela team
Plantain *(Musa paradisiaca)*	Pile	11.11	Omboué	May-08	Market survey	WCS and *Eaux et Forêts* Iguela team
Cassava *(Manihot esculenta)*	Sack 50-100kg/pile of 10 sticks	17.77/5.55	*Département* of Ndolou villages/ Mandji	Jun-08	Market survey	WCS and *Eaux et Forêts* Mandji team

Agricultural product	Unit	Purchase price/unit* ($)	Primary destinations	Date	Data collection	Sources
Plantain (*Musa paradisiaca*)	Bunch (*régime*)/ pile of 6 fingers	4.44 - 8.88 / 2.22	*Département* of Ndolou villages/ Mandji	Jun-08	Market survey	WCS and *Eaux et Forêts* Mandji team
Taro (*Colocasia esculenta*)	Pile	2.22	*Département* of Ndolou villages/ Mandji	Jun-08	Market survey	WCS and *Eaux et Forêts* Mandji team
Cassava (*Manihot esculenta*)	Sack 50-100kg/ pile of 10 sticks (*batons*)	11.11/4.44	Villages/ Tchibanga	Jun-08	Market survey	Moukalaba-Doudou NP ecoguards and WWF
Plantain (*Musa paradisiaca*)	Per kg	0.44	Villages around Tchibanga	Jun-08	Market survey	Moukalaba-Doudou NP ecoguards
Taro (*Colocasia esculenta*)	Sack 50-100kg	33.33	Tchibanga	Jun-08	Market survey	Moukalaba-Doudou NP ecoguards

*Based on an exchange rate of $ 1 = CFA 450

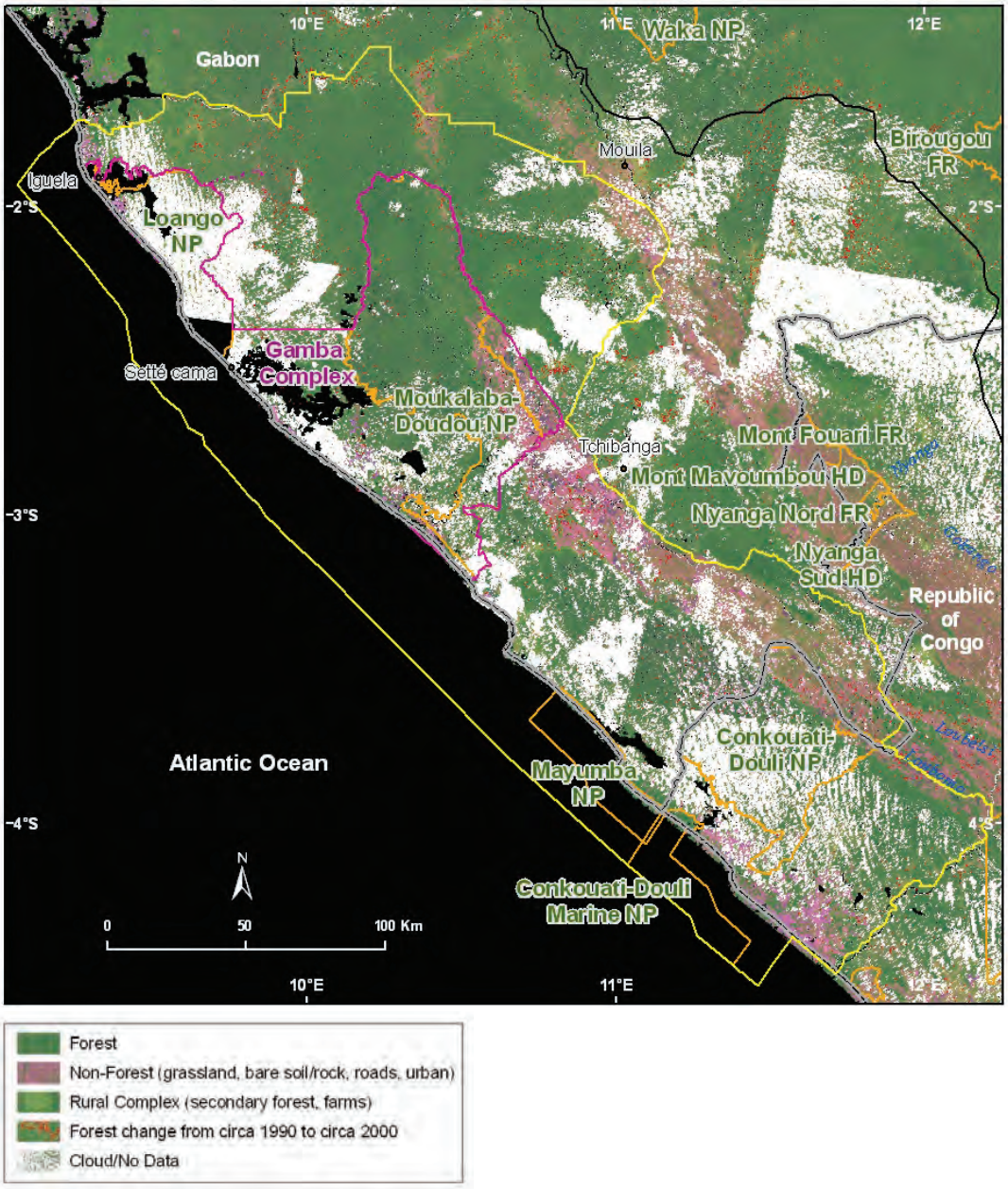
Table 16.2: Bushmeat trade in the Gamba-Mayumba-Conkouati Landscape

Bushmeat species	Unit	Purchase price/ unit* ($)	Primary destinations	Date	Data collection	Sources
Blue duiker (*Cephalophus monticola*)	Whole	5.55 village / 16.55 city	Village / Pointe-Noire	Sep-07	Household surveys: Kondi, KM4 and Mpella villages	Michelle Wieland, unpublished data
Brush-tailed porcupine (*Atherurus africanus*)	Whole	6.67 village / 17.78 city	Village / Pointe-Noire	May-08	WCS, socio-economic team	Guy-Noël Tchitiamouna, unpublished data
Moustached monkey (*Cercopithecus cephus*)	Whole	12.22 village / 24.44 city	Village / Pointe-Noire	May-08	WCS, socio-economic team	Guy-Noël Tchitiamouna, unpublished data
Blue duiker (*Cephalophus monticola*)	Depends on size	6.66 or 7.77	Inside Landscape	May-08	Mayumba market survey	Mayumba NP ecoguards
Brush-tailed porcupine (*Atherurus africanus*)	Depends on size	6.66 or 7.77	Inside Landscape	May-08	Mayumba market survey	Mayumba NP ecoguards
Monkey spp.	Depends on size	5.55/11.11	Inside Landscape	May-08	Mayumba market survey	Mayumba NP ecoguards
Duiker spp. (usually Blue duiker (*Cephalophus monticola*)	Depends on size	11.11/13.33	Gamba	Jun-08	Market survey	WWF and Loango NP ecoguards
Red river hog (*Potamochoerus porcus*)	Per kg / 1gigot	3.33/33.33	Gamba	Jun-08	Market survey	WWF and Loango NP ecoguards
Brush-tailed porcupine (*Atherurus africanus*)	Depends on size	13.33/17.77	Gamba	Jun-08	Market survey	WWF and Loango NP ecoguards
Crocodiles (generally slender-snouted crocodile (*Crocodylus cataphractus*) and dwarf crocodile (*Osteolaemus t. tetraspis*)	Per kg / half piece	2.22/16.66	Gamba	Jun-08	Market survey	WWF and Loango NP ecoguards

Bushmeat species	Unit	Purchase price/ unit* ($)	Primary destinations	Date	Data collection	Sources
Small monkey spp.	Depends on size	11.11/22.22	Gamba	Jun-08	Market survey	WWF and Loango NP ecoguards
Forest buffalo (*Syncerus caffer nanus*)	1 gigot/ Per kg	77.77 or 88.88/11.11	Gamba	Jun-08	Market survey	WWF and Loango NP ecoguards
Fish (fresh)	Per kg	1.77	Omboué	May-08	Market survey	WCS and *Eaux et Forêts* Iguela team
Fish (salted)	Per kg	3.33	Omboué	May-08	Market survey	WCS and *Eaux et Forêts* Iguela team
Red river hog (*Potamochoerus porcus)*	Per kg	5.55	Omboué	May-08	Market survey	WCS and *Eaux et Forêts* Iguela team
Forest buffalo (*Syncerus caffer nanus*)	Per kg	2.22	Omboué	May-08	Market survey	WCS and *Eaux et Forêts* Iguela team
Blue duiker (*Cephalophus monticola)*	Whole	11.11	Omboué	May-08	Market survey	WCS and *Eaux et Forêts* Iguela team
Duiker spp. (*Cephalophus monticola*, *Cephalophus dorsalis, Cephalophus ogilbyi)*	Depends on size and species	8.88/22.22	Mandji	Jun-08	Market survey	Mandji WWF and *Eaux et Forêts* team
Red river hog (*Potamochoerus porcus)*	Whole/ Per kg/1 hind leg/1 front leg/ rib/lower jaw	100/8.88/26.66 - 33.33/20.00 - 22.22/6.66 - 8.88/ 4.44	Mandji	Jun-08	Market survey	Mandji WWF and *Eaux et Forêts* team
Brush-tailed porcupine *(Atherurus africanus)*	Depends on size	7.77	Mandji	Jun-08	Market survey	Mandji WWF and *Eaux et Forêts* team
Sitatunga (*Tragelaphus spekei)*	Whole/1 front leg/ 1 hind leg	66.66/17.77/ 22.22	Mandji	Jun-08	Market survey	Mandji WWF and *Eaux et Forêts* team
Water chevrotain (*Hyemoschus aquaticus*)	Whole	13.33	Mandji	Jun-08	Market survey	Mandji WWF and *Eaux et Forêts* team
Forest buffalo *(Syncerus caffer nanus)*	Per kg	1.77	Mandji	Jun-08	Market survey	Mandji WWF and *Eaux et Forêts* team
Blue duiker *(Cephalophus monticola)*	Whole	7.77	Tchibanga	Apr-08	Market survey	Moukalaba-Doudou NP ecoguards
Red river hog (*Potamochoerus porcus)*	1 Gigot	15.55	Villages/ Tchibanga	Jun-08	Market survey	Moukalaba-Doudou NP ecoguards and WWF
Brush-tailed porcupine *(Atherurus africanus)*	Whole	11.11	Tchibanga	Apr-08	Market survey	Moukalaba-Doudou NP ecoguards

* Based on an exchange rate of $ 1 = CFA 450

Forest Cover



Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

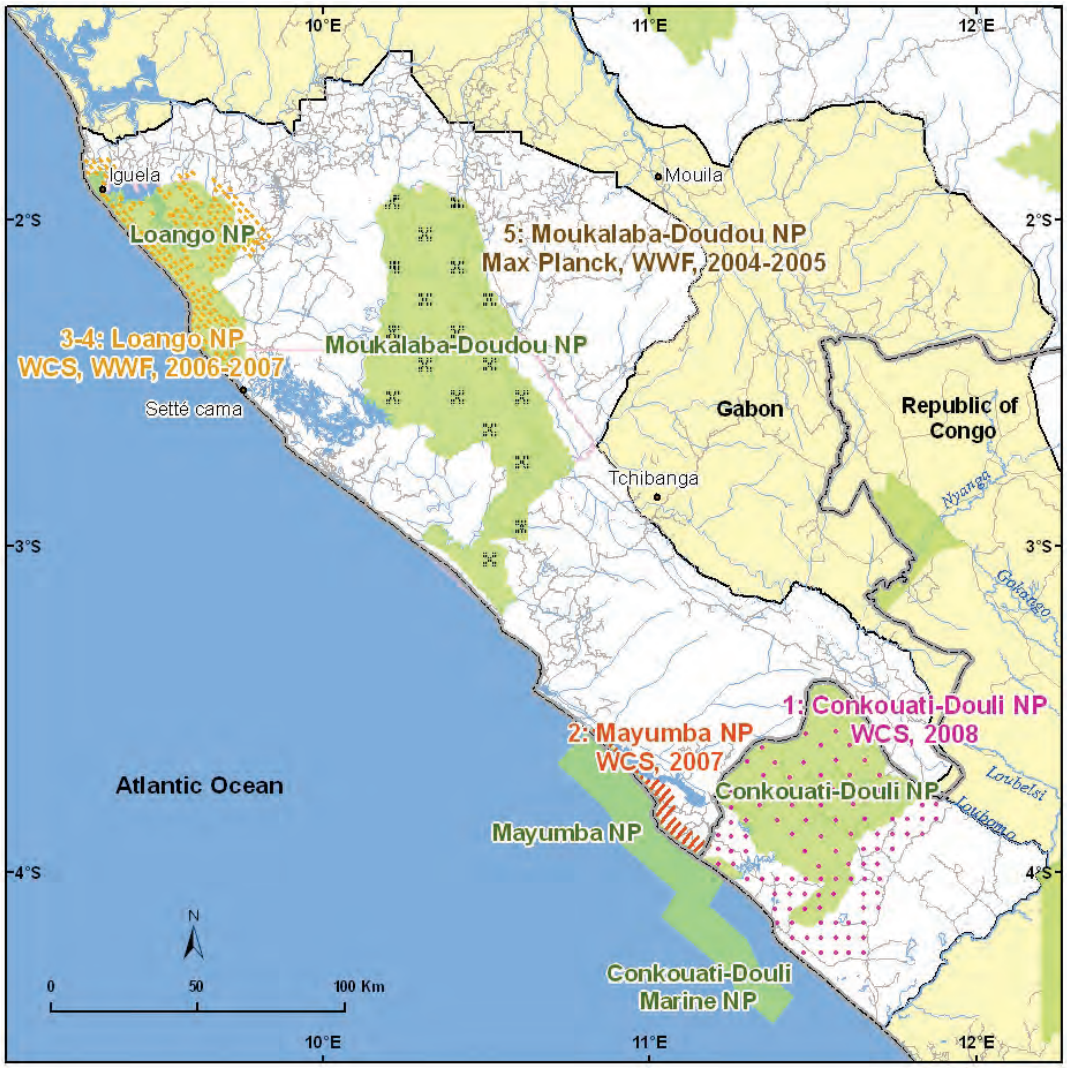
Figure 16.2: Composite Landsat satellite image of the Gamba-Mayumba-Conkouati Landscape overlain with 1990 to 2000 forest loss (in red)

Table 16.3: Forest Cover and Forest Loss in the Gamba-Mayumba-Conkouati Landscape from 1990 to 2000

	Forest area			Forest loss			
Landscape area	1990 (km^2)	2000 (km^2)	2005 (km^2)	1990-2000 (km^2)	1990-2000 (%)	2000-2005 (km^2)	2000-2005 (%)
35,073	29,153	28,709	N/A	444	1.52	N/A	N/A

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

Large Mammal and Human Impact Monitoring



Sources: WWF, WCS, Max Planck, UMD-CARPE, OSFAC, FORAF.

Figure 16.3: Biological surveys conducted in the Gamba-Mayumba-Conkouati Landscape

Special Interest

MEFEPA/CBG/TEREA/WWF

Land use planning and logging concessions' macro-zoning in the Gabon segment of the Gamba-Conkouati Landscape have significantly changed over the last year due to the geographical relocation of activities of the logging company CBG *(Compagnie des bois du Gabon)*, which is the only industrial company within the Gabon segment of the Landscape.

A family company established more than 20 years ago in the south-west of Gabon and owning several different smaller concessions, CBG decided in 2001 to aim at long term sustainable development of their concession areas. Following four years of inventories, studies and consultations, the management plan for the Forestry Concession under Sustainable Management *(Concession forestière sous aménagement durable (CFAD))*, located in the northern periphery of the Gamba Complex of Protected Areas, covering a total surface area of 352,100 ha, was approved by the Ministry of Forestry (MEFEPA). During the same period, CBG also prepared a management plan for a second CFAD within the Landscape, called CFAD-Mayumba (192,000 ha), located in the Mayombe hills near the border with the Republic of Congo.

In March 2007, within the framework of the Central Africa World Heritage Forest Initiative (CAWHFI) and the Congo Basin Forest Partnership (CBFP), a partnership was formalized between MEFEPA, WWF and CBG, with the support of the consultancy firm TEREA, for the implementation of a wildlife management program in all forest areas under CBG management.

This partnership aims to develop and implement a wildlife management plan for all logging concessions under CBG management, with the active participation of all stakeholders concerned (CBG, local populations, local authorities, international NGOs, UNESCO, research institutes, the national forestry school (ENEF) and several oil and gas companies). To achieve this goal, a joint MEPEPA/WWF office was opened in the local town of Mandji in April 2007.

After only one year of operations of the program, very important progress has been made

Photo 16.5: As in many rivers in Gabon, the slender-snouted Crocodile (Mecistops cataphractus) is still quite common on the Bongo River, which flows into Ndougou Lagoon.

Photo 16.6: Sawing on site reduces the volume of wood that has to be transported.

on the ground, and more than half of its objectives have already been met. Current key actions include the finalization and endorsement of the wildlife management plan and the active involvement of oil companies in its execution.

Early 2008, the Ministry of Forestry Economy initiated a series of consultations with CBG and conservation professionals, in order to substitute the CFAD of Mayumba with a new forest area guaranteeing CBG's long term economic survival and the development of its industrialization program, while evolving towards Forest Stewardship Certification (FSC) for all its concession areas as of 2009.

As a result of numerous meetings between the General direction of the Ministry of Forestry, international NGOs and the scientific community, CBG signed a Provisional Management Agreement for Exploitation and Transformation *(Convention provisoire d'aménagement exploitation et transformation (CPAET))* with the forest administration for a concession of 260,500 ha located to the south of their current CFAD.

This area, known for its high biodiversity, partially overlaps two Hunting Domains within the Gamba Complex between Loango and Moukalaba Doudou national parks. The area is also known as the ecological industrial corridor because of the importance of the biodiversity of these forests in relation to ongoing oil production activities by oil and gas companies (Dallmeier *et al.*, 2006; Buij *et al.*, 2007).

Results from biodiversity studies in the area, mainly undertaken by the Smithsonian Institution, as well as results from ongoing forest and wildlife inventories, undertaken by CBG with technical an staffing support from WWF, will serve to establish the management plan for this concession and to identify its High Conservation Value Forests, with the overall aim to propose new zoning for the remaining protected areas within the Gamba Complex.

As a result of this process, about 200,000 ha will be attributed to CBG to constitute a new CFAD, with the remaining surface area to be reclassified as protected area. This zoning will be submitted for endorsement by the Government in order to maintain the important biodiversity of the Gamba Complex and to assure the long term conservation of wildlife populations and biodiversity within the CFAD of CBG and the adjacent protected areas, forming a total forest area of more than 1,500,000 ha under sustainable management.

Table 16.4: Biological survey results from the Gamba-Mayumba-Conkouati Landscape

Survey	Site name	Survey date	Lead organization(s)	Number of transects	Total km of transects	Methodology	Elephant presence	Elephant dung pile encounter rate per km	
1	Conkouati-Douli NP	Jul-Aug 08	WCS	115	114.34	Line-transect foot survey	Yes	1.58 ± 0.26	
2	Mayumba NP	Sep 07	WCS	23	32.57	Annual monitoring of 32 transects in limited terrestrial zone of the park	Yes	4.45 (c.i. 2.69)	
3	Loango NP	Feb 06-Sept 07	WCS, WWF	215	202.643	Line transect	Yes	11.894 ± 0.003	
4	Loango NP	Mar 06-Aug 07	WCS, WWF	302		Point transect	Yes	10.982 ± 0.003	
5	Moukalaba Doudou NP	Apr 04-Jul 05	Max Planck / WWF	439		Point transect	N/A	N/A	

1) Vanleeuwe, 2008.

2) WCS, unpublished report.

3) and 4) WCS and WWF, unpublished report.

5) Max Planck/WWF, undated.

5.1) Kuehl, et al., 2007.

5.2) Kuehl, et al., submitted.

	Elephant dung pile density per km²	Ape presence	Ape nest encounter rate per km	Ape nest density per km²	Ape nest group encounter rate per km	Ape nest group density per km²	Human sign presence	Human sign per km
	339 ± 63	Yes	1.21 ± 0.17	2.23 ± 0.45	1.65 ± 0.17		Yes	3.47 ± 0.41
	N/A	Yes			0.90 (c.i. 0.49)	N/A		3.02 (c.i. 1.69)
	1,217.61 ± 323.75	Yes	1.15 ± 0.06	27.49 ± 10.30			Yes	0.91 ± 0.11
	1,807.37 ± 334.26	Yes	0.77 ± 0.06	59.54 ± 21.80			Yes	0.25 ± 0.09
	N/A	Yes	3.08 ± 0.02	1378.1±170.40	0.7835 ± 0.08	336.84 ± 52.3	No	

CHAPTER 17
Lopé-Chaillu-Louesse Landscape

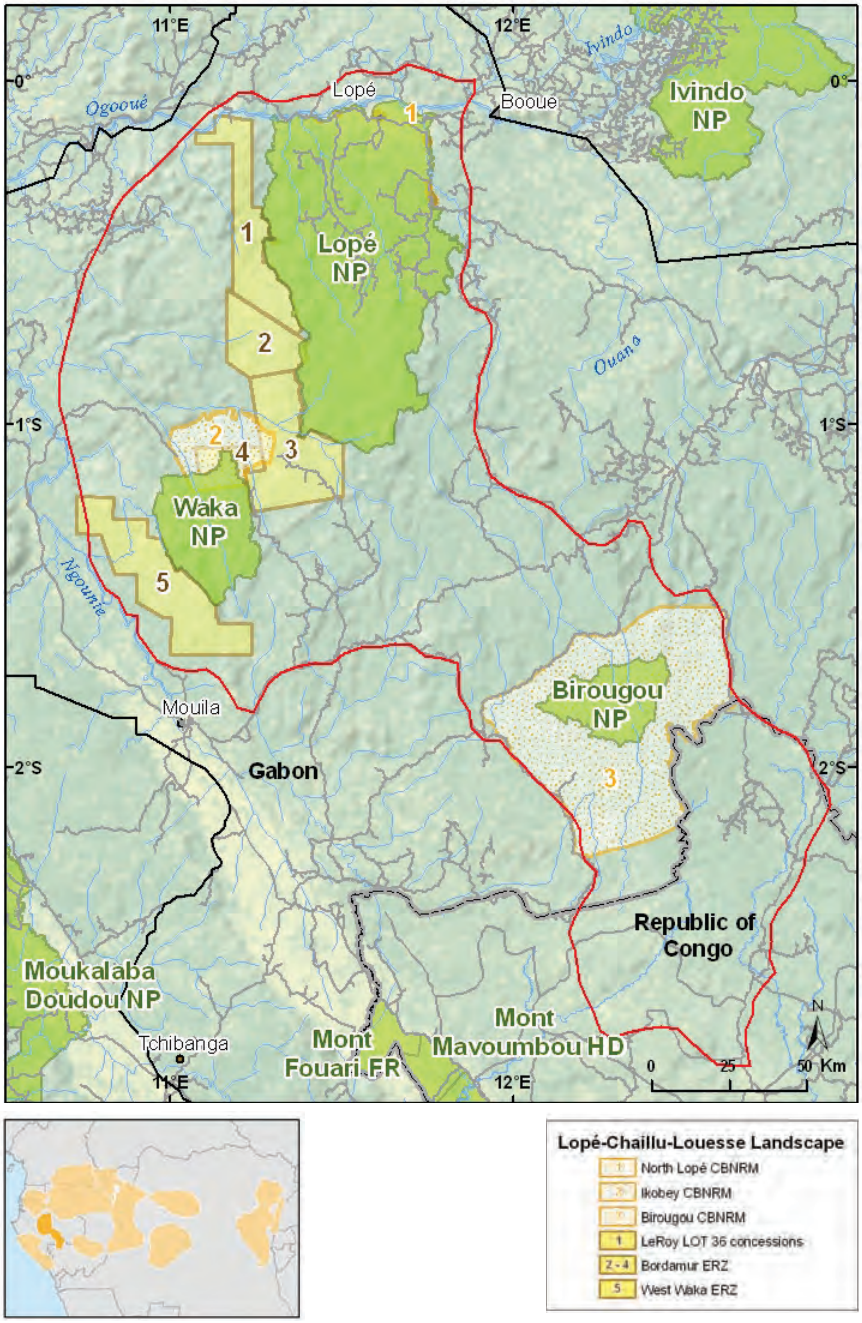
Malcolm Starkey and Fiona Maisels

Land Use Planning

The Lopé–Chaillu–Louesse Landscape covers 35,000 km² and extends over 275 km from north to south and from the center of Gabon to 50 km inside the Republic of Congo. It centers on the Chaillu Massif, a mountainous region that is assumed to have sheltered one of the forest refuges of the Pleistocene, explaining the presence of numerous endemic species.

The macro-zoning of the landscape was implemented by the Gabonese government following the review leading to the 2001 Forestry Code. The Gabonese section of the landscape includes Lopé, Waka and Birougou national parks, which with their buffer zones comprise approximately half of the Gabonese portion of the landscape. Three large logging companies (Bordamur, Leroy Gabon and IFL) have concessions covering the bulk of the remaining landscape outside of the national parks. However, in many areas, community zones, logging concessions and park buffer zones overlap, producing a complex mosaic of land use micro-zones.

In this context, where the large-scale macro-zoning of the landscape is essentially complete, the CARPE consortium has to date focused on data collection, raising awareness and lobbying, which are necessary to produce effective management plans and micro-zoning within these macro-zones. In this section we illustrate the progress being made by highlighting, as an example, the process undertaken in one of the seven macro-zones in this landscape: the Waka-Lopé corridor extractive resource zone.



Sources: WCS, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.

Figure 17.1: Macro-zones in the Lopé-Chaillu-Louesse Landscape

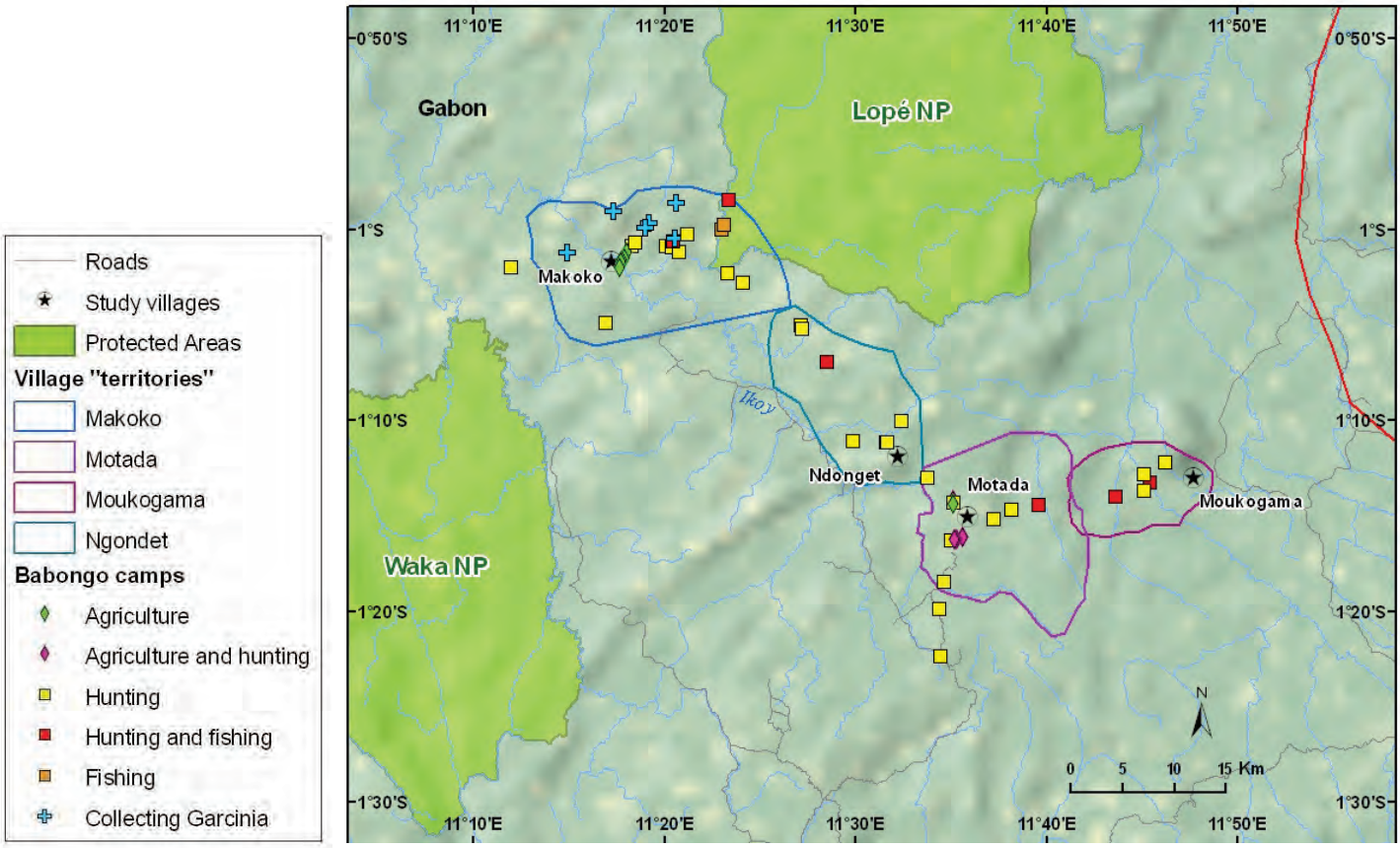
Photo 17.1: The savannas of Lopé National Park are dotted with clusters of rock of indeterminate age, which shelter a very particular flora.

Progress in the Waka-Lopé Corridor

The 2,800 km^2 'corridor' in the remote center of the Lopé-Chaillu-Louesse Landscape, between Lopé and Waka national parks is a highly dissected forest landscape, of which more than half is unlogged old-growth rainforest. The area is extremely remote, with no roads, but it is allocated in a logging concession and so new roads are being opened very rapidly and will soon cover the whole area. A large portion of the corridor falls within the buffer zone of Lopé and Waka national parks.

The forest corridor is inhabited by the Babongo pygmies, who live in isolated forest camps and villages. No reliable data on the number, location or economy of these villages existed. Indeed, they do not figure in national census reports (including the census of 2003) or on official maps. Such basic information is clearly an essential prerequisite for effective land use planning and obtaining it was a priority for the CARPE consortium. To investigate the situation, WCS carried out a systematic participatory mapping survey, including 6 field missions, covering over 400 km on the footpaths of this remote forest area. During the survey, four main villages were located and 55 forest camps were mapped. Given the remote nature of the terrain, and the need to clearly explain and receive the consent of the villages concerned, this process took many months.

It was found that approximately 350 Babongo pygmies live in these villages and camps (not including those living in road-side villages), subsisting mainly from small-scale agriculture and what the forest can provide. Although primarily a subsistence economy, there is limited bushmeat commerce in the south and east of the area, and considerable commerce of the bark of *Garcinia cola* (a stimulant, used for fermenting local palm wine) in the north. Consultation meetings were held in each of the four main villages, and follow-up meetings permitted the first-ever contact between national park representatives and these villages.



Sources: WCS, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.

Figure 17.2: Locations of 55 forest camps and 4 main forest villages mapped in the remote center of the landscape

Following contact with the population of the area and preliminary evaluation, work has progressed on two parallel tracks: 1) enhancing the local population's capacity to engage with the land use planning process and 2) continuing to collect data on the different values of the forest in order to inform the land use planning process. The capacity building activities have been subcontracted to the Indigenous Peoples of Africa Coordinating Committee (IPACC), who have extensive experience in the field. IPACC supports the creation of local civil-society associations, continues with the process of participatory mapping and provides technical support.

The data collected to support the micro-zoning process included: 1) baseline data on wildlife distribution and densities (conducted by WCS) and 2) data on more general forest diversity notably botanical diversity (conducted by MBG). From the wildlife surveys, the ape population density was estimated at 0.8 individuals/km^2 (95 % CI 0.54-1.2), indicating a population of over 2,000 individuals, and elephant density was estimated at 0.45 individuals/km^2 (95 % CI 0.26-0.78). These densities were comparable to those in the adjacent national parks and indicate that these previously neglected areas have a considerable conservation value. The botanical surveys have identified areas of exceptionally high plant diversity, including the presence of new and rare species, especially on higher ground.

Photo 17.2: Data encoding follows data field collection.

Implications and Land Use Planning Follow-up

This zone illustrates the complexity of the land use planning process: the corridor is an area essential for the livelihoods of marginalized communities, and it also has high economic value, wildlife value and biodiversity value. While the area is at present remarkably intact, logging has the potential to seriously impact both the livelihoods of local populations and the wildlife and biodiversity value of the zone. The next steps will be to convene a stakeholder meeting at which the data gathered can be presented for validation and to launch the next phase of the planning process, which will focus on reaching agreement on micro-zoning. This example demonstrates the approach that has been taken in this zone, and illustrates the overall landscape approach of planning based on sound data.

Institutional Change and the Land Use Planning Process

As indicated above, the past years have permitted a considerable amount of data to be collected and discoveries to be made that will provide the basis for the land use planning process in the landscape. The emphasis over the coming years will be to use this information to develop and implement effective land use plans that take into account the needs of local communities, the private sector and the unique and diverse flora and fauna of the landscape. The recent (January 2008) establishment of a National Parks Agency, with a firm mandate to manage the parks and to oversee activities in the park buffer-zones (together comprising about 14,000 km^2 or nearly half the landscape), provides a sound legal basis for developing and implementing many of these plans. In community areas, several key legal instruments pertaining to land use planning remain to be

published. In particular, this includes decrees on the establishment of community forests and on the management of village hunting zones. Until these are published, management of community lands has to be based mostly on voluntary local agreements. This is a challenging process, but one that is essential if the rate of degradation of the landscape's forests is to be reduced for the benefit of both the people who depend on them and the landscape's globally significant flora and fauna.

Photo 17.3: Patrolling Lopé National Park involves traversing a diverse set of habitats.

Human Activities

The human population of the landscape is essentially divided into three zones. In the north, a complex mixture of ethnic groups including Okandé, Simba, Mbahouin, Makina and Saké live in 7 villages along the Ogooué and Offoué rivers. In the center of the landscape the population is a mix of Massango and Mitsogho – closely related but linguistically distinct ethnic groups – located along the roadsides, with a small population of Babongo pygmies maintaining a traditional lifestyle in forest villages and mixed with the Bantu population. The southern portion of the landscape, from approximately 1.5 degrees south through the Congolese sector, is inhabited mainly by the Nezbi (Banjabi) ethnic group, many of whom who live in larger villages than the inhabitants in the center and north of the landscape. Dispersed across the landscape are small pockets of Akélé. In both the northern and the southern sections there are also small pockets of Babongo who have switched to a more sedentary lifestyle and now live in fixed villages. As elsewhere in Gabon, the four main administrative centers in the landscape (Lopé, Iboundji, Mimongo and Mbigou) include a cosmopolitan population with representatives of most of the other major ethnic groups in Gabon, as well as an array of West African traders.

Despite the ethnic diversity, the defining feature of the landscape is its low population density. Road maintenance in the wet and steeply dissected center of the landscape is poor, and most trade is outside of the landscape rather than across it. For this reason, most economic opportunities are in administrative and commercial centers on the edges or just outside the landscape and there is a gradual but noticeable movement of people (particularly in the economically active segments of the population) out from the center of the landscape. Six large forestry camps, which comprise a significant portion of the population of the landscape, and contain cosmopolitan populations, are the exception to this trend, causing people to move to formerly remote areas in the center of the landscape.

Note the relative lack of men in the 15-25 and 25-35 age classes. Such population pyramids are typical in villages all over Gabon (and are frequently more pronounced than this example) and result from young economically active members (more frequently men), moving away from the village to seek opportunities in logging camps and urban centers outside the landscape.

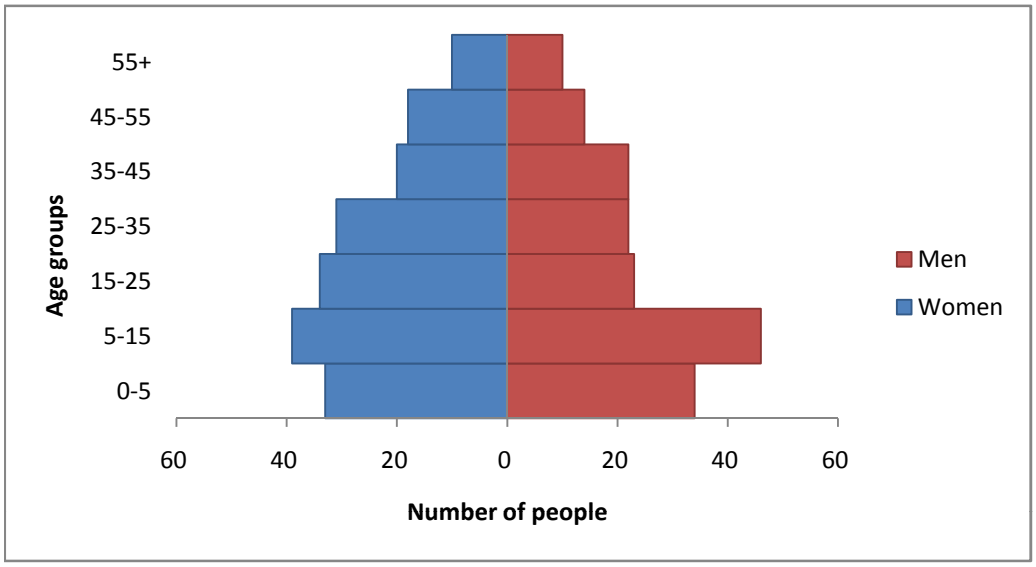


Figure 17.3: Population distribution in Babongo villages in the center of the Landscape. The relative lack of men in the 15-25 and 25-35 year-old cohort is representative of age pyramids in the villages of Gabon (and often even more striking than in this example). The structure of this pyramid is the consequence of the departure of economically active young men from their villages (often in search of better income) to logging camps and urban centers outside of the Landscape.

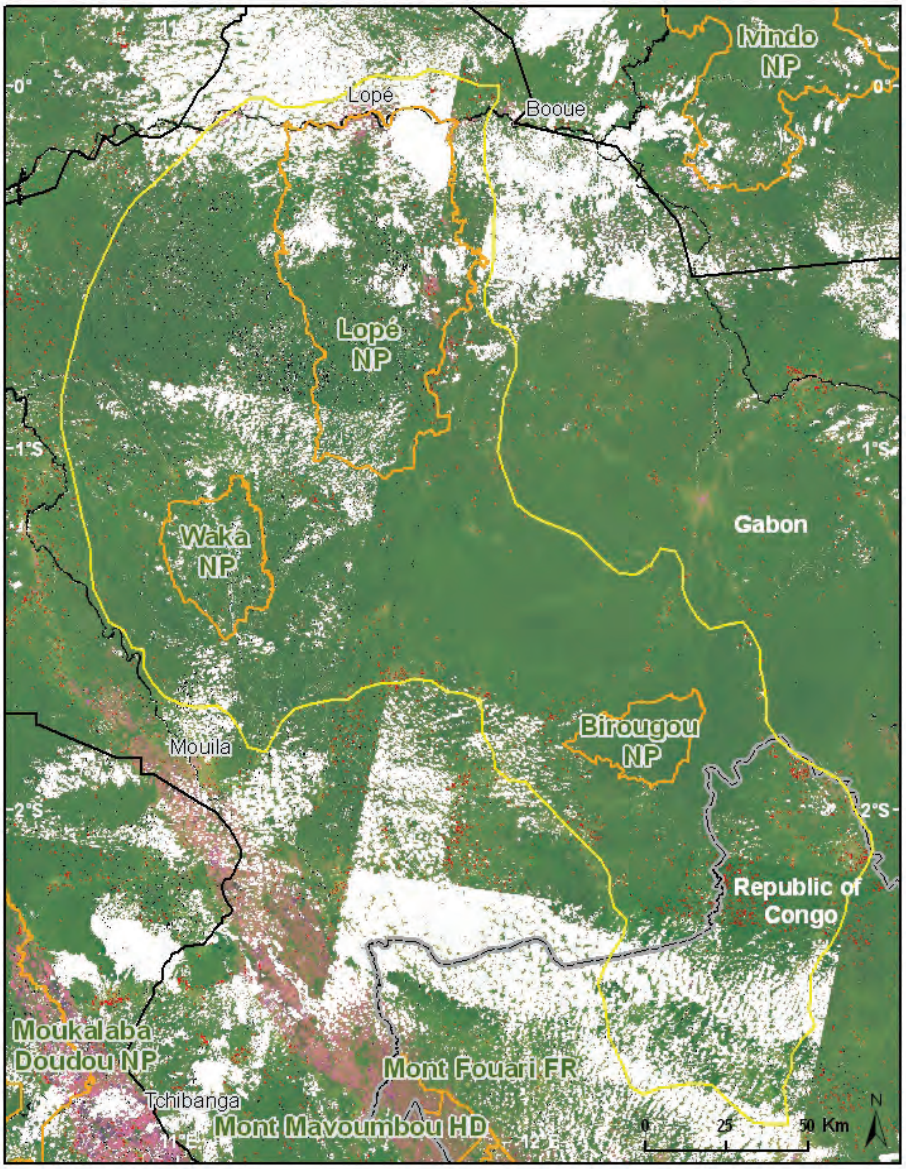
Table 17.1a: Important agricultural products trade in the Lopé-Chaillu-Louesse Landscape

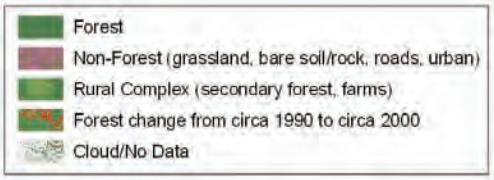
Agricultural product	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Birougou villages						
Sugar cane (*Saccharum*) wine	Liter	0.76		2005-2006	Household surveys, 620 households	Parks and People Database, Boston College
Manioc (*Manihot esculenta*) *batons*	Stick *(Baton)*	0.82		2005-2006	Household surveys, 620 households	Parks and People Database, Boston College
Manioc (*Manihot esculenta*) tubers	Sack	2.22		2005-2006	Household surveys, 620 households	Parks and People Database, Boston College
Waka villages						
Sugar cane wine	Liter	1.05		2005-2006	Household surveys, 712 households	Parks and People Database, Boston College
Palm wine	Liter	0.80		2005-2006	Household surveys, 712 households	Parks and People Database, Boston College
Manioc tubers	Sack	6.94		2005-2006	Household surveys, 712 households	Parks and People Database, Boston College

Table 17.1b: Bushmeat trade in the Lopé-Chaillu-Louesse Landscape

Bushmeat species	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Birougou villages						
Blue duiker (*Cephalophus monticola)*	Whole animal	5.92	Libreville	2005-2006	Household surveys, 620 households	Parks and People Database, Boston College
Brush-tailed porcupine (*Atherurus africanus)*	Whole animal	5.80	Libreville	2005-2006	Household surveys, 620 households	Parks and People Database, Boston College
Various « red duikers » (*Cephalophus dorsalis, C. callipygus, C. nigrifrons,* and *C. ogylbyi)*	Whole animal	17.50	Libreville	2005-2006	Household surveys, 620 households	Parks and People Database, Boston College

Forest Cover





Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 17.4: Composite Landsat satellite image of the Lopé-Chaillu-Louesse Landscape overlain with 1990 to 2000 forest loss (in red)

Table 17.2: Forest cover and forest loss in the Lopé-Chaillu-Louesse Landscape from 1990 to 2000

	Forest area			Forest loss			
Landscape area	1990 (km²)	2000 (km²)	2005 (km²)	1990–2000 (km²)	1990-2000 (%)	2000-2005 (km²)	2000-2005 (%)
34,770	33,845	33,647	N/A	198	0.59	N/A	N/A

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

Large Mammal and Human Impact Monitoring

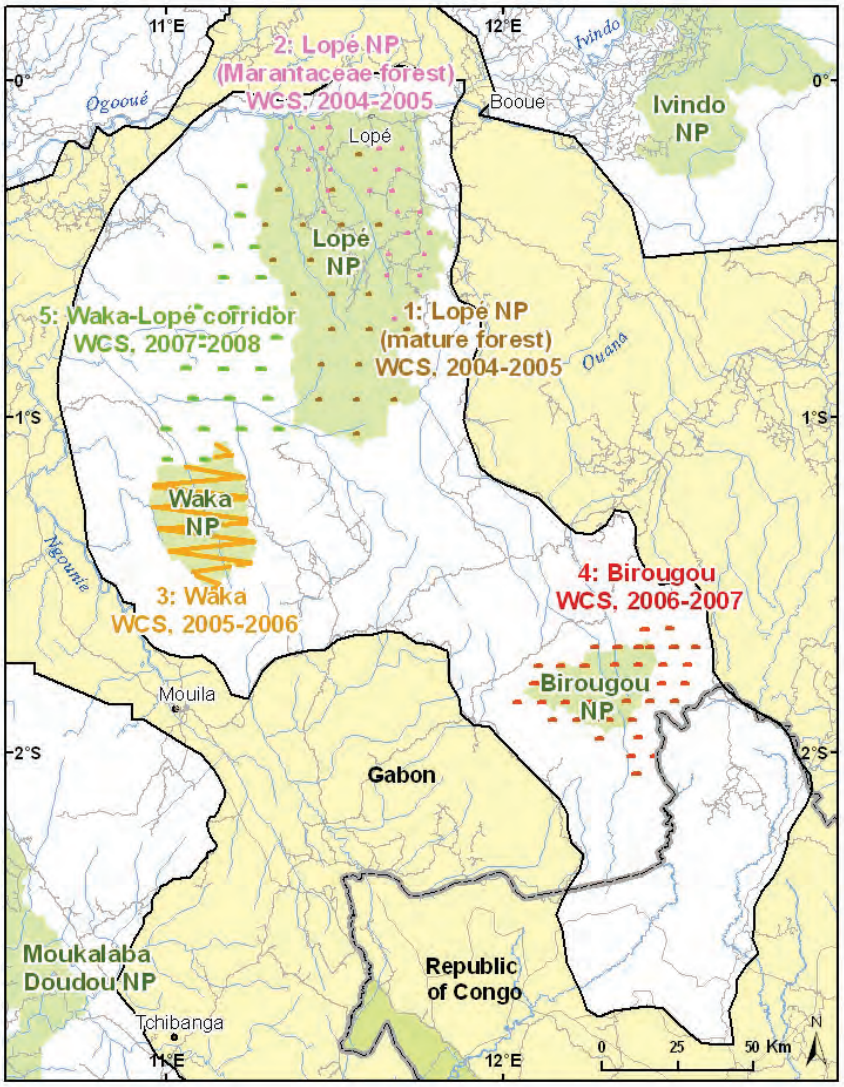
Wildlife and human impact surveys were conducted in Gabon between 2004-2005 in Lopé National Park, 2005-2006 in Waka National Park, 2006-2007 in Birougou National Park, and 2007-2008 in the logging concessions between the Waka and Lopé National Parks and in the large CBNRM around Birougou National Park. In the Republic of Congo, much of the landscape was surveyed in 2004-2005. Methods used were line transect surveys except in Waka and in the Congo sector, where guided recces were used; all large mammal and human sign were recorded and georeferenced.

The landscape as a whole is composed of large tracts of intact (never logged) mature rainforest on extremely rugged terrain, especially in the south, and "younger" (about 1,400 years old) rainforests in the north. Some very ancient, isolated savannas occur in the north of the landscape.

Important populations of large mammals including elephants, gorillas, chimpanzees, and a suite of monkey and forest ungulate species occur in all the sectors so far surveyed, both inside the protected areas and in much of the areas where land use is either logging or CBNRM. The endemic monkey found in the Landscape, the Sun-Tailed Guenon, was recorded in the north of Birougou National Park, extending its known distribution by about 30 kilometers southwards.

Some of the younger forests have been selectively logged in the recent past. Some of both the mature and younger forests are currently being, or are about to be, logged, including much of the Congo sector. Human impact is fairly low throughout the Gabon sector, the most impacted areas being those near human settlements or along logging roads, including disused roads.

In Waka National Park, human sign was almost absent except in the extreme north near the villages and, in Birougou National Park, human sign was rare and mostly in the west of the Park near to the town of Mbigou. Inside Lopé National Park, human sign was around the Ayem railway station, in the northwest of the park, in and around the abandoned logging camps of Soforga and Mitende, and in the extreme south near a village zone. In the Congo sector, there were hunting signs throughout most of the areas surveyed, which are mainly active logging concessions. It seems that remoteness and rugged terrain, at least in this landscape, serves as a *de facto* protection for wildlife.



Sources: WCS, UMD-CARPE, OSFAC, FORAF.

Figure 17.5: Biological surveys conducted in the Lopé-Chaillu-Louesse Landscape

Photo 17.4: Buffaloes (Syncerus caffer) are abundant and relatively tame in the savannas of Lopé National Park.

Table 17.3: Biological survey results from the Lopé-Chaillu-Louesse Landscape

Survey	Survey date	Total km of recces	Number of transects	Total km of transects	Elephant presence	Elephant dung pile encounter rate (N/km)	Elephant dung pile density (N/km²)	Ape presence	Ape nest group encounter rate (N/km)	Ape nest group density (N/km²)	Human sign (N/km)
1	Aug 2004-Dec 2005		22	21.8	Yes	2.6 (2)	544 (599)	Yes	1.05	29 (18.7)	0.1
2	Aug 2004-Dec 2005		26	13.1	Yes	11.6 (3.6)	1,299 (889)	Yes	0.68	18.8 (15.7)	0.21
3	Dec 2005-July 2006	344	-	-	Yes	3.4 (0.8)	NA	Yes	0.73	N/A	0.16
4	Oct 2006- Apr 2007		40	79.5	Yes	1.5 (0.64)	385 (173)	Yes	1.55 (0.31)	41.52 (10.06)	0.53 (0.27 – 0.79) (on transects; and 1.04 (0.63 – 1.45) (guided-recces)
5	Oct 2007-Mar 2008	289.7 (recces were recce-voyages, not guided-recces)	23	57.3	Yes	2.8 (1.8-4.3)	694 (439-1,097)	Yes	1.2	25.1	0.1 (transects); 0.4 (recce-voyages)

1 and 2) Maisels et al., 2006.

3) Abitsi, 2006.

4) Aba'a and Bezangoye, 2007.

5) Abitsi, et al., 2008.

Special Interest

Mandrill Tracking Ecotourism

Finding sustainable means of generating value from intact forests and wildlife populations is an important component of limiting the degradation of forest in Central Africa. Ecotourism can be one such activity. While the overall magnitude of revenue from tourism may not rival those from extractive industries, ecotourism can generate revenue that is locally significant and if managed well, can contribute to sustainable forest management. In tropical forests, other than at rare clearings or 'bais', wildlife is difficult to see, and both special techniques and unusual combinations of favorable habitat and charismatic species are required for successful wildlife viewing. One such situation occurs in northern Lopé National Park, where the landscape features, and the presence of an unusual and charismatic species – the mandrill – combine to present a novel opportunity for ecotourism to support both conservation and sustainable livelihoods.

Mandrills *(Mandrillus sphinx)*, the world's most colorful primate, are found in the forests of Congo, Cameroon and Equatorial Guinea, but the vast majority of their range is in Gabon. They live in social groups, known as hordes, which average 6-700 and occasionally over 1,000 individuals. These are the largest natural aggregations of non-human primates in the world. Mandrill hordes are composed mostly of females and young males, with the large and brightly-colored adult males joining them principally during the breeding season.

Photo 17.5: In the dry season, when the waters are very low, the bedrock of the Ogooué River is visible.

Normally, mandrills are incredibly flighty, and with up to 2,000 eyes looking out for potential predators, including people, it is virtually impossible to approach them on foot in their forest habitat. In the north of Lopé, the habitat is mainly savanna, with forest growing only on high hills, at old village sites and in long, thin 'galleries' of forest following rivers and streams. Using radio tracking, researchers from WCS and CIRMF found that several groups of mandrills used these thin strips of forest on a regular basis. However, mandrills avoid the exposed savanna (where they could easily fall prey to eagles or leopards), and so when a horde is in narrow gallery forest, they can only move in two directions – forward or back. By fitting mandrills with special collars that emit a radio signal that can be picked up by a detector, the group can be located and their direction of travel determined. This makes it possible for adventurous visitors to set up a hide ahead of the mandrills in the gallery, and lie in wait, completely concealed. In this way, it is possible to find oneself surrounded by a mandrill horde and observe their behavior at close quarters.

To take advantage of this unique opportunity, a pilot project was developed. Following development of an initial business plan, the successful deployment of radio collars, and recruitment and training of three local guides in 2006, mandrill tourism excursions were offered to the public as a trial product in 2007. A total of 105 tourists participated in 43 excursions during the year. Bookings increased through the year as the product became better known. Visitor feedback was very positive. In response to post-excursion evaluations, 90 % percent of visitors ranked the overall quality of the excursion as `Excellent' or `Good' (figure 17.6). Reservations for the first 3 months of 2008 were already much higher than for the same period in 2007.

Figure 17.6: Visitors feedback on mandrill excursions in 2007 (N=100 respondents)

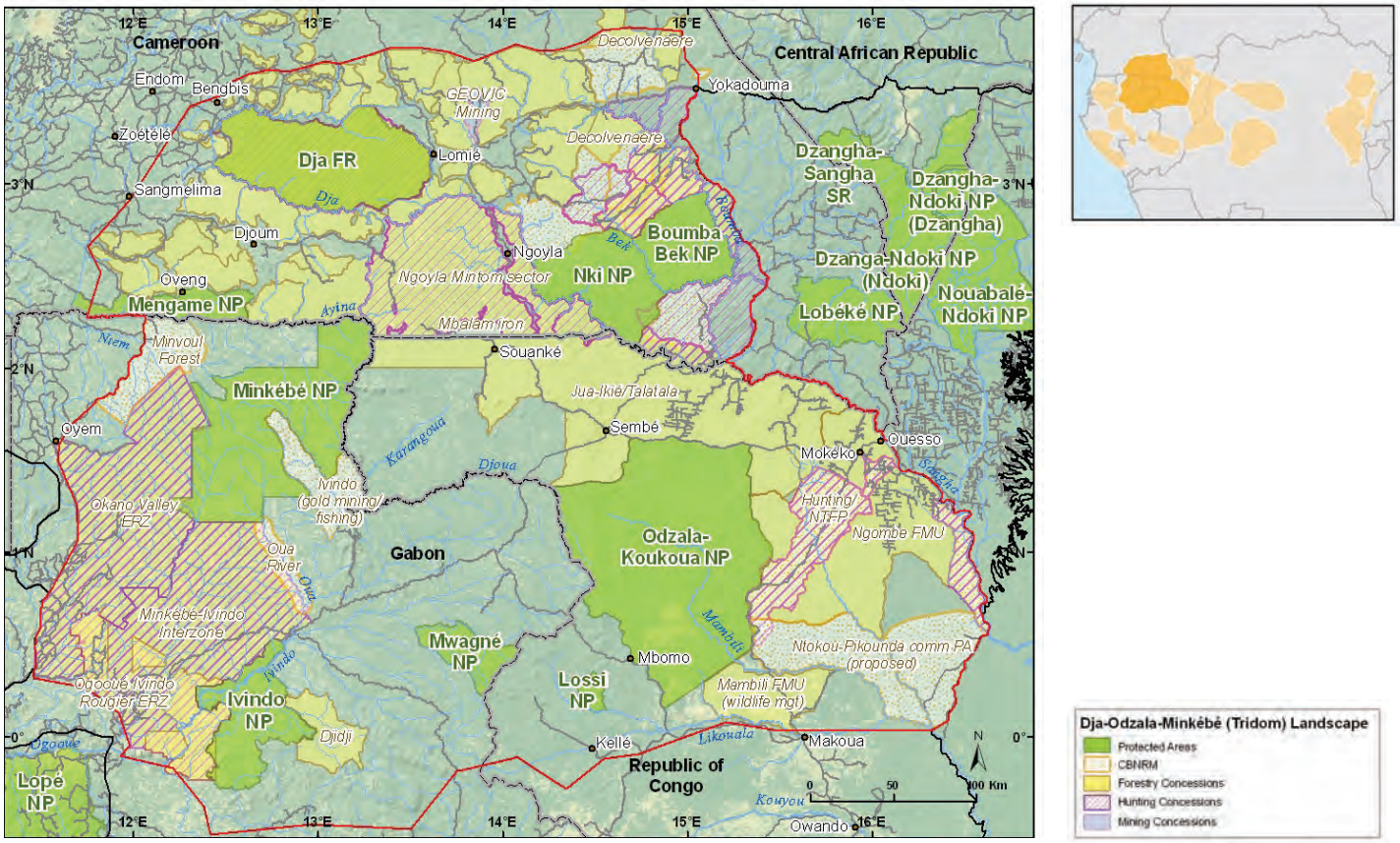
The project has so far focused on the technical aspects of developing mandrill tourism: the project has shown that it is possible to offer mandrill-tracking safaris that are of sufficient quality to meet tourist expectations. The next step is to ensure that it is financially viable over the long term – the first part of this will be to conduct a review of the business plan based on the experience gained over the past 18 months, and to develop a viable marketing and pricing strategy.

In North Lopé, the home range of the focal mandrill horde is adjacent to a village, Kazamabika, which is enclaved by the national park. The mandrill horde rarely enters the village lands, but some villagers continue to hunt wildlife outside the village enclave, including the mandrill groups. Therefore, finding an effective way to partner with this village (via revenue sharing or joint marketing of complementary tourism products) is an essential next step. A trial strategy, where tourists tracking the mandrills will also attend a traditional dance in Kazamabika village, thereby bringing revenue to that village, has been piloted in the second half of 2008. While the overall amount of revenue generated for the local population (through the employment of guides and a partnership with the village) may not be large, it is significant in an area where there are few other economic options. These are early days for this venture, but the results so far suggest that developing an economic product based on mandrill tourism can provide benefits to both the forest and local communities.

CHAPTER 18
Dja-Odzala-Minkébé (Tridom) Landscape

Pauwel De Wachter, Richard Malonga, Bede Lucius Moussavou Makanga, Tomo Nishihara, Zacharie Nzooh, and Léonard Usongo

Land Use Planning



Sources: WWF, WCS-Congo, WCS-Gabon, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.

Figure 18.1: Macro-zones in the Dja-Odzala-Minkébé (Tridom) Landscape

The COMIFAC Tridom intergovernmental collaboration agreement, signed in 2005, defines Tridom as a transborder complex of protected areas connected by a vast inter-zone in the countries of Cameroon, Republic of Congo and Gabon. The agreement specifies that the limits of the Tridom relate to the protected areas as well as to the limits of the inter-zone to be defined in between the protected areas. In 2006, a COMIFAC Tridom meeting recommended that each country take steps to define the limits of the Tridom taking into account its master plan (if available), the peripheral zones of the protected areas, ecological connectivity needs, and natural limits (including roads). The application of this principle, and including the logging concession blocks in the periphery of the protected areas, leads to a 191,541 km² landscape.

Much of the Tridom area has already an assigned primary land use class (logging concession, protected area, and community managed areas).

Photo 18.1: Misty morning in Odzala National Park.

Photo 18.2: Locusts of the family Pyrgomorphidae are often brightly colored -- a warning to potential predators that they are not edible.

Nineteen percent of Tridom has secured protected area status with nine protected areas totaling 37,498 km² (Dja, Boumba Bek, Nki, Mengame, Odzala, Lossi, Minkébé, Mwagne, Ivindo). Dja has a validated management plan while management plans are currently being drafted for the other protected areas, with the exception of Mengame and Lossi.

In the field, a number of sites have been identified that are good candidates for additional conservation zones, as they contain still largely intact forest ecosystems, are remote from human intervention, improve connectivity between protected areas, and would strengthen the robustness of the Landscape. Park services and wildlife departments in collaboration with NGO partners have identified to date a total of 17,227 km² of such "critical sites," of which four areas are in Congo (Ntokou-Pikounda 3,256 km², Dja 1,400 km², Djoua-Ivindo 5,268 km², Lossi-Mwagne Inter-zone 1,430 km²), and four areas in Gabon (Minkébé Mengame Corridor 2,333 km², Sing Nouna Ridge 1,658 km², Mvoung Kouyé Forest 1,466 km², Mwagne National Park extension 416 km²). As for Cameroon, in 1996, the government decided, not to allocate nine forest management units ("the Ngoyla-Mintom Forest, 9,321 km²) for logging, withdrawing them from the concession attribution process. It was thought that the area was special as an inter-zone between Dja, Nki and the (then planned) Minkébé protected areas. This freezing of the allocation process provides time for a land use planning process of this inter-zone.

To accompany this innovative governmental initiative, a WWF planning team is proposing a zoning plan for the Ngoyla Mintom Forest dividing it into a permanent forest estate and a non-permanent forest estate (agroforestry domain), covering 8,118 km² and 1,583 km² respectively. In the permanent forest domain, two town council-managed forests are proposed: Ngoyla (980 km²) and Mintom (586 km²). The remaining permanent forest domain is to be allocated to logging (1,084 km²) and a forest conservation domain (no logging) with four hunting zones and five community hunting zones as well as a totally protected core zone. The zoning proposal is currently being evaluated by the Cameroonian Government.

Almost 70 % of Tridom will be used for timber production and most of it will be located within forest concessions. Tridom's ecological health depends critically on these forests under concession as they provide large areas of continuous habitat in the periphery of the protected areas. In addition, logging companies have an important socio-economic role to play in remote, and often impoverished, rural areas. It is thus an important, and encouraging, trend that more companies are interested in FSC certification. Rougier, a French company, is engaged in the FSC certification process and aims for 20,000 km² of FSC-certified forest in Gabon, Congo, and Cameroon. In Tridom, Rougier's Ogooué Ivindo concession (2,820 km²) was FSC-certified in 2008, and it is engaged in the certification process for its 2,620 km² concession in South Cameroon. In Congo, IFO/Danzer is engaged in the FSC certification process for its 11,598 km² Ngombe concession, east of Odzala National Park. In Cameroon, Decolvenaere logging company is equally engaged in such a process and 1,520 km² have successfully completed the FSC pre-audit.

In Gabon, in three large assemblages of logging concessions, multi-stakeholder memorandums of understanding (MOU) are being finalized and involve the Forest Economy Ministry, the park service, 22 logging companies, local communities and local authorities. The aim is to regulate hunting in each of these logging zones (9,490 km² Okano valley complex in western Minkébé Forest, 11,600 km² Minkébé Ivindo inter-zone complex, and 10,190 km² around Mwagne National Park). The Okano valley MOU was signed by 9 logging companies, authorities and communities in November 2008 and the MOU has now been transmitted to the Ministry of Forest Economy for signature by the Minister. The MOU's prohibit the use of access/logging roads and vehicles for hunting, and simultaneously secure village hunting grounds. Note that on the implementation side the Gabonese Ministry of Forest Economy,

Box 18.1: Income-generating activities around Odzala-Kokoua National Park in the Republic of Congo are setting an example for other protected areas in the sub-region.

Located at the edge of the vast Congo Basin forest massif, Odzala-Kokoua National Park (recently expanded to 13,500 km²) represents an extraordinary tropical forest ecosystem for conservation. In the periphery of the park, the Forest Ecosystems in Central Africa (ECOFAC) program is developing income-generating activities (IGA) as part of its fourth strategic axis (see box 1.4). The idea of IGA is to reduce poverty among local people and to limit human pressure on natural resources, particularly wildlife (bushmeat).

The local population, which is mainly concentrated along the northern and southwestern limits of the park and comprises approximately 6,000 people, is currently experiencing a drop in manioc production. As a result, people are putting more pressure on forest ecosystems to meet their essential needs. To address this pressure, medium and long term economically and ecologically viable IGA are being developed and monitored in the more vulnerable areas. These activities include: beekeeping; replacing mosaic virus infested manioc by healthy and resistant shoots; pisciculture; sustainable fisheries; small scale sheep, goat and poultry raising; re-launching cocoa crops; developing non-wood forest products; and developing village hunting and sporting zones in the periphery (an activity being tested in select pilot areas with support from ECOFAC).

In parallel, the ECOFAC program also encourages the development of strategic plans for socio-economic activities and supports the establishment of cooperative associations. The Bana Mawa cooperative, which is one of the most active in the *Sous-Préfecture* of Mbomo is carrying out IGA in the areas of pisciculture (eight fish ponds), small scale breeding, farming (manioc and corn), and the processing of basic products (installation of an electric mill for manioc flour production). The development of cooperative associations, along with the growing capacity of local organizations and the installation of a legally-recognized consensus-building framework, probably represent the most notable changes in the social landscape of Odzala-Kokoua National Park over the last ten years.

Initiatives to promote IGA demonstrate the capacity of people and communities to join efforts to improve living conditions and rally around a common project. The result is an increased diversification in the subsistence means of households, at the same time as addressing the priority goals of a protected areas for conserving ecological heritage and preserving natural resources.

Aquaculture is a monitored activity. The know-how of local associations should be supported and disseminated in the periphery of the park.

Rougier Gabon and WWF have signed a collaboration agreement in 2006 that sets up a funding mechanism for wildlife surveillance in Rougier Gabon's Ogooué Ivindo in the Tridom Landscape (2,820 km²) and Haute Abanga concessions in the Monte Alén-Monts de Cristal Landscape (2,886 km²). These agreements are seen as a precursor to a system where several logging companies increasingly contribute to the cost of wildlife patrols in their concessions.

In the periphery of Boumba Bek and Nki national parks, five logging companies with concessions totaling 500,000 ha with approved management plans also contribute to a local wildlife fund co-managed by WWF's Jengi project and the forest administration.

In Congo, IFO, a Danzer subsidiary, is worksing with WCS experts on a wildlife plan and on some of the social issues for the Ngombe concessions, located east of Odzala National Park. The resulting zoning plan for the concession takes into account village hunting zones, strict conservation zones and (temporary) no hunting zones.

Photo 18.3: Foresters sometimes limit access to concessions using 'natural' barriers.

Community-Based Resource Management

In Tridom-Cameroon, a MINFOF, SNV, and WWF planning team completed the design of 6 community forests around Boumba Bek and Nki national parks. Three of these community forests are already operational. GTZ and WWF contributed to the establishment of eight community hunting zones (CHZ) in the forests around Boumba Bek National Park. Management plans have been developed for 2 while the process is engaged for an additional 3 CHZ. In Boumba Bek National Park, WWF in collaboration with national and local NGOs completed participatory mapping of Baka use zones.

Photo 18.4: Baka children smoking the head of a red river hog (Potamochoerus porcus).

In the Republic of Congo, IFO and WCS have mapped community hunting areas (3,961 km²) inside IFO's Ngombe concession so as to define a village hunting domain.

In Gabon, as part of the MOUs in the logging concession complexes, a zone of 15 km along both sides of the public roads is typically reserved for customary village hunting.

In the Makokou area, a MINEF-ANPN-WWF planning team worked with gold miners and other stakeholders on access and hunting regulation related to small scale gold panning sites, as well as with fishermen on the Oua River to regulate hunting and access along this river. Multi-stakeholder MOU for the gold panning sites and the Oua River are expected to be signed by stakeholders in 2009.

In the periphery of the Minkébé National Park, and with the assistance of an EU-funded community forest project, two requests for community forests have been prepared.

In the Minvoul area, Fang and Baka communities have been consulted in the design of a protected corridor between Minkébé National Park in Gabon and Mengame National Park in Cameroon.

In Ivindo National Park, stakeholder meetings with fishermen and local authorities have been initiated to set up a fishery association and to take into account the subsistence fishery activities on the Ivindo river in the parks management plan.

Mining Development in Tridom

Large iron ore mines and associated infrastructure are being planned for the heart of the Tridom: Bélinga in Gabon, Mbalam in Cameroon and Avima in Congo. If the development of these huge iron ore deposits goes ahead without applying best environmental standards and not taking into account the potential impact on landscape ecology, it could lead to the end of the Tridom as a continuous interconnected forest ecosystem. Therefore, it is critical that the mining sector takes into account the Tridom ecology while developing its plans. To that effect, WWF is negotiating MOUs with GEOVIC (cobalt mining east of Lomié) and CamIron (Mbalam iron ore deposit) to address biodiversity conservation.

In Gabon, WCS and WWF are in the beginning of a long process of establishing constructive engagement and dialogue with the mining sector towards application of best environmental and social practices in the interest of the respective countries, the mining companies and the Tridom forests.

Human Activities

Governments have been approached by firms interested in industrial-scale palm oil plantation development. Although nothing has yet materialized on the ground, is a trend to be monitored.

In Gabon "family felling permits" have been abolished in favor of the possibility of requesting "community forests" as foreseen in the 2001 forest code. Two community forest requests have been prepared by an EU-funded project (DACEFI) involving MINEF and Nature +.

Photo 18.5: Loading of logs in the Bordamur timber concession.

Mining

The rise in commodity prices (until July 2008) has started to impact the Tridom. Rising iron ore prices have attracted mining companies to the Tridom. An Australian company, Sundance Resources Ltd. has been set up to develop the Mbalam iron ore deposit (Cameroon, near the Republic of Congo border) and is currently doing the pre-feasibility study while China National Machinery and Equipment Import and Export Corporation (CMEC) obtained the rights to develop the Belinga iron ore deposits in northeast Gabon. Both deposits are estimated each at 1,000 million tons of iron ore. Another Australian Company has started exploring iron ore deposits in the Avima mountains in Congo's Souanké panhandle.

Since mid-2007, at the Kongou Falls inside Ivindo National Park, CMEC has started creating a road and a base camp for the dam construction project related with the Belinga iron mining project, in violation of the new Gabonese national park law. It is yet unclear how the recent global economic crisis and fall in iron ore prices will impact these projects. No activity is currently (as of February 2009) taking place on site in Belinga.

Gold panning affects several sites in the Upper Ivindo area in Gabon and Congo. Gold prices in gold camps have almost doubled in a couple of years. In July 2008, gold sold at 8,500 CFA[1]/gram in the Minkébé gold camp and its population has risen from 150 people in 2004 to over 800 people (mostly Cameroonian illegal immigrants).

Land Use

If we include the peripheries of PA's in the Tridom, then the Landscape attains 197,400 km². Of these 37,498 km or 19 % are under a PA status. Logging concessions cover currently almost 60 % of the Landscape. The remainder is in the rural complex or in forests whose status has yet to be clarified.

[1] 1 Euro = CFA 655.957

Table 18.1: Large unprotected forest zones without logging concessions

Country	Large unprotected forest zone without logging concessions	Size (km^2)	Comment
Cameroon	Ngoïla-Mintom Forest	9,321	Attribution to logging companies put on hold by the Cameroonian Government pending potential creation of a conservation concession in this forest. A zoning proposal is currently being studied by the Government.
Gabon	Ayina Forest	2,333	Not allocated because of poor timber quality in this swampy, inaccessible forest. Proposed as a protected transborder corridor between Minkébé and Mengame.
	Djoua – Zadié Forest	1,300	Contiguous to Souanké panhandle forest in Congo. Not allocated for logging because of swampy conditions. Part of a great ape priority site identified during the May 2005 Great Ape Conference held in Brazzaville.
	Sing Nouna Forest	1,658	Contiguous with Minkébé National Park. Small-scale gold panning present. Mining interest (minor iron ore deposit). A mixed status conservation/mining could be developed.
Congo	Souanké 'panhandle forest'	8,141	Not yet allocated to logging, part of it very swampy. Proposition to locate a crossborder conservation corridor to link Minkébé National Park with Dja and Odzala National Park. Mining interest (gold, iron) in Avima mountains. Mixed status conservation/mining could be developed for part of the site.
	Ntokou Pikounda	3,255	Located south of IFO concession. Proposed as a protected area. Very high density of gorillas.

Source: WWF-Minkébé.

Table 18.2a: Important agricultural products in the Tridom Landscape

Agricultural product	Unit	Purchase price/unit	Primary destinations	Date	Data collection	Sources
Odzala segment, Congo (Ngombe ERZ)						
Cassava	Wheelbar-row	$8.30	Ouesso	May 2008	Data collected by direct observation. No formal study was conducted to meet project objectives.	WCS, Malonga
Cocoa	1 kg	$1.10	Sembe	Feb 2008		WCS, Malonga
Maize	Sack (80 kg)	$101.2	Ouesso	Apr 2008		WCS, Malonga
Gabon segment, Makokou market						
Plantain	Bunch (5 kg)	CFA5,250	Inhabitants of Makokou	June 2008	Data collected by direct observation in the town market	WWF, Ikossa Koumamanga
Cassava	Packet of sticks *(batons)* (5 kg)	CFA2,000	Inhabitants of Makokou	June 2008		WWF, Ikossa Koumamanga
Peanut paste	1 eating spoon	CFA100	Inhabitants of Makokou	June 2008		WWF, Ikossa Koumamanga
Gabon segment, Ogooué Ivindo villages						
Cassava	Stick (*baton)*	$0.79	Inside Landscape - Makokou	2005-2006	Household surveys, 662 households	Parks and People Database, Boston College
Cassava	Sack of tubers	$5.68	Inside Landscape - Makokou	2005-2006	Household surveys, 662 households	Parks and People Database, Boston College
Cane wine	Liter	$3.75	Inside Landscape - Makokou	2005-2006	Household surveys, 662 households	Parks and People Database, Boston College
Cameroon segment, Gribé						
Plantain	Average bunch	$1.55	Yokadouma consumers	March 2008	Stratified sampling	Fogue and Defo, 2006
Macabo (Xanthosoma sagittifolium)	8-9 kg bowl *(cuvette)*	$4.44	Yokadouma consumers	March 2008	Stratified sampling	Fogue and Defo, 2006
Cassava (couscous)	8-9 kg bowl *(cuvette)*	$5.55	Yokadouma consumers	March 2008	Stratified sampling	Fogue and Defo, 2006
Congo segment, Sembe Market						
Peanut paste	2.6 kg	CFA2,500	Sembe	June 2008	Data collected by direct observation in the town market	WWF, Mbolo
Plantain	3 kg	CFA350	Sembe	June 2008	Data collected by direct observation in the town market	WWF, Mbolo
Cassava	1 stick *(ba-ton),* 350 g	CFA100	Sembe	June 2008	Data collected by direct observation in the town market	WWF, Mbolo
Gabon segment, Oyem market						
Cassava	10 stick (*ba-tons)* (5 kg)	CFA1,500	Oyem inhabitants	June 2008	Data collected by direct observation in the town market	WWF and MINEF, Owono Philbert
Plantain	Bunch (6kg)	CFA1,500	Oyem inhabitants	June 2008	Data collected by direct observation in the town market	WWF and MINEF, Owono Philbert
Peanut paste	0.8 kg	CFA2,500	Oyem inhabitants	June 2008	Data collected by direct observation in the town market	WWF and MINEF, Owono Philbert

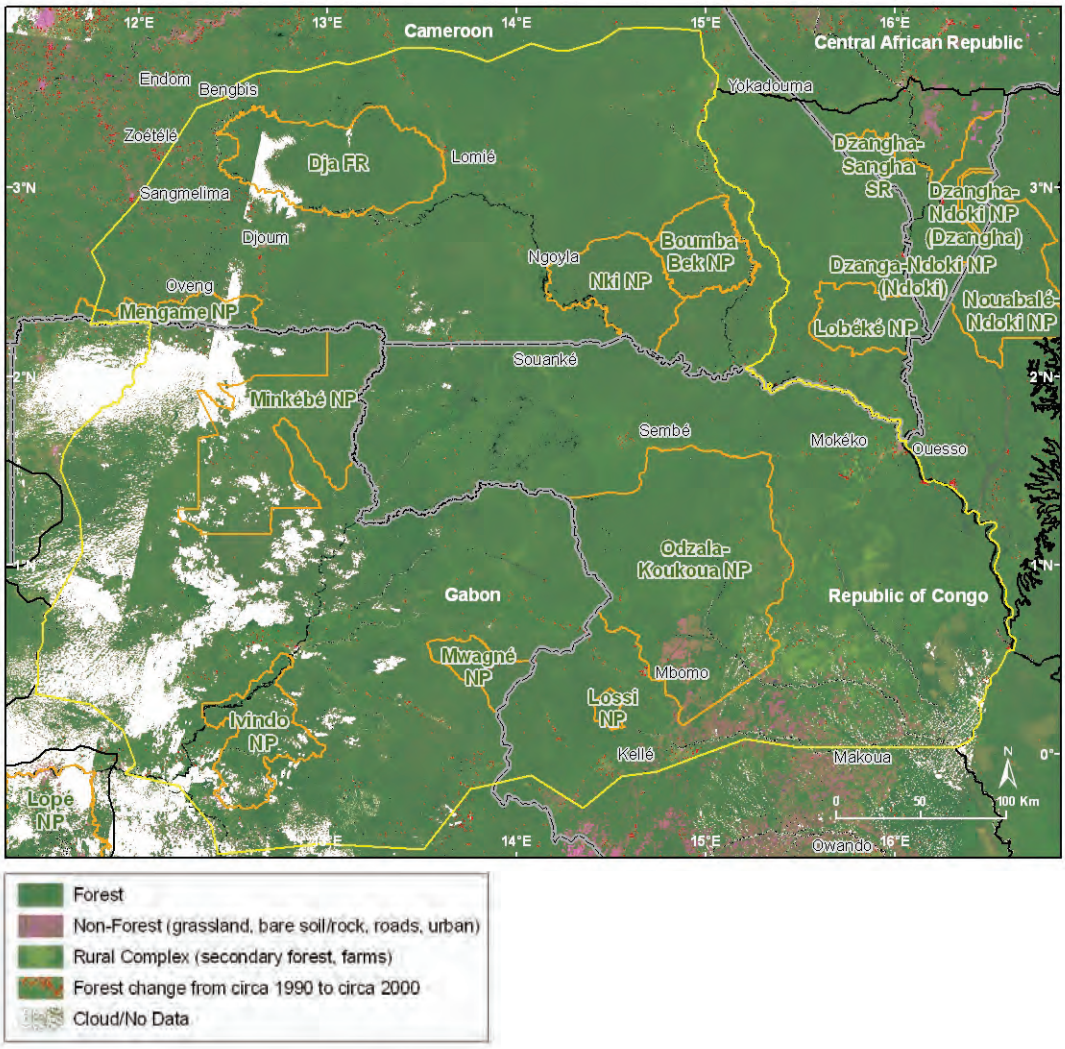
Agricultural product	Unit	Purchase price/unit	Primary destinations	Date	Data collection	Sources
Market in Gabon, Libreville PK8						
Cassava	6.5 kg (package of 10 *batons*)	CFA2,000	Small-scale retailers and Libreville end-consumers	June 2008	Data collected in the PK8 market	WWF/Stéphane Louembet
Plantain	Bunch (11 kg)	CFA6,500	Small-scale retailers and Libreville end-consumers	June 2008	Data collected in the PK8 market	WWF/Stéphane Louembet
Taro	65 kg	CFA22,000	Small-scale retailers	June 2008	Data collected in the PK8 market	WWF/Stéphane Louembet

Table 18.2b: Bushmeat trade in the Tridom Landscape

Bushmeat species	Unit	Purchase price/unit	Primary destinations	Date	Data collection	Sources
Congo Segment, Ouesso Market						
Red duiker (*Cephalophus sp.)*	Whole	$33.95	Ouesso market	December 2007	Data collected in Ouesso market.	WCS, Malonga R. and Elende A. G., 2008
Red river hog (*Potamochoeurus porcus)*	Whole	$73.53	Ouesso market	December 2007		WCS, Malonga R. and Elende A. G., 2008
Brush-tailed porcupine (*Atherurus africanus*)	Whole	$9.99	Ouesso market	December 2007		WCS, Malonga R. and Elende A. G., 2008
Gabon segment, Makokou market						
Red duiker (*Cephalophus sp.)*	Whole	CFA14,000	Inhabitants of Makokou	June 2008	Data collected by direct observation in the town market	WWF, Ikossa Koumamanga
Brush-tailed porcupine (*Atherurus africanus*)	Whole (average)	CFA4,500	Inhabitants of Makokou	June 2008		WWF, Ikossa Koumamanga
Red river hog (*Potamochoeurus porcus*)	Quarter	CFA14,000	Inhabitants of Makokou	June 2008		WWF, Ikossa Koumamanga
Fresh fish from Ivindo River	Heap (1.5 kg)	CFA2,000	Inhabitants of Makokou	June 2008		WWF, Ikossa Koumamanga
Gabon segment, Ogooué Ivindo villages						
Red duiker (*Cephalophus sp.)*	Whole	$18.47	Primarily Libreville, also Makokou	2005-2006	Household surveys, 533 households	Parks and People Database, Boston College
Blue duiker (*Cephalophus monticola*)	Whole	$7.02	Primarily Libreville, also Makokou	2005-2007	Household surveys, 533 households	Parks and People Database, Boston College
Brush-tailed porcupine (*Atherurus africanus*)	Whole	$7.11	Primarily Libreville, also Makokou	2005-2008	Household surveys, 533 households	Parks and People Database, Boston College

Bushmeat species	Unit	Purchase price/unit	Primary destinations	Date	Data collection	Sources
Cameroon segment, Gribé						
Brush-tailed porcupine (*Atherurus africanus*)	Whole and fresh	$2.22	Wholesalers selling in Yokadouma	March 2006	Stratified sampling	Fogue and Defo, 2006
Blue duiker (*Cephalophus monticola*)	Whole and fresh	$3.33	Wholesalers selling in Yokadouma	March 2006	Stratified sampling	Fogue and Defo, 2006
Red duiker (*Cephalophus sp.)*	Whole and fresh	$15.55	Wholesalers selling in Yokadouma	March 2006	Stratified sampling	Fogue and Defo, 2006
Congo Segment, Sembe						
Blue duiker (*Cephalophus monticola*)	Whole and fresh	CFA3,000	Sembe, Ouesso	June 2008	Data collected by direct observation in the town market	WWF, Mbolo
Red duiker (*Cephalophus sp.)*	Whole and fresh	CFA9,000	Sembe, Ouesso	June 2008	Data collected by direct observation in the town market	WWF, Mbolo
Brush-tailed porcupine (*Atherurus africanus)*	Whole and fresh	CFA2,500	Sembe, Ouesso	June 2008	Data collected by direct observation in the town market	WWF, Mbolo
Gabon segment, Oyem market						
Blue duiker (*Cephalophus monticola*)	Whole and fresh	CFA6,000	Oyem inhabitants	June 2008	Data collected by direct observation in the town market	WWF and MINEF, Owono Philbert
Red duiker (*Cephalophus sp.)*	Whole and fresh	CFA15,000	Oyem inhabitants	June 2008	Data collected by direct observation in the town market	WWF and MINEF, Owono Philbert
Brush-tailed porcupine (*Atherurus africanus*)	Whole and fresh	CFA9,000	Oyem inhabitants	June 2008	Data collected by direct observation in the town market	WWF and MINEF, Owono Philbert
Gabon, Libreville, Oloumi market						
Blue duiker (*Cephalophus monticola)*	Whole	CFA9,000	Libreville end-consumers	June 2008	Data collected in the market	WWF/Stéphane Louembet
Brush-tailed porcupine (*Atherurus africanus*)	Whole	CFA13,000	Libreville end-consumers	June 2008	Data collected in the market	WWF/Stéphane Louembet
Red river hog *(Potamochoeurus porcus)*	Quarter	CFA20,000	Libreville end-consumers	June 2008	Data collected in the market	WWF/Stéphane Louembet
Red duiker (*Cephalophus sp.)*	Whole	CFA30,000	Libreville end-consumers	June 2008	Data collected in the market	WWF/Stéphane Louembet

Forest Cover



Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 18.2: Composite Landsat satellite image of the Tridom Landscape overlain with 1990 to 2000 forest loss (in red)

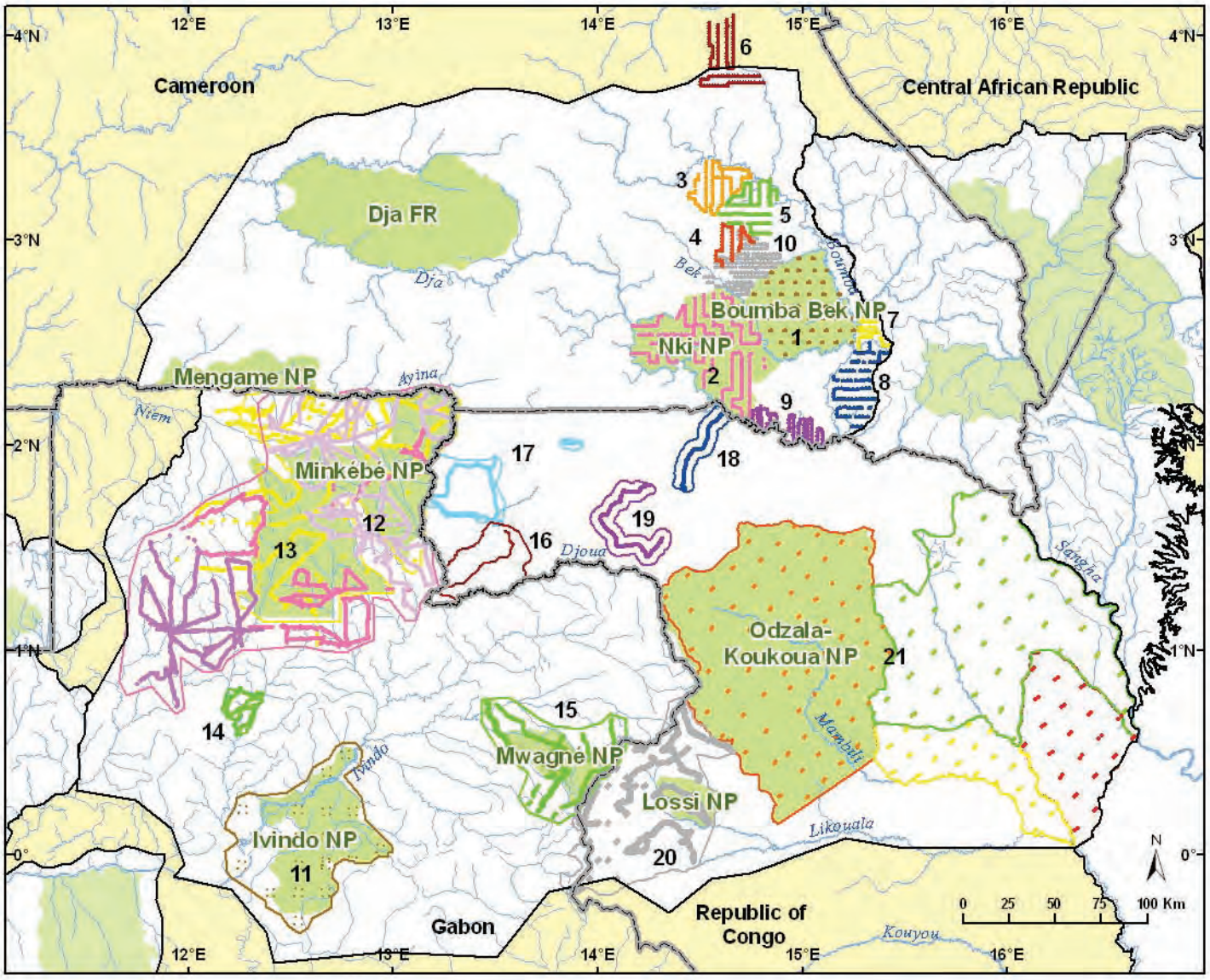
Table 18.3: Forest cover and forest loss in the Tridom Landscape from 1990 to 2000

	Forest area			Forest loss			
Landscape area	1990 (km²)	2000 (km²)	2005 (km²)	1990–2000 (km²)	1990-2000 (%)	2000-2005 (km²)	2000-2005 (%)
191,541	186,065	185,729	N/A	336	0.18	N/A	N/A

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

The major land use change over the last twenty years has been logging. As the primary method of logging is selective it does not result in major forest cover change. Commercial and subsistence agriculture has more or less stabilized in the Landscape. Rural population growth is low, as population growth is concentrated in towns where schools and jobs are located. However, these are trends of the past and should not be extrapolated to the future.

Large Mammal and Human Impact Monitoring



Sources: WWF, WCS-Congo, WCS-Gabon, UMD-CARPE, OSFAC, FORAF.
Figure 18.3: Biological surveys conducted in the Tridom Landscape

Table 18.4: Biological survey results from the Tridom Landscape

Survey	Site name	Survey date	Lead organization(s)	Total km of recces	Number of transects	Total km of transects	Elephant presence	Elephant dung pile encounter rate	Elephant dung pile density	Ape presence	Ape nest group encoun-ter rate	Ape nest group density	Human sign
1	Boumba Bek National Park	Oct 2003-May 2004	WWF	473	47	47	Yes	2.00 ± 0.25		Yes	0.32 ± 0.06		0.82 ± 0.13
2	Nki National Park	Nov 2005-Feb 2006	WWF	291	258	258	Yes	4.806 ± 0.289	1,840.1 ± 128.35	Yes	0.891 ± 0.081	207.00 ± 22.942	0.545 ± 0.11
3	UFA 10-021	Feb-May 2003	WWF and Decolvenaere	121	120	60	Yes	0.366 ± 0.070	202.63 ± 96.94	Yes	0.216 ± 0.057	47.844 ± 16.882	1.632 ± 0.232
4	UFA 10-022	Jul-Aug 2004	WWF and SCIFO	46	45	45	Yes	0.6 ± 0.20	170.01 ± 62.502	Yes	0.263 ± 0.132		1.307 ± 0.275
5	UFA 10-023	Mar-May 2006	WWF and SFCS/TTS	87	86	86	Yes	0.546 ± 0.207	121.43 ± 47.383	Yes	0.209 ± 0.074	42.702 ± 20.586	4.12 ± 0.50
6	UFA 10-052	Apr-May 2003	WWF and Decolvenaere	127	127	63.5	Yes	0.138 ± 0.076		Yes	0.09 ± 0.045		3.197 ± 0.286
7	ZICGC 8	May-Aug 2007	WWF and GTZ	42	46	46	No			Yes	0.717 ± 0.257	174.43 ± 66.135	5.1 ± 0.61
8	ZICGC 9	Apr-July 2007	WWF and GTZ	94	91	91	Yes	0.0756 ± 0.059		Yes	0.594 ± 0.159		3.41 ± 0.39
9	ZICGC 10	Jul-Sep 2006	WWF	103	103	100	Yes	1.39 ± 0.284	278.06 ± 61.996	Yes	0.68 ± 0.102	96.026 ± 17.575	1.669 ± 0.293
10	ZICGC 14	Jul-Sep 2006	WWF	155	149	147	Yes	0.355 ± 0.964	174.9 ± 49.875	Yes	0.232 ± 0.046	49.464 ± 12.044	2.253 ± 0.249

Survey	Site name	Survey date	Lead organization(s)	Total km of recces	Number of transects	Total km of transects	Elephant presence	Elephant dung pile encounter rate	Elephant dung pile density	Ape presence	Ape nest group encoun-ter rate	Ape nest group density	Human sign
11	Ivindo National Park, Gabon	Apr 2004-Feb 2005	WCS		18	37.5	Yes	5.94 (1.56)	497 (323)	Yes	1.17 (0.56)	48 (36)	0.36 (0.42) on transects; 1.01 (0.03) on guided-recces
12	National Park and periphery (northern, western and southern)	May 1998-Jun 2000	WWF	2,742			Yes	5.40 (along topofil measured distance)		Very low	0.032		0.70
13	Minkébé National Park	Aug 2003-Jun 2004	WCS, WWF	659	61	61	Yes	See below, analysis per stratum		Very low			
13	Minkébé National Park: low human impact zone	Aug 2003-Jun 2004	WCS, WWF		16	16	Yes	19.1	6,498 (5.107-8.269)	Very low	0.19		0 (transect) 0.04 (recce)
13	Minkébé National Park: medium human impact zone	Aug 2003-Jun 2004	WCS, WWF		20	20	Yes	12.3	4,981 (3.557-6.974)	Very low	0		0.21 (transect) 0.51 (recce)
13	Minkébé National Park: northern periphery, high human impact zone	Aug 2003-Jun 2004	WCS, WWF		25	25	Yes	15.9	4,808 (3.112-7.425)	Very low	0.13		0.60 (transect) 0.72 (recce)

Survey	Site name	Survey date	Lead organization(s)	Total km of recces	Number of transects	Total km of transects	Elephant presence	Elephant dung pile encounter rate	Elephant dung pile density	Ape presence	Ape nest group encoun-ter rate	Ape nest group density	Human sign
14	Mvoung Kouyé inter-zone, southern periphery of Minkébé National Park	Oct-Dec 2007	WWF	109			Yes	5.97		Yes	0.1		0.03
15	Mwagne National Park and periphery	2004- 2005	ANPN, WWF	310			Yes	4.19		Very low	0.02		0.56
16	Garabinzam-Djoua Forest (Souanké panhandle, Congo)	May- Jun 2005	WWF	75			Yes	4.51 (along topofil measured distance)		Yes	0.85 (along topofil measured distance)		0.67
17	Garabinzam-Ivindo (Souanké panhandle, Congo)	Aug- Sep 2004	WWF	72			Yes	7.35 (along topofil measured distance)		Yes	0.39 (along topofil measured distance)		Few human sign in between Garabin-zam and Ivindo, but high around Avima Mts gold mining camps
18	UFA Souanké-Balmessok-Meyebe Forest	Sep-06	WWF				Yes	3.87		Yes	0.09		0.77
19	Djoua Forest-Mts Letiouk-bala (Souanké panhandle, Congo)	Apr- May 2006	WWF	141			Yes	0.76		Yes	0.11		0.79

Survey	Site name	Survey date	Lead organization(s)	Total km of recces	Number of transects	Total km of transects	Elephant presence	Elephant dung pile encounter rate	Elephant dung pile density	Ape presence	Ape nest group encounter rate	Ape nest group density	Human sign
20	Lossi Mwagne Forest, Districts of Mbomo and Kelle, Congo		MEF-PNOK, WWF	644	41	41	Yes	3.59 (transect) 0.68 (recce)		Yes	0.12 (transect) 0.08 (recce, all nests counted)		1.02 (transect) 0.59 (recce)
22	Ngombe ERZ	Jan-May 2007	WCS	475.7	38	76	Yes	6.3± 0.3	1,013.3 c.i. [600.11; 1,710.8]	Yes	1.9 ± 0.3	126.68 c.i. [80.8; 198.61]	0.8 ± 0.01
22	Ntokou CBNRM	Nov-Dec 2006	WCS	214.0	18	36	Yes	5.7 ± 0.5	1,291.2 c.i. [836.5; 1,993.1]	Yes	2.5 ± 0.7	144.85 c.i. [90.37; 232.14]	0.19 ± 0.005
22	Pikounda ERZ	Jan-May 2007	WCS	238.5	18	36	Yes	2.7± 0.6	752.7 c.i. [313.6; 1,806.6]	Yes	2.4 ± 0.8	211.94 c.i. [20.56; 139.06]	0.24 ± 0.006
22	Odzala National Park	Aug-Dec 2005	WCS and ECOFAC		73	73	Yes	8.57 (6.89-10.67)	1,765 (1,384-2,250)	Yes	Gorilla: 0.69 (0.7-1.2) unidentified: 0.025	62.47 (gorillas')	

Sources: (1) Bene-Bene, 2004; (2) Nzooh Dongmo et al., 2006; (3) Nzooh Dongmo et al., 2003; (4) Nzooh Dongmo et al., 2004; (5) Ghogue and Nzooh Dongmo, 2006; (6) Nzooh Dongmo and Bassama, 2003; (7) Mendomo Biang and Nzooh Dongmo, 2007; (8) Maho, 2007; (9) Nzooh Dongmo et al., 2008; (10) Nzooh Dongmo et al., 2008; (11) Maisels, 2005; Latour, 2004; Maisels, et al., 2006;(12) Apes: Huijbregts et al., 2003; Elephants and human sign: WWF analysis of Minkébé data base; (13) Blake, 2005; (14) WWF, unpublished a; (15) WWF, unpublished b; (16) Schaffner Cappello, and Zebene, 2005; (17) Schaffner Cappello, and Ibata, 2004; (18) Madzou, 2006a; (19) Madzou, 2006b; (20) Bassouama et al., 2006; (22) Kominou et al., 2007; Nganga et al., 2007; Malonga et al., 2007; Blake, 2006.

Special Interest

"The Baka participate enthusiastically in zoning in and near Boumba Bek National Park (Cameroon)"

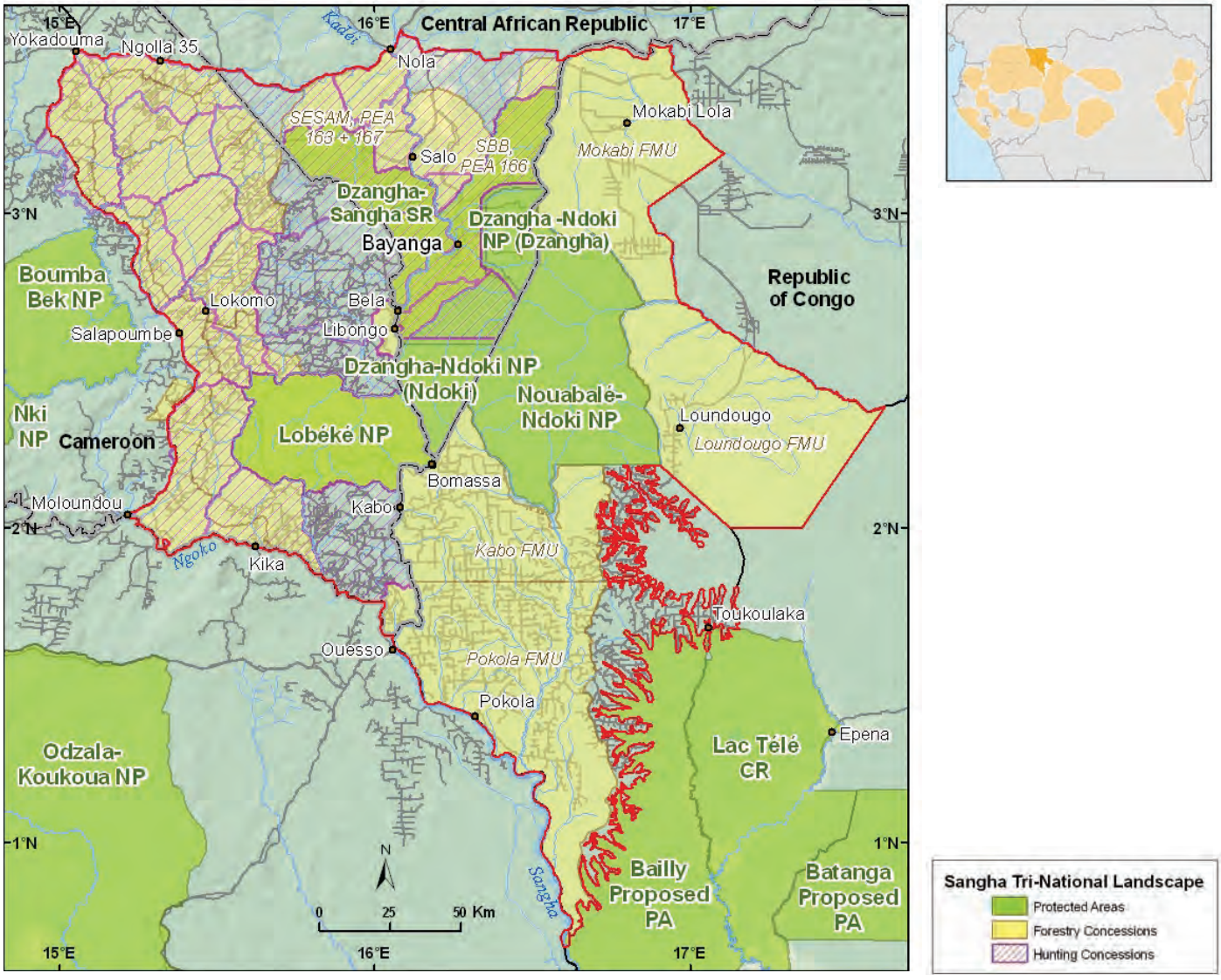
The Baka pygmy communities around Boumba Bek National Park have over the years complained of being marginalized in the natural resource management decision making process. Relations between the Baka communities and conservation authorities have been tense at times. Conservation success in the area will depend partly on participation of the Baka in the overall natural resource management process. This is critical given the key role played by Baka as local guides, hunters and informants to big game hunters. In previous meetings with Baka communities, they categorically refused to recognize superficial boundaries imposed on them by the government and conservation NGOs. It is within this context that WWF started a participatory zoning process to identify and map out Baka use zones inside the forest. The delimitation exercise of Baka use zones in the park was a big success as all communities supported the process and designated elected resource persons to participate. These communities enthusiastically participated in the forest surveys. Use zones were mapped and geo-referenced with colorful maps produced for village negotiations. Community leaders spoke out their satisfaction that their voice has been taken into account by conservation services. Today, WWF, park authorities, and Baka communities are working together to set ground rules for access and user rights inside the park. The ground rules will be incorporated in the park's management plan. Yesterday's protagonists now court each other in a mutual partnership geared towards sustainable natural resource management.

Photo 18.6: The construction of a dugout canoe can sometimes use an entire tree trunk.

CHAPTER 19
Sangha Tri-National (TNS) Landscape

Leonard Usongo and Zacharie Nzooh

Land Use Planning



Sources: WWF, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.
Figure 19.1: Macro-zones in the Sangha Tri-National (TNS) Landscape

The Sangha Tri-National (TNS) Landscape consists of three national parks: Lobéké (Cameroon), Nouabalé-Ndoki (ROC) and Dzanga-Ndoki (CAR), covering in total 4,520,000 ha. The surrounding multiple use zones with logging concessions, community use zones and professional hunting areas make up 3,751,800 ha.

The TNS land use plan is a state of the art document that describes the TNS Landscape's forest vegetation types and presents land uses and the management strategies employed by the diverse actors in the different segments of the TNS Landscape. It brings together existing knowledge

Photo 19.1: Children also take advantage of forest products.

concerning: vegetation types, animal populations and movements, road infrastructure and human settlements, land use zoning maps and overlays and conservation management (law-enforcement) infrastructure. It is a technical document defining the broad axis of landscape management and identifying the weak spots in the management.

The TNS land use plan is also:

- A strong visionary statement that describes perspectives on land use planning, and implementation strategies with direct participation of all stakeholders within context of trans-boundary collaboration. The document defines, from a local perspective, policy issues related to forest and wildlife legislation and issues related to land-use (access) rights of local/indigenous peoples. It identifies problems of implementing national legislation and proposes appropriate solutions.

- A showcase that clearly demonstrates to the governments and donors, the management of complex landscapes. This document will provide technical, institutional and political leverage for the TNS Landscape to COMIFAC and may serve as a tool for facilitating the implementation of the TNS Trust Fund process and other long term funding initiatives for the region.

The land use plan proposes a vision for the TNS Landscape and, in broad terms, a ten-year strategy of how to get there. The master plan provides guidelines for managing natural resources in the Landscape based on a major axis of cross boundary interventions and coordination. Some of the sensitive issues described in the land use plan document include:

- differences in forest legislation (e.g., the ban on exporting logs) or forest management influencing land use planning in the different units of the TNS Landscape;
- differences in subsistence and sport hunting legislation;
- access and land rights of Pygmies (bearing in mind that the TNS Landscape may have the highest concentration/number of Pygmies in Central Africa) as well as those of other local peoples;
- locations of human settlements in the TNS Landscape.

Significant progress has been made in management planning for individual land use units within the TNS Landscape. A number of national parks have management plans approved, as do a number of forestry concessions and wildlife zones. Although the management plan for Dzanga Ndoki National Park in CAR is yet to be developed, most information and baseline data exist for the Park. Furthermore, management plans have been approved for a number of forest concessions and some forestry companies have made progress towards certification. A total of 1,051,600 ha out of 3,388,803 ha of forest concessions are FSC certified (table 19.1). Even though these activities are executed within the specific contexts of each country and are, therefore, not supported under the umbrella of the TNS Landscape, it is these management planning processes of individual land units that define by-and-large the TNS land use plan.

Photo 19.2: Logging trucks being controlled by State agents.

Table 19.1: Management effectiveness for forest management units (FMU) inside TNS

Country	Logging company	Area (km^2)	Year attributed to present holder	Forest under exploitation since (year)	FMU management planning process	Certification process stage	Level of transformation	Other land-use	Co-management agreement for wildlife
Cameroon									
FMU 10-008, 10-009, 10-010, 10-012	SEFAC/ SEBAC	2,910		1970	Plan adopted	FSC-certified except UFA 10-009) (09/2007)	2 + 3	ZIC 29, 30, 36	Nsok Safaris, Faro West Safaris, Africam Safaris
FMU 10-001, 10-002, 10-003, 10-004	Vicwood-Thanry	1,931	1996	1997	Plan adopted	Chain of custody approved by SGS	1	ZIC 35, 36 + ZICGC 5, 4	Bosacam, Africam Safaris, COVAREF Bangue and Bidjouki
FMU 10-007, 10-011	Vicwood-Thanry	1,709	1997	1990	Plan adopted	Chain of custody approved by SGS	1	ZIC 28 + ZICGC 01	Ngong Safaris, COVAREF Salokomo
FMU 10-005	STBK	893	2001	2002	Plan adopted	Not engaged	1	ZIC 37 + ZICGC 06	Patrick Teresi, COVAREF Bouloba
FMU 10-013	ALPI-CAM	508	2002	1975	Planning convened	Not engaged	1	ZICGC 02	COVAREF Boumba-Ndjombi
FMU 10-063	SIBAF (1973)/ ALPI-CAM (2004)	689	2000	1973	Plan adopted	Engaged	1	ZICGC 03	COVAREF Ndjombi Bolo
FMU 10-064	Filière Bois	1,144	2001	1975	Plan adopted	FSC-certified (09/2007)	2 + 3	ZIC 31	Polo Safari
Congo									
FMU Kabo	CIB	2,870	1997	1968	Plan adopted	FSC-certified (06/2006)	1	Village + semi-nomad	WCS
FMU Pokola	CIB	4,500	1968	1975	Draft plan available	FSC-certified (07/2008)	2	Village + semi-nomad	WCS
FMU Loundougou	CIB	4,230	2002	2003	Planning convened	In process		Village + semi-nomad	WCS
FMU Toukoulaka FMU Mokabi	CIB	2,080	1968 (as Pokola)	1993	Planning convened	In process		Village + semi-nomad	WCS
	Rougier	3,600	1999	1999	Planning convened	-------	0		

Country	Logging company	Area (km^2)	Year attributed to present holder	Forest under exploitation since (year)	FMU management planning process	Certification process stage	Level of transformation	Other land-use	Co-management agreement for wildlife
CAR									
PEA 166	Ex-SBB	2,876	Currently not attributed	1975	No plan		1 + 2	Safari hunting zone	
PEA 163	SESAM 1	3,693	Currently not attributed	1985	No plan		1 + 2	Safari hunting zone	
PEA 167	SESAM 2	943	Currently not attributed	1968	No plan		1 + 2	Safari hunting zone	
PEA 185	SCAF	2,706	2005	1972	Planning convened		1 + 2		PDS (WWF, GTZ)
PEA 164	Vicwood-Thanry	2,249	1995	1995	Plan adopted		1 + 2	Safari hunting zone	

Human Activities

The TNS Landscape spans four districts (*"Préfectures"* or *"Départements"*) located in three countries:

- Cameroon: The Boumba and Ngoko District with the administrative center of Yokadouma;
- CAR: The Sangha Mbaéré District with the administrative center of Nola;
- ROC: The Likouala Department with the administrative centers of Ouesso and Impfondo, respectively.

Yokadouma, Nola and Ouesso are at the periphery of the Landscape. Impfondo falls outside the currently defined limits of the TNS Landscape.

The TNS economy is entirely based on extractive exploitation of the forest resources, in the formal sector for timber and in the informal sector for diamonds, bushmeat, palm wine, fish and other NTFPs. Locally, agricultural production has some importance in Cameroon. The impacts of this extractive economy on the socio-economic conditions and activities in the administrative centers or the local villages are not easy to quantify as they are diffuse and fluctuate considerably over time. However, what is evident is that poverty is rife. Social services, such as schooling and health, benefit little from the revenue generated from forest exploitation. Although some local people find employment in this industry, most of the jobs go to better trained workers who are brought in from elsewhere.

The industrial logging towns are self-reliant islands where the concession holder (owner) is expected to provide, which he does in most cases, social services and infrastructure for the concession's own workers and families. The extent to which this benefits local villages and the local administrative towns is, as mentioned above, very small.

With a surface area of about 45,200 km^2 and a total population of around 200,000, the population density of the TNS Landscape can be estimated at 5 individuals/km^2. Approximately two thirds of the populations in the industrialized towns are immigrants from outside the TNS Landscape. Table 19.2 summarizes human population densities and distribution in major towns and villages within the TNS Landscape. In the context of the table, the general term "Pygmies" is used as a common designation for different "semi-nomadic" ethnic groups. Inside the limits of the TNS Landscape, there are distinct Pygmy populations, known as "Baka" in South-East Cameroon, "BaAka" in Southern CAR, and "Mbenzélé" in northern Congo.

The principal threats to biodiversity conservation within the TNS Landscape remain hunting and the commercial bushmeat trade, unsustainable commercial logging, uncontrolled mining, ivory trade and the capture and trade in African grey parrots. These threats are addressed by the land use plan and tackled directly by field project activities.

Table 19.2: Population distribution inside the limits of the Sangha Tri-National Landscape

Country	Administrative centers		Industrial towns		Rural villages (all)		Pygmies
	Name	Population	Name	Population	Name	Population	Population
Cameroon	Yokadouma	10,000	Lokomo	2,700	*Sous-préfecture* Yokadouma	24,300	3,400
	Moloundou	3,200	Libongo/ Bela	4,300	*Sous-préfecture* Moloundou	16,100	7,100
			Kika	1,400			
			Ngolla 35	1,150			
CAR	Nola	37,000	Bayanga	4,000	Dzangha-Sangha Special Reserve	2,250	1,150
			Salo	2,000	Outside the Reserve	8,000	3,000
Congo	Ouesso	22,000	Kabo	3,000	FMU Kabo	650	
			Pokola	14,500	FMU Pokola	2,500	1,700 (50 % in Pokola)
					FMU Toukoulaka	2,300	900
					FMU Loundougou	6,000	2,700
					FMU Mokabi	4,000	
Total		**72,200**		**33,050**		**66,100**	**19,950**
Total population TNS: approx. 191,000							

Source: Defo, 2007; APDS, 2006; PROGEPP, 2005; Kamis, 2006.

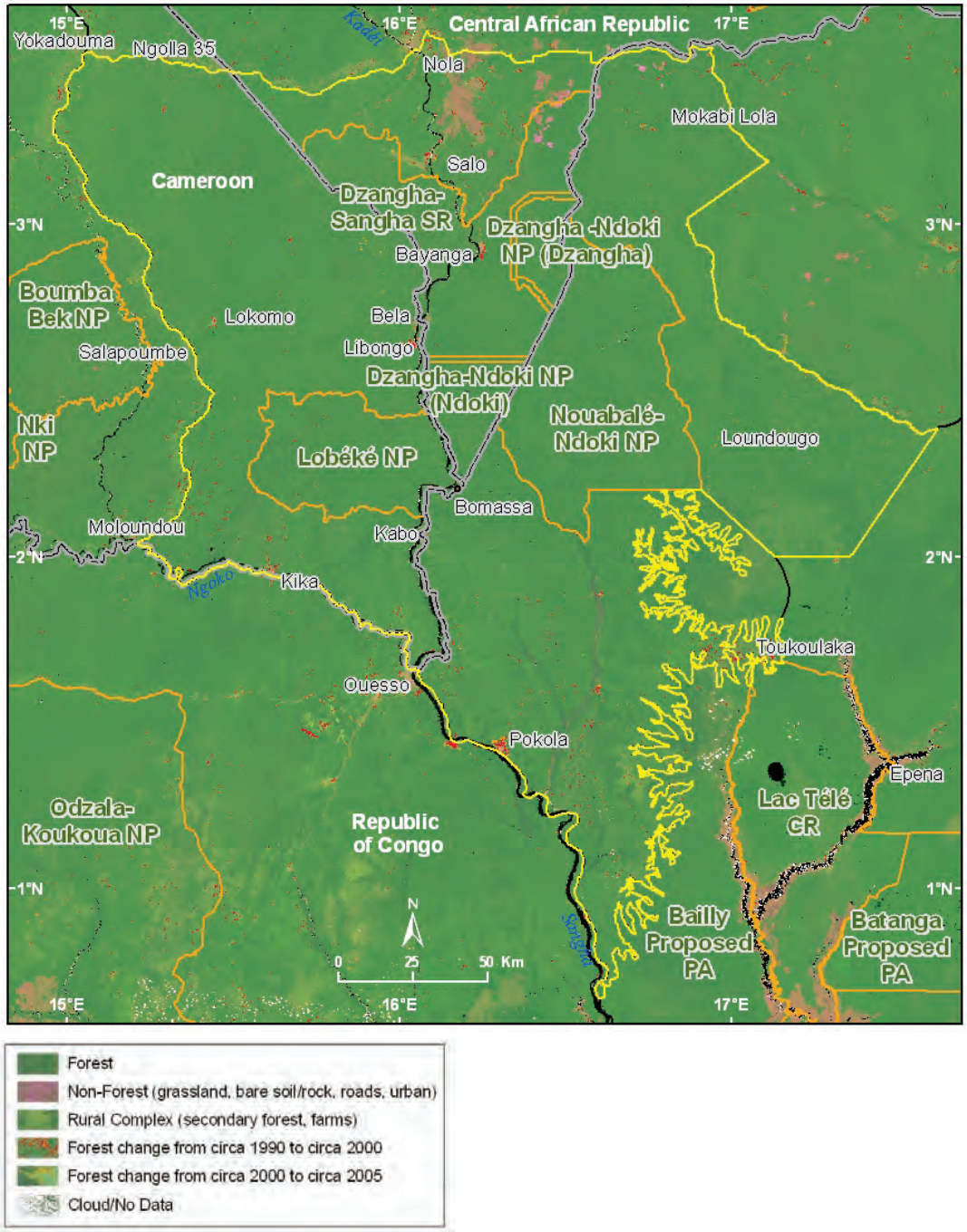
Table 19.3a: Important agricultural products trade in the markets of Sangha Tri-National Landscape

Agricultural product	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Dzanga Ndoki, CAR						
Coco (*Gnetum africanum* and *Gnetum bucholzianum*)	1 cup	0.11	Bayanga	2006-2008	Market surveys	APDS unpublished data
Chili /piment (*Capsicum spp.)*	1 cup	0.11				
Manioc leaves (*(Manihot esculenta)*	1 cup	0.11				
Amarante (*Amaranthus hybridus*)	1 cup	0.11				
Spinach (*Spinacia oleracea*)	1 cup	0.11				
Lobéké segment, Cameroon						
Plantain *(Musa paradisiaca)*	Bunch (average size)	2.22	Mboy II-Mang	Feb 2007	Stratified sampling	Fogue and Defo, 2007
Macabo *(Xanthosoma sagittifolium)*	Bowl	3.33				
Manioc (couscous) *(Manihot esculenta)*	Bowl	4.44				

Table 19.3b: Bushmeat species trade in the markets of Sangha Tri-National Landscape

Bushmeat species	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Dzanga Ndoki, CAR						
Blue duiker (*Cephalophus monticola*)	Kg	3.57	Bayanga	2006-2008	Market surveys	APDS unpublished data
Bongo (*Tragelaphus euryceros*)	Kg	3.57				
Yellow-backed duiker (*Cephalophus sylvicultor*)	Kg	3.57				
Water chevrotain (*Hyemoschus aquaticus*)	Kg	3.1				
Moustached monkey (*Cercopithecus cephus*)	Kg	2.38				
Greater white-nosed monkey (*Cercopithecus nictitans*)	Kg	2.38				
Black and white colobus (*Colobus guereza*)	Kg	3.1				
Crested mangabey (*Cercocebus agilis*)	Kg	3.8				
Red river hog (*Potamochoerus porcus*)	Kg	3.8				
Major settlements and Loundoungou Forestry Management Unit, Congo						
Blue duiker (*Cephalophus monticola*)	Kg	0.75	Loundoungou FMU	Sep 07-Feb 08	Market surveys	PROGEPP unpublished data
Peter's duiker (*Cephalophus callipygus*)	Kg	0.74				
Red river hog (*Potamochoerus porcus)*	Kg	0.69				
Lobéké segment, Cameroon						
Brush-tailed porcupine (*Atherurus africanus*)	Whole (fresh)	4.44	Mboy II-Mang	Feb 2007	Stratified sampling	Fogue and Defo, 2007
Blue duiker (*Cephalophus monticola*)	Whole (fresh)	3.33				
Red duiker: Bay duiker, Peter's duiker, White-bellied duiker, Black-fronted duiker (*Cephalophus dorsalis, C. callipygus, C. leucogaster, C. nigrifrons*)	Whole (fresh)	22.22				

Forest Cover



Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 19.2: Composite Landsat satellite image of the Sangha Tri-National Landscape overlain with 1990 to 2000 forest loss (in red)and 2000 to 2005 forest loss (in orange)

Table 19.4: Forest cover and loss in the Sangha Tri-National Landscape from 1990 to 2005

	Forest area			Forest loss			
Landscape area	1990 (km²)	2000 (km²)	2005 (km²)	1990–2000 (km²)	1990-2000 (%)	2000-2005 (km²)	2000-2005 (%)
43,936	42,820	42,743	42,608	77	0.18	135	0.32

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

Photo 19.3: Overview of a bai in Dzanga-Ndoki National Park.

The most striking feature of vegetative change in the TNS Landscape is the extent to which forests have been heavily exploited by commercial logging with significantly lower cover of primary forest in many areas. The only exceptions are unlogged forests of Dzanga-Ndoki zone and part of northern Congo. Estimated proportion of forest loss from circa 1990 - 2000 is about 0.2 % which is relatively low when compared to other areas in the Congo Basin. However, several factors such as increased allocation of forest concessions and expanding slash-and-burn agricultural practices account for the significant percentage (0.32 %) of forest loss in the region between 2000 and 2005.

It is well recognized that forest exploitation generates a dynamic in vegetation that is not per se negative. Elephants and gorillas are known to prefer to forage on vegetation types found in secondary forest regrowth areas. On the whole, the biodiversity of the entire landscape will be enhanced if there is a balance between undisturbed primary forest and well managed forest concession areas.

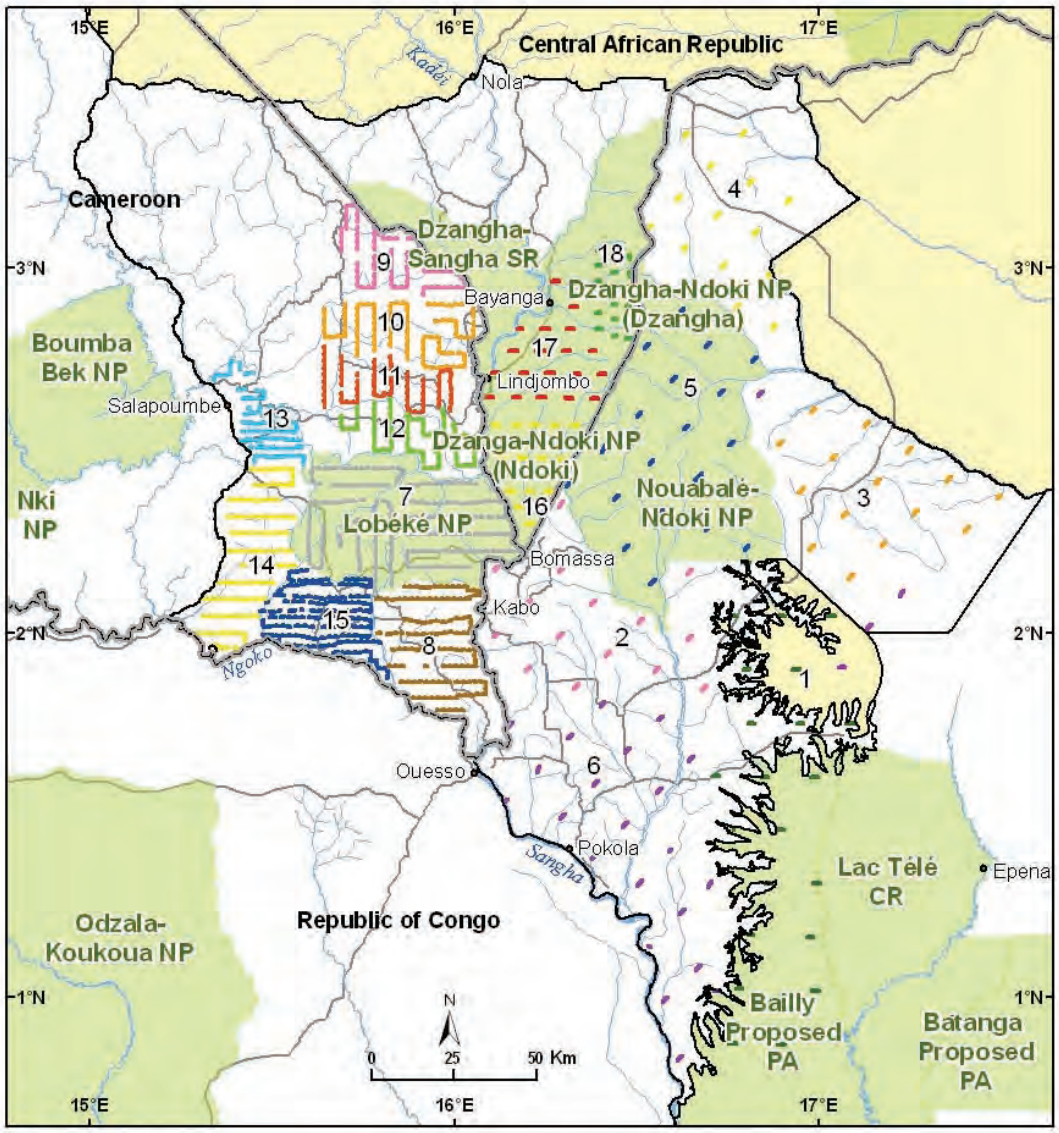
Large Mammal and Human Impact Monitoring

Biological surveys have been carried out in about 60 % of the TNS Landscape with results indicating relatively healthy populations of flagship species notably elephants and great apes. Results of dung counts of elephants in national parks gave counts of 550.96 ± 169.1 dung/km² in Nouabalé Ndoki (NN) and 2,555.2 ± 222.2 dung/km² in Lobéké. Similar surveys in logging concessions surrounding the national parks, indicated figures ranging from 22.19 ± 30.7 dung/km² in the Mokabi UFA (north Nouabalé Ndoki National Park) to 2,125.3 ± 423.47 dung/km² in UFA 10-012 (north Lobéké National Park). Results of dung counts indicate high and relatively stable populations of elephants within the TNS Landscape. Hunting of elephants for ivory trade remains a significant threat to elephant populations in the area. For example in July 2008, in Lobéké, Cameroon, 22 elephant tusks were confiscated from arrested poachers.

With regards great ape populations, results from nest counts in national parks, indicated 70.28 ± 30.74 nest group/km² in Nouabalé Ndoki National Park as compared to 162.12 ± 26.01 nest group/km² in Lobéké. The TNS Landscape harbors some of the healthiest populations of great apes in Central Africa as confirmed by results of nest counts.

Human activities, especially hunting and bushmeat trade, are relatively intense in surrounding extractive use zones such as logging concessions. Areas with the high hunting intensities within the TNS Landscape include Mokabi FMU in Congo and UFA 10-008 in Cameroon which are densely populated with workers of logging companies.

Photo 19.4: Path in Dzanga-Ndoki National Park used to see habituated gorillas.



Sources: WWF, WCS, SEFAC, GTZ, MIKE, UMD-CARPE, OSFAC, FORAF.

Figure 19.3: Biological transects and recces conducted in Sangha Tri-National Landscape

Table 19.5: Biological survey results from the Sangha Tri-National Landscape

Survey	Site name	Survey date	Lead organization(s)	Number of transects	Total km of transects	Elephant presence	Elephant dung pile encounter rate (N/km ± 95 % confidence interval)
1	Bailly/Bodingo / Toukoulaka	Jan-May 2006	WCS	24	48	Yes	2.68 ± 2.57
2	Kabo FMU	Jan-May 2006	WCS	15	30	Yes	3.83 ± 1.62
3	Loundougou FMU	Jan-May 2006	WCS	20	40	Yes	2.07 ± 1.62
4	Mokabi FMU	Jan-May 2006	WCS	15	30	Yes	0.14 ± 0.19
5	Nouabalé-Ndoki National Park	Jan-May 2006	WCS	20	40	Yes	3.42 ± 1.00
6	Pokola FMU	Jan-May 2006	WCS	21	42	Yes	4.34 ± 2.39

(*) For accuracy purpose, ape nest group density estimates are based on fresh/recent nests (not old ones).
Source: Stokes, 2007.

Survey	Site name	Survey date	Lead organization(s)	Total km of recces	Number of transects	Total km of transects	Elephant presence	Elephant dung pile encounter rate (N/km ± 95 % confidence interval)
7	Lobéké National Park	Nov 05-Feb 06	WWF	198	194	190	Yes	8.01 ± 0.641
8	UFA 10-064	Jul-Oct 2004	WWF and SEFAC	129	123	123	Yes	4.42 ± 0.5
9	UFA 10-008	Feb-Jul 2005	WWF and SEFAC	77	77	77	Yes	0.234 ± 0.201
10	UFA 10-009	Feb-Jul 2005	WWF and SEFAC	91	91	91	Yes	1.429 ± 0.462
11	UFA 10-010	Feb-Jul 2005	WWF and SEFAC	70	70	70	Yes	2.186 ± 0.70
12	UFA 10-012	Feb-Jul 2005	WWF and SEFAC	76	76	76	Yes	3.684 ± 1.258
13	ZICGC 1	May-Aug 2007	WWF and GTZ	92	88	88	Yes	2.367 ± 0.472
14	ZICGC 2	Apr-Jun 2007	WWF and GTZ	112	111	110	Yes	0.341 ± 0.127
15	ZCGC 3	May-Aug 2007		155	154	154	Yes	0.521 ± 0.121
16	Dzanga-Ndoki National Park (Ndoki)	Aug 2003-Apr 2004	WCS (MIKE)	383	75	26	Yes	8.5
17	Dzangha-Sangha SR	Aug 2003-Apr 2004	WCS (MIKE)			24	Yes	1.4
18	Dzangha-Ndoki National Park (Dzangha)	Aug 2003-Apr 2004	WCS (MIKE)			7.5	Yes	9.9

7) Nzooh Dongmo et al., 2006; 8) Nzooh Dongmo et al., 2004; 9, 10, 11 and 12) Nzooh Dongmo et al., 2005; 13) Mendomo Biang and Nzooh Dongmo, 2007; 14) Ghogue and Nzooh Dongmo, 2007; 15) Mengamenya Goue and Nzooh Dongmo, 2007; 16-18) Blake, 2005

	Elephant dung pile density (N/km² ± 95 % confidence interval)	Ape presence	Ape nest group encounter rate (N/km ± 95 % confidence interval)	Ape nest group density* (N/km² ± 95 % confidence interval)	Human sign (N/km ± 95 % confidence interval)
	432.44 ± 416.4	Yes	0.65 ± 0.33	26.6 ± 13.58	0.75 ± 0.09
	616.81 ± 266.6	Yes	1.31 ± 0.75	52.89 ± 30.48	1.60 ± 0.92
	333.81 ± 263.4	Yes	1.59 ± 0.82	64.21 ± 33.51	1.26 ± 0.53
	22.19 ± 30.7	Yes	0.45 ± 0.50	18.26 ± 20.26	3.93 ± 0.41
	550.96 ± 169.1	Yes	1.74 ± 0.75	70.28 ± 30.74	0.28 ± 0.21
	697.94 ± 390.6	Yes	3.07 ± 1.65	123.65 ± 67.23	2.21 ± 0.38

	Elephant dung pile density (N/km² ± 95 % confidence interval)	Ape presence	Ape nest group encounter rate (N/km ± 95 % confidence interval)	Ape nest group density* (N/km² ± 95 % confidence interval)	Human sign (N/km ± 95 % confidence interval)	Apes nest density
	2,555.2 ± 222.2	Yes	0.474 ± 0.057	162.12 ± 26.01	0.681 ± 0.149	252.7 ± 42.24
	1,832.63 ± 3,223.83	Yes	0.623 ± 0.102	138.6 ± 29.131	0.933 ± 0.138	375.45 ± 85.534
		Yes	0.39 ± 0.182	0.97 ± 0.26	2.019 ± 0.343	148.68 ± 43.048
	499.54 ± 96.275	Yes	0.604 ± 0.183	206.54 ± 41.63	1.286 ± 0.327	295.83 ± 62.959
	1,179.5 ± 292.55	Yes	0.429 ± 0.81	144.2 ± 45.38	0.645 ± 0.146	205.69 ± 67.693
	2,125.3 ± 423.47	Yes	0.184 ± 0.120	92.42 ± 41	0.821 ± 0.215	158.27 ± 74
	1,950.3 ± 403.7	Yes	1.111 ± 0.16	2.243 ± 0.41	4.374 ± 0.49	3.993 ± 0.759
	1.60 ± 0.62	Yes	0.70 ± 0.108	185.71 ± 34.98	3.229 ± 0.333	287.87 ± 59.073
	137.51 ± 34.853	Yes	1.285 ± 0.133	161.76 ± 20.592	2.200 ± 0.256	326.74 ± 45.043
	960.4	Yes	1.04	1.49	2.92 transects 1.72 recces	
	162.7	Yes	0.58	0.84	6.89 transects 4.84 recces	
	1,114.2	Yes	0.66	0.96	4.28 transects 1.42 recces	

Photo 19.5: Wildlife mirador over a rainforest bai.

Photo 19.6: A female sitatunga (Tragelaphus spekei), a species with an affinity for wetlands.

Photo 19.7: School built using revenues generated by sport hunting.

Special Interest

How Conservation is Contributing to Livelihood of Local Communities of TNS

In the heart of the Congo Basin rainforest, a people-centered conservation approach is yielding benefits to local people and contributing to wildlife protection. This has been made possible due to the rich wildlife and fascinating magical traditions of indigenous forest people, the Baka and BaAka pygmies and Bantu communities. Thanks to efforts of key conservation partners in the region, namely WWF, WCS and GTZ, the local communities have been organized and are involved in ecotourism and other income generating activities aimed at improving their living conditions.

In Bayanga, Central African Republic, a gorilla habituation project presages a new era for local people. Each year, tourists visit the area where they are offered extraordinary opportunities to accompany the BaAka pygmies on guided tours to observe western lowland gorillas and see the elusive forest elephants and other wildlife. Traditional hunting by BaAka pygmies, using bows and arrows, nets etc. and collection of medicinal and edible plants are a source of attraction and an income earner too. These activities have contributed significantly to the local economy with accompanying improvement in the living condition of local people. Proceeds from this project have been spent on provision of health services and education, training in agricultural techniques, and helped legalize village traditional hunting by BaAka pygmies in the area. The economic position as well as their political standing of BaAka pygmies has been strengthened by assisting them to maintain their habits and exploit the forest according to their traditions.

In Nouabalé Ndoki National Park, local communities are directly involved in guided tours to the Mbeli Bai, a swampy clearing measuring some 15 ha visited by 130 gorillas. Locals also guide adventurous tourists to track groups of habituated gorillas through the forest in another Congo site outside the park, known as Mondika. These activities have had significant impact on the local economy. Every visitor pays CFA 5,000[2] daily. The proceeds are managed by a village development fund. In 2007, the funds, totaling CFA 3,325,000 (approximately $ 6,500), were spent on basic amenities such as schools, dispensaries and electricity supply in Bomassa and Makao, villages located at the periphery of the park. This has created a propitious environment for other fledgling tourist activities, amongst them traditional dances and making of artistic objects, hitherto less developed in the area.

Around Lobéké National Park, trophy hunting in a community hunting area is generating some $ 50,000 each year. This money is managed by local wildlife management committees. It is invested in education, through the construction of schools (Figure 19.4) and the provision of potable water through improvement of water sources and well construction. The result is greater involvement of local communities in wildlife protection.

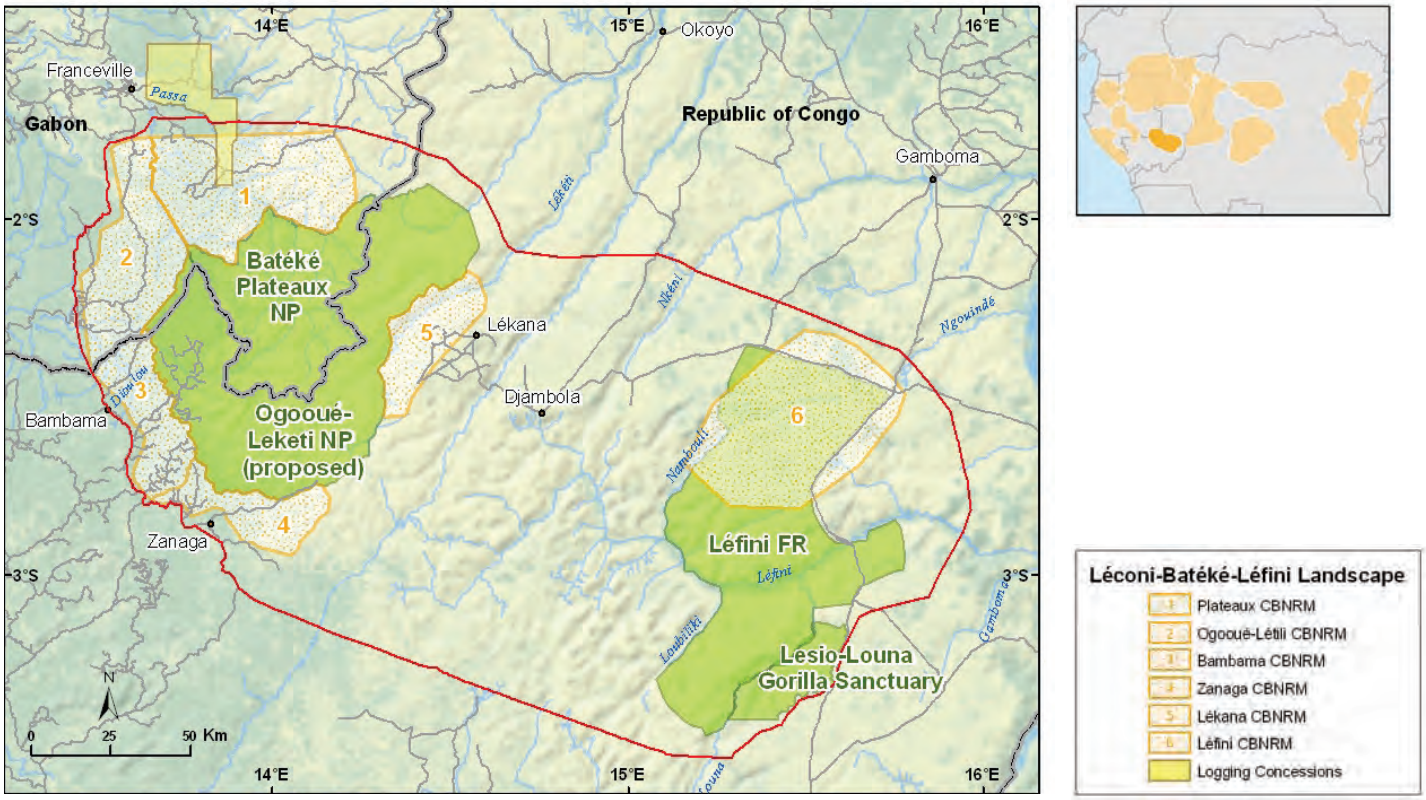
The people-centered conservation approach has enabled local communities to recognize the links between conservation and development to improve their living conditions given accrued benefits from ecotourism, trophy hunting and other income generating activities. Another important aspect is granting access to forest resources to indigenous forest peoples and surrounding Bantu communities. The co-management initiatives have stimulated greater local community participation in and support for conservation work in the region. WWF and other conservation partners will continue to support this people oriented approach within the TNS Landscape.

[2] CFA 1 = 655.957 Euro

CHAPTER 20
Léconi-Batéké-Léfini Landscape

Paul Telfer, Fiona Maisels, Noe Mabiala, Alain Ampolo, Apolinar Tsoumou, Clement Inkamba-Nkulou, Sandra Nse Esseng, and Nicolas Bout

Land Use Planning



Sources: WCS, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson US National Park Service.
Figure 20.1: Macro-zones in the Léconi-Batéké-Léfini Landscape

The Léconi-Batéké-Léfini Landscape land use planning process is well underway. Baseline socio-economic studies, biological surveys and ecological monitoring have been completed throughout the Landscape and follow up information continues to be gathered and integrated into these databases. These data have allowed the Landscape Consortium partners and other prominent stakeholders to establish the priority macro-zones where land use plans are to be elaborated, adopted and partially implemented over the course of the next three years.

In the Léconi-Batéké-Léfini Landscape, three protected area macro-zones have been identified: the Plateaux Batéké National Park (PBNP), the proposed Ogooué-Lékéti National Park (OLNP) and the Léfini and the Lesio-Louna reserves. Around each protected area a set of community-based natural resource management (CBNRM) zones have been identified with two to the north of the PBNP in Gabon, three around the south of the proposed OLNP and one to the north east of Léfini. Work carried out by The Aspinal Foundation - *Projet protection des gorilles* (TAF-PPG) to the east of Lesio-Louna is advancing and may lead to the development of an additional CBNRM in this region. Only one extractive resource zone (ERZ) exists in the Landscape, that of the Rougier-Gabon Léké forestry concession. Rougier is seeking Forest Stewardship Council (FSC) certification and is developing a management plan that will allow them to sustainably manage this ERZ.

With the priority macro-zones identified, the Landscape Consortium and partners have created a steering committee to develop the Landscape-wide land use plan strategy and to oversee the implementation of short-term and medium-term (3 years) activities to be carried out throughout the Landscape. The committee includes a representative from each Landscape Consortium member (WCS and Pact), a protected area governmental administrator from each country in the Landscape, and a representative from each major partner in the Landscape (TAF-PPG, CIRMF and MBG). The steering committee is also charged with ensuring that all stakeholders are identified and engaged, and to oversee the development of land use plans for each macro-zone.

Progress to date in the land use plan process includes the development of a landscape land use plan strategy to be implemented over the next three years. In addition, the land use plan process has begun in several CBNRMs as well as in the protected areas. Each macro-zone has land use plan strategies adapted to the social, cultural, political and biological particularities of the zone.

The management plan for Plateaux Batéké National Park (PBNP) in Gabon is in its final stages. The draft of the PBNP management plan was created during a 10-day workshop organized by the National Parks Agency (ANPN) and WCS in Léconi, Gabon. This workshop brought together important stakeholders, park administrators (ANPN), international NGO's (WCS and PPG), and representatives from all of the local communities in adjoining areas (villages from the departments of the Plateaux and Ogooué-Létili and from the towns of Bongoville, Boumango and Léconi) to discuss and develop a consensus for land use within the park limits, elaborate park regulations, determine and prioritize future park activities, and identify the priorities for future research. The draft plan has been ratified by the major partners and stakeholders and will likely be adopted in early 2009.

Photo 20.1: A few miles north of Batéké Plateau National Park, erosion has exposed the hard sandstone cores. This process predates the arrival of human populations, neolithics or metallurgists, in the region, 2,000 to 3,000 years ago.

Although the proposed OLNP in Congo has not yet been officially gazetted, progress has been made to establish a transboundary protected area with the adjoining PBNP in Gabon. Recent meetings between park managers, local Gabonese and Congolese government representatives and conservation NGOs have established local agreements that will facilitate the harmonization of park management plans and free circulation of park and project personnel between parks.

In the Léfini and Lesio-Louna reserves, land use plan strategies have been developed that include redefining the limits of the two reserves, i.e., combining the southern Léfini reserve and Lesio-Louna into a single administrative unit while restructuring northern Léfini to accommodate the CBNRM zones to the northeast.

An important component of the Landscape strategy is to develop a technical platform through which local and regional land use plans are accepted and respected by national government authorities. The Landscape partners have worked extensively with local communities, local authorities and other stakeholders to establish the legal recognition of community associations and their land use plans. To this end, the Léfini CBNRM in Congo has been successful in developing and ratifying at the local government level a simplified management plan that defines the roles and responsibilities of the community associations, civil society and government in a signed "Charter of Responsibilities". This central document gives the community associations within the CBNRM legal status which acknowledges their right to sustainably manage natural resources to which they have had traditional access and it spells out the rights and responsibilities of all partners.

Similar progress has been made in Gabon in that the legal status of the community associations within both the Plateaux and Ogooué-Létili CBNRM macro-zones has been recognized by the local authorities (the *Préfecture*) and dossiers have been assembled and submitted to the Ministry of the Interior for legal recognition at a national level.

To the southeast of the Léfini reserve in Congo, lies the Lesio-Louna Gorilla Sanctuary where

Landscape partners TAF-PPG have performed extensive socio-economic surveys and have begun to develop community associations to provide alternative livelihoods to illegal hunting and charcoal-making in the reserve. As part of this process, they have applied standardized methodologies provided by one of the Landscape Consortium member, Pact, and there is a possibility of developing a new CBNRM in this area.

Progress is also being made in the Lékana CBNRM as work toward a legal framework continues and alternative livelihood activities are being evaluated. Within the Impini community association, discussions have been taking place to increase corn production to supply community members in the Mpoh community association, 200 km to the southeast, where pork husbandry is being considered as an alternative to hunting. While these dialogues are preliminary and the activities await feasibility studies, they show promise as complementary and interlinked livelihood alternatives within the Landscape.

Work is just starting in the Zanaga and Bambama CBNRM zones due to logistic difficulties and limited human and financial resources. However, the lessons learned while implementing CBNRM activities in the other macro-zones are expected to help the Landscape Consortium partners successfully develop land use plans in these remaining zones.

Rougier-Gabon is one of the larger forestry companies operating in Gabon. They possess the only active logging concession (Léké) located in the north of the Landscape. This is also the only ERZ in the Landscape. The Gabonese government requires that all forestry companies establish a sustainable management plan for each logging concession but Rougier is taking this one step further by applying for Forest Stewardship Council (FSC) certification in their Léké concession. WCS has assisted the auditors in this process (Bureau Veritas) and has been working to establish an agreement with Rougier to insure that they comply with the highest standards possible in terms of their social, technical and environmental practices.

Photo 20.2: Acraea cepheus is one of several species in this genus that inhabit the shrubby savanna and gallery forest edges of the Batéké Plateau.

Human Activities

The ethnic and cultural composition of the Léconi-Batéké-Léfini Landscape remains dominated by the Téké people, however in villages along the main roads and in the urban centers, the number of migrants from DRC and other African countries is increasing.

While the density of the population in the Landscape has not changed significantly, the trend is toward an increased human presence. New villages of one or two families are appearing along the major trunk roads in the Landscape between Djambala and Ngo, and between Ngo and Brazzaville. This is due mainly to people seeking new agricultural opportunities to develop small scale farms to furnish the markets of Djambala and Brazzaville. This increased agricultural intensity along the roads has reduced the productivity of the soils in immediate proximity to many villages, requiring longer fallow periods between planting and pushing people into new areas farther from the villages. Participative mapping around Lékana and Ngo indicates that compared to 20 years ago, villagers must travel on average 6 km farther from their villages to find areas with sufficient natural resources to support their current activities.

The current direct threats posed by the human element in the Landscape are from commercial hunting to supply food to the larger towns of Djambala, Lékana, Franceville and Brazzaville and the frequent occurrence of anthropogenic brush fires concomitant with this illegal hunting. However, future iron ore and forestry exploitation in the area around Zanaga will increase pressure on natural resources caused by the influx of people seeking employment in these sectors. Three one-year studies of bushmeat markets in the Congolese districts of Lékana, Zanaga and Bambama in the north of the Landscape have shown unsustainable levels of commercial off-take of protected and keystone species including chimpanzees, leopards, buffalo, aardvarks, water chevrotains, Grimm's duiker and giant pangolins.

Although there is very little industrial logging occurring at the moment, both Congo and Gabon have awarded forestry concessions in the northwest. In Gabon, the logging company working in the Landscape is seeking FSC certification and is developing a management plan to minimize the negative impact of their activities. In Congo, although no logging has taken place,

three concessions have been awarded in the area adjacent to the Plateaux Batéké National Park in Gabon (Decree N°8520/MEFE/CAB) in an ecologically sensitive area that shows the highest density of elephants and great apes in the landscape. The government and Landscape partners are in discussions about how best to protect both the ecological and economic interests of the area that is within the proposed limits of the soon to be created Ogooué-Lékéti National Park of Congo.

Table 20.1: Important agricultural products in the Léconi-Batéké-Léfini Landscape

Agricultural product	Unit	Purchase price/ unit* ($)	Primary destinations		Date	Data collection	Source
			Inside Landscape	Outside Landscape			
Information on agricultural trade of Lékana							
Fufu	Sack (*sac de farine)*	22	Lékana, Léconi	Franceville, Brazzaville	2005-2008	Surveys of cultivators and market sales	WCS-Plateaux Batéké Project
	Bowl (8-9 kg) *(cuvette)*	6					
Beans	Tin can (1 kg) *(Quaker)*	1	Djambala, Lékana	Brazzaville			
Potatoes	Bowl (8-9 kg) *(cuvette)*	12	Lékana	Brazzaville			
Groundnuts	Sack (*sac de farine)*	32	Lékana	Brazzaville			
Maize	Bowl (8-9 kg) *(cuvette)*	7	Lékana	Brazzaville			
Information on agricultural trade of Zanaga							
Cassava	Stick (*baton)*	0.4	Zanaga		2005-2008	Surveys of cultivators and market sales	WCS-Plateaux Batéké Project
Groundnut	Sack (*sac de farine)*	20	Zanaga				
Plantain	Bunch (*régime)*	3	Zanaga	Sibiti, Franceville, Pointe-Noire, Dolisie			
Banana (sweet)	Bunch (*régime)*	2	Zanaga	Sibiti, Franceville, Pointe-Noire, Dolisie			
Palm oil	Liter	0.9	Zanaga, Bambama	Sibiti, Franceville.			

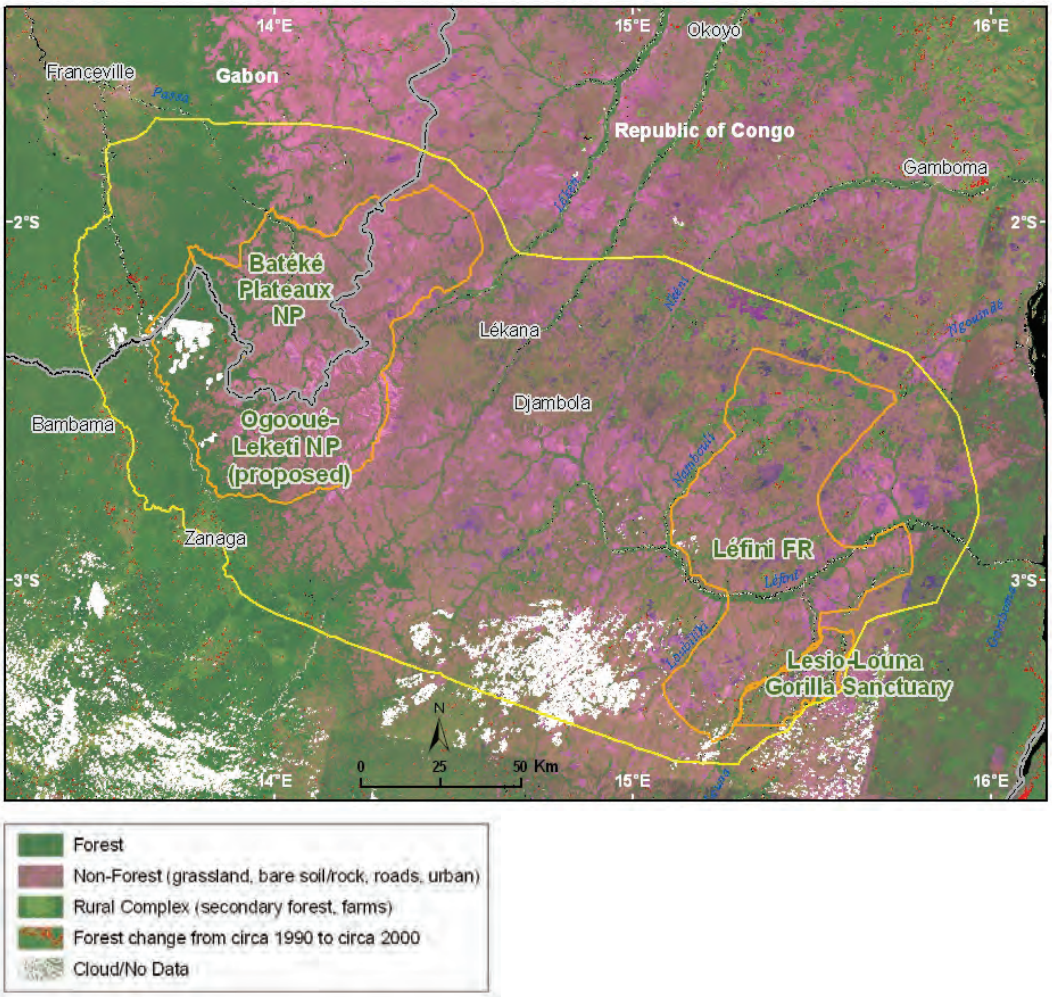
*Based on an exchange rate of $ 1 = CFA 500. The prices may vary by season. The prices indicated are an average of seasonal prices.

Table 20.2: Bushmeat trade in the Léconi-Batéké-Léfini Landscape

Bushmeat Species	Unit	Purchase price/ unit* ($)	Primary destinations		Date	Data collection	Source
			Inside of Landscape	Outside of Landscape			
Information on bushmeat trade of Lékana							
Grimm's duiker (*Sylvicapra grimmia*)	Whole fresh adult	12.9	Lékana		Feb 2006-Jan 2008	Surveys of hunters as they left for the forest and of traders and sellers in Mpini. Hunters were interviewed every day except Sundays and holidays.	WCS-Plateaux Batéké Project
	Smoked without bowels	12	Lékana	Franceville			
Sitatunga (*Tragelaphus spekei*)	Whole fresh adult	0.9	Lékana				
	Smoked without bowels	1.2	Lékana				
Moustached monkey (*Cercopithecus cephus cephus*)	Whole fresh adult	3.9	Lékana				
	Smoked without bowels	3.3	Lékana				
Red river hog (*Potamochoerus porcus*)	Fresh quarters/kg	0.8	Lékana				
	Fresh quarters/kg	1.8	Lékana				
Information on bushmeat trade of Zanaga							
Blue duiker (*Cephalophus monticola*)	Whole fresh adult	4.3	Zanaga, Lékana	Sibiti, Nkayi	Feb 2006-Jan 2007	Surveys of hunters as they left for the forest and of traders and sellers in Ogooué. Hunters were interviewed every day except Sundays and holidays.	WCS-Plateaux Batéké Project
	Smoked without bowels	3.8	Zanaga, Lékana	Sibiti, Nkayi, Brazzaville, Franceville			
	Fresh meat of 200g	0.4	Zanaga (Ogooué)				
	Smoked meat 180g	0.4	Zanaga (Ogooué)				
Brush-tailed porcupine (*Atherurus africanus*)	Whole fresh adult	3.9	Zanaga, Lékana				
	Smoked without bowels	3.7	Zanaga, Lékana	Sibiti, Nkayi, Brazzaville, Franceville			
	Fresh meat of 200g	0.4	Zanaga (Ogooué)				
	Smoked meat 180g	0.4	Zanaga (Ogooué)				
Moustached monkey (*Cercopithecus cephus cephus*)	Whole fresh adult	4.1	Zanaga	Sibiti, Nkayi			
	Smoked without bowels	3.5	Zanaga	Sibiti, Nkayi, Brazzaville, Franceville			
	Fresh meat of 200g	0.4	Zanaga (Ogooué)				
	Smoked meat 180g	0.4	Zanaga (Ogooué)				
Red river hog (*Potamochoerus porcus*)	Whole fresh adult	1.1	Zanaga	Sibiti, Nkayi			
	Smoked without bowels	1.3	Zanaga	Sibiti, Nkayi, Brazzaville, Franceville			
	Fresh meat of 200g	0.4	Zanaga (Ogooué)				
	Smoked meat 180g	0.4	Zanaga (Ogooué)				

Based on an exchange rate of $ 1 = CFA500, prices of larger animals are estimations based on price per kilogram.

Forest Cover



Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 20.2: Composite Landsat satellite image of the Léconi-Batéké-Léfini Landscape overlain with 1990 to 2000 forest loss (in red)

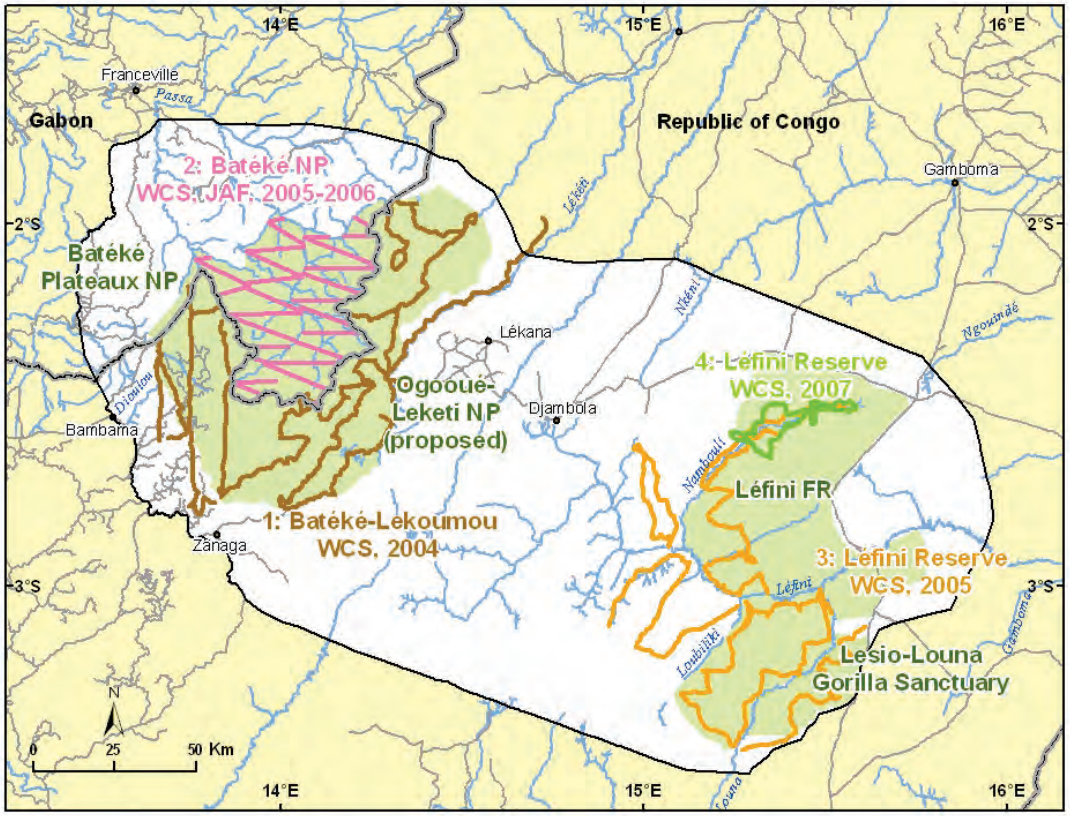
Table 20.3: Forest cover and forest loss in the Léconi-Batéké-Léfini Landscape from 1990 to 2000

	Forest area			Forest loss			
Landscape area	1990 (km^2)	2000 (km^2)	2005 (km^2)	1990-2000 (km^2)	1990-2000 (%)	2000-2005 (km^2)	2000-2005 (%)
35,917	7,073	6,968	N/A	105	1.48	N/A	N/A

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

For the most part the Léconi-Batéké-Léfini Landscape forest cover remains stable. The slight reductions seen from 1990-2000 are due to small scale agriculture and fuel wood extraction around small towns, rather than from industrial logging. As the towns grow there will be increased pressure on the forests but the rate of deforestation will remain low. Additionally, the logging activities proposed by Rougier under the FSC certification will insure reduced impact extraction in the northeast of the Landscape.

Large Mammal and Human Impact Monitoring



Sources: WCS, JAF, MEF, UMD-CARPE, OSFAC, FORAF.

Figure 20.3: Biological surveys conducted in the Léconi-Batéké-Léfini Landscape

Table 20.4: Biological survey results from the Léconi-Batéké-Léfini Landscape

Survey	Site name	Survey date	Lead organization(s)	Total km of recces	Elephant presence	Elephant dung pile encounter rate (N/km)	Elephant dung pile density (N/km²)	Ape presence	Ape nest group encounter rate (N/km)	Ape nest group density (N/km²)	Human sign (N/km)
1	Batéké-Lekoumou area, Congo	Jul-Nov 2004	WCS	840	Yes	0.9	N/A	Yes	0.22	N/A	1.48
2	Batéké NP, Gabon	Apr 2005-Feb 2006	WCS/ JAF	586	Yes	0.83 ± 0.53	N/A	Yes	0.005	N/A	8.05 ±11.65
3	Léfini Reserve, Congo	Jul-Aug 2005	WCS	713	Yes	0.3	N/A	Yes	0	N/A	0.16
4	Léfini Reserve, Congo, small patch around 2 bais in northern area only	Feb-Mar 2007	WCS	132 (non random foot searches around two bais in the north of the Reserve)	Yes	N/A	N/A	No	N/A	N/A	Many
5	Lesio-Louna, Congo	Jan-Dec 2006	JAF/ MEF	1815	Yes	0.003	N/A	No	N/A	N/A	0.27

1) Inkamba-Nkulu and Diahouakou, 2005; 2) Bout, 2006; 3) Nganga et al., 2006; 4) Inkamba- Nkulu and Tsoumou, 2008; 5) Mathot et al., 2006.

The Léconi-Batéké-Léfini Landscape is mostly savanna with large patches of lowland forest on its northwestern limits. It has a number of endemic plant and bird species, but wildlife in general has been heavily hunted, and occurs at very low densities. Wildlife and human impact surveys were conducted using recce surveys in the Landscape in both Gabon and Congo from 2004 to 2007.

The area that had been proposed as the new Ogooué-Lékéti National Park (OLNP) by the Government of Congo just across the border from, and contiguous with, the Batéké Plateaux National Park (BPNP) in Gabon was surveyed in 2004. A second survey in the forested northwest section of the proposed new park has just been completed (June 2008) with data analyses to be completed shortly. The two other protected areas in the Landscape (BPNP in Gabon, and the Léfini Reserve in Congo) were surveyed in 2005 through 2006, with a second survey in Léfini taking place late in 2007. As for all surveys of this type, all large mammal and human sign were recorded and geo-referenced.

Based on the data gathered from these recent surveys across the Landscape, it is doubtful that any lions (*Panthera leo*) remain, however, hippopotamus (*Hippopotamus amphibious*) can still be found in the Léfini reserve and are reported to still be present in the Leketi and Ogooué rivers in Congo. Savanna species such as Grimm's duiker (*Sylvicapra grimmia*), the side-striped jackal (*Canis adustus*) and the aardvark (*Orycterpus afer*) are scarce but present throughout the northern portion of the Landscape in the transboundary protected area. Additionally, the surveys revealed that the DeBrazza monkey (*Cercopithecus neglectus*) was shown to occur about 140 km farther south in Gabon, and about 80 km farther west in Congo than was previously known. The only place where both wild chimpanzees (*Pan troglodytes*) and gorillas (*Gorilla gorilla*) are reported together is the forested area in the northwest of the Landscape. Chimpanzees also occur in the BPNP along the Mpassa River.

Our data also show that although many large mammal species (including elephants, chimpanzees, and buffalo) occur in all of the sectors surveyed so far, their numbers have been greatly reduced. Elephant sign in the Léfini area has decreased considerably (0.3/km to 0.003/km) and only a small population remains in the northern part of the reserve. Elephant sign is highest in the northwest of the Landscape in the border area of the BPNP where a number of mineral-rich clearings attract forest elephants and other wildlife (0.9/km in Congo and 0.83 ± 0.53 in Gabon). In this area, human sign was lowest on the Gabon side of the border due to its remoteness but future logging activities across the border in Congo will create new roads and potential access to hunters. It is clear from our survey work that enforcement of current legislation needs to be increased.

Photo 20.3: Yellow-mantled Widowbirds (Euplectes macrourus) are very common to the tall grass savannas of the Batéké Plateau.

Special Interest

The Successful Start-up of the "Plateaux Batéké Elephant Project"

Among the CARPE-led successes in the Léconi-Batéké-Léfini Landscape, one stands out above the rest. The WCS Batéké Plateaux Project in collaboration with our landscape partners CIRMF, CIRAD and PPG successfully launched the "Plateaux Batéké Elephant Project". This project combines activities taking place in CBNRM zones and protected areas by combining monitoring of key elephant habitats, anti-poaching patrols, research, infrastructure development, and community based eco-tourism initiatives. This project establishes a synergy between conservation and the sustainable use of natural resources in and around the future transboundary protected area in the north west of the Landscape by integrating the study and protection of elephants while involving local populations in resource management and protection as part of community based development activities.

In order to focus project activities, two key elephant sites were chosen as priority areas. The first site is Bai Jobo in the southwest of the Batéké Plateaux National Park and the second is a series of mineral rich beaches 50 km north of the bai on the Mpassa River, near the communities of the Kessala Regroupement. At these two sites we will combine elephant conservation, research and community-based eco-tourism development.

Two different approaches are being employed simultaneously to protect the elephants in the focus areas. For Bai Jobo and two newly identified nearby bais across the border in Congo, a comprehensive monitoring and research program is being established while at the Kessala Elephant Beaches, we are developing a community-based natural resource management zone (CBNRM) in which the villagers and other stakeholders work together

Photo 20.4: Harvesting forest products is a daily activity for many people.

to identify solutions that will benefit both people and wildlife. To this end, the project developed two complementary proposals, one for the bai and monitoring activities and the other for empowering the communities and engaging them in activities that will promote conservation while addressing their development needs. Financing recently received from USFWS and CIRMF has permitted project personnel to conduct monitoring, research and anti-poaching patrols in the transboundary area around the bai. The funding and subsequent initiation of this project has led to commitments from Total Gabon to fund the construction of an operations base. This base will be the Plateaux Batéké Ecological Research station which will become the base of the elephant monitoring and research endeavors.

Simultaneously, with the implementation of the research efforts, the project began community activities in the communities around the Kessala Elephant beaches. Stakeholder meetings and participative methodologies were employed, culminating in the creation of a community association. This association called "Ondhigi," which means "friendship," has identified activities to help community members better manage their natural resources. These activities include the development of ecotourism based on elephant viewing in their traditional territory, incorporating protection of wildlife and the promotion of equitable distribution of eco-tourism revenues.

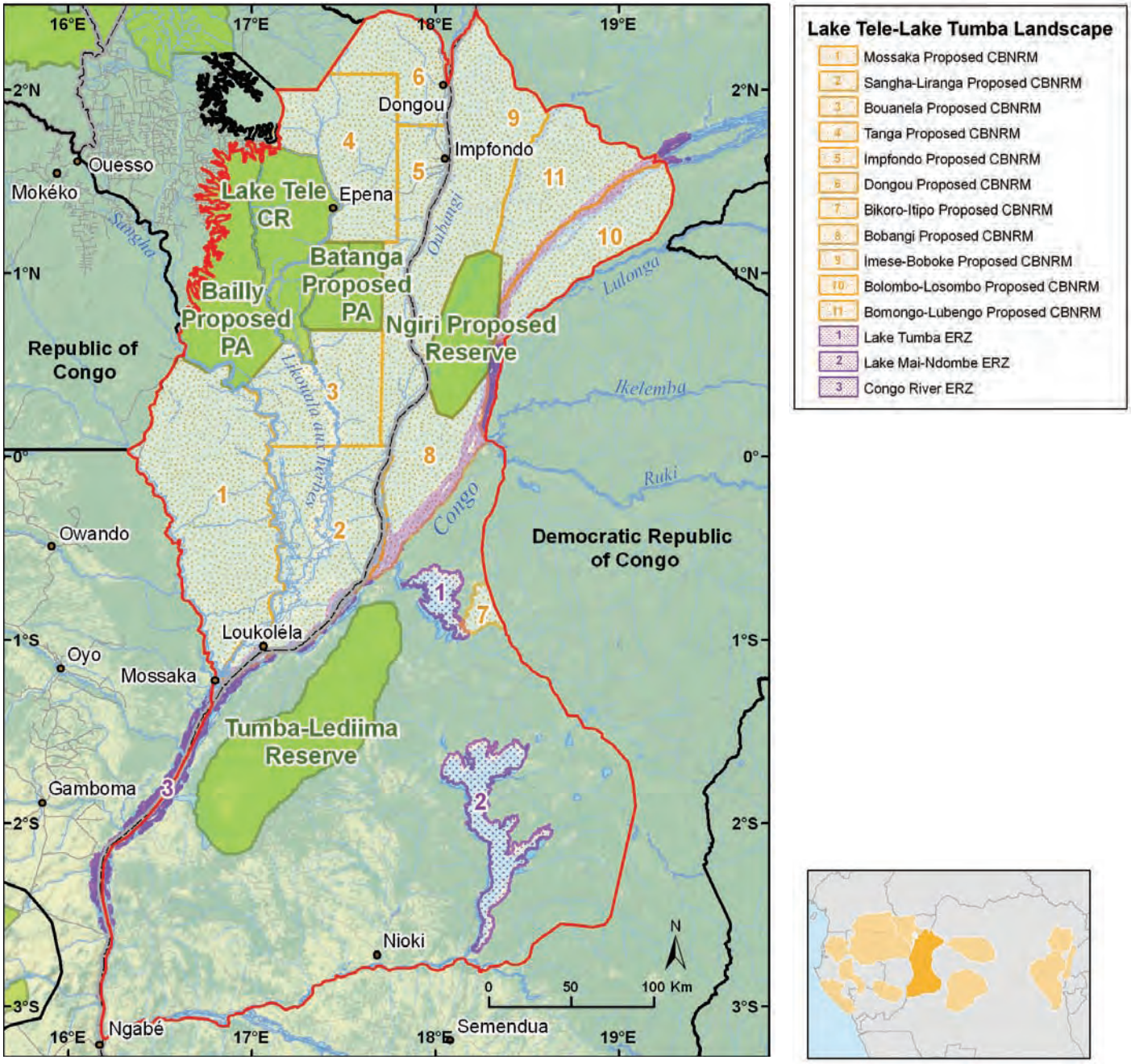
As the research activities continue, five new bais used by the Batéké elephants have been identified near the village grouping of Mopia. Mopia is located west of the Kessala Regroupement home of the Ondhigi community association and news of its success had already reached Mopia by the time the survey teams verified the existence of the bais. The citizens of Mopia contacted project administrators and asked for assistance in creating their own village association based on the model of Kessala. The project has since included this new area, and has expanded the scope of activities and partners by inviting CIRMF to participate through the construction of an elephant monitoring platform at one of the bais. The platform serves a dual purpose of hosting researchers while at the same time being available to the community to accommodate tourists.

Recently three European zoos recognized the unique value of this integrated project and have offered to finance the placing of satellite-tracking collars on 10 elephants. These collars will benefit research and more importantly will provide information about the elephants ranging behavior that will help us reduce human-elephant conflicts and guide natural resource management and the community eco-tourism project.

CHAPTER 21
Lake Télé-Lake Tumba Landscape

Felin Twagirashyaka and Inogwabini Bila-Isia

Land Use Planning



Sources: WCS, WWF, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.
Figure 21.1: Macro-zones in the Lake Télé-Lake Tumba Landscape

Photo 21.1: The vast expanses of water and marshy meadows provide a rich landscape.

The Lake Télé – Lake Tumba Landscape encompasses 126,000 km² in the Republic of Congo (ROC) and the Democratic Republic of Congo (DRC). There are currently two protected areas in the Landscape: Lake Télé Community Reserve (in ROC) with an area of 4,400 km² created in 2001 and the Tumba-Lediima Natural Reserve (in DRC) with an area of 7,500 km² created in 2007.

In July 2007, government officials, COMIFAC representatives, Ramsar focal points, scientists and members of the Landscape Consortium met in Brazzaville to discuss the land use planning process, focusing primarily on establishing a cross-border agreement for landscape management and on the Ramsar process to classify part of the Landscape as one of the world's largest wetland sites. A strategy with benchmarks was adopted and a draft document for the bilateral agreement was developed.

Creating a transboundary Ramsar site in the Landscape, spanning ROC and DRC, was deemed an important part of the strategy for the land use planning process because it provides an international legal framework for a large portion of the Landscape, which will be adopted in national legislations in both DRC and ROC. Ramsar sites have now been officially classified in both DRC and ROC, but the inter-ministerial agreement for the transboundary management of these sites has been delayed. With 65,696 km² of the Ramsar site in DRC alone, it will be the world's largest Ramsar site. The Landscape is currently divided into 23 macro-zones including 4 proposed PAs, 13 CBNRMs and 6 ERZs. The boundaries of the macro-zones will likely change as these areas are poorly known and sites with high conservation value are still being identified. The survey work is being conducted zone by zone, focusing on empowering local communities to become part of the planning teams (with special attention to women and marginalized groups).

Photo 21.2: Products from harvesting, fishing and hunting co-exist in markets.

Bailly PA (proposed) and Batanga PA (proposed), ROC

Under Congolese law, the Lake Télé Community Reserve (LTCR) is a recognized protected area. During participatory mapping of villages in the LTCR, it was found that the community territories of Bouanela and Dzeke villages overlap the proposed Batanga PA. The community territories of Moungouma-Bailly and Kinami village also overlap the proposed Bailly PA. It is therefore logical and, from a management perspective, more efficient to propose an extension of the limits of the existing PA (LTCR) to also include these areas.

Lake Télé Protected Community Reserve, ROC

In the LTCR, all villages in the reserve were mapped and community regulations allowing the communities to manage their resources have been drafted. Additionally, the mapping of community areas outside of LTCR, including the Bailly zone and the southern Likouala-aux-herbes (e.g., Moungouma-Moke and Ebambe) in the Bouanéla CBNRM, has been finalized. Awareness campaigns explaining landscape activities and targeting local and regional authorities such as the *Préfet*, the *Sous Préfets* and the Departmental Directors were conducted. These authorities have agreed to actively participate in the land use planning, which is important for the success of the process.

Tumba-Lediima Reserve, DRC (IUCN cat. II)

Planning sessions were organized between ICCN and WWF to agree on the management of the reserve. An agreement was reached to include local communities in the process of implementing the management plan for the reserve. A human occupational map documenting changes in land occupation between 1986 and 2006 was produced and will feed into the development of the management plan. The map and on-going local consultations will generate a management *modus operandi* between local communities and the ICCN Management team.

Lake Tumba ERZ (proposed), DRC

Local Committees for the Management of Natural Resources (LCMNR) have been created for most of the villages surrounding the lake. The LCMNR's *raison d'être* is to constitute the planning group at a local level because there is a need to train communities in advocacy and organization. After the creation of these LCMNRs, the second phase of the process was the selection of pilot communities for the establishment of a community based fisheries monitoring system and organization of stakeholder groups to improve the quality of post-harvest fish processing. A general meeting, including both provincial and territorial authorities, LCMNRs and other stakeholders, was held in September – October 2008 to agree on the management of the lake. A draft of the management plan was produced and is going through the approval process.

Photo 21.3: Fishing village on the Ruki River.

Ngiri Biosphere Reserve (proposed), DRC (IUCN cat. II)

Biological data have been collected and key biodiversity areas identified. Some important biodiversity areas geographically overlapped with the Bobangi, DRC CBNRM (proposed), indicating the need to undertake a fine scale participatory mapping exercise. Currently, negotiations are under way with ICCN to conduct another assessment, which will include the creation of LCMNRs and the drafting of a preliminary agreement between ICCN and the local communities on the appropriate ways to manage different micro-zones within the PA.

SEBO *(Société des Élevages du Bandundu Occidental)* Grazing Concession and Adjacent Forests ERZ (proposed), DRC

LCMNRs were created in villages located within the SEBO grazing concessions. The LCMNR of Mpelu, Nkala, and Nko have met several times and are now working, with critical input from the NGO Mbou-Mon-Tour (MMT), toward the implementation of a CBNRM in the gallery forests of Nkala. WWF is helping to negotiate proper community land tenure of these lands. Next steps include negotiations with the territorial authorities as part of the planning process, and the submission of an official request for tenure, as required by the DRC forestry law.

Imese CBNRM (proposed) and Bomongo-Lubengo CBNRM (proposed), DRC

In both of these proposed CBNRMs, fine-scale biological surveys were conducted and local areas of biological importance were identified. Results of these surveys will inform the micro-zoning process when the LCMNRs are developed.

Human Activities

The top three commercial agricultural products in the ROC section of the Landscape are cassava, Koko leaves and palm nuts. Data were collected from the market of Epena, the district capital, where cassava is sold in three forms: cassava leaves, cassava flour and cassava *baguette*. The leaves are the most abundantly sold at CFA 100 ($ 0.09) for 1,200 g. Cassava flour ("*le foufou*") is sold in small plastic bags of 500g at CFA 100 ($ 0.18). It is possible to get 1 sack of flour of 50 kg for CFA 8,000 ($ 14.5), if ordered in advance. The sale of agricultural products is done exclusively by women. The cooked cassava *baguette* is also exclusively made by women and is derived from the cassava root which is pounded, wrapped, and cooked in *Marantacae* leaves. The 2nd and 3rd most abundantly sold products in the Epéna market are the leaves of *Gnetum africanum* (*"koko"*) which are gathered in the forest, and palm nuts, respectively. In the DRC part of the Landscape, the most common commercial agricultural products are: palm oil which is sold in containers of 25 liters, bananas which is sold in bunches or "*régimes*" and peanuts which are sold in 80-kg sacks

Photo 21.4: A stand of Terminalia along the river.

Bushmeat data were collected in the villages of Mokengui, Koundoumou and Dzéké (ROC). The top three commercialized species are dwarf crocodile (*Osteolaemus tetraspis*), monkeys (*Cercopithecus sp.*) and red river hog (*Potamocherus porcus*). The prices vary between $ 10 and $ 15 for an entire dwarf crocodile; between $ 3 and $ 5 for a monkey and $ 6 and $ 9 for a quarter of red river hog. Bushmeat is mostly exported to Impfondo and Brazzaville. Other species found on the market are sitatunga, duiker, and turtle. In the ROC part of the Landscape there is also a high consumption of fish, with *Clarias* and *Parachana* being the most commercialized species. In DRC, the products which are most sold are red river hog, monkeys and sitatunga at Mbandaka market. The prices vary from $ 22 for a monkey to $ 111 for a red river hog.

Table 21.1a: Important agricultural products in the Lake Télé-Lake Tumba Landscape

Agricultural product	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Town of Mbandaka						
Palm oil	Can (25 l)	8.88	Mbandaka	May-05	Household and market interviews	Lake Tumba socioeconomic study, 2006
Banana	Whole bunch	4.00	Mbandaka	May-05	Household and market interviews	Lake Tumba socioeconomic study, 2006
Peanuts	Sack (80 kg)	111.11	Mbandaka	May-05	Household and market interviews	Lake Tumba socioeconomic study, 2006
CBNRM Lake Télé, markets of Epéna and Dzeke						
Cassava leaves (*Manihot esculenta*)	1,200 g	0.09	Epena	Apr-07	Market surveys	Otto *et al.*, 2007
Cassava meal (*Manihot esculenta*)	500 g	0.18	Epena	Apr-07	Market surveys	Otto *et al.*, 2007
Cassava stick (*Manihot esculenta*)	50 g	0.18	Epena	Apr-07	Market surveys	Otto *et al.*, 2007

Table 21.1b: Bushmeat trade in the Lake Télé-Lake Tumba Landscape

Bushmeat species	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Mbandaka						
Red river hog (Nsombo, *Potamocherus porcus*)	Whole	111.44	Mbandaka	May-05	Market survey	Lake Tumba socioeconomic study, 2006
Monkey (non specified)	Whole	22.22	Mbandaka	May-05	Market survey	Lake Tumba socioeconomic study, 2006
Sitatunga (*Tragelaphus spekei*)	Packet of 3	111.11	Mbandaka	May-05	Market survey	Lake Tumba socioeconomic study, 2006
Village of Dzeke (CBNRM Lake Télé)						
Dwarf crocodile (*Osteolaemus tetraspis*)	Whole	14.55	Dzeke	Jun-07	Household surveys	Otto *et al.*, 2007
Spot-nosed guenon (*Cercopithecus nictitans*)	Whole	3.64	Dzeke	Feb-07	Household surveys	Otto *et al.*, 2007
Red river hog (*Potamocherus porcus*)	Quarter (gigot)	9.09	Dzeke	Jun-07	Household surveys	Otto *et al.*, 2007
Village of Koundoumu (CBNRM Lake Télé), periphery of the Reserve						
Dwarf crocodile (*Osteolaemus tetraspis*)	Whole	9.09	Koundoumou	Jun-07	Household surveys	Otto *et al.*, 2007
Caterpillar (Chenille)	Cooking pot	0.18	Koundoumou	Aug-07	Household surveys	Otto *et al.*, 2007
Red river hog (*Potamocherus porcus*)	Piece	1.09	Koundoumou	Mar-07	Household surveys	Otto *et al.*, 2007
Village of Mokengui (periphery of the LTCR)						
Dwarf crocodile (*Osteolaemus tetraspis*)	Whole	12.73	Mokengui	Aug-07	Household surveys	Otto *et al.*, 2007
Spot-nosed guenon (*Cercopithecus nictitans*)	Whole	3.64	Mokengui	Aug-07	Household surveys	Otto *et al.*, 2007
Red river hog (*Potamocherus porcus*)	Quarter	6.36	Mokengui	Jun-07	Household surveys	Otto *et al.*, 2007

Human Density and Distribution in the Landscape

There have been no major changes in human density and distribution since the 2006 SOF report, except that the United Nations High Commission for Refugees (UNHCR) has repatriated a large number of the refugees in DRC, which might have impacts on the distribution of the population in the Landscape.

The main activities in the Landscape remain fishing and agriculture. Small-scale trade is practiced by migrant women from Brazzaville who come to buy fish and bushmeat. Below are the activities as reported from the 2007 census. The concession in Maboula Mbondo is now active in the ROC section.

Photo 21.5: Piroques made from tree trunks are an important form of transportation in the Landscape.

Table 21.2: Principal activities for the populations of 27 villages of the Lake Télé Community Reserve

Activity	% main activity		% secondary activity	
	Men	Women	Men	Women
Farming (agriculture)	15.07	83.96	45.17	26.31
Fishing	57.20	8.84	26.38	55.63
Hunting	9.71	0.21	8.49	0
Traditional activities	3.11	0.79	13.19	4.13
Crafts	10.86	0.68	3.31	0.35
Cattle	0.07	0	0.62	0
Small trade	3.97	5.52	2.83	13.58

Source: Otto et al., 2007.

Direct Threats

There are three main direct threats to sustainable management of the Lake Télé – Lake Tumba Landscape: commercial hunting, refugees in the Landscape and roads.

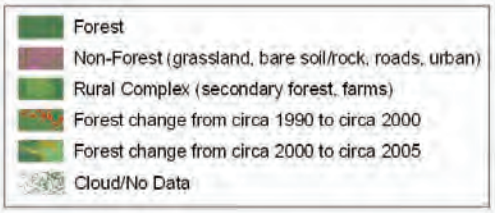
Soldiers visiting the region while on holiday usually bring in weapons which are then given to the local population to hunt for the soldiers. The meat is then transported by boats to Brazzaville.

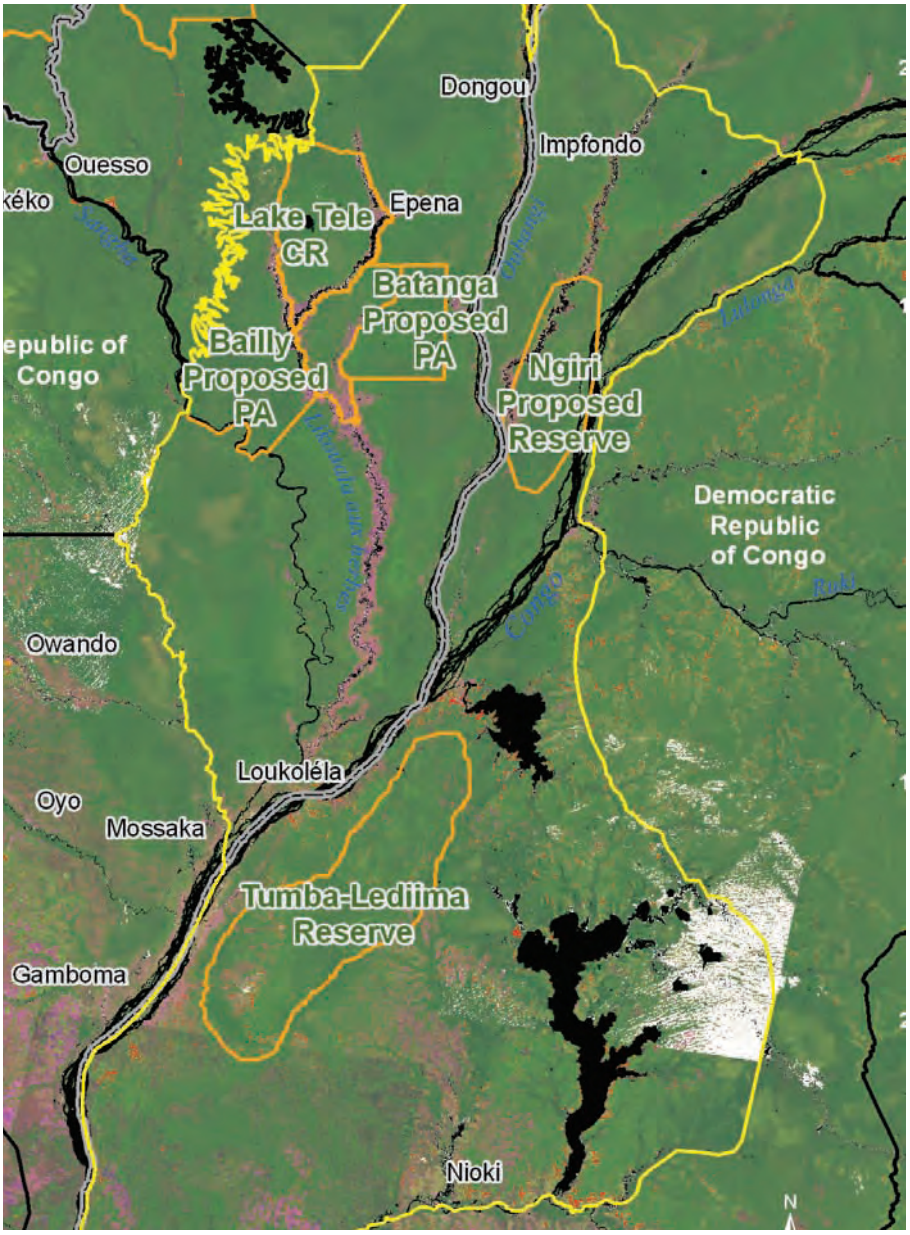
In the northeast of the Landscape (ROC), refugees from DRC living in the villages adjacent to the Oubangui River are poaching intensively. Ivory and meat are transported by boat to be sold in Impfondo and Brazzaville. Additionally, the refugees have developed intensive agriculture in the forest along the river; the consequence is severe degradation of the ecosystem in the area.

In the western part of the reserve, roads and agricultural paths are being opened which creates easy access to the forest for hunters, and facilitates the transportation of bushmeat.

Forest Cover

With around 1 % of forest loss, the rate of forest loss was high between 1990 and 2000 in the Landscape. However, the net loss in forest cover went down to about 0.2 % between 2000 and 2005. Most forest cover changes occurred in the southern part of the Landscape in the DRC segment where most of the logging concessions are located. Overall, swamps prevented forest cover losses because logging activities are difficult to undertake and prohibitively expensive in such inundated and/or seasonally inundated habitat. Fire is also apparent in all the Landscape, particularly in the forest-savanna mosaics and along major rivers. Fire is used as a management tool for raising cattle (especially in the DRC segment). The decrease in forest cover lost between 2000 and 2005 may reflect the impact of the moratorium that was imposed on allocations of new concessions in the DRC.





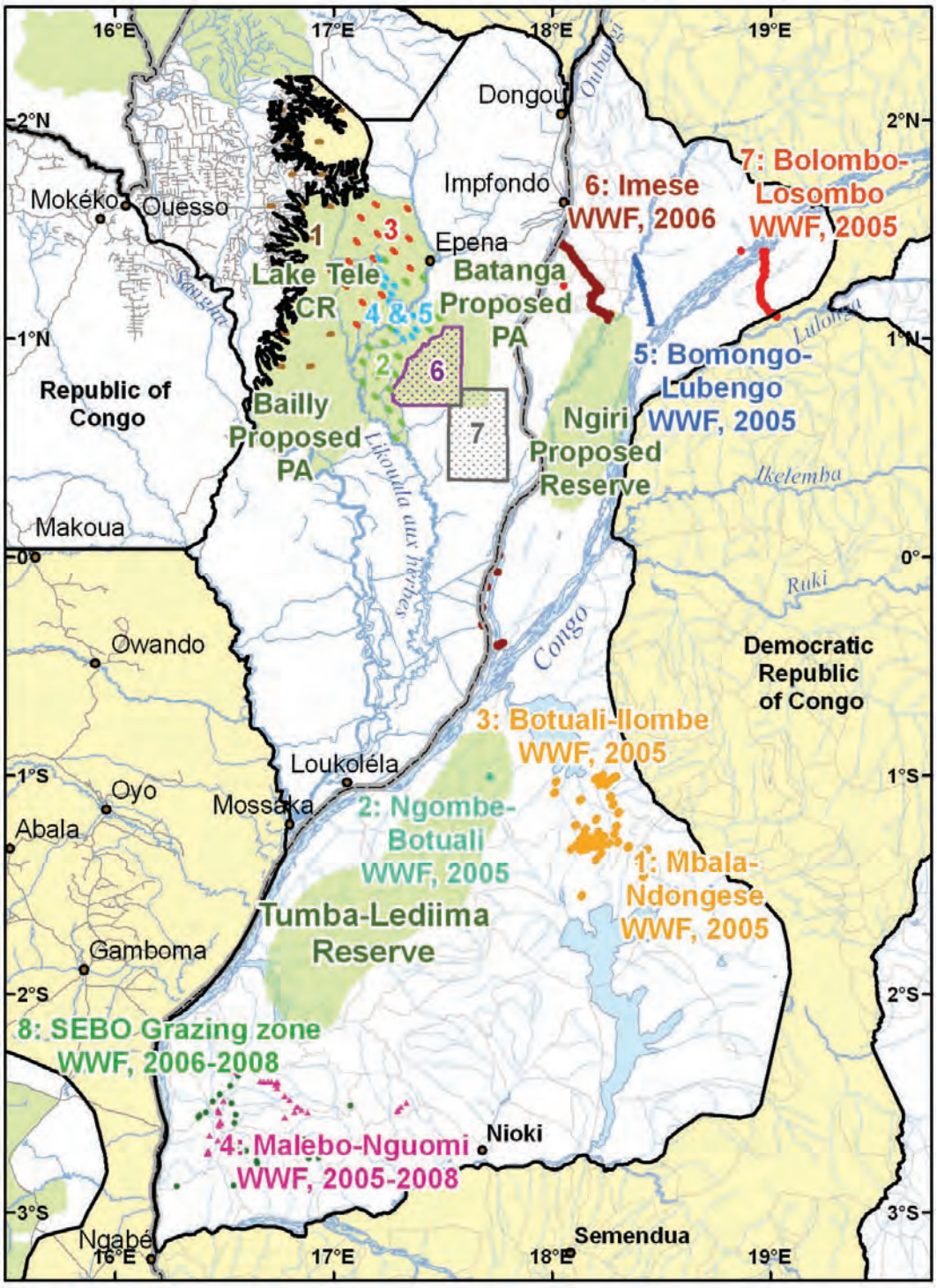
Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 21.2: Composite Landsat satellite image of the Lake Télé-Lake Tumba Landscape overlain with 1990 to 2000 forest loss (in red) and 2000 to 2005 forest loss (in orange)

Table 21.3: Forest cover and forest loss in the Lake Télé-Lake Tumba Landscape from 1990 to 2005

	Forest area			Forest loss			
Landscape area	1990 (km²)	2000 (km²)	2005 (km²)	1990-2000 (km²)	1990-2000 (%)	2000-2005 (km²)	2000-2005 (%)
130,710	100,285	99,366	99,177	919	0.92	189	0.19

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.



Sources: WCS, WWF, UMD-CARPE, OSFAC, FORAF.

Figure 21.3: Biological surveys conducted in the Lake Télé-Lake Tumba Landscape

Table 21.4a: Biological survey results for the Lake Télé-Lake Tumba Landscape, DRC segment

Survey	Site name	Survey date	Total km of recces	Number of transects	Other	Elephant presence	Elephant dung pile encounter rate (N/km)	Ape presence	Ape nest group encounter rate (N/km)	Ape nest group density (N/km²)	Human sign (N/km)
1	Mbala-Dokese	May 05-Feb 06	324	75		Yes	0.14	*Pan paniscus*		0.27	Snares = 0.54
2	Ngombe-Botuali	May 05-Feb 07									
3	Botuali-Ilombe	May 05-Feb 08						*Pan paniscus*		0.27	
4	Malebo-Nguomi	May 05-Feb 09						*Pan paniscus*		2.2	
5	Bomongo - Lubengo	May 05-Feb 10	111	12		Yes		*Pan troglodytes*	0.019		Hunting camps = 0.020
6	Imese	May 05-Feb 11	111	15		Yes	0.018	*Pan troglodytes*	0.009		Hunting camps = 0.032
6	Imese	May 05-Feb 13	61	10		No		*Pan troglodytes*	0.041		Hunting camps = 0.027
7	Bolombo-Losombo	May 05-Feb 12						*Pan paniscus*	0.057		
8	SEBO grazing zone	2006-2008			Presence-absence using McKenzie occupancy models						Major trails = 0.22
8	South of the SEBO grazing zone	2006-2008	148	6	Presence-absence using McKenzie occupancy models	Yes	0.038	*Pan paniscus*	1.02		Hunting camps = 0.019

1-5, 7-8) Inogwabini et al., 2007; 6) Biological inventory in the north of Lake Télé-Lake Tumba Landscape (DRC segment);-10) Large mammals inventory in the south of the Lake Télé-Lake Tumba Landscape (DRC segment).

Table 21.4b: Biological survey results for the Lake Télé-Lake Tumba Landscape, Congo segment

Survey	Site name	Survey date	Total km of recces	Number of transects	Total km of transects	Elephant presence	Elephant dung pile encounter rate (N/km)	Elephant dung pile density (N/km²)	Ape presence	Ape nest group encounter rate (N/km)	Ape nest group density (N/km²)	Human sign (N/km)
1	Bailly	Jan-May 06	341	24	48	Yes	2.68 ± 2.57	432.44 ± 416.4	Yes	0.65 ± 0.33	26.6 ± 13.58	0.75 ± 0.09
2	Lake Télé mixed forest	Jan-May 06	117	21	42	Yes	0.07 ± 0.20	11.49 ± 31.7	Yes	0.66 ± 0.73	26.65 ± 29.36	1.07 ± 0.33
3	Lake Télé swamp forest	Jan-May 06	132	17	34	Yes	0.06 ± 0.17	9.47 ± 16.4	Yes	1.06 ± 0.62	42.88 ± 25.42	0.71 ± 0.60
4 and 5	Lake Télé Terra Firma	Jan-May 06	55	15	30	No	0	0	Yes	1.30 ± 0.88	52.64 ± 35.91	0.5 ± 0.27
6	Batanga	Mar-Apr-07	118	21	42	Yes	1.1 ± 4.12	176.43± [40.75;763.85]	Yes	4.64 ± 5.88	217.29 ± [120.23-392.68]	0.10 ± 0.26
7	Impfondo	Mar-Apr 08	139	22	44	Yes	0.52 ± 1.42		Yes	1.25 ± 1.26	83.9 ± [48.62;144.799]	0.11 ± 0.38

1) Iyenguet et al., 2006; 2, 3, 4 and 5) Malanda et al., 2006; 6) Malanda et al., 2007; 7) Iyenguet et al., 2008.

In the Lake Télé-Lake Tumba Landscape the trend is that populations of great apes remain constant or are increasing slightly. In the eastern part of the Landscape in DRC, the data gathered from the bonobo habituation program indicates an increase in the number of individuals of the three monitored groups, as shown in the table 21.5. The group at Nkala has increased by 32 % since 2006. Despite this increase, there was evidence of bonobo hunting for bushmeat in the region of the Malebo proposed ERZ, DRC.

Table 21.5: Population of bonobos (Pan paniscus) in selected sites in the eastern part (DRC) of the Lake Télé – Lake Tumba Landscape.

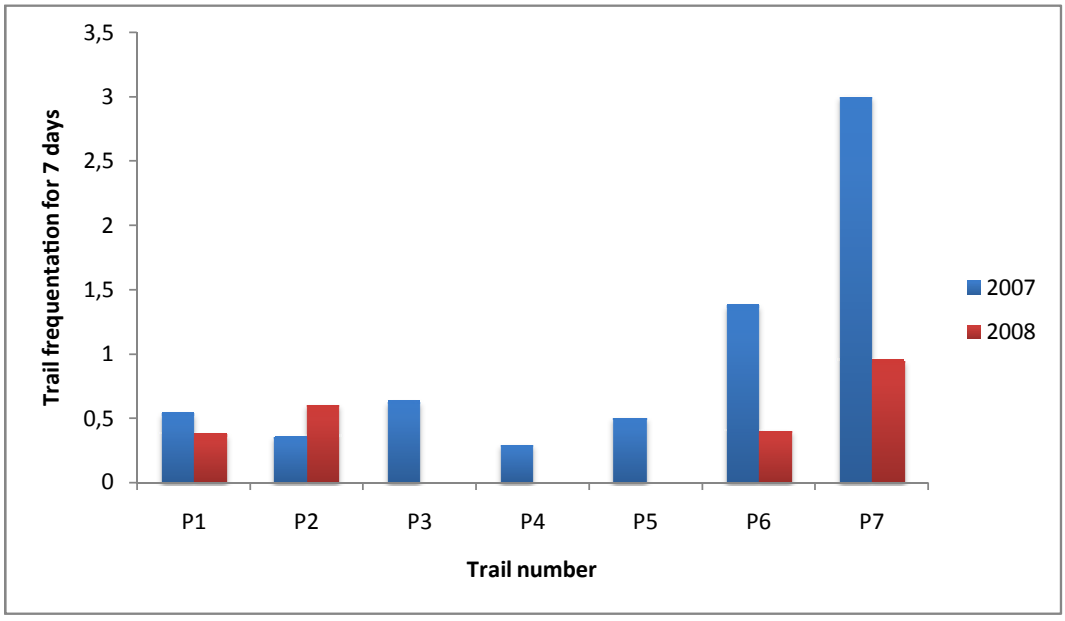
	Group size		Group composition			
Site	**2006**	**2008**	**Male**	**Females**	**Juveniles**	**Babies**
Nkala	40	53	15	20	10	8
Mpelu	23	25	*	*	*	2
Edzaengo	20	20	*	*	*	*
Tsieli	*	15	*	*	*	*
Lenga	*	25	*	*	*	3

Source: WWF Lake Tumba Project – Technical Progress Report 2008.

An overall fine-scale survey was conducted in the northern part of the Landscape and has provided critical information about chimpanzees in the region and in the region of the Bomongo-Lubengo proposed CBNRM, DRC. In addition, during this same period, the project has initiated a wildlife-domestic livestock interaction and health monitoring component, which is in its early stages.

In the ROC the monitoring results from the surveys between 2006 and 2008 show that the number of the great apes remains constant, probably due to the fact that the local communities are not targeting great apes in their hunting activities. The area of highest great ape potential (based upon the abundance of *Raphia* and an herbaceous coverage of *Cyperacae* which are preferred great ape food items) is in the Batanga zone proposed PA, ROC.

In the DRC Landscape segment, elephants were monitored through a pre-established network of elephant trails in the region of Malebo. As shown in Figure 21.4, the use of trails by elephants significantly decreased between 2007 and 2008.



Source: WWF Lake Tumba Project – Technical Progress Report 2008.
Figure 21.4: Frequency of trail use by elephants in the region of Malebo (DRC).

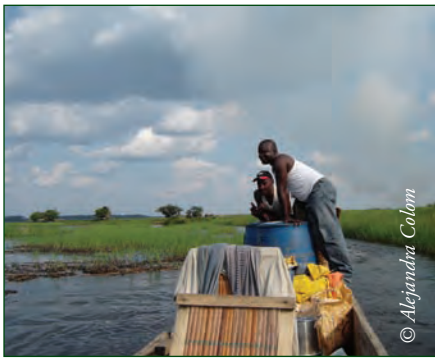


Photo 21.6: Waterways represent a primary transportation network throughout much of the Congo Basin.

In the ROC, the elephants are more localized in the periphery of the LTCR (Batanga proposed PA, Bailly proposed PA) and the Impfondo proposed CBNRM, ROC. A small population that was found inside the reserve by Poulsen and Clark (2002) was almost decimated when there was an increase in human traffic along the rivers in the south, which included the arrival of a large number of automatic weapons from recent war activities. The remaining elephant population is currently found in the swamp forests near the center of the reserve.

Human Signs

In the DRC, snares are mostly found in the Mbala-Dokese proposed ERZ. In the other surveyed areas, the human signs found were mostly hunting camps.

In the ROC, especially the eastern part of the LTCR and Bailly, there is moderate human encroachment because of proximity to villages, and especially the settlements and fishing camps along the rivers, which, in many cases, are transformed into hunting camps. In contrast, there is only one village in the entire Batanga zone proposed PA, ROC.

Special Interest

High Density of Great Apes in Africa's Largest Wetland

At 126,000 km^2, the Lake Télé-Lake Tumba Landscape is Africa's largest wetland and is made up mostly of swamp forest. Until the 1990s, these forests were believed to have relatively few large mammals because of the flooded nature of the region. Three endangered great ape species occur in DRC and ROC, western lowland gorillas (*Gorilla g. gorilla*), chimpanzees (*Pan troglodytes*) and bonobos (*Pan paniscus*), and all three can be found in the swamp forests of the Lake Télé - Lake Tumba.

Until recently, the Lake Télé Community Reserve (LTCR) in the western part of the Landscape was the sole protected area in the Landscape. In 2001, WCS estimated a population of over 13,000 gorillas and 3,000 chimpanzees in the 4,400 km^2 reserve. In the DRC portion of the Landscape where bonobos occur, no surveys to estimate their abundance or distribution had ever been attempted.

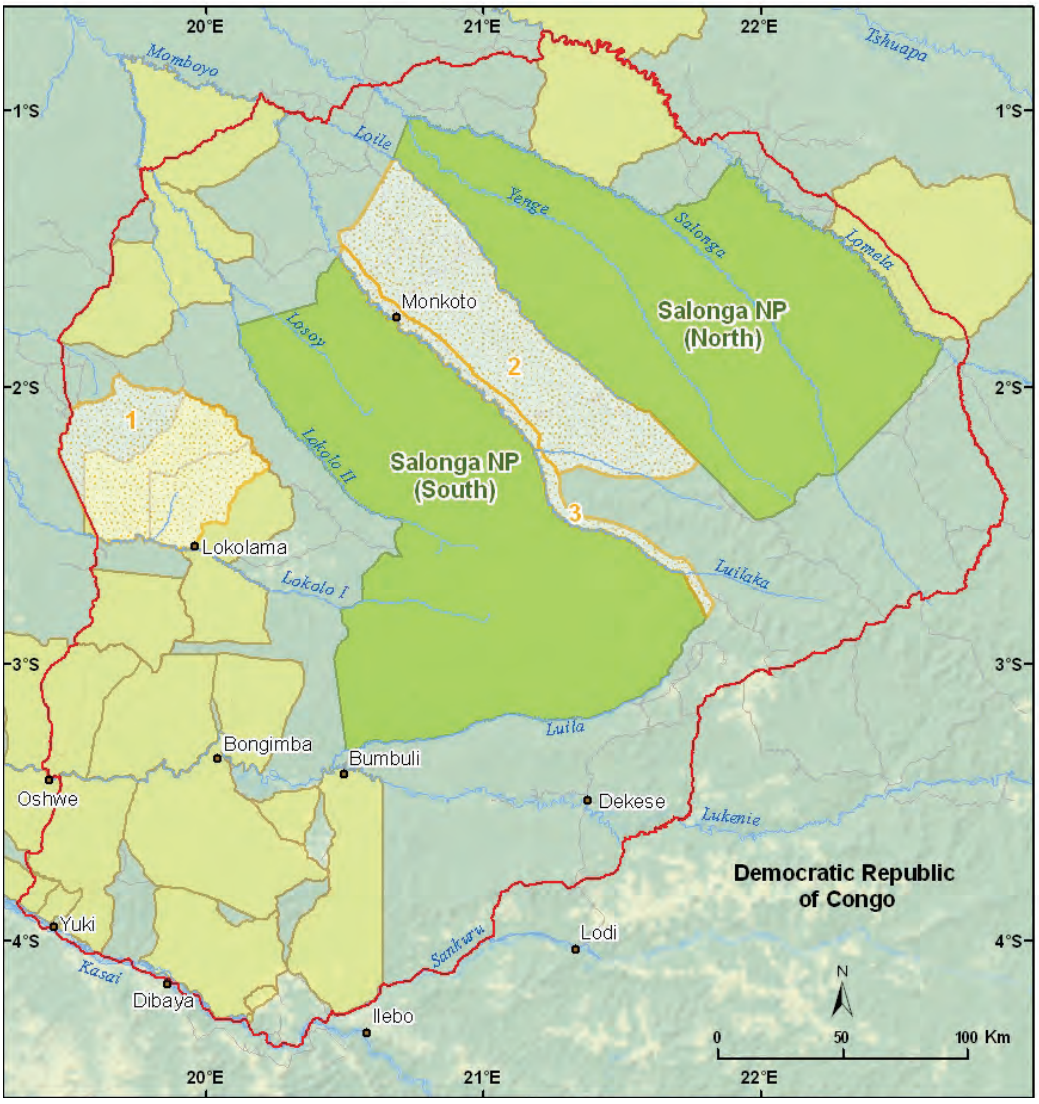
In 2007, WCS carried out additional surveys in the periphery of the LTCR to determine the value of swamp forests for great apes. As a result, several very important and previously unknown populations of gorillas were identified. The area surveyed included 1,029 km^2 in the south east of the LTCR. The density of gorilla was estimated there at 5.72 gorillas/km^2 (2.97 – 11.05). A less conservative analysis produced an estimate of 7.90 gorillas/km^2 (4.34 - 14.39). These are the highest recorded densities of great apes in Central Africa. Thus swamp forests in ROC could hold a very large proportion of the world's remaining gorilla population and be vital for long term gorilla conservation. As these forests are very difficult to penetrate and the timber quality is poor; they provide natural protection for the swamp gorillas.

In DRC, the bonobos were surveyed and the main populations were found in the south of the Lake Tumba and in the west of the Lake Mai Ndombe. The largest population was found at Malebo-Nguomi with an estimate of 2,300 bonobos, exhibiting the highest ever recorded mean density for this species (2.2 individuals/km^2, within the margins of 1.8 – 3.4 individuals/km^2) (Inogwabini *et al.*, 2007). As a result of these findings, the DRC government decided to protect the area and ensure conservation for the species by creating the Tumba-Lediima Natural Reserve, an area of 7,500 km^2.

CHAPTER 22
Salonga-Lukenie-Sankuru Landscape

Lisa Steel , Omari Ilambu, Gay Reinartz, Patrick Guislain, Robert Mwinyihali, Fiona Maisels, Emola Hashim, Désiré Rokotondranisa, Jack Etsa, Alfred Yoko, and Alejandra Colom

Land Use Planning



Sources: WWF, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.
Figure 22.1: Macro-zones in the Salonga-Lukenie-Sankuru Landscape

The Salonga-Lukenie-Sankuru (SLS) Landscape covers 104,144 km^2 of the "*Cuvette Centrale*" region of the Democratic Republic of Congo (DRC). Straddling the four provinces of Equateur, Bandundu, Kasai Oriental and Kasai Occidental, it contains the world's second largest tropical forest park, Salonga National Park (SNP).

The Salonga-Lukenie-Sankuru Landscape consortium members[3] and other partners[4] are working with the government of DRC to develop, implement and monitor an integrated land use plan for the Landscape based on the designation of different use or macro-zones and associated management plans defining resource use and governance. The results are intended to mitigate the

[3] WWF, Pact, WCS, ZSM

[4] International Conservation and Education Fund (INCEF), GACC, INADES, CTSF/Smithsonian, American Museum of Natural History

threats to the Landscape's biodiversity and natural resources while contributing to the improved livelihoods of its human population.

When the CARPE Consortium began work in the Landscape in 2004, little baseline information was available aside from preliminary results of biological surveys in Salonga National Park. There was also no agreed upon road map to guide the land use plan development process. The government of DRC was promoting the idea of land use planning, but without a prescribed methodology.

In four years, the Consortium and its partners - with the technical support of CARPE/USAID and the US Forest Service (USFS) - have made important inroads in defining a land use planning process for the SLS Landscape and initiating its development.

The principal role of the Landscape planning team is to finalize a land use plan strategy and to oversee its development, monitoring and adoption nationally. Initial membership in 2007 included Consortium partner institutions and representatives of the Ministry of Environment and ICCN among other institutions. Further analysis revealed gaps in expertise. Consequently, a decision was made to include representatives from the Ministries of Agriculture, Mines and Infrastructure. Other ministries and associated expertise may be included in the future on a permanent or *ad hoc* basis.

Photo 22.1: Monkoto wharf on the Luilaka River.

Provincial participation in the planning team remains under discussion and is complicated by two factors: (1) the boundaries of the SLS Landscape overlap with four provinces; and (2) there are differing opinions on the role of provincial governments in the process and validation of land use plan and land attribution. However, representatives from three provinces have participated in a planning team meeting and have assisted in developing specific elements of the land use plan (desired conditions, unique values, draft objectives, zoning criteria).

The Consortium and its partners have already assembled a wealth of information and data on the SLS Landscape including:

- *socioeconomic characteristics:* socioeconomic studies in 128 villages (18 % of total); commodity chain analyses.
- *ecological features:* biological inventories of 59 % of the Landscape; freshwater fish and floristic inventories; carbon quantification.
- *capacity assessment:* ICCN, civil society and communities.
- *spatial attributes:* administrative, protected area, logging concession, rivers, roads, villages, etc.
- *trends:* forest cover change, wildlife commerce (on-going).

The successful development and implementation of the SLS landscape land use plan depends on securing the commitment of a suite of stakeholder groups, each with a differing level of interest in conservation and sustainable natural resource use. Preliminary assessment of different landscape stakeholder groups revealed that they lacked the knowledge and capacity to participate in land use planning. Consequently, the stakeholder participation strategy includes three components: creating platforms of consultation, capacity building, and communications. Examples of the three components as they relate to specific macro-zones and stakeholder groups include:

Landscape planning team: Represents an opportunity to build capacity in land use planning and to secure the commitment of a group of multi-disciplinary and institutional actors including provincial governments.

CoCoSi and SNP: ICCN has already created a structure for SNP that lends itself to planning, the *Comité de coordination de site* or CoCoSi.

Community-based natural resource management (CBNRM) zones: Thematic commissions for 113 villages and 55 village-based "natural resource management committees" have been created in two CBNRM zones – Monkoto Corridor and Lotoi-Lokoro - with similar structures planned for a third zone, the Luilaka River. These structures have received capacity building and information on a variety of subjects including land use planning, community forest management, environmental legislation, and best land and natural resource practices. In one area a CBNRM governance committee is being installed, bringing together local authorities and village representatives to plan for and oversee the management of the zone in its entirety.

Building capacity of civil society: l´Institut africain pour le développement économique et social (INADES), a national NGO investing in building civil society capacity to act collectively to address market demands or to advocate on their own behalf in initiatives affecting their land and natural resources, has initiated a series of workshops in areas of the Landscape.

Communication tools: A recent initiative by the Consortium's newest partner, the International Conservation and Education Fund (INCEF), will support the development and execution of a community-based media campaign. Communities and partners such as ICCN, together with national level counterparts, will translate threats, lessons learned and other information into a locally targeted, culturally appropriate format. Themes for production include the importance of SNP, monkeypox, promotion of collective action, bushmeat trade, and poaching.

Despite the success and promise of the aforementioned strategies, the participation of marginalized groups such as women and Batwa has been insufficient, and new strategies are required to insure their inclusion.

The adoption of the process of land use planning at the national level has been promoted and discussed at a series of workshops starting with the September 2007 intergovernmental workshop on large scale land use plan organized by CARPE/USAID and the USFS. The Ministry of Environment held a second workshop on the process of forest zoning in May 2008. The government and institutions such as the World Bank have now designated the landscapes, including SLS, as pilot sites for large scale land use planning. A technical team created at the national Ministry of Environment is to be tasked with further refining the process, including the steps leading to the formal recognition of the plan.

The planning team includes several institutions and individuals who will be instrumental in promoting the adoption of land use plans– in particular the Director of SPIAF (*Service permanent d'inventaire et d'aménagement forestier*), an advisor to the Minister of Environment, and Provincial Environmental Ministers.

The planning team has drafted the unique values and desired conditions for the SLS Landscape. Using the public participation strategy as a reference, the drafts will be vetted with a series of stakeholder groups ranging from national and provincial ministries to scientific organizations and civil society representatives.

The development of a Landscape zoning plan is on-going. As a first step, the Consortium mapped existing legally recognized land use units totaling 58 % of the Landscape, including SNP (33,346 km^2 or 32 % of the Landscape) and 21 logging concessions (27,340 km^2 or 26 % of the Landscape). The results of biological and socioeconomic baseline work and consultation with stakeholder groups led to identification of three potential CBNRM areas totaling 10,499 km^2 or 10 % of the Landscape. The limits of CBNRM areas are being further refined through participatory mapping with community groups.

Spatial analysis and decision support systems such as Marxan modeling are allowing the planning team and other partners to study different zoning options based on existing and future trends in resource use and management. The process is taking into consideration desired biological conditions (persistence of ecological processes, habitat, species) as well as improved livelihoods by mapping and forecasting for future agricultural needs and identifying areas most suitable for economic development (looking at population concentrations, market and transport access).

Photo 22.2: Involving traditional authorities is essential to manage local conflicts.

Human Activities

Humans in the SLS Landscape are mostly a homogenous population comprised of subgroups of the nation's second largest ethnic group, the Mongo, although there are also small numbers of Batwa, Ngombe and Mbole. There are an estimated 180,586 inhabitants, residing in 716 villages and 4 towns. The population density outside of Salonga National Park is 2.5 people per km^2.

The low number of immigrants, estimated at 1.7 % of the total population, does not capture the impact of semi-permanent and seasonal residents on natural resources. During the dry season, fisher families from as far away as Mbandaka establish camps on the banks of rivers bordering SNP. Poaching camps that litter the Landscape are often controlled or manned by hunters originating from outside of the Landscape.

Almost 100 % of the population is dependent on the exploitation of natural resources. Agriculture and the collection of non-timber forest products (NTFPs) represent the most widely practiced activities with each engaging over 95 % of Landscape households. Hunting and fishing are the third and fourth most practiced activities, reported by more than 75 % of the population.

While agriculture remains the principal economic activity, transport systems are severely degraded and often limited to travel by foot, bike or dugout canoe. As market opportunities are limited within the Landscape and terms of trade unfavorable, merchants may travel weeks to reach their destinations often pushing bikes loaded with their products. The economies of scale of this type of transport favor less perishable products with a higher rate of return per kilogram of weight, i.e. bushmeat versus crops such as maize. Agricultural production has been further hindered by decreased yields due partially to disease and lack of access to new cultivars and cropping techniques.

However, and as illustrated in table 22.1, there are considerable profits to be made from agriculture. In the Lokolama sector where hunting for the bushmeat trade has reached a disconcerting magnitude, beans have the potential to generate far greater financial gains. With a 0.25 hectare field yielding at least 100 kg, farmers could sell their harvest locally to traders for at least $ 145. In bushmeat terms this translates to over 70 blue duikers and almost 22 red duikers. In the Monkoto Corridor CBNRM area between the two sectors of SNP, products with a potential profit margin include maize as well as mushrooms, fumbwa (*Gnetum africanum*), fish, caterpillars and copal (Rokotondranisa *et al.*, 2006).

Commercial hunting represents a threat to the Landscape's biodiversity and to the socioeconomic well-being of its communities. Not only is the sale of bushmeat ranked second only to agriculture as an income-generating activity, but bushmeat is the principal protein source for many communities. The continuing decline in wildlife will impact local livelihoods by further marginalizing communities already struggling to meet their basic necessities, with the most immediate threat to vulnerable populations such as children and the elderly.

Photo 22.3: Crocodiles of the Luilaka River are not immune to poaching activities.

Table 22.1: Important agricultural products in the Salonga-Lukenie-Sankuru Landscape

Agricultural product	Unit	Purchase price /unit* ($)	Primary destinations	Date	Data collection	Sources
Cassava	Sack (80 kg)	6.00 10.00 20.00	Monkoto (internal market) Mbandaka (external market) Kinshasa (external market)	Jul 06-Aug 06	Interviews at markets, with traders, and with producer groups in Monkoto (Participatory Rapid Rural Appraisal)	Rokotondranisa *et al.*, 2006.
Palm oil	Container (25 l)	7.00 8.00	Monkoto (internal market) Mbandaka (external market)	Jul 06-Aug 06		
Maize	Sack (60 kg)	6.00 14.00 28.0	Monkoto (internal market) Mbandaka (external market) Kinshasa (external market)	Jul 06-Aug 06		
Beans	Glass (200 g) Sack (100 kg)	0.29 (1.45/kg) 180.00	Lokolama (internal market) Kinshasa (external market)	Mar 08- Jul 06-Aug 06	Collected as a part of surveys on household production and marketing potential	Partially from: Rokotondranisa *et al.*, 2006.
Maize	Bucket (10 kg)	0.89	Local/Lokolama	Mar 08		
Groundnuts/ peanuts	Glass (200 g)	0.20	Lokolama (internal market)	Mar 08		

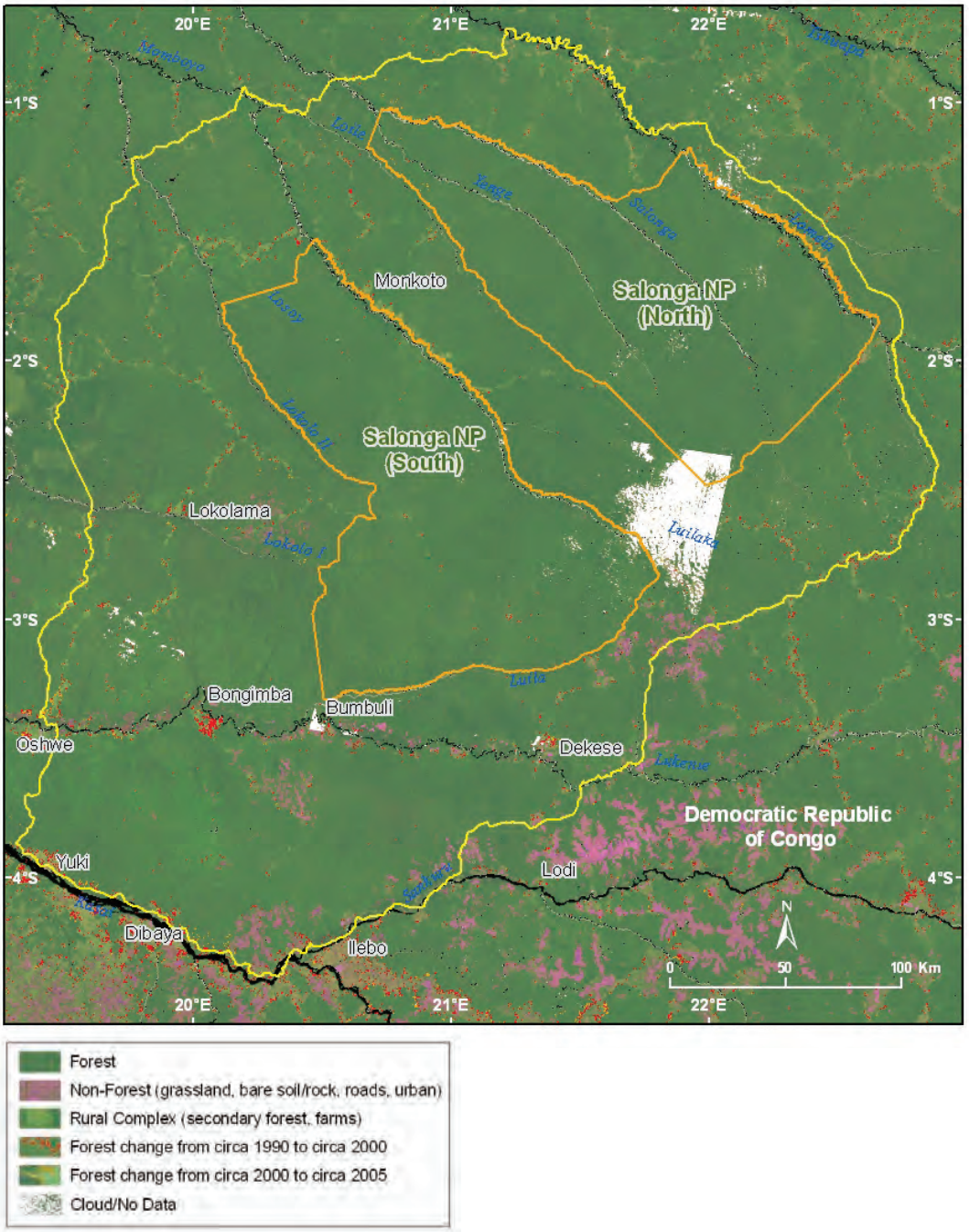
** Based on an exchange rate of $ 1=500 Congolese Francs.*

Table 22.2: Bushmeat trade in the Salonga-Lukenie-Sankuru Landscape

Bushmeat species	Unit	Purchase price/unit* ($)	Primary destinations	Date	Data collection	Sources
1. Red duiker (*Cephalophus spp*) 2. Tshuapa red colobus (*Piliocolobus tholloni)* 3. Blue duiker (*Cephalophus monticola*)	Whole Whole Whole	6.60 3.80 2.00	***Lokolama*** market. Purchase price paid by market vendor, either directly to hunter or middleperson.	Nov 07 – Feb 08	Market surveys	WWF SLS Landscape database. Preliminary analysis of field data.
1. Red duiker (*Cephalophus spp*) 2. Monkey (red colobus, de brazza, black mangabey) 3. Blue duiker (*Cephalophus monticola*)	Half Whole Whole	6.40 4.40 3.90	***Ilebo*** market, just south of the Landscape limits. Purchase price paid by vendor, either directly to hunter or middleperson.	Nov 07 – Feb 09	Market surveys	
1. Red duiker (*Cephalophus spp*) 2. Blue duiker (*Cephalophus monticola)* 3. Monkey (red colobus, de brazza, black mangabey)	Half Whole Whole	3.40 2.10 3.00	***Dekese*** market. Purchase price paid by market vendor, either directly to hunter or middleperson.	Nov 07 – Feb 10	Market surveys	
1. Red duiker (*Cephalophus spp*) 2. Blue duiker (*Cephalophus monticola)* 3. Red river hog (*Potamocherus porcus)*	Whole Whole Whole	13.20 2.80 20.50	***Oshwe*** market. Purchase price paid by market vendor, either directly to hunter or middleperson.	Nov 07 – Feb 11	Market surveys	

Based on an exchange rate of $ 1=500 Congolese Francs.

Forest Cover



Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 22.2: Composite Landsat satellite image of the Salonga-Lukenie-Sankuru Landscape overlain with 1990 to 2000 forest loss (in red) and 2000 to 2005 forest loss (in orange)

Table 22.3: Forest cover and forest loss in the Salonga-Lukenie-Sankuru Landscape from 1990 to 2005

	Forest area			Forest loss			
Landscape area	1990 (km^2)	2000 (km^2)	2005 (km^2)	1990-2000 (km^2)	1990-2000 (%)	2000-2005 (km^2)	2000-2005 (%)
104,205	101,570	101,198	99,177	343	0.37	264	0.26

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

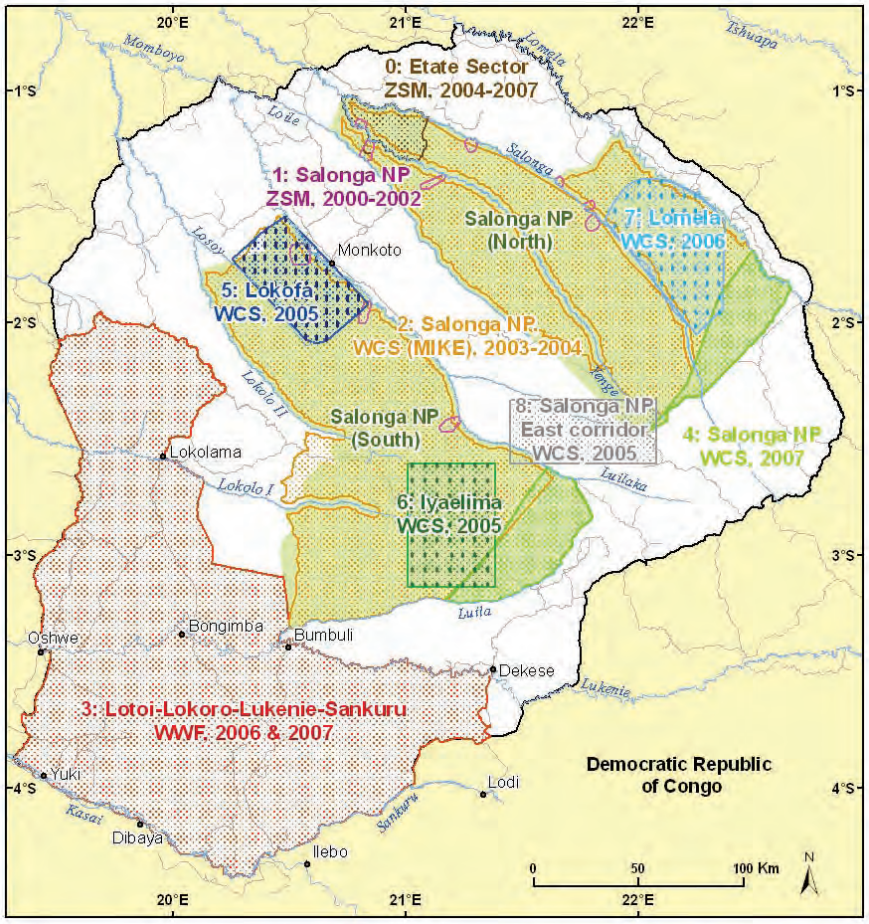
Forest cover loss in the Salonga-Lukenie-Sankuru, at a rate of less than 0.4 % between circa 1990 and circa 2000, was mostly limited to agricultural expansion around villages, towns and along roads and rivers. Analysis indicated that most 97.8 % of forest loss occurred within 2.5 km of existing non-forest, indicating an absence of new settlements and associated habitat fragmentation.

An estimated 25 % of the Landscape has been consigned to logging companies. Continued monitoring of forest cover change will be crucial for lobbying private companies and government officials to mitigate environmentally destructive practices including excessive road construction, destruction of waterways, and the unchecked expansion of logging-related human settlement and resource use.

Large Mammal and Human Impact Monitoring

The Landscape is of global significance for the long term survival of the bonobo (*Pan paniscus*), one of the world's four great apes. Inventories covering 60 % of the Landscape have documented a significant bonobo population across the Landscape. Their distribution is often referred to as "patchy" which is partially explained by the positive association of nesting habitat with lowland, *terra firma* forest with *Maranthaceae* under-story and the negative impact of hunting (Reinartz *et al.*, 2008). The estimated mean population of nest-building bonobos in SNP is 14,880 individuals (Grossman *et al.*, 2008).

The results of MIKE surveys (Blake, 2005) in Salonga National Park, the centerpiece of the Landscape, portray a bleak picture for the status of the forest elephant (*Loxodonta africana cyclotis*) conservation. Fewer than 0.3 dung piles per km were recorded signifying only 2,000 elephants. However, more intensive and targeted surveys continue to document occurrence and congregation of elephants associated with water habitats and bais. If protected, elephant populations could rebound.



Sources: WWF, ZSM, WCS, MIKE, UMD-CARPE, OSFAC, FORAF.

Figure 22.3: Biological surveys conducted in the Salonga-Lukenie-Sankuru Landscape

Photo 22.4: Indication of the presence of elephants in Bofula, along the Salonga River.

Special Interest

Information as a Tool for Good Governance and Improved Natural Resource Management

The Strategic Objective of the CARPE program is to reduce the rate of forest degradation and loss of biodiversity through increased local, national, and regional natural resource management capacity. For local communities to assume management in rural landscapes such as Salonga-Lukenie-Sankuru they must first be provided with the tools and capacity to define, defend, and implement their vision for natural resource management and governance. To achieve this objective, in August 2007, WWF partnered with *Avocats Verts*, a national DRC NGO, whose mission is to protect the environment and to defend the rights of local communities. *Avocats Verts* lawyers are also principals in the development of national environmental legislation.

Avocats Verts was tasked specifically with introducing communities to Congolese legislation governing natural resource use and management. This new knowledge could then be used to guide decision-making on the management of land and natural resources in community areas. Working with the four thematic commissions comprised of representatives from Monkoto Corridor villages, *Avocats Verts* presented and discussed DRC legislation on:

1. Nature conservation (wildlife exploitation, management and trade, protected areas);

2. Fishing and freshwater resources;

3. Forests (protection, zoning, classification and management regimes, etc.).

To assist commission members during the debates and during debriefings in their respective villages, each participant received two legal guides: *Les Forêts de la RDC* and *La conservation de la nature, la protection de la faune, des ressources halieutiques et des forêts en RDC*. Copies of the 2002 Forest Code in Lingala and in an illustrated format were also distributed.

The workshop was an overwhelming success for participants and facilitators alike. Prior to the workshop most participants had little or no knowledge of Congolese law. At the end of the workshop participants recognized the illegality of many of their present practices. They also concluded that other government officials including ICCN would greatly benefit from similar workshops.

Facilitation by *Avocats Verts* was particularly valued. A telling remark, echoed by several participants, was that the presence of *Avocats Verts* lent credibility to the presentation and discussion on protected area laws and particularly those governing national parks such as Salonga. Participants stated that if the same presentations had been made by ICCN, the information would have been questioned if not treated as lies and deception.

Avocats Verts also benefited from the exchange, gleaning important insight on *de facto* and traditional systems of resource use and governance by landscape communities. It is hoped that this knowledge will inform *Avocats Verts*' contributions to the on-going development of implementing decrees for resource and land use and management.

As national governments, the donor community and international NGOs correctly promote community participation, decentralized management and respect of customary norms, the interactions between legal experts and rural communities highlight the need for increased dissemination and discussion of laws and potentially further legal reform. The discussions during the workshop demonstrated that customary use and governance are often in contradiction to national law. One striking example is illustrated in figures 4 and 5. At the workshop customary chiefs wore emblems of their societal ranking including leopard skins and teeth, and eagle feathers. They were surprised that the law did not provide exemptions for customary use of protected species. In another example, communities or clans traditionally "own" fishing areas each with their own limits and rules governing access. This *de facto* ownership contradicts national law which states that fishing is open to all. However, traditional systems based on limited access are likely to be the most conducive to sustainability and improved management of the resource base.

Photo 22.5: "Piroguier" awaiting departure on the Luilaka River.

Numerous other contradictions were highlighted during the workshop and will only be resolved through increased exchange between lawmakers and rural communities. However, for communities to participate as equal partners in these debates, they must first be provided with the knowledge and tools, which include information and an understanding of the laws that impact their very livelihoods.

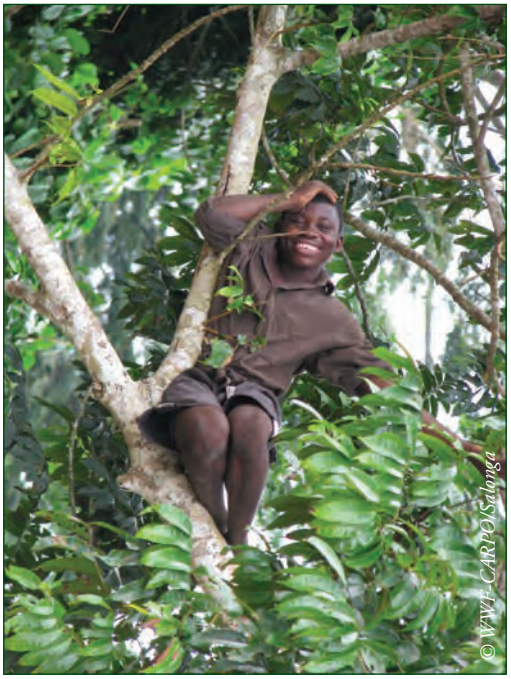


Photo 22.6: Forest resources are an inextricable part of daily lives in much of the Congo Basin.

Photo 22.7: Chief wearing a necklace of leopard teeth, a headdress of eagle feathers and animal skins during a 2007 workshop.

Photo 22.8: Meeting of traditional leaders in Monkoto.

Table 22.4: Biological survey results for the Salonga-Lukenie-Sankuru Landscape

Survey	Site name	Survey date	Lead organization(s)	Total km of recces	Number of transects	Total km of transects	
0	SNP: Etate sector	Dec 2004-2007	ZSM	145.9	58	70.3	
0	SNP: Etate Transect Area	Dec 2004-2007		0	28	47.5	
1	SNP: Lokofa	Apr 02		32.7	7	10.76	
1	SNP: Etate	Nov 00		17.8	5	7.5	
1	SNP: Beminyo	Apr 02		12.5	4	2.75	
1	SNP: Isanga	Aug 01		7	5	10	
1	SNP: Yongo	Nov 01		9.9	8	8.83	
1	SNP: Ikolo	Dec 00		10	6	9	
1	SNP: Bonima	Aug 01		37.3	5	10	
1	SNP: Biondo-Biondo	Aug 01		3	1	1.5	
1	SNP: Lotulo	Nov 00		3	5	7.5	
1	SNP: Nkinki	Nov 01		15.3	0	0	
1	SNP: Bekongo	Apr 02		13.7	0	0	
2	SNP: north and south sectors	May 03-Jul 04	WCS (MIKE)	1,727	130	130	
3	SLS Landscape: Lotoi-Lokoro	Apr-Jun 2006	WWF	82.5	Low intensity methodology using combination of guided/directed and non-guided recces. Only guided recces are reported on here.		
3	SLS Landscape: Lokoro-Lukenie	Jun-Jul 06; Feb-Mar207		67.5			
3	SLS Landscape: Lukenie-Sankuru	Oct-Dec 2006; Feb-Apr 2007		77.5			
4	SNP: southern block, south-east portion	Oct-Dec 2007	WCS	233	0	0	
4	SNP: northern block, south east portion	Oct-Dec 2007		270	0	0	
5	SNP: block Lokofa	2005		Compass line: 583	55	76.6	
6	SNP: block Iyaelima	2005		Compass line: 511	63	88.2	
7	SNP: block Lomela	2006		Compass line: 515	68	95.2	
8	SNP: east corridor	2005		Compass line: 205	0	0	

** Human sign: Relative hunting level index, per block, integrating encounter rates of snares, hunting camps, direct encounters of hunters, and gun shot. See Hart et al., 2008 for definitions.*

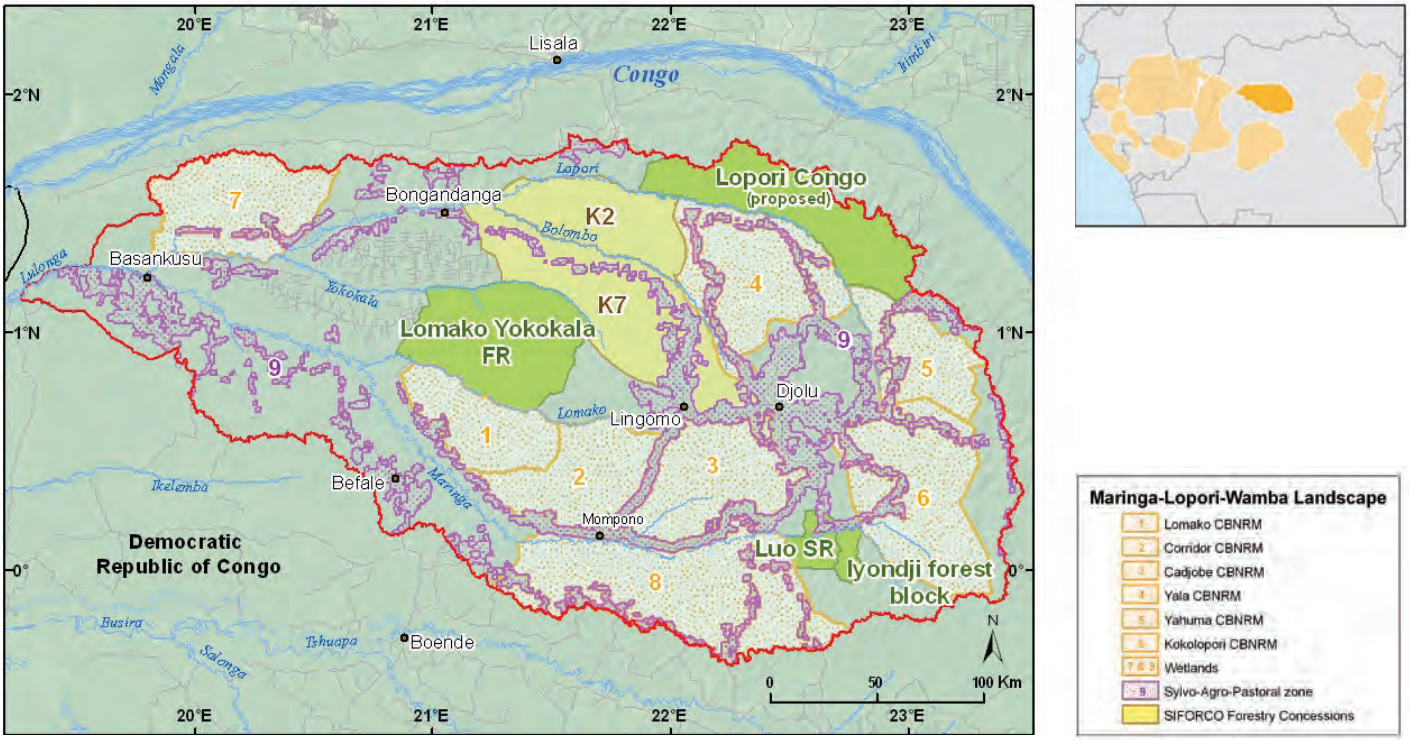
	Elephant presence	Elephant dung pile encounter rate (per km)	Elephant dung pile density (per km²)	Ape presence	Ape nest group encounter rate (per km)	Ape nest group density (per km²)	Ape nest density (Transect)	Human sign encounter rate (per km)
	Yes	0.17 +/- 0.08		Yes	0.65 +/- 0.17			0.60 +/- 0.15
	No	0		Yes	2.4 +/- 0.49	Not calc.	Not calc.	0
	Yes	2.7		Yes	2.3	55.1	275	0.65
	No	0		Yes	1.5	37.7	160	0.53
	Yes	0		Yes	1.1	18.7	135	0
	Yes	3.3		Yes	0.4	10.5	10	0.1
	Yes	0.7		Yes	0.7	14.4	18.5	0
	No	0		Yes	0.1	2.9	5.9	9.33
	No	0		Yes	0	0	0	1
	No	0		No	s	0	0	3.4
	Yes	3.2		No	0	0	0	0.53
	No	0		Yes	0	0	0	0
	No	0		No	0	0	0	0
	Yes	0.29 low human impact -transects	91.6	Yes	0.26 +/- 0.14	Not calc.	Not calc.	0.76 transects 1.00 recce-voyage
		0.28 high human impact - transects				Not calc.	Not calc.	
	Yes	1.4		Yes	0.44			0.3
	Yes	0.43		Yes	1.2			0.33
	Yes	0 (dung piles only observed on non-guided recces)		Yes	0.6			1.3
	Yes	0.14		Yes	0.32			1.5
	Yes	0.09		Yes	0.18			2
	Yes	Mean: 0.780	No data	Yes	Average, total effort: 0.954	29 (16-52)		Intermediate*
	Yes	Mean: 0.322	No data	Yes	Average, total effort 1.950	55 (32-94)		Intermediate*
	Yes	Mean: 0.01	No data	Yes	Average, total effort 4.821	90 (62-131)		High*
	Yes	Mean: 0.206	No data	Yes	Average, total effort 1.553	No data		Intermediate*

(0) Reinartz et al., 2008; 1) Reinartz et al., 2006; 2) Blake, 2005; 3) Steel, 2007; 4) Maisels, F. pers. com; 5) Grossmann et al., 2008; 6) WCS-DRC, IMU, 2006; 7 and 8) Hart et al., 2008.

CHAPTER 23
Maringa-Lopori-Wamba Landscape

Jef Dupain, Janet Nackoney, Jean-Paul Kibambe, Didier Bokelo, and David Williams

Land Use Planning



Sources: AWF, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.
Figure 23.1: Macro-zones for the Maringa-Lopori-Wamba Landscape

The 74,000 km² Maringa-Lopori-Wamba (MLW) forest Landscape is located in north-central Democratic Republic of the Congo (DRC). The Landscape is in one of the Congo Basin's least developed and remote regions. Its inhabitants are some of the poorest in Africa; most depend on natural resources to meet basic needs. Land use planning is needed to address a growing human population and the potential of a revived logging sector which could jeopardize both biodiversity and existing human livelihoods.

In recent years, a consortium of partners from several local and international institutions led by the African Wildlife Foundation, has been working together to begin building the foundation for a land use plan which will provide a scientific basis for prioritized interventions to make the MLW Landscape socio-economically, culturally and ecologically viable. The framework for achieving this objective is based upon spatially explicit landscape land use planning and zoning, combined with development and implementation of natural resource management plans for the specific zones.

During the past four years, members of the MLW consortium have been designing a land use planning model for MLW based on both AWF's Heartland Conservation Process (HCP) approach and the Central African Regional Program for the Environment (CARPE) Program Monitoring Plan. The model is being developed using biological and socio-economic surveys, interpretation of satellite imagery and consultations with local, national and international stakeholders. The results of the model contribute to preliminary land use planning and zoning within the Landscape. This zoning process is considered highly impor-

tant at the national level as the government of DRC has explicitly expressed the need for zoning plans within the country since the publication of DRC's Forestry Act in 2002.

Working with partners at the national and local level, significant progress has been made in developing a land use plan for MLW which includes a draft zoning map covering about 70 % of the MLW Landscape (Figure 23.1) and an agreed process for plan completion. As a result of the zoning process, the first macro-zone, the Lomako Yokokala Faunal Reserve (RFLY), was gazetted in 2006. A major objective of MLW's land use planning activities includes a dynamic zoning process of the proposed Sylvo-Agro-Pastoral zone (SAP). SAP refers to the rural complexes, or land that should respond to the spatial needs for agriculture and other human activities. One goal of the MLW project is to limit future land use and land cover changes to the delineated SAP zone. Remaining land outside the SAP zone will exist as undisturbed habitat, where a network of protected areas with maximum interconnectivity will be developed. Wildlife connectivity will be ensured by maintaining permanent forest managed in a sustainable manner by local communities.

The University of Maryland (UMD) and the *Université Catholique de Louvain* (UCL) are working in joint partnership to support land use planning in MLW. Together, UMD and UCL are providing the MLW team with spatially explicit maps and modeled data outputs of human population distribution, human accessibility, human threats to biodiversity, and predictive models of land use change for land use planning and zoning activities in MLW. These modeled outputs help to systematically predict future threats to forested areas in the Landscape and guide zoning, planning, and Landscape management.

The work of the AWF-led consortium in the MLW Landscape has been valuable to national and regional policy-making and is noted for being both participatory and dynamic. Because of this, the work has been acknowledged to serve as a potential model for implementing future land use planning and zoning in other CBFP Landscapes. Consequently, the MLW Consortium will seek ways to refine its work and share its learning experiences with members of other CBFP Landscapes.

Spatial modeling, complemented by field reconnaissance, is both increasing our understanding of the local socio-economic drivers within the MLW Landscape and informing us of opportunities to improve conditions for humans and biodiversity. Consortium efforts include assisting in the development of tools enabling sustainable development and land use planning. The MLW Consortium team will share findings from the work in order to contribute to international efforts reducing pressure on the environment and assist in proposing sustainable development alternatives for local people whose lives depend directly on the benefits extracted from their surrounding ecosystems.

Photo 23.1: Loading a barge in Basankusu.

Table 23.1: Vegetation cover, land use/land cover change (2000-2005) and estimation of human population densities for each of the preliminary identified macro-zones.

Macro-zone name	Area (km²)	% swamp	% forest	% rural complex and young secondary forest	Active fire points 2006-2007	% change 2000-2005	Human population density (inh./km²)
Wetlands	8,405	35.1	62.1	2.3	N/A	0.4	6.3
Kokolopori	4,002	9.9	89.4	0.7	N/A	0.2	4.8
SIFORCO K7	3,816	25.8	71.7	2.1	14.0	0.3	7.5
Yala CBNRM	3,411	16.6	80.6	2.1	N/A	0.6	8.5
Yahuma area	1,889	10.2	88.1	1.7	N/A	0.1	2.2
Lomako Yokokala Faunal Reserve	3,626	20.3	78.9	49.0	9.0	0.1	3.8
Corridor CBNRM	2,440	19.2	78.1	2.6	5.0	0.1	6.5
Lomako CBNRM	2,042	32.9	66.5	0.4	2.0	0.1	4.0
SIFORCO K2	2,485	16.4	81.4	1.1	13.0	0.3	4.0
Lopori Congo area	3,381	15.7	83.2	0.8	5.0	0.3	2.8
Cadjobe CBNRM	2,821	11.7	86.0	2.2	16.0	0.2	5.6
Iyondji forest block	719	18.9	79.7	0.8	0.0	0.2	9.3
SAP (Marxan)	10,372	12.0	53.2	34.6	1,017.0	3.4	31.8
Total	**49,409**					**1.0**	
Outside macro-zones	**23,557**					**0.4**	
Total MLW	**72,966**	**25.9**	**67.3**	**6.42**		**0.8**	**8.0**

Source: AWF/UCL/UMD.

Human Activities

Information on the distribution of human populations in the MLW Landscape has been updated and is shown in table 1. Contrary to the formerly estimated population density of 3-6 inhabitants/km² in MLW (Congo Basin Forest Partnership, 2006), recent spatial modeling on human distribution suggests that human density is 8 inhabitants/km² (Kibambe, 2007), with densities of 2-4 inhabitants/km² in the proposed or existing protected areas and 31.8 inhabitants/km² in the proposed Sylvo-Agro-Pastoral zone. The total human population of the MLW Landscape is estimated to be 586,732 inhabitants.

The primary livelihood activity of most of the inhabitants of MLW is slash-and-burn agriculture. The MLW program has been monitoring the environmental impact of these human activities through the observation of active fire points detected by the MODIS sensor on board the Aqua and Terra satellites and distributed online by the Fire Information for Resource Management System (FIRMS). Fires, which are strongly associated with slash-and-burn agricultural activities in MLW, are observed primarily on the periphery of roads, established settlements, and agricultural areas. Active fires have increased in quantity and intensity in recent years, indicating a steady recovery of agricultural activities in the Landscape. MLW's agricultural recovery is likely facilitated by recent renewed political stability in the region, coupled with a gradual reopening of access to the urban markets. The MLW project, through its land use planning and zoning activities, is actively working toward limiting agricultural activities to a Sylvo-Agro-Pastoral (SAP) zone designed to concentrate cultivation in areas with good access to markets.

In 2005, for the first time after over half a decade of war and instability in the region, 700 tons of agricultural goods was transported to Kinshasa along the Maringa River (Belani, 2006). Since 2007, the total number of barges and smaller boats assuring the transport of basic commodities and agricultural crops along the Maringa and Lopori rivers has increased.

Although agriculture is slowly recovering, local communities continue to depend on bushmeat as a source of protein in MLW. For most people in the MLW Landscape, it is more economical to hunt wildlife (including such species as porcupine, sitatunga, and forest hog) than purchase domestic meat at the market.

Surveys have determined that hunting pressures are most acute in former logging concessions

and in areas surrounding high slash-and-burn activity. The needs of growing local communities are driving expansion of slash-and-burn agriculture and charcoal production resulting in deforestation, fragmentation, and habitat loss threatening wildlife populations and providing new inroads for bushmeat hunting. The Landscape's biodiversity, therefore, is threatened by an array of interacting human activities. MLW's land use planning activities should mitigate and guide human livelihoods for the well-being of both people and biodiversity.

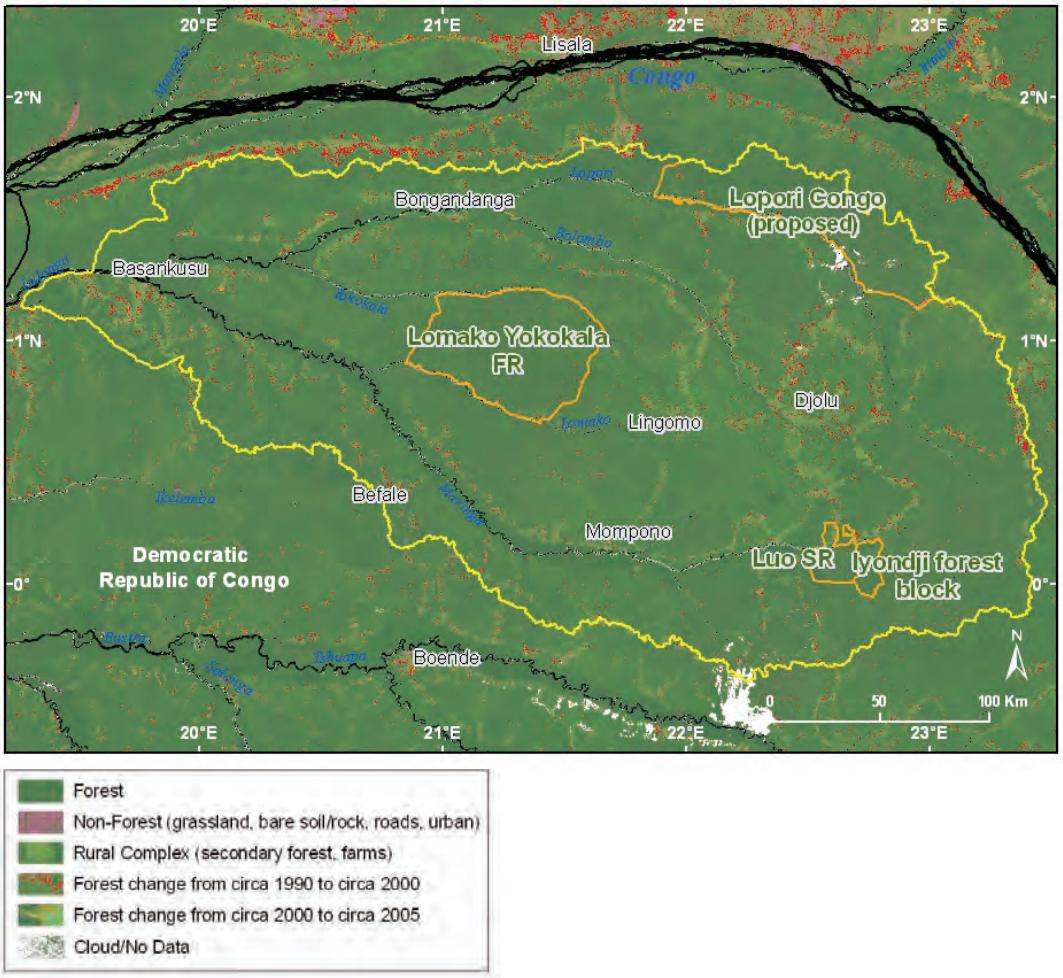
Table 23.2a: Agricultural trade in the Maringa-Lopori-Wamba Landscape

Agricultural product	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Maize	Sack (120 kg)	9	Djolu	Nov-07	Market surveys	Tabu, A., 2008.
Cassava	Sack (120 kg)	11	Bongandanga	Feb-08	Market surveys	Tabu, A., 2008.
Groundnut	Sack (50 kg)	89	Mbandaka: Lomata port	May-08	Market surveys	Senga, G. AWF., 2008. Pers. obs.

Table 23.2b: Bushmeat trade in the Maringa-Lopori-Wamba Landscape

Bushmeat species	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Peter's duiker (*Cephalophus callypigus)*	Whole/smoked	12.10 (n=3; 9.10-14.50)	Mbandaka	June 08	Market surveys	Dupain, J. AWF. 2008 Pers. obs.
Porcupine *(Atherurus africanus*)	Whole/smoked	10.00 (n=3; 9.10-10.90)	Mbandaka	June 08	Market surveys	Dupain, J. AWF. 2008. Pers. obs.
Black mangabey *(Lophocebus aterrimus)*	Whole/smoked	19.60 (n=4; 12.70-27.30)	Mbandaka	June 08	Market surveys	Dupain, J. AWF. 2008. Pers. obs.
Blue duiker *(Cephalophus monticola)*	Whole/smoked	11.50 (n=3; 10.00-12.70)	Mbandaka	June 08	Market surveys	Dupain, J. AWF. 2008. Pers. obs.
Sitatunga *(Tragelaphus spekei)*	Fore leg smoked	18.20 (n=1)	Mbandaka	June 08	Market surveys	Dupain, J. AWF. 2008. Pers. obs.
Sitatunga *(Tragelaphus spekei)*	Hind leg/smoked	31.90 (n=2; 27.30-36.40)	Mbandaka	June 08	Market surveys	Dupain, J. AWF. 2008. Pers. obs.
Sitatunga *(Tragelaphus spekei)*	Whole/smoked	77.30 (n=2; 72.70-81.80)	Mbandaka	June 08	Market surveys	Dupain, J. AWF. 2008. Pers. obs.
Red river hog *(Potamochoerus porcus)*	Three quarter/ smoked	72.70 (n=1)	Mbandaka	June 08	Market surveys	Dupain, J. AWF. 2008. Pers. obs.
Red river hog *(Potamochoerus porcus)*	Whole/smoked	100.60 (n=3; 90.90-109.10)	Mbandaka	June 08	Market surveys	Dupain, J. AWF. 2008. Pers. obs.

Forest Cover



Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 23.2: Composite Landsat satellite image of the Maringa-Lopori-Wamba Landscape overlain with 1990 to 2000 (in red) and 2000 to 2005 forest loss (in orange)

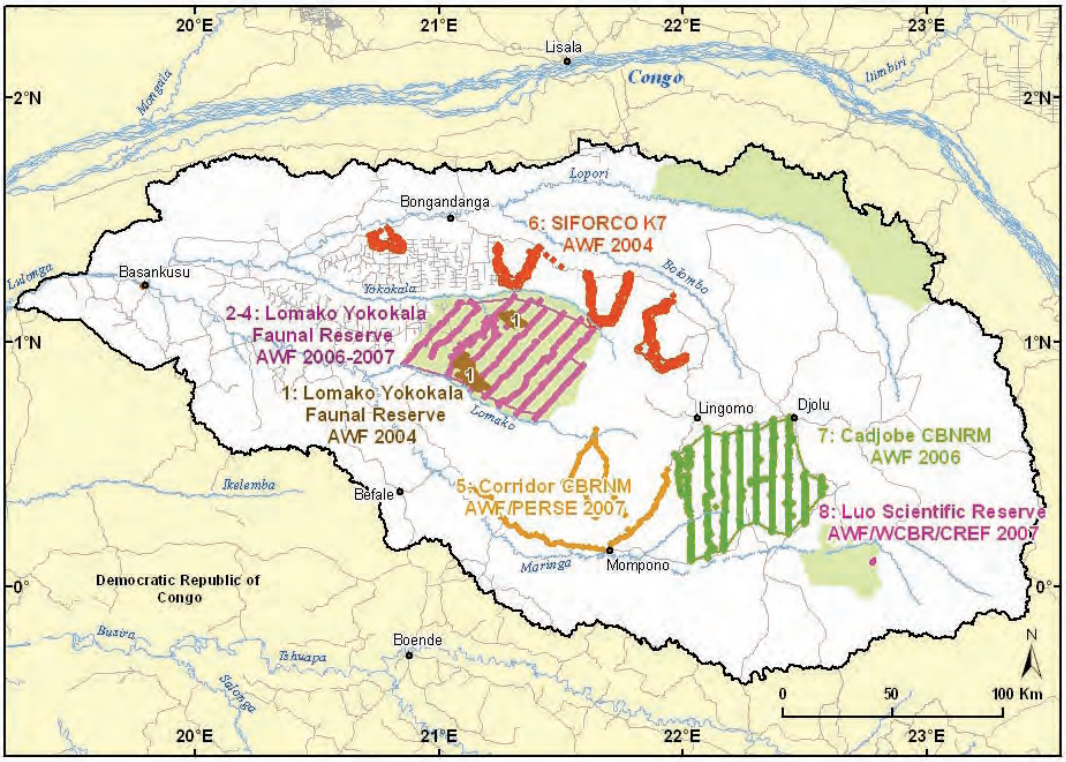
Table 23.3: Forest cover and forest loss in the Maringa-Lopori-Wamba Landscape from 1990 to 2005.

	Forest area			Forest loss			
Landscape area	1990 (km²)	2000 (km²)	2005 (km²)	1990-2000 (km²)	1990-2000 (%)	2000-2005 (km²)	2000-2005 (%)
72,369	68,756	68,162	67,938	594	0.86	224	0.33

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

Forest change (tables 23.1 and 23.3, Figure 23.2) throughout the Landscape is still relatively low in comparison to other regions within the Congo Basin. Spatial analyses of deforestation patterns (based on 173,289 points of land cover change between 1990 and 2000) show that more than 98 % of deforestation occurring in MLW took place in areas having a human density of 3-15 inhabitants/km² (Kibambe, 2007). In 2006-2007, 89 % of the 1,355 detected MODIS active fire points from UMD's FIRMS project were located within 1 kilometer from existing roads, suggesting that rural complexes are expanding around existing roads and settlements. The proposed Sylvo-Agro-Pastoral zone experienced a 3.42 % decrease in forest from 2000 to 2005 (Hansen, *et al.*, 2008). However, a number of active fire points were detected at larger distances from roads and settlements. This indicates an ongoing trend of patchy habitat destruction, and thus also hunting, in remote forest blocks. Even the Lomako Yokokala Faunal Reserve, a protected area, experienced a 0.1 % forest loss between 2000 and 2005. The MLW team hopes that toward 2010, through improved management, forest loss will be limited to the suggested SAP macro-zones.

Large Mammal and Human Impact Monitoring



Sources: AWF, PERSE, WCBR, CREF, UMD-CARPE, OSFAC, FORAF.
Figure 23.3: Biological and human activity survey transects in the Maringa-Lopori-Wamba Landscape

Photo 23.2: Field mission to record the boundaries of the Lomako Reserve.

Since 2004, the MLW team has conducted 8 biological surveys covering over 2,000 km of transects in the Landscape (Figure 23.3). The surveys recorded observations of large mammals as well as selected human threats to biodiversity (table 23.4). The team has adapted its approach over time; recent surveys use standardized reconnaissance methodologies (Omasombo, in prep.). The objective of the surveys has been to assess conservation potential within the Landscape, including within potential macro-zones, focusing primarily on observations of bonobos and other large mammals as well as human activities which threaten the viability of the species' populations.

Throughout the Landscape, the presence of bonobos is confirmed, albeit in very different densities. It is possible that MLW might harbor a significant proportion of the global bonobo population, and ongoing biological surveys aim to help improve understanding of the spatial distribution and densities of their populations within the Landscape as related to human activities and ecological factors. Forest elephants have also been observed in MLW. Although the spatial

distribution of their populations is not yet well understood within the Landscape, they seem to be surviving mostly in patchy relict populations.

When a macro-zone is gazetted, a monitoring program is developed. In the Lomako Yokokala Faunal Reserve (RFLY zone), biological surveys are now conducted twice per year as part of the zone's monitoring program. The latest results of these surveys show for the first time a significant increase in observations of traces of bonobos and forest elephants (see Special Interest section).

Special Interest

Increase of Bonobo Presence in the Lomako Yokokala Faunal Reserve (RFLY)

The Lomako Yokokala Faunal Reserve (RFLY), created in 2006 with support from AWF, covers 3,026 km². From the 1970's to 1990's, this forest was famous for being a long-term bonobo research site. The Congolese Institute for Nature Conservation (ICCN) manages the RFLY with support from AWF. Funding is provided by USAID/CARPE, the Alexander Abraham Foundation, the Arcus Foundation and the French Agency for Development through FFEM.

Since the beginning of the MLW program in 2004 and the initiation of gazettment of the proposed Reserve, AWF has been leading efforts to monitor populations of large mammals and human activities, both of which have been major components of the Reserve's management plan under development. While monitoring surveys were conducted initially by AWF, the surveys are now conducted by agents of ICCN as well as representatives of local communities trained by AWF. Recording observations of forest elephants, bonobos, and human activities, the surveys, which are organized twice per year, consist of nine reconnaissance transects covering 450 kilometers. In September-October 2007, a third biological survey was conducted. The survey summary presented in table 5 shows a sharp increase in observations of both the number of bonobo nests and of traces of forest elephants through time, along with a sharp decrease in the number of active hunting camps: of an initially recorded 45 hunting camps, 30 are now abandoned.

Photo 23.3: Hunting camp in Lomako Reserve.

Table 23.5: Indices of kilometer abundance (IAK) for signs of forest elephants, bonobos and active hunting camps.

	IAK June-July 2006	IAK Sept-Dec 2006	IAK Sept-Dec 2007
Forest elephant (*Loxodonta africana cyclotis*) traces	0.11	0.09	0.22
Bonobo (*Pan paniscus)* nest observations	0.27	0.34	0.68
Active hunting camps	0.1	0.07	0.03

Forest elephants: number of traces. Bonobos: number of nest observations. Human activity: number of active hunting camps.
Source: Belembo, 2007.

Table 23.4: Biological survey results from the Maringa-Lopori-Wamba Landscape

Survey	Site name	Survey date	Lead organization(s)	Total km of recces	Number of transects	Total km of transects	Elephant presence	Elephant traces encounter rate	Ape presence	Ape nest group encounter rate	Human sign
1	Lomako-Yokokala Faunal Reserve	Aug-Oct 2004	AWF		21	105	No		Yes	0.8/km	0.7/km
2	Lomako-Yokokala Faunal Reserve	Apr-Jun 2006	AWF	450			Yes	0.11 traces/km	Yes	0.27 individual nests/km	1.1/km
3	Lomako-Yokokala Faunal Reserve	Sept-Dec 2006	AWF	380				0.09 traces/km	Yes	0.34 individual nests/km	0.73/km
4	Lomako-Yokokala Faunal Reserve	Sept-Dec 2007	AWF	450				0.22 traces/km	Yes	0.7/km	0.61/km
5a	Corridor (CBNRM)	Oct-Dec 2007	AWF, PERSE	120			No		Yes	0.00/km	3.23/km
5b	Corridor (CBNRM)	Aug 2008	AWF	63			Yes	0.46 traces	Yes	0.70/km	0.36/km
6	SIFORCO K7	Aug-Oct 2004	AWF	211			Yes	N/A	Yes	N/A	N/A
7	Cadjobe (CBNRM)	Apr-Jun 2006	AWF	401			No	0.00 traces/km	Yes	0.00/km	1.51/km
8	Luo Scientific Reserve (proposed extension)	Aug-Sept 2007	AWF, WCBR, CREF	32			No		Yes	0.31/km	N/A

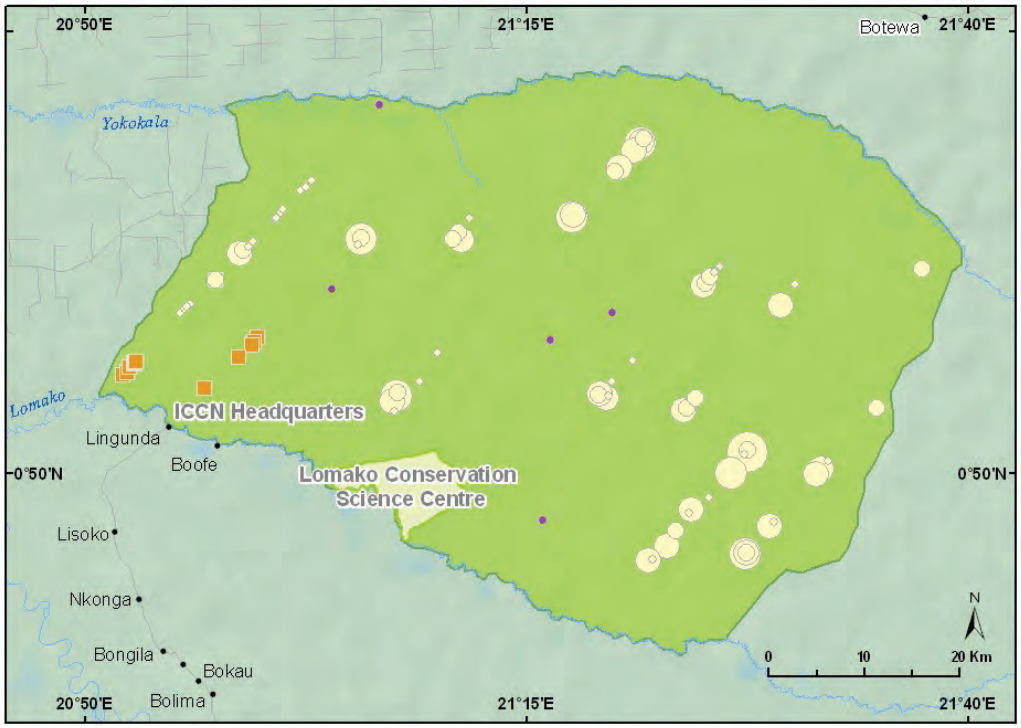
1) a). Omasombo, V. 2004; 1) b). Omasombo, et al.,. 2005; 2) Omasombo and Mpiana, 2006; 3).Mpiana and Belembo, 2007; 4).Belembo, 2007; 5) a) Likondo and Bekoma, 2008; 5) b)Belembo, in prep. 6) Likondo et al., 2004; 7) Likondo, 2007; 8) Likondo et al., 2007.

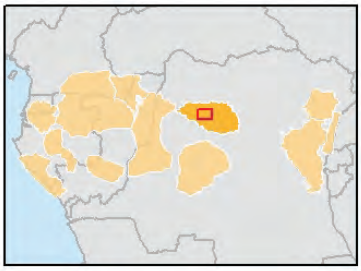
Increased evidence of bonobo and forest elephant presence in the Reserve coupled with evidence of hunting camp abandonment are encouraging signs for the general viability for these species within the Reserve. However, there is still much to learn about both species, including their exact numbers in the Reserve, their spatial distribution, and the importance of the Reserve for their habitat. For instance, it is not clear why, according to the surveys, bonobos are present in the Reserve only in patchy densities, or why forest elephant traces have been encountered only in close proximity to the ICCN-headquarters (Figure 23.4). It is hoped that ongoing surveys will help researchers learn more about these species in the RFLY Reserve.

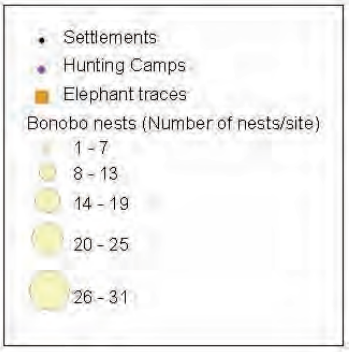
AWF is leading a bonobo habituation program which will prepare the RFLY Reserve for great ape tourism. An increase in bonobo observations has been corroborated by reports from community members living in and around the re-activated research site at Ndele, where bonobo habituation is taking place. AWF has been spreading the news of these developments within the primate research community. Tourism agencies interested in the development of bonobo-focused tourism will visit the RFLY Reserve in the coming months. Revenue from tourism in RFLY will be reinvested in the management of the Reserve and directed to the local communities. This should further strengthen the management of this unique protected area for the well-being of fauna and for the local communities living in the Reserve's periphery.

Photo 23.4: Trapping in the Lomako forest.

Photo 23.5: Harvesting of non-timber forest products is an important economic activity for many families.







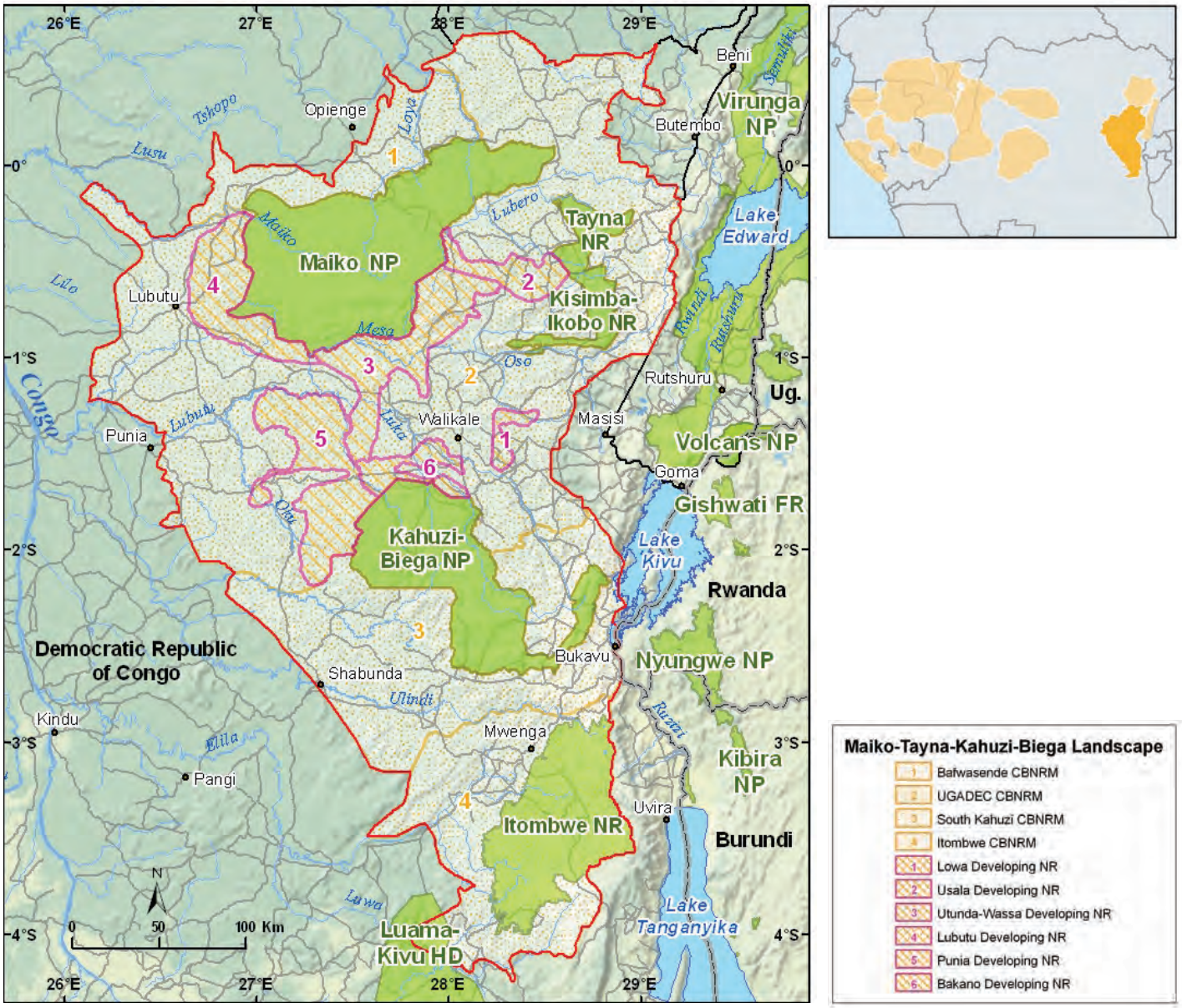
Sources: AWF, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.

Figure 23.4: Abundance and distribution of bonobo nests and of traces of elephants recorded during the survey Sept-Dec 2007

CHAPTER 24
Maiko-Tayna-Kahuzi-Biega Landscape

Patrick Mehlman

Land Use Planning



Sources: CI, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.
Figure 24.1: Macro-zones in the Maiko-Tayna-Kahuzi-Biega Landscape

Since 2003, much progress has been made towards comprehensive land use planning in the Maiko Tayna Kahuzi-Biega (MTKB) Landscape, despite its vast size (10 million ha), the logistical challenges related to travel and communications, and difficulties posed in some sectors where the presence of illegally armed groups has created military insecurity.

Photo 24.1: Tea plantations on the edge of Kahuzi-Biega National Park.

Macro-Zoning in the Landscape

Central to land use planning is the identification of macro-zones in a participatory process with stakeholders. For this Landscape, there are currently eight macro-zones that have been identified (Figure 24.1); four are protected areas, and four are community-based natural resource management (CBNRM) areas (there are no extractive macro-zones in the MTKB Landscape). Of the four protected areas, two are National Parks (Maiko and Kahuzi-Biega), managed directly by ICCN. These two National Parks were gazetted by the government between 1970 and 1974, and as a result were readily defined as protected areas macro-zones.

Two other protected areas, however, were created from within a CBNRM macro-zone by local communities. In an innovative approach, local NGOs used participatory mapping and a sensitization program based on gorilla conservation to reach consensus among local land users to effectively "cede" large integral zones in which flora and fauna are afforded 100 % protection. The local NGOs then applied to the government to transform these integral zones into nationally recognized protected areas, and in 2006, they were gazetted as nature reserves (Tayna and Kisimba-Ikobo) by a Ministry of Environment decree. This was accompanied by a management contract between the ICCN and each NGO, in which the latter were subcontracted to manage their corresponding nature reserve.

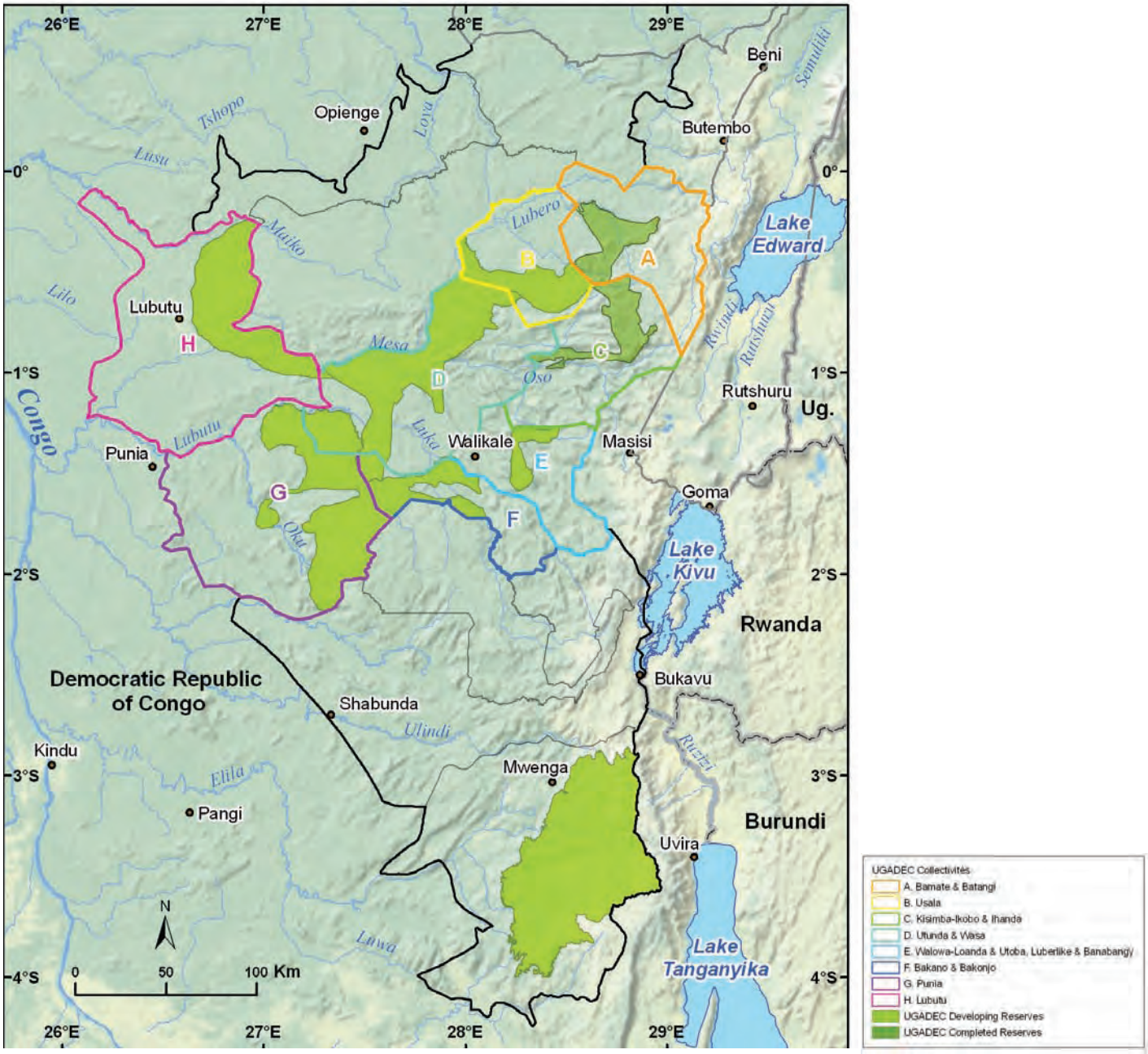
The MTKB Consortium's methodological approach for macro-zoning thus includes a number of large CBNRM zones in which communities are creating protected areas. To reflect this process and plan for future zoning changes, we designate these as "macro-zones under development" (and also indicate areas that are being developed as future nature reserves, figure 24.1). For example, the UGADEC[5] CBNRM is managed by a federation of eight local NGOs representing more than 14 Chefferies[6] (figure 24.2). Although it is currently being managed as a CBNRM macro-zone, six of its NGO members are currently seeking to create government-authorized Nature Reserves, modeled after the Tayna NR. By identifying this as a "macro-zone under development," the consortium and stakeholders can plan for the six additional protected area macro-zones that will exist within the UGADEC CBNRM, surrounded by the development zones of their collectivités (figure 24.2, white areas within the UGADEC area).

In a somewhat similar process, the Itombwe Nature Reserve (figures 24.1 and 24.2), which received its Ministerial Decree in 2006, is embedded in the Itombwe CBNRM. In the case of this reserve, however, its limits are still under development through a participatory planning process with local communities, and its internal integral zones have yet to be identified or zoned. Once completed, however, this will be an additional case in which a protected area macro-zone will be developed by the local population from within a CBNRM zone.

Photo 24.2: A hydro-electric station serves the Tayna Center for Conservation Biology and nearby village of Kasugha.

[5] UGADEC is the Union des associations de conservation des gorilles pour le développement communautaire à l'est de la République démocratique du Congo.

[6] A chefferie is a chiefdom (formerly called a "collectivité chefferie" or sector). Administrative organization in DRC is by province, then territory, then chefferie.



Sources: CI, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.

Figure 24.2: UGADEC, a CBNRM macro-zone with two protected area macro-zones completed and six in development. Note that the UGADEC Nature Reserves under development will form a biological corridor between Maiko National Park and Kahuzi-Biega National Park

Human Activities

Demographic data for this Landscape are unreliable, particularly since the displacement of populations during recent conflicts. The population is unevenly distributed, with a rising density gradient moving from west to east: on the mountains of the Albertine Rift, the density is over 300 inhabitants/km^2; the western lowland regions are relatively sparsely populated with approximately 80 % of the Landscape covered by forests without any permanent villages. The Landscape encompasses a mosaic of Bantu people characterized by their languages, notably Nande, Pere, Hunde, Nyanga, Rega, Kwame, Kumu and Shi. There are also small populations of Twa Pygmies, the majority of whom live near Kahuzi-Biega National Park in the south. Swahili is the most common language.

The principal economic activities in the Landscape are subsistence farming, hunting, extensive cattle farming, goat and/or sheep farming, mining, and some fishing. Most farming is carried out using slash-and-burn methods, with principal crops being manioc, cassava, rice, and beans (table 24.1). There are a few plantations near villages that grow oil palm, banana, co?ee and cinchona, but most commercial plantations are no longer functional. Oil palm, extracted by simple hand methods throughout the landscape, is an important product traded in local villages, and may be transported by bicycle to larger village markets in the east.

Subsistence hunting takes place throughout the Landscape. The trade in bushmeat is not as developed as in western Central Africa, but consumption of bushmeat is high near mining camps and in some smaller towns and villages. Most local bushmeat trade is monkey, duiker, antelope and rodents (table 24.2). Hunting for ivory also exists throughout the Landscape and is carried out by illegal armed groups. When an elephant is slaughtered, the meat also enters the bushmeat markets. River fishing is common throughout the Landscape, and some fish farming occurs near villages around Walikale.

Artisanal mining for gold, tin (tin-stone), coltan and diamonds is intensive in several areas of the Landscape, facilitated by dealers from neighboring countries who move the materials out by small plane. In some places, notably Walikale, these operations are so successful that the inhabitants have abandoned farming. Consequently, large quantities of food are brought in by plane at very high prices, completely destabilizing the local economy. There are few usable roads, but one asphalt surfaced road from Lubutu to Walikale in the center of the Landscape serves as a runway for small planes used by the mining business. In addition to the artisanal activities there are several commercial gold mining concessions in the southern segment of the Landscape.

There are no commercial logging concessions in the Landscape, but small-scale logging operations have long existed around certain villages. On the eastern fringes of the Landscape, charcoal production is also an important trade, supplying urban centers in the region.

Commercial cattle ranchers (along with goats and sheep) are extensively spreading throughout the highlands of the eastern portion of the Landscape. This is particularly damaging for the environment, since they practice clear-cutting of forest to create large expanses of pasture land.

Photo 24.3: Training of guards in mapping.

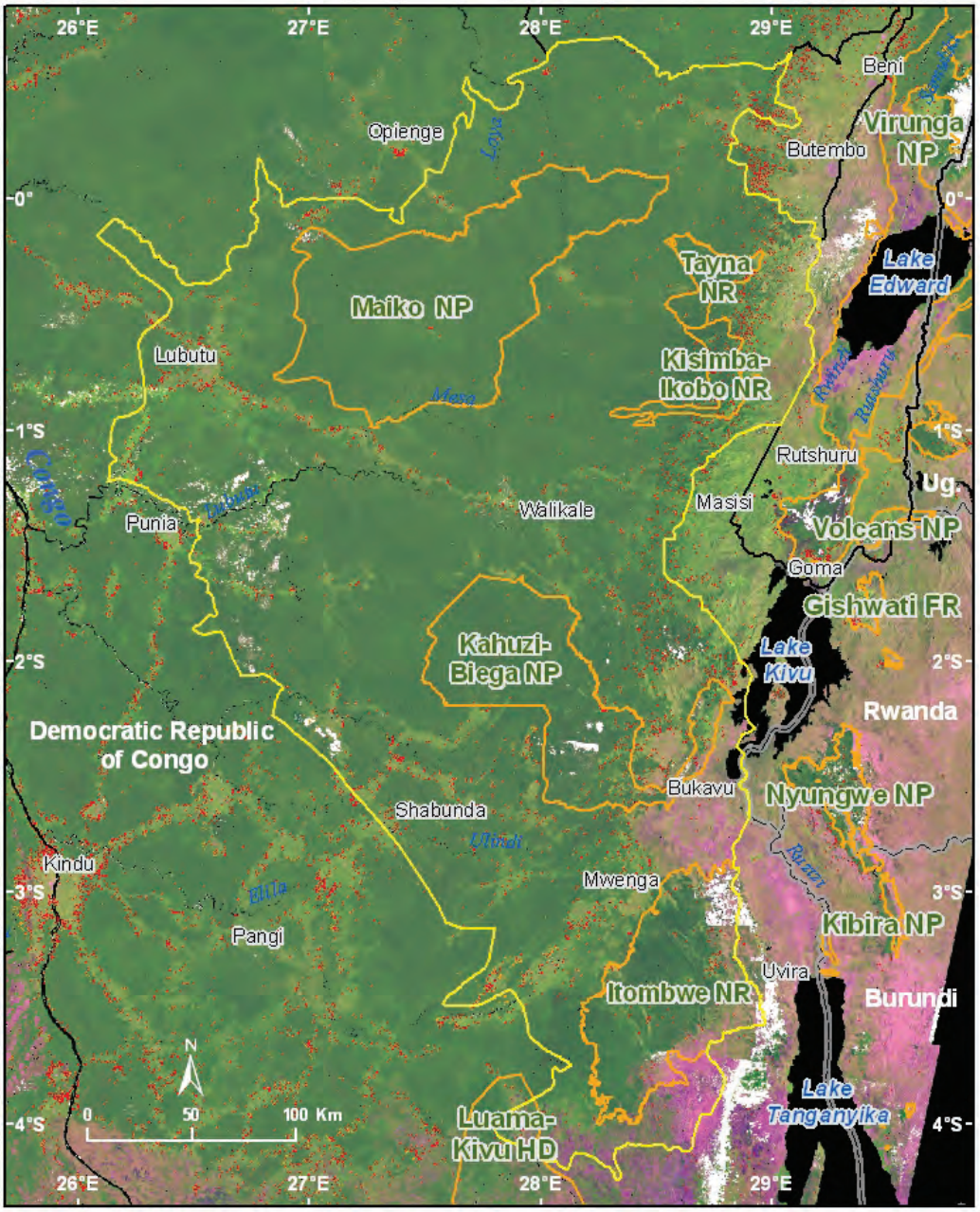
Table 24.1: Important agricultural products in the Maiko-Tanya-Kahuzi-Biega Landscape

Agricultural product	Unit	Purchase price/$ per kg	Primary destinations	Date	Data collection	Sources
Location: UGADEC						
Cassava	Sack (100 kg)	30/0.30	Goma, Butembo, Kasugho, Miriki, Walikale, Pinga, Kasese, Lubutu	Jun-Aug 07	Data collection was made following three strategies: direct observations in mining camps, small villages and markets of bigger towns; discussions with the vendors; household surveys on main subsistence activities and small trades.	Socioeconomic surveys, field reports
Oil palm	*Bidon* (20 liters)	20/1.00 per l	Goma, Walikale, Bukavu, Pinga, Kanyabayonga, Kirumba, Mwesso, Masisi	Jun-Aug 07		
Rice	Sack (100 kg)	50/0.5	Wakikale, Goma, Kasese, Pinga, Masisi	Jun-Aug 07		
Location: Kahuzi-Biega						
Cassava	Sack (100 kg)	50/0.5	Bunyakiri	2004-2008	Market surveys	
Rice	Sack (100 kg)	50/0.5	Kamituga	2004-2009	Market surveys	
Beans	Sack (100 kg)	50/0.5	Baraka	2004-2010	Market surveys	

Table 24.2: Bushmeat trade in the Maiko-Tayna-Kahuzi-Biega Landscape

Bushmeat species	Unit	Purchase price/ unit ($)	Primary destinations	Date	Data collection	Sources
Location: UGADEC						
Monkeys (*Colobus* and *Cercopithecus*)	Half	10	*Carrés miniers* (Bisie, Irameso, Kasugho, Kibeleketa, Sakima) and villages (Oninga, Opyenge, Lubutu, Kasese, Walikale, Miriki, Rusamambu, Kibua, Mpofi, Bunyatenge)	Aug 07-Apr 08	Data collection was made following three strategies: direct observations in mining camps, small villages and markets of bigger towns; discussions with the vendors; household surveys on main subsistence activities and small trades.	Socioeconomic surveys, field reports
Antelope/duiker	Quarter	7	*Carrés miniers* (Bisie, Irameso, Kasugho, Kibeleketa, Sakima) and villages (Oninga, Opyenge, Lubutu, Kasese, Walikale, Miriki, Rusamambu, Kibua, Mpofi, Bunyatenge)	Aug 07-Apr 08		
Porcupine (*Atherurus*)	Whole	5	*Carrés miniers* (Bisie, Irameso, Kasugho, Kibeleketa, Sakima) and villages (Oninga, Opyenge, Lubutu, Kasese, Walikale, Miriki, Rusamambu, Kibua, Mpofi, Bunyatenge)	Aug 07-Apr 08		
Location: Itombwe						
Monkeys (*Cercopithecus*)	Whole	5 per kg	Kambegeti (PNKB), Lulimba (Itombwe),	2004-2008	Market surveys	
Antelope/duiker	Whole	5 per kg	Kambegeti (PNKB), Lulimba (Itombwe),	2004-2009	Market surveys	
African elephant (*Loxodonta africana*)	Whole	5 per kg	Kambegeti (PNKB), Lulimba (Itombwe),	2004-2010	Market surveys	

Forest Cover



Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 24.3: Composite Landsat satellite image of the Maiko-Tayna-Kahuzi-Biega Landscape overlain with 1990 to 2000 forest loss (in red) and 2000 to 2005 forest loss (in orange)

Table 24.3: Forest cover and forest loss in the Maiko-Tayna-Kahuzi-Biega Landscape from 1990 to 2005.

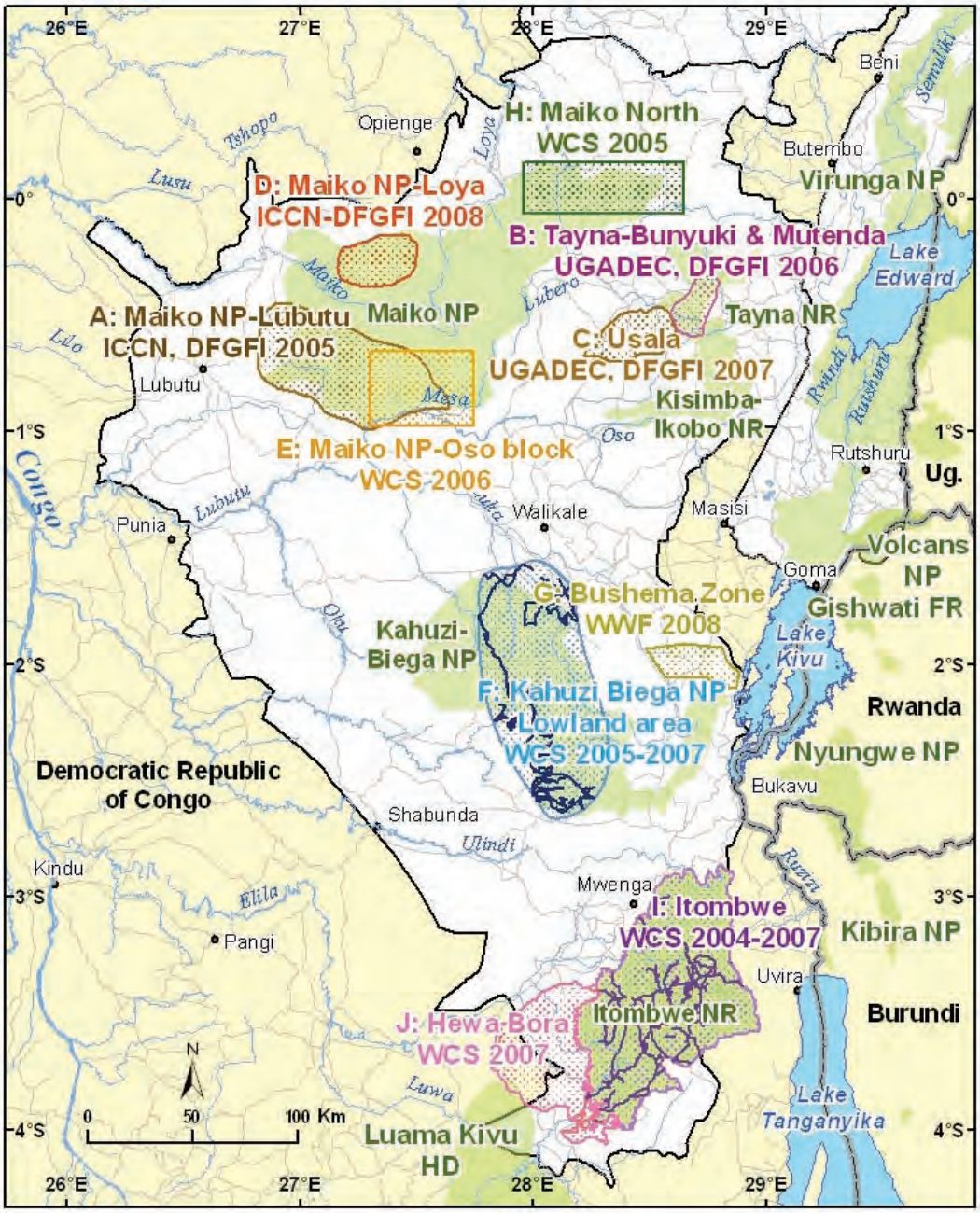
	Forest area			Forest loss			
Landscape area	1990 (km^2)	2000 (km^2)	2005 (km^2)	1990-2000 (km^2)	1990-2000 (%)	2000-2005 (km^2)	2000-2005 (%)
105,736	92,376	91,404	90,600	972	1.05	804	0.88

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

Forest loss was concentrated in three areas and can be attributed in general to expansion of agriculture and commercial pasturelands, as well as illegal mining. The largest expanse of deforestation was along the Albertine Rift region (area west of Lakes Edward, Kivu, and Tanganyika, from Butembo in the north, to Bukavu and Uvira in the south), where human population density is known to sometimes exceed 300 individuals per km^2. Here, there was a steady advance of forest loss from east to west, due to agricultural expansion as people sought more farmland, as well as the expansion of commercial cattle ranching (as in Latin America) to serve the beef and milk-product markets for large cities such as Butembo, Goma, and Bukavu. A second area of deforestation occurred around Lubutu and towards the southeast along the "Trans-African Highway". This highway, clearly visible in the satellite image as a narrow corridor of pre-existing and newly degraded areas, is mostly paved between Lubutu and Walikale, and for much of the 1990s and early 2000s (as well as today) served as a series of airstrips facilitating the illegal mining of first coltan, and then cassiterite (tin), both highly valued in the electronics industry and controlled by various illegal militias. Conversion of forest to agricultural fields in this area was related to new migrants moving into the area attracted by the illegal mining. A third area of forest loss spreads northeast from Shabundu and southeast to Mwenga and merges with the westward front of deforestation from the Bukavu area of the Albertine Rift. This area of deforestation was caused primarily by new migrants attracted to the illegal mining industry in the west, combined with farming and cattle ranching expansions coming from the Bukavu area in the east. Forest cover degradation is most severe in the Nindja ecological corridor (narrow zone between the highland and lowland sectors of Kahuzi-Biega NP) due to the illegal settlement of farmers and ranchers. It is also important to note that forest cover in the highland sector of the Kahuzi-Biega National Park is also threatened by an invasive species of vine (*Sericostachys scandens*) that covers and eventually kills many of the species of tree in this Afromontane habitat.

Large Mammal and Human Impact Monitoring

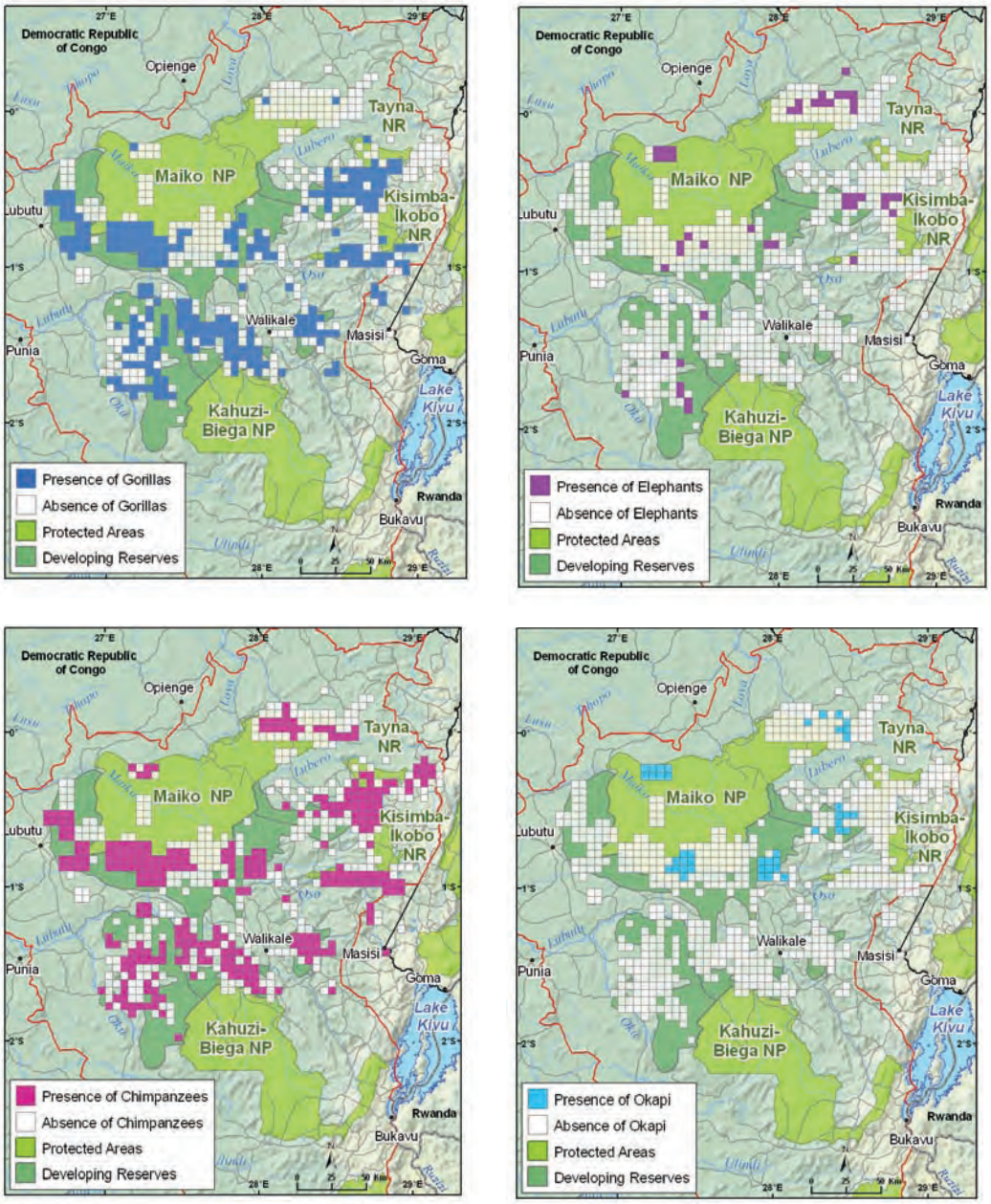
Photo 24.4: Gorilla (Gorilla beringei graueri) in the high altitude sector of Kahuzi Biega National Park.



Sources: CI, DFGFI, UGADEC, ICCN, WWF, WCS, UMD-CARPE, OSFAC, FORAF.

Figure 24.4: Biological surveys conducted in the Maiko-Tayna-Kahuzi-Biega Landscape

The locations of biological surveys carried out in the MTKB Landscape are shown in Figure 24.4 and the results of these surveys for the baseline biological indicators are displayed in table 24.4. For these landscape surveys, there have been a total of 1,469 km of reconnaissance and transect surveys. Elephant presence has been observed at low densities in each survey location. Great ape nest group encounter rate has been quite similar for each survey location (between 0.12 and 0.31 nest groups per km surveyed) with the exception of the Tayna area, where elephant and great ape encounter rates are elevated compared to other sites. In the northern segment of the Landscape, a method of opportunistic data collection was employed, which included absence/presence observations in quadrants by trained teams (figure 24.5). The surveys revealed occupancy ranges for elephant, gorilla, chimpanzee and okapi. In the highland sector of Kahuzi-Biega NP, 121 gorillas in 9 social groups are regularly monitored by ICCN staff. In the Tayna NR, 14 gorillas in one social group is habituated and regularly monitored by Tayna staff.



Sources: DFGFI, UGADEC , CI, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.

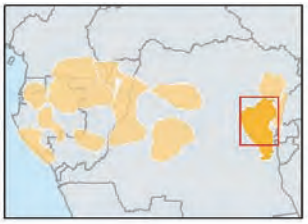


Figure 24.5: A system of quadrant (5.6 km by 5.6 km) monitoring by trained UGADEC field teams indicates those quadrants in which opportunistic surveys have been conducted (purple) against those quadrants in which evidence of gorilla, chimpanzee, elephant, and okapi have been recorded. This system is building a basic model of occupancy ranges for these species.

Table 24.4: Biological survey results from the Maiko-Tayna-Kahuzi-Biega Landscape

Survey	Site name	Survey date	Source	Lead	Total km of recces	Number of transects	Total km of transects	Other
A	Maiko NP-Lubutu	Feb-Apr 2005	DFGFI report	ICCN, DFGFI	170			
B	Tayna - Bunyuki and Mutenda	Mar-06	DFGFI report	UGADEC, DFGFI	61		28	
C	Usala	Mar-Apr 2007	DFGFI report	UGADEC, DFGFI	204			
D	Maiko NP-Loya (preliminary results)	May 2008	DFGFI report	ICCN, DFGFI	45			
E	Maiko Oso	Mar-May 2006	WCS-IMU tech. report 6	WCS	A) compass line: 301	0	No data	Compass line recces, linking 5 x 5 km grid centroids in a 600 km² survey zone
F	Kahuzi lowland	2004 - 2007	WCS-IMU tech. report 8	WCS	A) Compass line: 511 B) trail 293	0	No data	A) Compass line recces oriented to selected waypoints in site, B) Recces along established paths
G	Bushema zone	2008	WWF report	WWF		7	14	Methods used: *Transect-observation done on both sides of the transect by using GPS and compass. Hunters were associated. *Recces
H	Maiko North	Jul-Aug 2005	WCS-IMU tech. report 4	WCS	A) compass line: 378	0	No data	Compass line recces, linking 5 x 5 km grid centroids in a 1,250 km² survey zone
I	Itombwe	2004-2007	WCS-IMU Itombwe interim figures	WCS	Compass line and trail total: 1038	0	No data	Compass line and path recces, not separated in analysis.
J	Hewa Bora	2007	WCS-IMU Itombwe interim figures	WCS	Compass line and trail total: 71	0	No data	Compass line and path recces, not separated in analysis.

	Elephant presence	Elephant dung pile encounter rate (N/km)	Elephant dung pile density (N/km²)	Ape presence	Ape nest group encounter rate (N/km)	Ape nest group density (N/km²)	Human sign (N/km)
	Yes	0.02	0.005	Yes	0.14	0.03	
	Yes	0.56	0.36	Yes	1.16	0.75	0.84
	Yes	0.005	0.001	Yes	0.31	0.07	0.49
	Yes	0.29	0.05	Yes	0.15	0.03	0.38
	Yes	0.26	No data	Chimpanzee: yes gorilla: yes	Chimpanzee: 0.11 gorilla: 0.01	No data	Hunting: 0.76 Total: not calculated
	No	0	0	Chimpanzee: yes gorilla: yes	Chimpanzee: 0.14 gorilla: 0.05	No data	Hunting: 0.83 Mining: 0.15
	No	No data	No data	Yes			
	Yes	0.99	No data	Chimpanzee: yes gorilla: yes	Chimpanzee: 0.05 gorilla: 0.00	No data	Hunting: 0.74 Total: 1.90
	Yes	< 0.01	No data	Chimpanzee: yes gorilla: yes	Chimpanzee: 0.02 gorilla: 0.03	No data	Hunting: 0.41 Mining: 0.15
	Yes	0.06	No data	Chimpanzee: yes gorilla: yes	Chimpanzee: 0.76 gorilla: 0.15	No data	Hunting: 0.89 Mining: 0.04

Special Interest

Developing a Conservation Village

One of the first development incentives UGADEC communities asked of Dian Fossey Gorilla Fund International and Conservation International in exchange for their commitment to conservation was education. The Tayna Center for Conservation Biology (TCCB, registered with the state as the Kasugo University for Conservation and Rural Development) is the product of that partnership. By any measure, establishing the TCCB is an extraordinary achievement for an association of rural communities in a developing country. Under the prevalent conditions in eastern DRC, it defies belief. In addition to its academic facilities, the University supports a student-run AM radio station, a 28-bed clinic, complete with a laboratory and operating theater, a primary school and orphanage. And this entire complex was hand-built by the villagers of Kasugho – the widow's association pressed and fired the bricks; local craftsmen built all the furniture, doors, and windows. With the support of Jane Goodall Institute, in November 2007, the TCCB and the neighboring village of Kasugho began operating a 37kW hydro-electric dam that provides constant and emissions-free electricity to the university, the hospital, and public lighting to the village. A village committee overseas its operation, and is making available electrical power to small development projects.

By October of 2008, more than 200 students had received their diplomas in conservation biology (a three-year degree). As the sons and daughters of the stewards whose land easements form the reserves of UGADEC, these graduates will one day inherit their parents' responsibility to adjudicate land-use rights in their communities. Without the leadership and vision of their elders, these students would likely have been limited to a life tilling the land, mining under harsh conditions, or poaching protected wildlife. Yet as new graduates, they have returned to their communities, qualified to work as field researchers, rangers, wardens, protected area managers, teachers, conservation journalists, and out-reach workers. Once the traditional rights of their elders are passed on to them, these graduates will have both the knowledge and the skills needed to make the critical decisions necessary to protect their land.

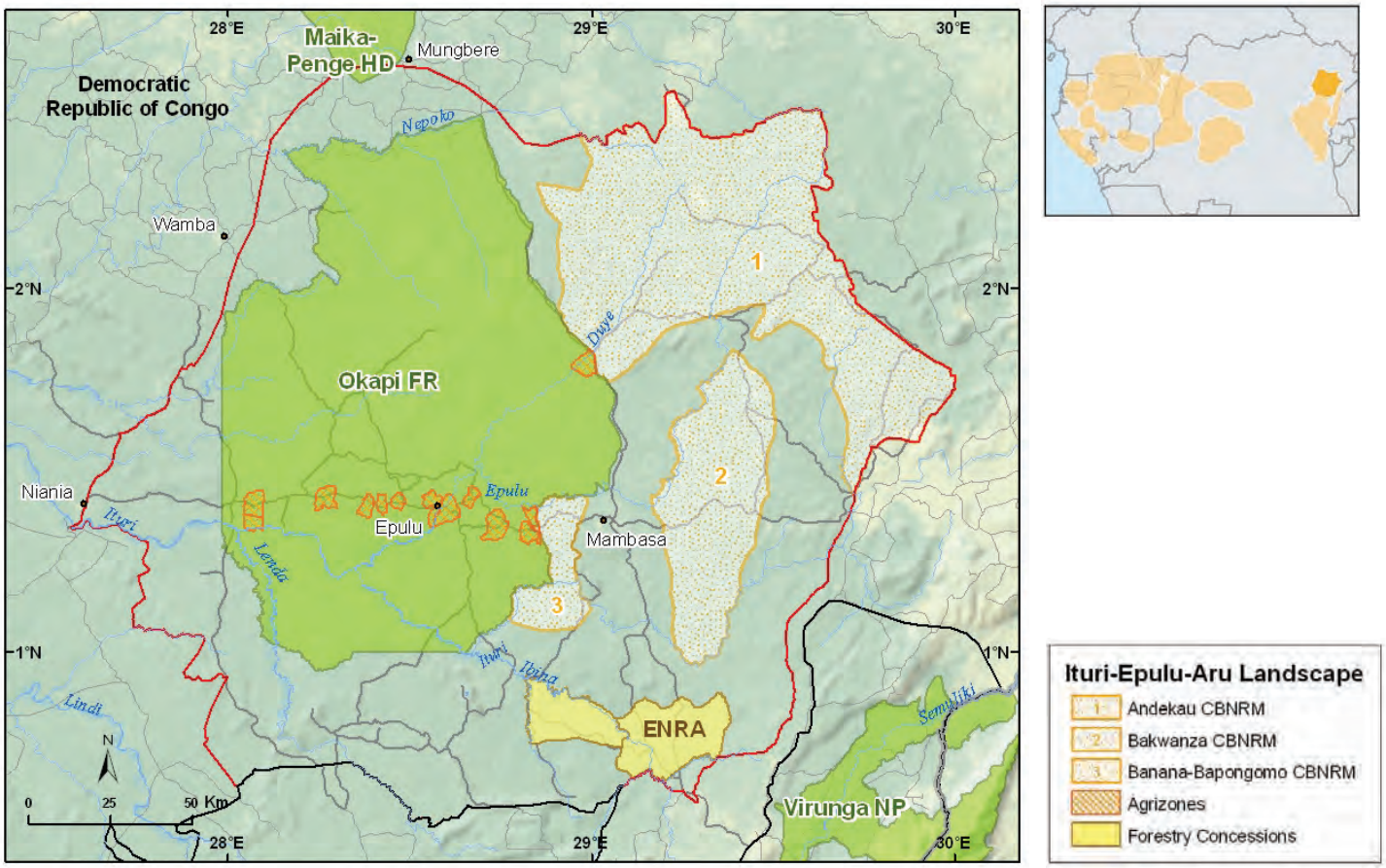
The impact of the university is remarkable and far-reaching. In addition to construction jobs, the local population now has access to doctors, nurses, and the health center's services. Agricultural extension programs support local farmers, and children have access to primary and high school education. The radio station broadcasts messages to the local communities concerning conservation, politics, music, culture, and women's and family issues. However, the University's true value for conservation rests with the students: they are the new generation of conservation stewards of the land that lies within the Maiko-Tayna Kahuzi-Biega corridor.

Photo 24.5: The Tayna Center for Conservation Biology is a a community-managed university, specializing in conservation biology, and serving the needs of local people involved in community conservation.

CHAPTER 25
Ituri-Epulu-Aru Landscape

Ellen Brown, Robert Mwinyihali, John Hart, Baby Ngungu, Mto Wells, and Emola Makambo

Land Use Planning



Sources: WCS, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.
Figure 25.1: Macro-zones in the Ituri-Epulu-Aru Landscape

The Ituri-Epulu-Aru Landscape covers 40,862 km² with five designated macro-zones including:

- a protected area: Okapi Faunal Reserve (13,720 km²)
- three community-based natural resource management zones: Banana (575 km²), Andekau (6,973 km²), and Bakwanza (2,181 km²)
- an extractive resource zone: Enzyme Refiners Association (ENRA) logging concession (520 km²)

In 2006, the Democratic Republic of Congo (DRC) held its first presidential elections in over 30 years and since then institutions have slowly begun to function again and widespread national road rehabilitation is underway. The government is amending conservation laws and drafting implementation guidelines for the national forestry code. These national level efforts to revise the forestry code and conduct land use zoning are being assisted at the local level by three NGOs supported through USAID's CARPE program. The Ituri Landscape planning team includes consortium members (WCS, Pact and GIC) and local management partners such as the DRC protected area management authority (ICCN) and the Ministry of Environment. CARPE consortium partners are working with stakeholders to develop management plans for protected areas, community-based natural resource management zones (CBNRM)

Photo 25.1: Characteristic markings of the okapi, a large antelope endemic to DRC.

and extractive resource zones (ERZ). New Landscape boundaries were delineated since the last State of the Forest (CBFP, 2006) report in order to include the ENRA logging concession in the Landscape.

In 2006, the Ituri-Epulu-Aru Consortium began work on a land use planning strategy document for the Landscape. As part of this process, a stakeholder participation strategy is being developed. Consortium members raise awareness and educate stakeholders about the national forestry code and the value of zoning and land use planning. Since local government authorities lack funds and training, consortium NGOs help build local capacity by facilitating the creation of local resource management structures and by helping stakeholders to articulate a vision for resource management.

The Ituri-Epulu-Aru Landscape's unique ecological, socio-economic, and socio-cultural value will be reflected in the land use plan. The overall management vision and objectives have been drafted and will be presented to stakeholders in 2009.

Data has been collected on human populations and their livelihood activities in the Landscape. Biological and socio-economic data were collected in the logging concession. Studies on bushmeat hunting, non-timber forest products (NTFP), and artisanal timber exploitation were conducted. Participatory sketch mapping was conducted in 42 villages in three CBNRM zones. This information will be used to guide the land use planning process, especially for community-managed forests.

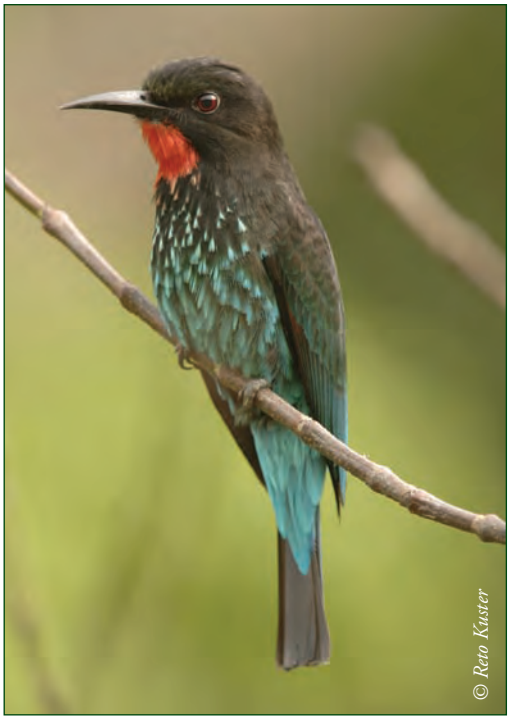


Photo 25.2: Black bee eater (Merops gularis).

Geo-referenced mapping was conducted in the Okapi Faunal Reserve (OFR), ENRA concession, three CBNRM zones and other sites such as abandoned coffee plantations in the wider landscape. In addition to macro-zone boundaries, geo-referenced data (waypoints) were recorded for roads and rivers in the Landscape.

Protected area: In the OFR, managers are drafting a revised management plan. Micro zoning is underway; 12 agriculture zones (34,982 ha) have been delimited with management agreements signed between ICCN and local communities and authorities. Participatory mapping has yielded geo-referenced data for hunting territories in 9 villages covering 271,599 ha, and results from biological surveys helped define the limits of a proposed core conservation zone covering 481,600 ha in the center of the Reserve.

Community-based natural resource management zones: As mentioned above, the three CBNRM zones in the Landscape are Banana (575 km^2), Andekau (6,397 km^2) and Bakwanza (2,181 km^2). A land use planning strategy document was written for these zones and local committees were formed to serve as governance structures for sustainable resource use, including timber exploitation in community-managed forests, bushmeat alternatives, and agriculture.

Extractive resource use zone: Surveys of large mammals, plants, and signs of human activities have contributed to a management plan for ENRA's 520 km^2 logging concession. A strategy document was drafted and an agreement between local stakeholders and logging concession managers' has been signed and validated by local and territorial authorities. WCS will continue their assistance to ENRA in drafting its management plan when the conversion process is completed. Eventually, the management plan may contribute to ENRA's efforts to pursue forest certification status.

Studies and mapping have also been conducted to document the presence and activities of squatters in the concession. This will contribute to strategies to reduce conflicts over land and natural resources between the logging company and human communities present in the concession.

Human Activities

The Landscape is located on a settlement frontier where during the last 60 years, and most notably in the last 30, considerable migratory movements have transformed parts of the region. Some immigrants have fled insecurity in their home region; but most were motivated by easy access to cultivable land, jobs in mining or small-scale forestry and the small businesses these activities generate. Most recent immigrants in the Landscape originate from the densely populated heights of the Albertine Rift on the border with Rwanda and Uganda.

The human population of the Landscape is estimated at 300,000. Mambasa and Niania, two major towns in the Landscape, have approximately 20,000 inhabitants each and are growing rapidly. The most recent census (2003) conducted in the OFR documented 17,000 people in the reserve and 37,000 people within 15 km of the limits.

The population of Mbuti and Efe Pygmies in the Landscape is estimated at 30,000. The main ethnic groups of Bantu and Sudanic speaking shifting cultivators are the Bila, Ndaka, Lese, Mbo and Mamvu. They depend on small-scale slash-and-burn agriculture, supplemented by? shing and hunting. Two main immigrant groups are the Nande, from the mountains to the east of the Landscape, and the Budu, from the densely populated regions to the north and west of the Landscape.

Most people practice a suite of subsistence activities throughout the year including agriculture, fishing and hunting, but they may also rely on wage labor, artisanal mining and logging. Unemployment is widespread; most who gain wages are employed through churches or international organizations, including conservation NGOs. The collapse of the road network in the 1970s has limited both access to markets and development possibilities. Repairs to the trans-African highway between Kisangani and Bunia have recently been completed which will facilitate immigration, market access and resource extraction.

Agriculture: Manioc, plantain, rain-fed rice, beans and groundnuts are the main crops in the Landscape. Forest dwelling subsistence farmers practice a field rotation system with two years of crops on the same land (0.5 – 1 ha) followed by ten-year fallows, which allow the soil to regain its fertility. Recent immigrants practice more intensive agriculture with larger fields, shorter fallow periods, and more extensive clearing of primary forest. They are able to hire field labor because they have more economic power than indigenous farming groups, which in turn enables them to open larger fields and clear more forest.

Subsistence hunting: Hunting is an important source of protein and revenue for people in the Landscape. Mbuti and Efe (Pygmies) hunt using nets and bows and arrows, while village-based Bantu and Sudanic groups use snares. Eight species of small ungulates are the principal game species captured with net and snare hunting, while bow hunters target monkeys. Some people specialize as full time hunters, but most adult men set snare lines periodically during the year when agricultural activities are less intense. Current hunting levels are not sustainable, and if this continues unchecked, duiker populations will continue to decline.

Commercial bushmeat hunting: Snare hunting has intensified over the course of the last decade and has now reached remote regions of the Landscape. The trading network involves dealers and buyers in the towns of Mambasa, Niania, Beni, Butembo, Kisangani and Isiro. Recent wildlife surveys in the OFR show that populations of five duiker species declined dramatically from 26 % to 59 % depending on the species.

Very few instances of legal hunting rifles exist in the Landscape; instead guns are in ready supply from military and police who loan them out to local hunters. In some large towns in the Landscape,

Photo 25.3: The rehabilitation of the road between Kisangani and Beni has helped open up Kisangani.

the proliferation of guns results in sack-loads of monkeys for sale at local bushmeat markets.

Poaching: Elephant hunting and ivory poaching intensified in 1996 with the beginning of the civil war and again in 2002-2004 when militia and police established hunting camps in the Landscape, recruited and armed professional hunters and signed contracts with local dealers to sell meat and ivory. Elephant poaching has now been reduced considerably, thanks to a UNESCO-funded joint effort by ICCN and the Congolese Army (FARDC) to evacuate poaching camps in the OFR. Elephant populations in the OFR were reduced by an estimated 48 % since the 1995 census, which translates to an estimated loss of 3,260 elephants to poaching. Okapi were reduced by 43 %, with a loss of an estimated 2,000 animals since the outset of the conflict.

Artisanal mining: The Ituri region is rich in gold, coltan and diamonds. Hundreds of small permanent or semi-permanent mines have become active since the liberalization of mining in the 1980s. Mining is illegal in protected areas in DRC, but during the conflict period this law was impossible to enforce. In 2006, a joint effort between ICCN guards and the national army conducted evacuations of all active mines in the reserve. The mines remain abandoned and vegetation and wildlife have begun to return to these former mining sites, but this requires ongoing surveillance and monitoring from ICCN. Though mining is a localized threat, it can have major repercussions when accompanied by uncontrolled population movements and increased bushmeat hunting. Mining contributes to the establishment of permanent settlements.

Logging: There is only one legal logging concession, Enzyme Refiners Association (ENRA), in the Landscape which covers 52,000 ha and produces 5,000-7,000 m^3 of sawn timber a year. As mentioned above, the CARPE consortium works in collaboration with ENRA. However, the majority of logging in the Landscape is artisanal and informal. In 2007, a container truck, over-loaded by several tons with lumber, caused a bridge to break over the Ituri River. However, even this has not prevented the steady export of timber out of the Landscape towards the east, as there is a ready supply of labor to carry timber to the river's edge, transfer it to wooden pirogues to cross the river, and then unload it on the other side.

Photo 25.4: Gold mining in the Ituri River.

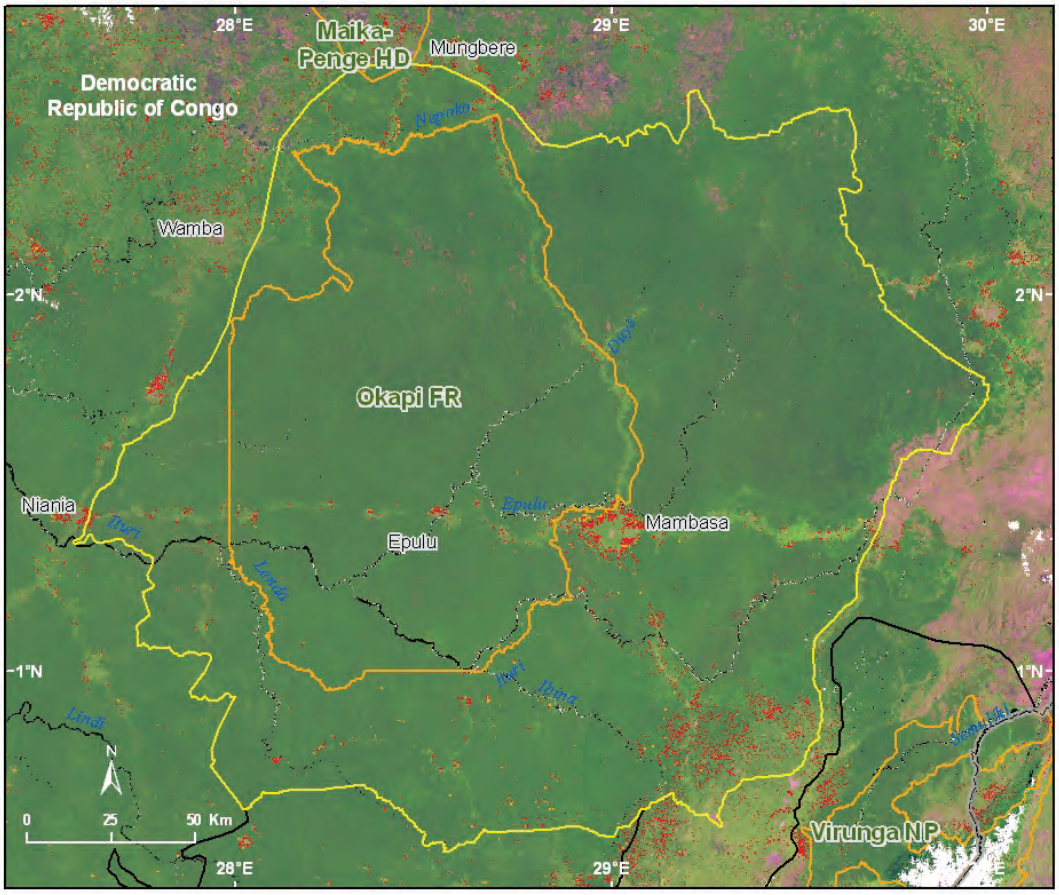
Table 25.1a: Important agricultural products in the Ituri-Epulu-Aru Landscape

Site	Agricultural product	Unit	Purchase price/unit ($)	Primary destination	Date	Data collection	Sources
Protected area: Okapi Faunal Reserve, Epulu	Rice	Sack (100 kg)	80	Inside Landscape	May-08	Market surveys	WCS
	Beans	Sack (100 kg)	80	Inside Landscape	May-08	Market surveys	WCS
	Groundnuts	Sack (100 kg)	100	Inside Landscape	May-08	Market surveys	WCS
CBNRM Andikau	Rice	Sack (100 kg)	30	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
	Cassava (dried tuber)	Sack (100 kg)	40	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
	Groundnuts	Sack (100 kg)	50	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
	Beans	Sack (100 kg)	100	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
CBNRM Bakwanza	Cassava (dried tuber)	Sack (100 kg)	35	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
	Rice	Sack (100 kg)	46	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
	Groundnuts	Sack (100 kg)	60	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
	Beans	Sack (100 kg)	100	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
CBNRM Banana	Rice	Sack (100 kg)	25	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
	Cassava (dried tuber)	Sack (100 kg)	49	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
	Maize	Sack (100 kg)	56	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
	Groundnuts	Sack (100 kg)	65	Inside Landscape	Jun-08	Household surveys and PRA	Pact/WCS
Mambasa town	Rice	Sack (100 kg)	35	Inside Landscape	Jun-08	Market surveys	Pact/WCS
	Cassava (dried tuber)	Sack (100 kg)	42	Inside Landscape	Jun-08	Market surveys	Pact/WCS
	Maize	100 kg	73	Inside Landscape	Jun-08	Market surveys	Pact/WCS
ERZ Makumo (ENRA)	Cassava (dried tuber)	100 kg	18	Inside Landscape	Jun-08	Market surveys	Pact/WCS
	Maize	Sack (100 kg)	21	Inside Landscape	Jun-08	Market surveys	Pact/WCS
	Rice	Sack (100 kg)	45	Inside Landscape	Jun-08	Market surveys	Pact/WCS
	Beans	100 kg	75	Inside Landscape	Jun-08	Market surveys	Pact/WCS
Niania town	Cassava (dried tuber)	Sack (100 kg)	30	Inside Landscape	Jun-08	Market surveys	Pact/WCS
	Rice	Sack (100 kg)	49	Inside Landscape	Jun-08	Market surveys	Pact/WCS
	Beans	Sack (100 kg)	80	Inside Landscape	Jun-08	Market surveys	Pact/WCS

Table 25.1b: Bushmeat trade in the Ituri-Epulu-Aru Landscape

Bushmeat species	Site	Unit	Purchase price/ unit ($)	Primary destinations	Date	Data collection	Sources
Blue duiker (*Cephalophus monticola*)	Protected area, Epulu	Whole	4	Inside Landscape	May-08	Market surveys	WCS
	CBNRM Andikau	Whole	3	Inside Landscape	Jun-08	Household surveys and PRA	Pact/ WCS
	CBNRM Bakwanza	Whole	4.5	Outside Landscape	Jun-08	Household surveys and PRA	Pact/ WCS
	CBNRM Banana	Whole	4	Inside Landscape	Jun-08	Household surveys and PRA	Pact/ WCS
	Mambasa town	Whole	5.5	Outside Landscape	Jun-08	Market surveys	Pact/ WCS
	Makumo town	Whole	12	Outside Landscape	Jun-08	Market surveys	Pact/ WCS
Monkey spp.	CBNRM Bakwanza	Whole	4	Outside Landscape	Jun-08	Household surveys and PRA	Pact/ WCS
	Mambasa town	Whole	6	Outside Landscape	Jun-08	Market surveys	Pact/ WCS
	Komanda town	Whole	7	Outside Landscape	Jun-08	Market surveys	Pact/ WCS
	Niania town	1/6	3	Inside Landscape	Jun-08	Market surveys	Pact/ WCS
Red duikers (ex. *Cephalophus dorsalis, C. callipygus, C. sylvicultor, C. leucogaster*, etc.)	Protected Area, Epulu	1/4	4	Inside Landscape	May-08	Market surveys	WCS
	CBNRM Andikau	1/6	3	Inside Landscape	Jun-08	Household surveys and PRA	Pact/ WCS
	CBNRM Bakwanza	1/6	4.6	Outside Landscape	Jun-08	Household surveys and PRA	Pact/ WCS
	CBNRM Banana	1/8	2	Inside Landscape	Jun-08	Household surveys and PRA	Pact/ WCS
	Mambasa town	1/6	5.5	Inside Landscape	Jun-08	Market surveys	Pact/ WCS
	Komanda town	1/6	7	Outside Landscape	Jun-08	Market surveys	Pact/ WCS
	Niania town	1/6	4.5	Inside Landscape	Jun-08	Market surveys	Pact/ WCS
Hog (ex. *Potamochoerus porcus*)	CBNRM Bakwanza	kg	1.5	Inside Landscape	Jun-08	Household surveys and PRA	Pact/ WCS

Forest Cover



Forest
Non-Forest (grassland, bare soil/rock, roads, urban)
Rural Complex (secondary forest, farms)
Forest change from circa 1990 to circa 2000
Forest change from circa 2000 to circa 2005
Cloud/No Data

Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 25.2: Composite Landsat satellite image of the Ituri-Epulu-Aru Landscape overlain with 1990 to 2000 forest loss (in red) and 2000 to 2005 forest loss (in orange)

Table 25.2: Forest cover and forest loss in Ituri-Epulu-Aru Landscape from 1990 to 2005

	Forest area			Forest loss			
Landscape area	1990 (km²)	2000 (km²)	2005 (km²)	1990-2000 (km²)	1990-2000 (%)	2000-2005 (km²)	2000-2005 (%)
40,862	39,663	39,449	39,310	214	0.54	139	0.35

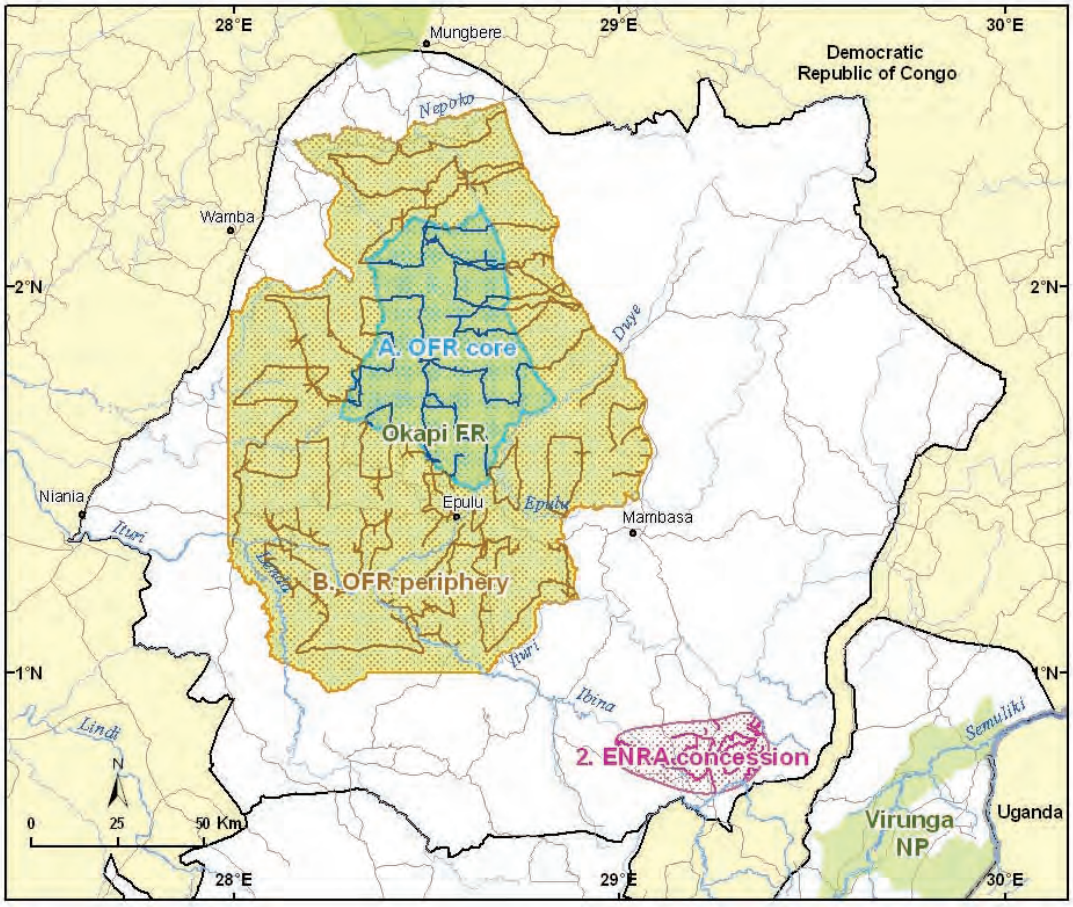
Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

The Landscape is covered with a closed canopy of dense evergreen forest consisting of areas of monodominance as well mixed forests. The north and the east of the Landscape are characterized by semi-deciduous forests whose canopies contain more light-demanding species, such as *Entandrophragma spp.*, *Khaya anthotheca, Albizia spp.* and *Canarium schweinfurthii*, and a growing proportion of dendritic *Euphorbiaceae* and *Rubiaceae*. At the northern and eastern ends of the forests, the dense forests turn into a mosaic of dry forests, evergreen forest galleries and wooded savannas. The northwestern side of the Landscape is characterized by the granite inselbergs with many xe-

rophilic plant formations including many species that are of global importance for conservation. Throughout the Landscape there are clearings, called "Edo" locally, which are maintained by elephants, but used by a wide variety of fauna.

Secondary forests of varying ages cover large parts of the Landscape, partly as a result of natural causes such as the violent storms or from the result of human activities mainly shifting agriculture and, to a lesser extent, small-scale logging. In the southeast of the Landscape, degradation of forests and deforestation are increasing due to the extension of agriculture and artisanal logging causing the formation of vast areas covered with a mosaic of degraded forest and cultivated land.

Large Mammal and Human Impact Monitoring



Sources: WCS, ICCN, UMD-CARPE, OSFAC, FORAF.

Figure 25.3: Biological survey transects in Ituri-Epulu-Aru Landscape

Photo 25.5: Forest elephants are often victims of poachers involved in ivory trafficking.

Table 25.3: Biological survey results from the Ituri-Epulu-Aru Landscape.

Survey	Site name	Survey date	Lead	Total km of recces	Number of transects	Total km of transects	Elephant presence	Elephant dung pile encounter rate	Elephant dung pile density	Ape presence	Ape nest group encounter rate	Okapi presence	Okapi dung pile encounter rate	Okapi dung pile density (per km²)	Human sign: hunting only
A	OFR core	2005-2007	WCS, ICCN	282	35	105	Yes	1.71		Yes	0.82	Yes	0.51		2.83
B	OFR periphery	2005-2007	WCS, ICCN	872	75	175	Yes	1.18		Yes	0.41	Yes	0.18		3.86
A, B	OFR	1993-1995	WCS, ICCN	0	110	280	Yes	2.99	409 (st. err. =78.1)	Yes		Yes	0.45	106 (st. err.=19.9)	3.09
A, B	OFR	2005-2007	WCS, ICCN	0	110	280	Yes	1.29	213 (st. err. =61.4)	Yes	0.49	Yes	0.25	60 (st. err.=12.2)	3.52
2	ENRA conces-sion	2007	WCS	106	0	0	No	0		Yes	0.06	Yes	0.007		1.93

Sources: (A and B) Hart, J. et al., 2008; (A, B) Beyers, R., 2008; (2) Madidi, J et al., 2007.

Biological surveys of key large mammal populations and human activities were conducted in the OFR in 2005-2007 and in the ENRA logging concession in 2007. The surveys were the first in the OFR since the outbreak of conflict in 1996, and the results permitted managers to evaluate changes in faunal densities over the 10-year period of conflict. Results showed that significant populations of the OFR's flagship species remain, including forest elephant, okapi and chimpanzee. Most faunal populations were significantly more abundant in the center of the Reserve in a zone proposed for conservation than in the zones designated for traditional hunting and agricultural settlement. The exceptions were elephants, which were concentrated in areas that suffered less poaching during the period of conflict, and monkeys (12 species), which were abundant in agricultural zones and secondary forests.

Survey results from the ENRA forest concession show that two out of three forest blocks have been settled by illegal squatters who practice agriculture and artisanal logging, and only small patches of intact forest remain in the concession. Unsurprisingly, very few signs of primates and ungulates were found in these two blocks where human activities are intense. However, in the third forest block, which remains intact, abundant signs of chimpanzees and monkeys, as well as signs of ungulates were recorded.

Special Interest

This success story is focused on the progress and potential of CBNRM zones for natural resource management and conservation. Activities conducted in the Landscape's three CBNRM zones, such as socioeconomic surveys, trainings, and formation of natural resource management committees, has attracted the attention of other towns in the region, notably Niania to the west of the OFR. Niania, a town at the western limit of the Ituri-Epulu-Aru Landscape outside the OFR has an important influence on the Landscape, especially on the OFR.

Chiefs and land owners in Niania recognize that their forest is disappearing through both agriculture and artisanal logging; but that their community is not developing as a result. They have contacted the CARPE consortium to request that a CBNRM zone be created to help them organize themselves and conduct natural resource and land use planning. Local chiefs have already taken some initiatives which include: requesting that farmers work along the roadside rather than clearing fields in primary forest and the formation of a hunting management committee with the help of a local NGO.

In the current context, artisanal logging is done in an unorganized and individual manner. However, if the CBNRM model could be applied in Niania – they could be helped to create a structure for natural resource management – that would bring together key stakeholders to elaborate a vision of conservation and development. The consortium and its partners could then help to build capacity in accounting, logistics, and project conception and feasibility studies. The two current CBNRM zones, Banana and Andikau, which are located partially in the OFR buffer zone, are proving to be pilot experience projects for protected area buffer zone management which may prove useful for other sites in DRC and the region.

Photo 25.6: Blue Duikers (Cephalophus monticola) in a Mbuti Pygmy hunting camp.

CHAPTER 26
Virunga Landscape

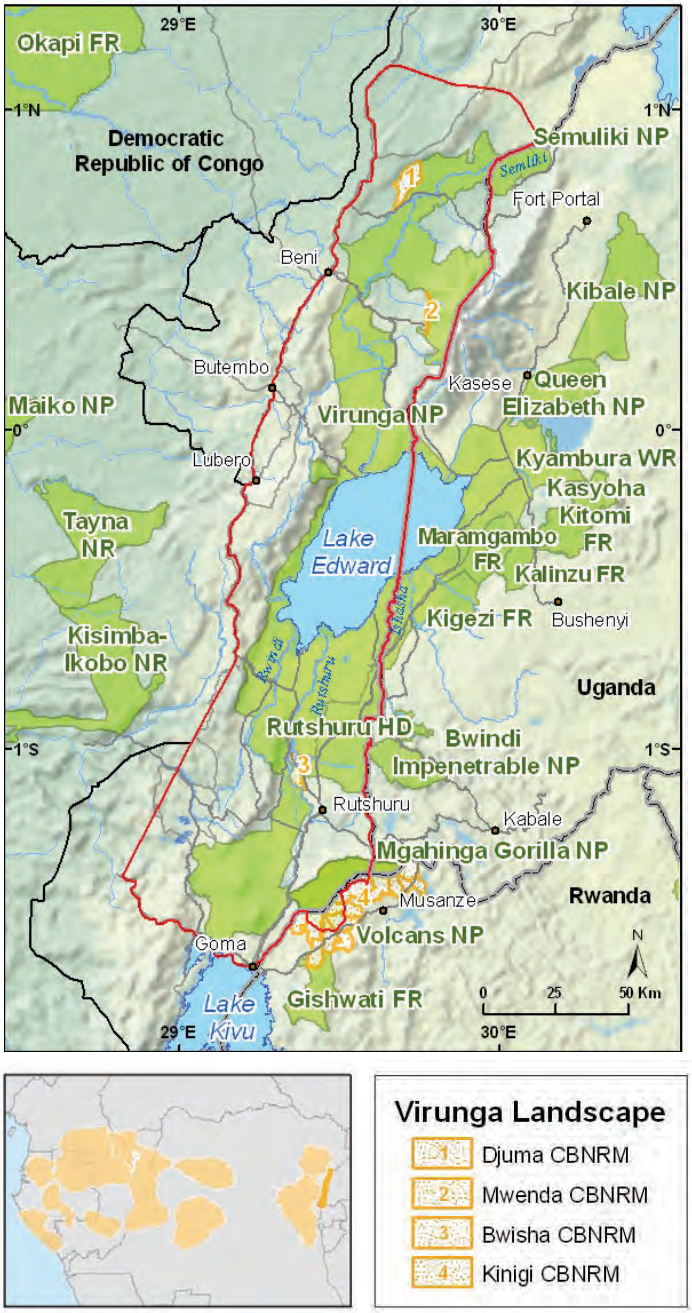
Thierry Bodson, Roy Buhendwa, Marc Languy, and Paya de Marcken

Land Use Planning

The Virunga Landscape, located in eastern DRC and Rwanda along the Ugandan border, presents a unique and complex case study for land use planning. The region has a history of fierce conflicts and instability, and since the early 1990s different areas of the Landscape have been occupied by national forces (FARDC: *Forces armées de la République démocratique du Congo*) as well as numerous rebel groups, including: the ADF/NALU (Allied Democratic Front), Interahamwe groups (FDLR: *Forces démocratiques de libération du Rwanda*), Mai Mai and the CNDP (*Congrès national de défense du peuple*). Controlling natural resources, including gold, diamonds, tin and coltan, has played a role in recent conflicts and underscores the necessity of effective resource management in the region.

In the midst of the ongoing conflicts and at the cornerstone of the Landscape is Virunga National Park (PNVi). Created in 1925, PNVi covers 784,368 ha and is under the authority of ICCN. Two smaller protected areas are also located within the Landscape: the Hunting Domain of Rutshuru in DRC and Volcans National Park in Rwanda. The primary objectives of these parks are to conserve the unique and diversified ecosystems that exist in the Albertine Rift.

Surrounding these protected areas, and in contrast to many of the other landscapes in the Congo Basin, the Virunga Landscape contains areas of very high population densities (up to 600 individuals/km^2). These populations depend on the land and biological resources within the Landscape. The majority (80 %) of land outside of protected areas is used mainly for subsistence agriculture, but include also coffee, tea, cocoa and pyrethrum. A small percentage of land is also used for grazing. Charcoal is the main source of energy for permanent, as well as displaced, human populations.



Sources: WWF, AWF, UMD-CARPE, OSFAC, FORAF, IUCN, Tom Patterson, US National Park Service.

Figure 26.1: Macro-zones in the Virunga Landscape

Photo 26.1: Large tracts of forest are often degraded before they are totally deforested.

Photo 26.2: Improving public awareness of park limits and resource use regulations is important to maintaining the integrity of Virunga National Park.

In order to reconcile the objectives of different stakeholders, improve livelihoods and promote the sustainable management of natural resources, a consortium of four NGOs (WWF, WCS, SNV and AWF/IGCP) have been working in the Virunga Landscape since 2006 to promote land use planning at the landscape and macro-zone level. The consortium executes the activities planned in the Virunga Landscape with the collaboration of two national institutions: ICCN in DRC and ORTPN in Rwanda, as well as International NGOs (FZS, ZSL, and ACF), local NGOs (CREF, *Avocats Verts*, BREAD, etc.) and CBOs.

Two types of macro-zones form the basis for field activities: (1) protected areas (DRC: Virunga National Park and the Hunting Domain of Rutshuru; Rwanda: Volcans National Park) and (2) CBNRM areas (DRC: Mwenda and Bwisha; Rwanda: Kinigi). In a landscape where control over certain areas is uncertain, the legal status accorded to protected areas provides a framework in which to advance the land use plan. Simultaneously, in a landscape where the pressure on protected areas and natural parks is intense, CBNRM areas provide an opportunity to work with local communities to address their needs and develop sustainable management options. The dense human populations in the Virunga Landscape mean that many CBNRM areas are relatively small compared to other landscapes.

Despite the difficulties linked to the insecurity of the region and the disengagement of the SNV from the consortium in 2008, the Landscape Consortium has successfully advanced many aspects of land use planning in the past two years. Land use planning activities in the Virunga Landscape macro-zones have concentrated on: socio-economic and ecological studies to better understand resource use; a series of activities to mobilize stakeholders; increasing capacity to engage in land use planning, implementing agroforestry and promoting the more efficient use of resources; developing a system to resolve conflicts; establishing a greenbelt and buffer zone; delimiting macro-zones; and producing management plans.

In PNVi, the consortium held orientation meetings with ICCN, and a team charged with developing a management plan has almost completed the plan. Simultaneously, additional data continues to be collected on flora and fauna, as well as human activities, in the park. The consortium formed mixed commissions for the demarcation of the limits around the PNVi and worked in the Mavivi, Watalinga and Tshiaberimu areas to specify the boundary of the NP. A management system to resolve conflicts linked to land use in the Rwenzori sector was established and a document on conflict resolution for the whole PNVi was produced. A forum gathering traditional chiefs and North-Kivu provincial authorities to garner support for the protection of Virunga NP was carried out and activities to develop management strategies in the buffer zone continue.

Land use planning in the DRC CBNRM areas is still in its early stages. In order to engage stakeholders, the consortium and its partners worked to organize multiple workshops bringing together local authorities (administrators, traditional chiefs and community leaders) in the land use planning process. They endeavored to identify additional stakeholders (primary and secondary), including women, marginalized groups, and different ethnic groups in multiple areas of the Landscape, including the territories of Beni (Mwenda CBNRM) and Rutshuru (Bwisha CBNRM). In Bwisha and Mwenda, they undertook socio-economic and ecological surveys and held meetings to sensitize the communities to various concepts of natural resource management in the Landscape, and collected the opinions and views of the communities about developing CBNRM areas.

In Rwanda, preliminary studies in the Kinigi region revealed high population densities, vulnerable groups within the population, highly degraded soils and low productivity. Consultations with various stakeholders highlighted the need to harmonize and share the same understanding of the CBNRM implementation strategy among all stakeholders and the importance of a legal framework for the CBNRM plan implementation. Eventually it was decided that the CBNRM implementation plan should be part of the districts' planning process and implemented at a sector level, under the overall guidance of districts' authorities with technical support from NGOs and respective central government agencies. The management plan for the CBNRM has been completed and adopted.

Human Activities

In this section, we provide an update on human populations in the Virunga Landscape. The DRC census in 1984 showed an average annual growth rate of 3 %. In the Virunga Landscape, the main ethnic groups remain the Nande (Beni and Lubero), Hutu and Tutsi (Rutshuru and Masisi), Hunde (Masisi, Nyirangongo, Karisimbi) and Bashi. The primary activity for most people is subsistence farming (80 %), although a small percentage also fish and/or raise cows, sheep and/or poultry. In 2008, the widespread presence of armed groups (CNDP, FDLR and Mai Mai rebels) and the presence of 6 FARDC brigades in the Virunga Landscape produced significant population movement from the countryside to the urban centers surrounding PNVi. The territories of Masisi, Rutshuru and Lubero have been especially affected by the problems in North Kivu. Demographic data have not been collected in the areas controlled by the armed groups, but it is known that there are armed groups (FDLR, CNDP, Mai Mai, etc.) and the national army with their families inside the park and in the surrounding area.

The people living in the Kinigi area are predominantly subsistence farmers with 90 % of the households engaged in agriculture, less than 1 % engaged in aquaculture, and more than 30 % practice forestry.

Photo 26.3: Livestock husbandry is not prevalent in Central Africa. The exception is the Masisi region near Virunga National Park.

Table 26.1: Neighboring populations of PNVi in the Virunga Landscape in 1998

Territory/ Entity	Population				
	Male	Female	Children ≤ 15 years	Total	Density (km²)
Beni	204,012	215,465	347,812	767,289	102.5
Lubero	235,408	251,550	403,765	890,723	49.2
Rutshuru	157,128	160,174	263,093	580,395	109.7
Nyirangongo	8,630	9,084	14,686	32,400	198.7
Karisimbi	27,378	29,931	47,520	104,829	103.2
Masisi	157,905	162,692	263,339	583,936	122.7
Total	**790,461**	**828,896**	**1,340,215**	**2,959,572**	

Source: Division provinciale du Plan au Nord-Kivu.

Photo 26.4: Water collection is a daily activity for many families.

Table 26.2: Estimate of displaced families near Virunga National Park

Site	Families	Persons	Status
Goma area			
Bulengo	3,594	17,968	Camp
Mugunga 1	5,102	25,501	Camp
Mugunga 2	2,592	12,962	Camp
Buhimba	2,459	12,297	Camp
Kibati 1	14,261	71,306	Camp
Kibati 2	534	2,671	Camp
Nzulo	1,000	+/- 5,000	Unofficial camp
Total	**29,542**	**147,714**	
East of PNVi			
Kalengera Rubare 1	8,650	+/-43,250	Host families
Kalengera Rubare 2	350	+/- 1,750	Unofficial camp
Kiwanja-Rutshuru	20,000	+/- 80,000	Host families
Total	**29,000**	**125,000**	
West of PNVi			
Bambu	3,000	+/-15,000	Unofficial camp
Tongo	4,900	+/-24,500	Host families
Total	**7,900**	**39,500**	

Sources: HCR, IRC, Solidarités, November 2008.

Table 26.3: Populations living near Volcans National Park in Rwanda

District/Town	Total population 30 Aug 2002	Total area km²	Habitable area km²	Physical density (ind./ km²)
Buhoma	89,210	154.5	144.1	577.4
Bukamba	118,466	185.1	145.8	640
Kinigi	62,798	162	110.1	387.7
Mutobo	97,180	189.3	141.8	513.3
Mutura	122,934	201.7	167.3	609.3
Total	**490,588**	**892.6**	**709.1**	
Average				**545.6**

Source: Community-based natural resource management plan, Kinigi Area, Rwanda. June 2006.

Table 26.4a: Important agricultural products in the Virunga Landscape (Goma)

Agricultural product	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Cassava	Sack (100 kg)	45	Urban markets	May 2008	Market surveys	Survey in Goma market, 2008
Maize	Sack (100 kg)	30	Urban markets	May 2008	Market surveys	Survey in Goma market, 2008
Beans	Sack (100 kg)	65	Urban markets	May 2008	Market surveys	Survey in Goma market, 2008

Table 26.4b: Bushmeat trade in the Virunga Landscape (Goma, Kiwanja (Rutshuru) and Ishasha)

Bushmeat species	Unit	Purchase price/unit ($)	Primary destinations	Date	Data collection	Sources
Elephant (*Loxodonta africana*)	Pile (1 kg)	1	Kiwanja, Goma markets	Jun 2008	Market surveys	WCS/Goma, 2008
Hippopotamus (*Hippopotamus amphibious*)	Pile (1 kg)	1	Ishasha market	Jun 2008	Market surveys	WCS/Goma, 2008
Uganda Kob (*Kobus kob thomasi*)	Whole (1)	20	Kiwanja, Goma markets	Jun 2008	Market surveys	WCS/Goma, 2008

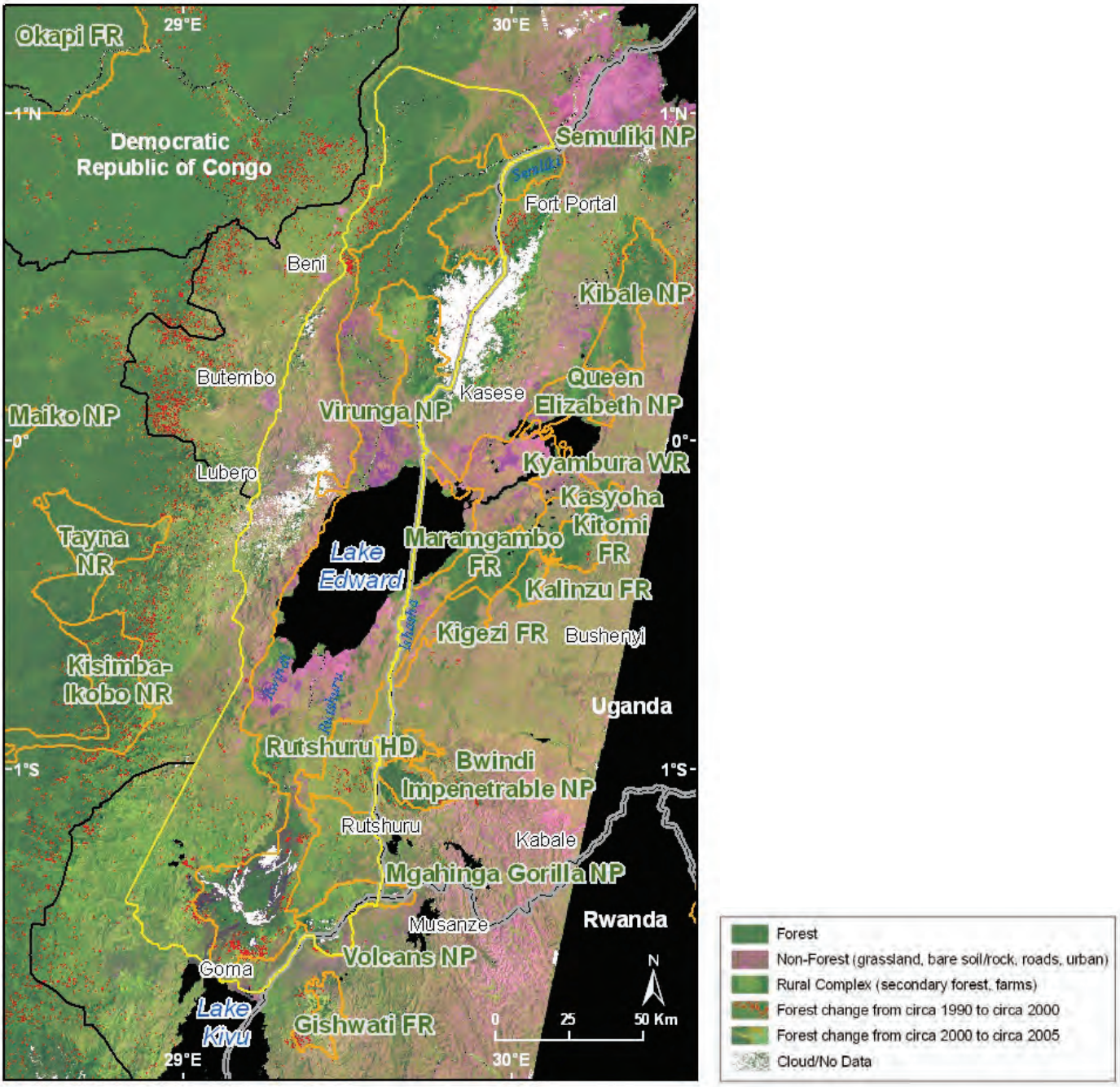
Table 26.5: Forest cover and forest loss in the Virunga Landscape from 1990 to 2005

	Forest area			Forest loss			
Landscape area	1990 (km^2)	2000 (km^2)	2005 (km^2)	1990-2000 (km^2)	1990-2000 (%)	2000-2005 (km^2)	2000-2005 (%)
17,403	3,480	3,279	3,143	202	5.79	136	4.14

Forest cover and forest cover loss are derived from Landsat and MODIS satellite data.
Sources: SDSU, UMD-CARPE, NASA.

The north of the Landscape (Rwenzori and Semiki sectors) and the Mikeno sector in the south are areas which are forested. The other areas are mostly savannas.

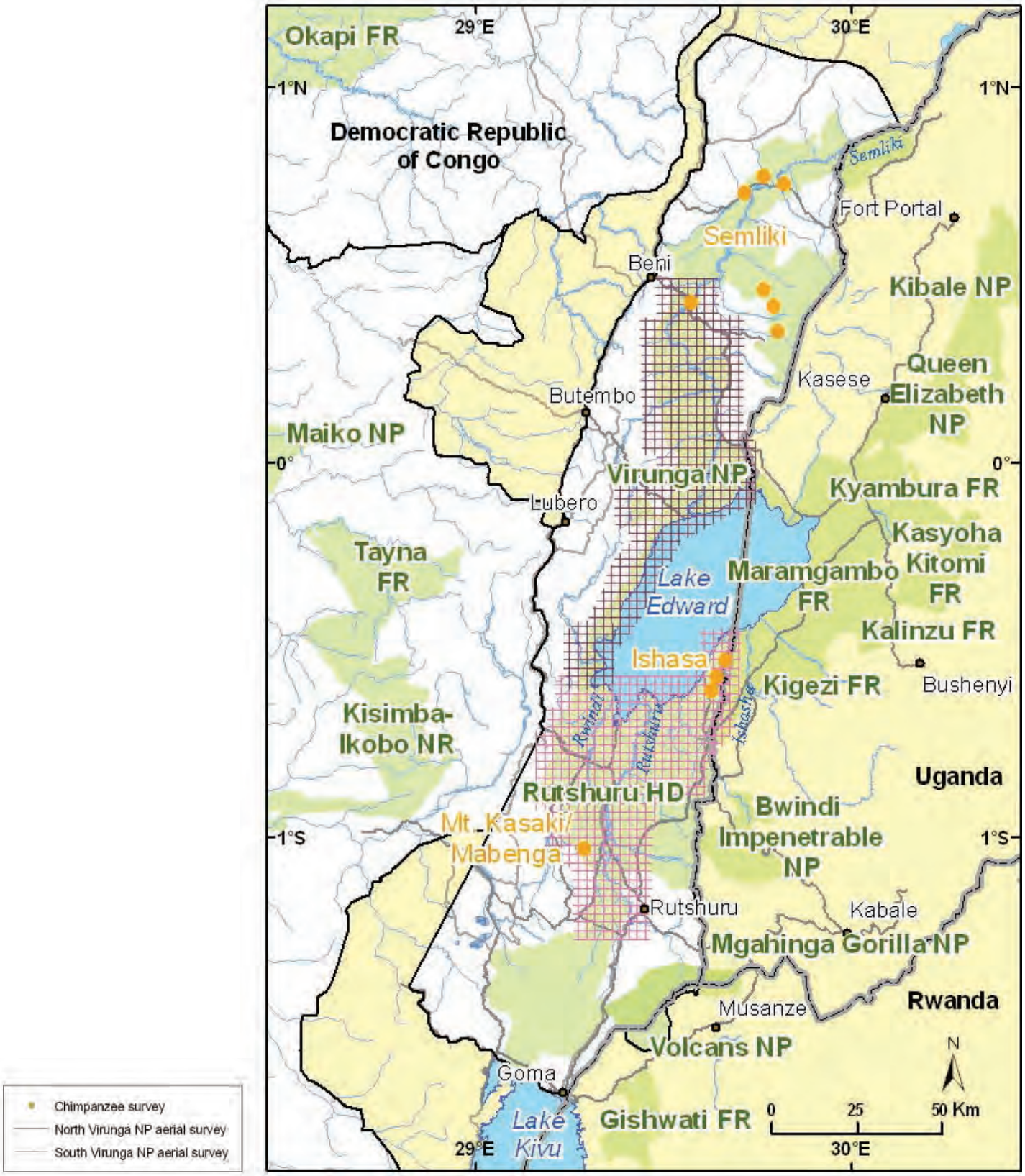
Forest Cover



Sources: SDSU, UMD-CARPE, NASA, SRTM, IUCN, FORAF.

Figure 26.2: Composite Landsat satellite image of the Virunga Landscape overlain with 1990 to 2000 forest loss (in red) and 2000 to 2005 forest loss (in orange)

Large Mammal Monitoring



Sources: WWF, USFWS, WCS, MacArthur Foundation, Daniel K. Thorne Foundation, ICCN, UMD-CARPE, OSFAC, FORAF.

Figure 26.3: Biological surveys conducted in the Virunga Landscape

The Virunga Landscape is an area that has long been recognized for its exceptional species richness and endemism, with dramatic habitat variations caused by extreme altitudinal and climate gradients. The history of species research and monitoring in the Landscape is rich and involves numerous individuals, organizations and a wide range of taxa[7]. In this 2008 State of the Forest report overview, we present a synopsis of recent findings, especially as concerns large mammals.

Approximately 218 species of mammals are known to occur in the Virunga area; however, many species have seen dramatic decreases in numbers over the last few decades. At one point, the total biomass of the main ungulate species in the Rwindi-Rutshuru-Ishasha plains (1,250 km^2) was estimated as the highest in the world (Bourlière and Verschuren, 1960). However, this high biomass was due to the presence of the world's largest population (numbering roughly 26,530 in 1959) of hippopotamus, *Hippopotamus amphibius*. In a very short period poaching has decimated this population to near extinction. In 2005, a census of hippopotamus in four rivers and around Lake Edward estimated the total population at 887 individuals (de Merode, 2006), representing a decline of 97 %. Hunting of other species, including buffalo, elephant and kob also continues (Kujirakwinja *et al.*, 2008).

The Landscape has 22 primate species and three taxa of great apes: the Mountain Gorilla (*Gorilla beringei beringei*) the Eastern Lowland Gorilla (*Gorilla beringei graueri)* and the Eastern Chimpanzee (*Pan troglodytes schweinfurthi)*. Systematic surveys of ape populations in the forested regions of PNVi have been difficult since the early 1990s due to ongoing rebel activities; however, in 2008, WCS with support from the USFWS undertook chimpanzee surveys in three areas of the national park (see figure 26.3). In the Semliki area, 72.7 km of transects were walked, in Ishasha 42.8 km and in the Mount Kasali/Mabenga region, 8.3 km. No chimp signs were encountered in Ishasha, however chimp nests were encountered in the other two areas. Encounter rates were used to estimate the total chimp population in the Semliki forest at between 950 and 1,000 individuals (Plumptre *et al.*, 2008). Mountain gorilla populations in the Mikeno sector in DRC were estimated at 380 (representing approximately 53 % of the world's total population) in 2003 (Gray *et al.*, 2005). In 2008, access to this area of the park was affected by the presence of CNDP rebel groups. However, in November 2008 ICCN was able to negotiate a deal which allows them to continue to monitor gorilla populations and a survey is currently underway and a recent study in Tshiaberimu revealed 19 gorillas.

The most recent systematic surveys of large mammals in savanna areas were aerial surveys carried out in 2003 and 2006 with support from the USFWS, WCS, the MacArthur Foundation and the Daniel K. Thorne Foundation (see table 26.6). These surveys suggest a slight increase in certain populations between 2003 and 2006 (Mushenzi *et al.*, 2003 and Kujirakwinja *et al.*, 2006). However, overall mammal populations, including elephant and buffalo, are a fraction of what they once were and current populations cannot be considered stable (see table 26.6).

Finally, a small, recently rediscovered population of Okapi (*Okapia johnstoni)* has survived on the banks of the Semliki River, in the extreme northern reaches of PNVi. These okapi have been recorded using camera traps and a 2008 study by the Zoological Society of London that covered 216 km, calculated a dung encounter rate of 0.20/km (Lusenge and Masudi, 2008). This population remains threatened by commercial hunting and charcoal production. The problems associated with overexploitation of fish species in Lake Edward reported in the 2006 State of the Forest Report (CBFP, 2006) continue.

[7] For a comprehensive review of monitoring and research through 2006 as well as the evolution of species' populations in PNVi, refer to Languy and de Merode (2006).

Table 26.6: Animal population estimates from aerial surveys in June 2006 in PNVi

	Northern sector		Southern sector		Total
	Estimated number	95 % confidence interval	Estimated number	95 % confidence interval	
Buffalo	74	12-208	3748	811-6,685	**3,822**
Elephant *(Loxodonta africana)*	50	8-153	298	145-470	**348**
Uganda kob *(Kobus kob thomasi)*	583	94-1,172	12,399	6,654-18,144	**12,982**
Defassa waterbuck (*Kobus ellipsiprymnus defassa)*	6	1-17	368	130-600	**374**
Topi *(Damaliscus lunatus jimela)*	0	0	1,353	408-2,298	**1,353**
Bushpig *(Potamochoerus larvatus)*	0	0	694	347-1,041	**694**
Baboon *(Papio anubis)*	0	0	737	104-1,389	**737**

Source: Kujirakwinja et al., 2006.

Special Interest

Hope in the Face of Crisis in the Democratic Republic of Congo

Thanks to conservation efforts during the last 20 years, the Mountain Gorillas of the Virunga Massif, shared between DRC, Rwanda and Uganda, have enjoyed a steady population increase, from 254 in 1981 to 380 in 2006. The year 2007 brought a strong reminder that these magnificent creatures, and the revenues they generate from tourism, are not yet out of the woods and remain critically endangered. From January to July 2007, 10 gorillas were killed in the Mikeno sector of Virunga National Park, in DRC, leading to what is now called the Mikeno crisis.

As a result of this crisis, ICCN called for international support. Our conservation partners, including WD, ZSL and FZS reacted quickly and met with ICCN to jointly develop an emergency plan. The CARPE consortium quickly joined in and pledged support. As the Consortium lead, WWF was tasked by ICCN to request supplemental support from USAID to fund part of the plan. This was done, and by October 2007, USAID committed additional funds while conservation partners initiated the work with their own resources.

The fact that the CARPE Program decided to join an initiative launched by ICCN and supported by sister-projects greatly helped ensure that activities are identified and implemented in a concerted way and that ICCN has a strong leadership and a clear operational document to which everyone refers.

Photo 26.5: The tourism potential of Virunga National Park is huge, but insecurity and lack of infrastructure hinder its development.

Wood Crisis

WWF, as CARPE consortium leader, secured resources to provide firewood to over 35,000 internally displaced people (IDPs) who fled the fighting in the Masisi area. Displaced people received support from humanitarian NGOs in terms of shelter, water and food, but were left to their own devices when it came to finding essential wood for cooking. As a result, they invaded Virunga NP in search of firewood and put further pressure on the rare montane forest of the area. By implementing a program to import firewood from neighboring wood plantations, WWF managed to alleviate a humanitarian crisis and a conservation crisis at the same time.

To face the continuous and important demand for firewood in the refugee camps and charcoal in the city of Goma, WWF is developing an ambitious program which aims to introduce the use of improved stoves that heats food quickly and reduces food consumption for each family living in the area. The next objective is to reduce the consumption of wood by half.

Photo 26.6: Forest products often come directly from Virunga National Park, while the buffer zone is being exploited in an unsustainable manner.

Hope of a Peaceful Cohabitation between the Local Population and ICCN in the Rutshuru Hunting Domain.

The Rutshuru Hunting Domain (RHD) is located between Virunga National Park limits and Bwisha in the territory of Rutshuru. Recognizing the intense pressure on the Park in this area, it was urgent to initiate a new dynamic involving all stakeholders. ICCN, with support from WWF and USAID, organized a series of meetings to gather all stakeholders.

Instigated by the Provincial Government, ICCN organized a workshop on management issues concerning the RHD in February 2008. The Provincial Minister in charge of the environment and his colleague in charge of agriculture, as well as the Province Governor's adviser, military and police authorities, local associations, traditional Chiefs and representatives of religious faiths all actively participated.

At the end of this workshop, an agreement on a management model for this zone was signed by all parties, enabling local communities to use practices which support sustainable agriculture. This zoning-based management model will help the communities to increase their agricultural output and attenuate the quasi permanent conflict related to the limits between the RHD and the Park.

Bibliography

Aba'a Nseme R., 2006. Abondance relative des grands mammifères et des activités humaines au parc national des Monts de Cristal et sa périphérie. WCS.

Aba'a R., Bezangoye A., 2007. Wildlife and human impact monitoring, Birougou National Park, Gabon. Report to WCS. 52 pp.

Abbadie L., Gignoux J., Le Roux X., Lepage M., 2006. (eds.) Lamto: Structure, Functioning, and Dynamics of a Savanna Ecosystem. Ecological Studies 179, Springer, 415 p.

Abell R., Thieme M.L., Revenga C., Bryer M., Kottelat M., Bogutskaya N., Coad B., Mandrak N., Balderas S.C., Bussing W., Stiassny M.L.J., Skelton P., Allen G.R., Unmack P., Naseka A. Ng. R., Sindorf N., Robertson J., Armijo E., Higgins J.V., Heibel T.J., Wikramanayake E., Olson D., Lopez H.L., Reis R.E., Lundberg J.G., Sabaj Perez M.H.and Petry P., 2008. Freshwater Ecoregions of the World: A New Map of Biogeographic Units for Freshwater Biodiversity Conservation. *BioScience*, 58, pp. 403-414.

Abitsi G., 2006. Inventaires de reconnaissance des grands mammifères et de l'impact des activités anthropiques. Parc National de Waka, Gabon. Décembre 2005-Juillet 2006. Report to WCS. 38 pp.

Abitsi G., Bezangoye A., Maisels F., 2008. Inventaires de reconnaissance des grands mammifères et de l'impact des activités anthropiques entre le Parc National de Waka et le Parc National de Lopé, Gabon. Report to WCS. 39 pp.

African Development Bank, 2006. Etat des lieux de la gestion des ressources en eau dans le bassin du Congo.

Alpert P. 1993. Conserving Biodiversity in Cameroon. Ambio 22: 44-49

Ampolo A., 2008. Utilisation de la viande de brousse autour du futur parc national Ogooué-Lékéti: cas de l'axe Impini, District de Lékana. WCS-Plateaux Batéké Project.

ANDEGE, 2008a. Landscape 1 GIS ANDEGE Quarterly Report.

ANDEGE, 2008b. ANDEGE FY08Q3 Quarterly Report.

ANDEGE, 2008c. Informe intermediario UICN-ANDEGE. (FY08Q2).

Andréassian V., 2004. Waters and forests: from historical controversy to scientific debate. *Journal of Hydrology*, 291, pp. 1-27.

Annuaire statistique du secteur forestier et cynégétique centrafricain 2006

Anonyme, 2000. Rapport sur la diversité biologique en RDC. Compilation des diagnostics effectués dans le cadre de la Conférence sur les Ecosystèmes de Forêts Denses Humides d'Afrique Centrale (CEFDHAC) du Plan d'action Forestier Tropical (PAFT), du Programme National d'Action Environnemental (PNAE) et de la Stratégie Nationale et Plan d'Action de la Diversité Biologique (SNPA-BD). CEFDHAC.

Anonyme, 2001. Rapport national sur la diversité biologique. Rapport élaboré par le gouvernement Congolais conformément à la décision II/17 de la seconde Conférence des Parties de la Convention sur la Diversité Biologique. Sous la coordination du Ministère de l'Industrie Minière et de l'Environnement. Brazzaville, Congo.

Anonyme, 2006. République Démocratique du Congo : Document de la Stratégie de Croissance et de Réduction de la Pauvreté.

Anonyme, 2007. Document de stratégie de réduction de la pauvreté. Comité national de lutte contre la pauvreté. 137pp. Brazzaville. République du Congo.

Anonyme, 2008. Rapport national d'investissement. Ebauche à soumettre au gouvernement du Gabon; in Conférence de haut niveau sur l'eau pour l'agriculture et l'énergie en Afrique: les défis du changement climatique. 10 pp

APDS, 2006. Résultat du dénombrement des villages de la Réserve Spéciale de Dzanga-Sangha.

Arnoldussen D., Binot A., Joiris D.V., Trefon T., Roulet P.A., Assenmaker P., 2008. Gouvernance et environnement en Afrique centrale : le modèle participatif en question. *MRAC, Tervuren*

Assembe Mvondo S., 2006. Forestry income management and poverty reduction: empirical findings from Kongo, Cameroon. *Development in Practice* 16(1):68-73

Atlas de la Guinée Equatoriale, 2001. Les Editions Jeune Afrique aux Editions du Jaguar, Paris. 64pp.

Aveling, unpublished data

Avissar R. and Werth D., 2005. Global hydroclimatological teleconnections resulting from tropical deforestation. *Journal of Hydrometeorology* 6(2): 134-145

Awono A., Ndoye O., Schreckenberg K., Tabuna H., Isseri F. and Temple L., 2002. Production and marketing of safou (*Dacryodes edulis*) in Cameroon and internationally: market development issues. Forests, Trees and Livelihoods 12: 125-147

Baker M., Clausen R., N'Goma M., Roule T. and Thomsaon J., 2003. Democratic Republic of Congo. Volume 3 of Conflict, timber dimensions of the problem in Asia and Africa. Report submitted to USAID, 7-115, ARD, Burlington, Vermont.

Banque Africaine de Développement, 2008. Indicateurs sur le genre, la pauvreté et l'environnement sur les pays africains.

Banque Mondiale, 2006. Etude socio-économique et environnementale du secteur forestier, République du Congo. Gestion de la Biodiversité. Banque Mondiale.

Banque Mondiale, 2006. http://web.worldbank.org/

Banque Mondiale, 2006. World development indicators. Worldbank.org

Banque Mondiale, 2008. Forêts tropicales du Cameroun: une décennie de réformes.

Bassouama A. G., Bongui A. S., Ibata S. R., Mahamadou M., 2006. Rapport d'inventaire faune et bois commercial dans la zone ETIC, périphérie sud-ouest du PN d'Odzala Kokoua, Rapport MEF Congo et WWF.

Batjes N. H., 2008. Mapping soil carbon stocks of Central Africa using SOTER. *Geoderma* 146:58-65

Bayol N., Cassagne B., Lafon C., Mugnier A., 2008. Estimation des stocks de carbone dans les peuplements forestiers du

Bassin du Congo. Rapport interne, Septembre 2008, Forêt Ressources Management (FRM), Mauguio / Grand-Montpellier, 13p.

Bayol N., Chabbert J., Jourget J., Martinez Plaza S., Yamba Yamba N., 2006-2008. Rapports d'étude socio-économique sur 7 garanties d'approvisionnement en RDC. FRM, groupe NST.

BCTF, 2006. Bushmeat Crisis Task Force. Economie de la Viande de Brousse. Fiche d'information. Online at : http://www.bushmeat.org January 20th,2009.

Belani J., 2006. Facilitation of access to the market for agricultural products of the MLW-Landscape. Report on the boat project. Report for USAID/CARPE. African Wildlife Foundation.

Belembo G., 2007. Monitoring of Large Mammal Populations and Human Activity in the Faunal Reserve of Lomako Yokokala. Report on the 2007 survey. Report for the Alexander Abraham Foundation. African Wildlife Foundation.

Belembo, 2008. In prep. Résultats préliminaires de recensement par recce dans la partie sud-est de la RFLY Septembre 2008. African Wildlife Foundation.

Bene-Bene C-L., 2004. Monitoring of the Illegal Killing of Elephants (MIKE), Inventaires en Afrique Centrale 2003-2004: site de Boumba Bek (Cameroun). Rapport Technique WWF-MIKE, 46 p.

Bennett E. L., Blencowe E., Brandon K., Brown D., Burn R. W., Cowlishaw G., Davies G., Dublin H., Fa J. E., Milner-Gulland E. J., Robinson J. G., Rowcliffe J. M., Underwood F. M. & Wilkie D. S., 2007. Hunting for consensus: Reconciling bushmeat harvest, conservation, and development policy in west and central Africa. *Conservation Biology,* 21, 884-887.

Beyers R., 2008. Natural and anthropogenic influences on elephants and other ungulates in the Congo forest. PhD Thesis. University of British Columbia, Canada. . https://circle.ubc.ca/handle/2429/960.

Bigombe Logo P (ed), 2004. *Le retournement de l'Etat forestier. L'endroit et l'envers des processus de gestion forestière au Cameroun*. Presses de l'UCAC, Yaoundé.

Bikoue M.A.C. and Essomba H., 2007. Gestion des ressources naturelles fournissant les produits forestiers non ligneux alimentaires en Afrique centrale. Produits forestiers non ligneux. Document de travail n° 5. World Agroforestry Centre / COMIFAC / FAO. 103p.

Binzangani Kamalandua, 2004. Impacts de la production des combustibles ligneux en RDC. Cas du Katanga, Kinshasa et Bas Congo. Actes des séminaires de formation et atelier de haut niveau en évaluation environnementale. Association Nationale pour l'Evaluation Environnementale (ANEE) pp 105-119. 17 pp.

Bird Life International, 2006. BirdLife International's review of the status of the African Grey Parrot and proposals to CITES for its conservation. 22nd meeting of the Animals Committee, 7-13 July 2006, Lima, Peru. Onlineat: http://www.birdlife.org/action/change/cites/grey_parrot_cites_2006.pdf May 12th , 2009.

Biringer J., Guariguata M.R., Locatelli B., Pfund J-L., Spanger-Siegfried E., Suarez A.G., Yeaman S. and Jarvis A., 2005. Biodiversity in a changing climate: a framework for assessing vulnerability and evaluating practical responses. In Carmenza Robledo, Markku Kanninen, Lucio Pedroni (eds). Tropical forests and adaptation to climate change: In search of synergies. CIFOR. Bogor. pp 122-153.

Blake S., 2006. Rapport final sur les inventaires d'éléphants et de grands singes du Parc National d'Odzala-Koukoua, Rapport WCS.

Blake S., 2005. Long Term System for Monitoring the Illegal Killing of Elephants (MIKE), Central African Forests: Final report on populations surveys (2003-2004). A report by the Wildlife Conservation Society produced for the CITES MIKE Programme.

Blake S., Strindberg S., Boudjan P., Makombo C., Inogwabini B.-I., Ilambu O., Grossmann F., Bene-Bene L., de Semboli B., Mbenzo V., S'Hwa D., Bayogo R., Williamson L., Fay M., Hart J., Maisels F., 2007. Forest elephant crisis in the Congo Basin. Plos Biology, 5:945-953.

Blake S., 2005. Forêts d'Afrique Centrale: Rapport final sur les relevés démographiques d'éléphants ,2003-2004, Wildlife Conservation Society, New York.

Blake S., 2005. Long Term System for Monitoring the Illegal Killing of Elephants (MIKE) - Central African Forests: Final Report on Population Surveys (2003-2004). WCS Report.

Blake S., 2006. Ces géants de l'ombre. EC/WCS/RAPAC. Gabon. 86 p

Blake S., Deem S., Strindberg S., Maisels F., Momont L., Inogwabini B.-I., Douglas Hamilton I., Karesh W. & Kock M. D.,2008. Roadless Wilderness Area Determines Forest Elephant Movements in the Congo Basin. *PLoS One,* 3, e3546. doi:3510.1371/journal.pone.0003546.

Blom A., 2000. The monetary impact of tourism on protected areas management and the local economy in Dzanga-Sangha (Central African Republic). *Journal of sustainable Tourism,* 8: 175-189.

Blom A., unpublished data

Bourlière F. and Verschuren J., 1960. Introduction à l'écologie des ongulés du Parc National Albert. Institut des Parcs Nationaux du Congo Belge. Exploration du Parc National Albert. Fasc. 1 and 2. Brussels, 158 pgs.

Bout N., 2006. Suivi écologique des grands mammifères et de l'impact humain. Rapport final. WCS/ JAF.

Brauman K. A., Daily G. C., Duarte T. K. and Mooney H. A., 2007. The nature and value of ecosystem services: an overview highlighting hydrologic services. *Annual Review of Environment and Resources* 32: 67-98.

Bravi C., Lescuyer G., 2004. Analyse financière et économique du Programme Sectoriel Forêts et Environnement du Cameroun. Rapport FRR & CIRAD, *Backwell Bristol*

Brinkman W.L.F., 1989. Hydrology. In *H. Lieth and M.J.A. Werger, eds*. Tropical Rain Forest Ecosystems: Biogeographical and Ecological Studies. Elsevier, Amsterdam. pp. 89-98.

Brown D., 1994. Freshwater Snails of Africa and their Medical Importance. Taylor & Francis, London, UK.

Brown S., 1997. Estimating biomass and biomass change of tropical forests: a primer. FAO forestry Paper 134, Rome,

55p. Online at http://www.fao.org/docrep/W4095E/W4095e00.htm April 27th, 2009.

Brown S., Gillespie A.J.R. & Lugo A.E., 1989. Biomass estimation methods for tropical forests with application to forest inventory data. *Forest Sciences* Vol. 15, No. 4 pp. 881-902

Brown S., Pearson T., Moore N., Parveen A., Ambagis S. & Shoch D., n.d. Impact of selective logging on the carbon stocks of tropical forests: Republic of Congo as a case study. Deliverable 6: Logging impacts on carbon stocks, Winrock International, Arlington, 21p. Online at http://carpe.umd.edu/resources/Documents/rpt_carbon_congo_3_2005_winrock.pdf April27th, 2009.

Bruijnzeel L.A., Critchley W.R.S., 1994. Environmental impacts of logging moist tropical forests. UNESCO, IHP Humid Tropics Programme Series n°7, Paris.

Bruijnzeel L. A., 2004. Hydrological functions of tropical forests: not seeing the soil for the trees? Agriculture, Ecosystems & Environment 104: 185-228.

Brummet R.E., 2005. Ornamental fishes: a sustainable livelihoods option for rainforest communities. *FAO Aquaculture Newsletter*, 33: 29-34. Online at: ftp://ftp.fao.org/docrep/fao/008/a0057e/A0057e12.pdf May 12th ,2009.

Brummett R.E. and Teugels G.G., 2004. Rainforest rivers of Central Africa: biogeography and sustainable exploitation. In: *R. Welcomme & T. Petr eds*, Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries, RAP 2004/16. Food & Agriculture Organization of the United Nations, Bangkok, Thailand.

Brummett R.E., Lazard J. and Moehl J., 2008. African aquaculture: Realizing the potential. *Food Policy*, 33, pp. 371-385.

Buij R., McShea W.J., Campbell P., Lee M.E., Dallmeier F., Guimondou S., Mackaga L., Guisseougou N., Mboumba S., Hines J.E., Nichols J.D., Alonso A., 2007. Patch-occupancy models indicate human activity as major determinant of forest elephant Loxodonta cyclotis seasonal distribution in an industrial corridor in Gabon. Biological Conservation 135(2): 189-201.

Bureau des Nations Unies pour la coordination des affaires humanitaires (OCHA) http://ochaonline.un.org/

Burgess, N. D., Hales, J. D., Ricketts, T. H. & Dinerstein, E. 2006. Factoring species,non-species values and threats into biodiversity prioritisation across the ecoregions of Africa and its islands. *Biological Conservation,* 127**,** 383-401.

Butcher T., 2008. Blood River: A Journey to Africa's Broken Heart, Vintage.

CARPE, 2005. The forests of the Congo Basin: A preliminary assessment. Central African Regional Program for the Environment (CARPE). 37pp

Cassagne B., Nasi R., 2007. Aménagement durable des forêts de production de la RDC : Progrès et perspectives, in « Quel avenir pour les forêts de la République Démocratique du Congo », Coopération Technique Belge, Bruxelles, 35 - 39.

Cayuela Serrano N., 2000. Guinée Equatoriale In Bahuchet S. et Maret P. (eds) Les peuples des forêts tropicales aujourd'hui. Vol III. Région Afrique Centrale. pp. 259-299.

CEMAC Facilité Energie, 2009. Electrification périurbaine intensive. Préparation au 3ème atelier régional de formation sur l'analyse prévisionnelle de la demande en électricité à l'horizon 2025 en milieu rural et périurbain. Douala (Cameroun) 1p.

Central Intelligence Agency, 2008. Factbook Cameroon. https://www.cia.gov/library/publications/the-world-factbook/geos/cm.htm February 4th, 2009.

Centre National de la Statistique et des Etudes Economiques, 2006. Service du Ministère du Plan de la République. http://www.cnsee.org/

Cerruti P.O et Tacconi L., 2006. Forests, illegality and livelihoods in Cameroon. Working paper 35. CIFOR. Bogor.

Cerutti P. O., Nasi R. and Tacconi L., 2008. "Sustainable forest management in Cameroon needs more than approved forest management plans." Ecology & Society 13(2): 36. http://www.ecologyandsociety.org/vol13/iss2/art36/ February 4th, 2009.

Chapman L.J. and Chapman C.A., 2003. Fishes of the African rain forests. In: T.L. Crisman, L.J. Chapman, C.A. Chapman & L.S. Kaufman, Conservation, Ecology and Management of African Fresh Waters. *University Press of Florida, Gainesville*.

Chave J., Condit R., Aguilar S., Hernandez A., Lao S. & Perez R., 2004. Error propagation and scaling for tropical forest biomass estimates. *Phil. Trans. R. Soc. Lond. B* 359, 409-420

Chave J., Andalo C., Brown S., Cairns M. A., Chambers J. Q., Eamus D., Fölster H., Fromard F., Higuchi N., Kira T., Lescure J.-P., Nelson B. W., Ogawa H., Puig H., Riéra B. & Yamakura T., 2005. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia* 145: 87–99

Chave J., Condit R., Muller-Landau H. C., Thomas S. C., Ashton P. S., Bunyavejchewin S., Co L. L. , Dattaraja H. S., Davies S. J., Esufali S., Ewango C. E. N., Feeley K. J., Foster R. B., Gunatilleke N., Gunatilleke S., Hall P., Hart T. B., Hernández C., Hubbell S. P., Itoh A., Kiratiprayoon S., LaFrankie J. V., Lao S., Makana J-R., Nur Supardi Noor Md., Kassim A. R., Cristián Samper , Sukumar R., Suresh H. S., Tan S., Thompson J. , Tongco Ma. D. C., Valencia R., Vallejo M., Villa G., Yamakura T., Zimmerman J. K., & Losos E. C., 2008. Assessing evidence for a pervasive alteration in tropical tree communities. *PloS Biol* 6(3):e45. Online at http://biology.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pbio.0060045 April 27th, 2009.

Chidumayo E.N., 1981. Woody biomass structure and utilisation for charcoal production in a Zambian miombo woodland-Bioresource Technology 37: 43-52

Chidumayo E.N., 1987. Woodland structure, destruction and conservation in the Copperbelt area of Zambia. *Biological Conservation* 40: 89-100.

Chidumayo E.N., 1990. Above-ground woody biomass structure and productivity in a Zambezian woodland. Forest Ecology and Management 36: 33-46.

Chidumayo E.N, 1993, Zambian charcoal production - miombo woodland recovery, Energy Policy 21:586-597

Chidumayo E.N., 2002. Changes in *miombo* woodland structure under different land tenure and use systems in central Zambia. *Journal of Biogeography* 29: 1619-1626

Christy P., Vande Weghe J. P., 1999. Les oiseaux d'Afrique Centrale: liste faunistique. ADIE, Libreville, Gabon

Christy P., Jaffré R., Ntougou O., and Wilks C., 2003. *La forêt et la filière bois au Gabon, pp398*. Gabon : *Multipress-Gabon*.

CIFOR, 2008. Statut de mise à jour des informations disponibles sur l'exploitation des PFNL dans le Bassin du Congo

Clark D. A., 2004. Sources or sinks? The responses of tropical forests to current and future climate and atmospheric composition. *Phil. Trans. R. Soc. Lond. B* 359, 477-491

Clark L.E. and Sunderland T.C.H. (Eds.), 2004. The Key Non-Timber Forest Products of Central Africa: State of the Knowledge. Technical Paper No. 122, USAID. Online at: http://pdf.dec.org/pdf_docs/PNADA851.pdf April 27th, 2009.

CNIAF, 2007. Communication personnelle avec la direction.

CNIAF, 2008. Communication personnelle avec la direction.

Commission Européenne, 2005 Etude « profil environnemental de la RDC » rapport provisoire de projet EURATA. 221 pp.

Commission Européenne, 2007 Intelligent energy. Coopener energy services for poverty alleviation in developing countries; 43 pp.

Communauté Economique et Monétaire de l'Afrique Centrale - CEMAC, 2008. Principaux indicateurs économiques, financiers et sociaux 1994-2008. 1p.

Congo Basin Forest Partnership, 2006. The Forests of the Congo Basin: State of the Forest 2006. Belgium: Congo Basin Forest Partnership, 2006. 257 p.

Conservation International ,2008 A Pilot Conservation Agreement for DRC : The Bonobo Conservation Concession Project. Conservation International & Bonobo Conservation Initiative, Washington

Corbera E., Brown K., Adger N., 2007 The equity and legitimacy of markets for ecosystem services. Development and Change 38(4):587-613

Costa M.H., Botta A. and Cardille J. A., 2003. Effects of large-scale changes in land cover on the discharge of the Tocantins River, southeastern Amazonia. *J Hydrol* 283: 206–17.

Cowlishaw G., Mendelson S. and Rowcliffe J.M., 2004. The Bushmeat Commodity Chain: patterns of trade and sustainability in a mature urban market in West Africa. ODI Wildlife Policy Briefing, n° 7 June 2004. 4 p. Online at :http://www.odi.org.uk/resources/specialist/wildlife-policy-briefings/7-bushmeat-commodity-chain-trade-sustainability-urban-market-west-africa.pdf May 12th ,2009.

Cumberlidge N., 1998. The African and Madagascan freshwater crabs in the Zoologische Staatssammlung, Munich (Crustacea: Decapoda: Brachyura: Potamoidea), *Spixiana*, 21(3): 193-214.

CUREF, 1998. Proyecto Conservacion y Utilizacion Racional de Los Ecosistemas Forestales de Guinea Ecuatorial (CUREF). Programa de Accion Forestal Nacional de Guinea Ecuatorial. (Projet pour la conservation et l'utilisation rationnelle des écosystèmes forestiers de Guinée Equatoriale. Programme d'action forestier national de Guinée Equatorial).

Cutrim E.M.C., Martin D.W., Butzow D.G., Silva I.M., Yulaeva E., 1999. Pilot Analysis of Hourly Rainfall in Central and Eastern Amazonia. *Journal of Climate 13: 326-1334*

Dallmeier F., Alonso A., Campbell P., Lee M.E., Buji R., Pauwels O.S.G., 2006. Ecological Indicators for the Industrial Corridor in the Gamba Complex of Protected Areas: a zone of High Biodiversity Value and Oil Exploitation in Southwest Gabon. Bulletin of the Biological Society of Washington. 12:243-252. 25, Jan 2006

de Merode E., 2006. Evolution des grands mammifère In Marc Languy & Emmanuel de Merode's (Eds) Virunga. Suivi du premier parc d'Afrique. (pp141 - 151.). *Edition Lannoo, Tielt Belgium,* 2006.

Debroux L.; Kaimowitz D.; Karsenty A. ; Topa G. ,2007. La forêt en RDC post conflit : Analyse d'un agenda prioritaire. Ed Cifor 77 pp.

Debroux L., Hart T., Kaimowitz D., Karsenty A., Topa G.Eds., 2007 Forest in post-conflict Democratic Republic of Congo: Analysis of a Priority Agenda. CIFOR, The World Bank and CIRAD.

Defo L., 2007. Synthèse des études socio-économiques dans l'UTO Sud-Est Cameroun, WWF, CCPO.

Desanker P.V., Frost P.G.H., Justice C.O., Scholes R. J.(eds.), 1997. The Miombo Network: Framework for a Terrestrial Transect Study of Land-Use and Land-Cover Change in the Miombo Ecosystems of Central Africa: Conclusions of the Miombo Network Workshop Zomba, Malawi, December 1995. IGBP Report 41, Stockholm, Sweden, 110p.

DFID , 2002. Food security and biodiversity. Biodiveristy Briefs n°6. DFID / IUCN.4p. Online at: http://www.undp.org/biodiversity/biodiversitycd/biodiv_brf_06.pdf May 12th, 2009.

Diaw C.M., 1997. Si, Nda Bot et Ayong : culture itinérante, occupation des sols et droits fonciers au Sud-Cameroun. Network paper 25C, Rural Development Forestry Network, Overseas Development Institute, London

Direction Générale de l'Environnement du Gabon, 2005. Communication nationale sur les changements climatiques. 144 pp.

Djiré A., 2003. Le secteur informel du bois d'œuvre. Rapport d'appui à la revue du secteur forestier en RDC. Rapport technique, CIRAD.

Doumenge C., Yuste J-E.G., Gartlan S., Langrand O. et Ndinga A., 2001. Conservation de la biodiversité forestière en Afrique Centrale atlantique : Le réseau d'aires protégées est-il adéquat ? Bois et Forêts des Tropiques. No 268 (2), 5-27

Drigo R.,2001. Projet GCP/RAF/354/EC - Programme de partenariat CE- FAO (2000 - 2002) Informations sur l'énergie ligneuse en Afrique. Examen des rapports CTPD par pays et comparaison avec l'étude régionale réalisée par le WETT. Composante de planification de l'énergie ligneuse et du développement 68 pp.

Dudley N. and Stolton S., 2003. Running pure: the importance of forest protected areas to drinking water. World Bank/WWF, Alliance for Forest Conservation and Sustainable Us*e*. 216

Duke J.A., 1993. Medicinal plants and the pharmaceutical industry. In: J. Janick and J.E. Simon (eds.), New crops. New Crops Proceedings of the Second National Symposium. New Crops Exploration, Research, and Commercialization. Wiley, New York. pp. 664-669. Online at: http://www.hort.purdue.edu/newcrop/proceedings1993/V2-664.html April27th, 2009.

Dupuy B., 1998. *Bases pour une sylviculture en forêt dense tropicale humide africaine*. FORAFRI Document no 4, CIFOR-CIRAD Ministère de la Coopération, Libreville, 328p.

Duveiller G., Defourny P., Desclée B., Mayaux P., 2008. Deforestation in Central Africa: Estimates at regional, national and landscape levels by advanced processing of systematically-distributed Landsat extracts. Remote Sensing of Environment, 112 (5), pp. 1969-1981.

Eba'a Atyi, R. 2006.Forest certification in Gabon in Cashore B, Gale F., Meidinger E. and Newson D.(eds) Conforting Sustainability:Forest Certification in Developing and Transitioning Countries, Yale F&ES Publication Series, Report Number 8,pp:443-476

EC., 2008. Consultation Process on Monitoring of International Trade in Ornamental Fish Background Information. Prepared for the EC by UNEP and WCMC. 40p. Online at: http://www.unep-wcmc.org/species/reports/Consultation%20Paper%20-%20Final.doc.doc April27th, 2009.

Economist Intelligence Unit, 2008. Country Report Cameroon, Economist Intelligence Unit, London

Ela Nsue Carmelo, 1998. Estudio Sobre la Historia de la Explotacion Forestal en Guinea Ecuatorial. *Proyecto CUREF*. 43 pp.

Endean F., 1968. The productivity of miombo woodland in Zambia. Forest Research Bulletin 14, Government Printer, Lusaka.

Fa J. E., Curie D. et Meeuwig J., 2003. Bushmeat and food security in the Congo Basin: linkages between wildlife and people's future. Environmental Conservation 30: 71 -78.

FAO, 2001a. Non-wood Forest Products in Africa: A Regional and National Overview. Online at: http://www.fao.org/docrep/003/y1515b/y1515b18.htm April27th, 2009.

FAO, 2001b. Forest Ressource Assesment 2000. http://www.fao.org/forestry/fra2000report/en/

FAO, 2005. Forest Ressource Assesment 2005. http://www.fao.org/forestry/fra2005/en/

FAO, 2007a. Plan of Action of the African Pollinator Initiative. FAO, Rome. 37p.Online at: http://www.fao.org/docrep/010/a1490e/a1490e00.htm April27th, 2009.

FAO, 2007b. Forests and energy in developing countries. Forests and energy working paper n°2; 32 pp.

FAO, 2007c. Forest Resources Assessment. State of the world Forests.

FAO, 2007d. Département des Forêts, Project GCP/RAF/398/GER Gestions des ressources naturelles fournissant les Produits Forestiers non Ligneux Alimentaires en Afrique Centrale, Document de Travail

FAO, 2007e. Situation des forêts du monde 2007. Annexe, Tableau 2. FAO Rome.

FAO, COMIFAC, 2007. Etude sur le cadre législatif et réglementaire régissant l'utilisation des Produits Forestiers Non Ligneux (PFNL) en Guinée Equatoriale. 23pp.

FAO, 2008. Stratégie de développement et Plan d'Action pour la promotion de la foresterie urbaine et périurbaine de la ville de Bangui. Projet TCP/CAF/3003. Proposition de stratégie. 54 pp.

Feldpausch T. R., McDonald A. J., Passos C. A.M., Lehmann J. & Riha S. J., 2006. Biomass, harvestable area, and forest structure estimated from commercial timber inventories and remotely sensed imagery in southern Amazonia. *For. Ecol. Manag.* 233:121–132

Ferraro PJ, 2002. The local costs of establishing protected areas in low-income nations: Ranomafana National Park, Madagascar. *Ecological Economics* 43:261-275

Ferraro P.J., Kiss A., 2002. Direct Payments to Conserve Biodiversity. *Science* 298:1718-19

Fogue I. and Defo L., 2006. Environnement socio-économique du Secteur Gribé Ngatto Nouveau,Yokadouma, WWF Jengi Technical report, (65p)

Fogue I. and Defo L., 2007. Le milieu socio-économique des localités Mboy II-Mang (Arrondissement de Yokadouma, Sud-Est Cameroun). Rapport Technique WWF CCPO. 52 p.

Foley J. A, Asner G. P., Costa M. H., Coe M. T., DeFries R., Gibbs H. K., Howard E. A., Olson S., Patz J., Ramankutty N. and Snyder P., 2007. Frontiers in Ecology and the Environment 5(1):25-32.

FORAF , 2008. Fiches de collecte des données sur les indicateurs de suivi de l'état des forêts d'Afrique central, niveau national. Cameroun, Congo, RDC, RCA, Gabon, Guinée Equatoriale. Projet FORAF, Kinshasa, RDC.

Freson R., Goffinet G. and Malaisse F., 1974. Ecological effects of the regressive succession in muhulu-miombo-savanna in Upper Shaba, Zaire. *In*: Proceedings of the first international congress of ecology. Structure, functioning and management of ecosystems, The Hague, September 1974, 365-371. PUDOC, Wageningen, Netherlands.

Frost P., 1996. The ecology of miombo woodlands. In: Campbell, B., ed., The Miombo in Transition: Woodlands and Welfare in Africa, pp 11-57. CIFOR, Bogor.

Gaston G., Brown S., Lorenzini M.& Singh K. D., 1998. State and change in carbon pools in the forests of tropical Africa. Global Change Biology 4:97-114.

Geschiere P., 1982. Village communities and the State. Changing relations among the Maka of South-eastern Cameroon since the colonial conquest. *Kegan Paul International, London*

Gibbs H.K. and Brown S., 2007. Geographical Distribution of Woody Biomass Carbon in Tropical Africa: An Updated Database for 2000, NDP-055b. Carbon Dioxide Information Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee. Online at http://cdiac.ornl.gov/epubs/ndp/ndp055/ndp055b.html April 28th, 2009.

Gibbs H. K., Brown S., Niles J. O & Foley J., 2007. Monitoring and estimating tropical forest carbon stocks: making REDD a reality. *Environ. Res. Lett.* 2 (2007) 045023 (13pp). Online

at http://www.iop.org/EJ/article/1748-9326/2/4/045023/erl7_4_045023.pdf?request-id=9894233d-c07d-46c3-9ff0-943d59e2ef7a January 8th, 2009.

Ghogue R. and Nzooh Dongmo Z-L., 2006. Forêt, Faune et Hommes: Les grands mammifères et les activités anthropiques dans l'UFA 10-023 ; Données de base pour l'aménagement durable de cette concession forestière. Rapport WWF CCPO - SFCS/TTS. 66 p + annexes.

Ghogue R., Nzooh Dongmo .Z-L., 2007. Les grands et moyens mammifères dans la ZICGC 2 : Abondance et Pressions. Rapport Technique WWF & GTZ, 59p.

Global Insight, 2007. Significant Debt Relief Triggers Global Insight's Revision of Cameroon's Sovereign Risk Rating, www.globalinsight.com February 4th, 2009.

Graf D. L. and Cummings K. S., 2006. Freshwater mussels (Mollusca: Bivalvia: Unionoida) of Angola, with description of a new species, Mutela wistarmorrisi. Proceedings of the Academy of Natural Sciences Philadelphia 155: 163-194.

Gray M., McNeilage A., Fawcett K., Robbins M. M., Ssebide B., Mbula D. and Uwingeli P., 2005. Virunga Volcano Range Mountain Gorilla Census 2003. Unpublished report to UWA/ORPTN/ICCN.

Grieg-Gran M., Porras I., Wunder S., 2005. How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America. *World Development* 33(9):1511-1527

GOFC-GOLD, 2008. Reducing greenhouse gas emissions from deforestation and degradation in developing countries: a sourcebook of methods and procedures for monitoring, measuring and reporting. GOFC-GOLD Report version COP13-2, (GOFC-GOLD Project Office, Natural Resources Canada, Alberta, Canada). Online at http://www.gofc-gold.uni-jena.de/redd/index.php May 12th, 2009.

Gourlet-Fleury S., Favrichon V., Schmitt L., Petronelli P., 2004. Consequences of silvicultural treatments on stand dynamics at Paracou. In: S. Gourlet-Fleury, J.-M. Guehl and O. Laroussinie (Eds). Ecology and Management of a Neotropical Rainforest. Lessons drawn from Paracou, a long-term experimental research site in French Guiana. Elsevier, Paris, pp.254-280.

Groombridge B. and Jenkins M., 1998. Freshwater biodiversity: a preliminary global assessment. World Conservation Monitoring Centre, Cambridge, UK.

Grossmann F., Hart J.A., Vosper A., Ilambu O., 2008. Range Occupation and Population Estimates of Bonobos in the Salonga National Park: Application to Large-scale Surveys of Bonobos in the Democratic Republic of Congo. In: Furichi, T and Thompson, J (eds) The Bonobos: Behavior, Ecology and Conservation. Pp 189-216. Springer, New York.

GTZ-MINFOF, 2006. Suivi de l'impact de la gestion forestière au Cameroun, situation de référence. Programme Sectoriel Forêt Environnement du Cameroun (PSFE). Programme de Gestion Durable des Ressources Naturelles (PGDRN). GTZ. Yaoundé, Cameroun.

Guedje N.M. and Fankap R., 2001. Utilisations traditionnelles de Garcinia lucida et Garcinia kola (Clusiaceae) au Cameroun Systematics and Geography of Plants, Vol. 71, No. 2, Plant Systematics and Phytogeography for the Understanding of African Biodiversity (2001), pp 747-758

Guy P.R., 1981. Changes in the biomass and productivity of woodlands in the Sengwa Wildlife Research Area, Zimbabwe. *Journal of Applied Ecology* 18: 507-519.

Hackel J.D., 1999. Community conservation and the future of Africa's wildlife. Conservation Biology 13(4):726-734

Hamilton K., Sjardin M., Marcello T., Xu G., 2008. State of the voluntary carbon markets. Katumba Group's Ecosystem Marketplace, Forest Trends, Washington D.C.

Hansen M.C., Roy D.P., Lindquist E., Adusei B., Justice C.O. and Altstatt A., 2008a. A method for integrating MODIS and Landsat data for systematic monitoring of forest cover and change in the Congo Basin. *Remote Sensing of Environment*, 112, pp. 2495-2513.

Hansen M.C., Stehman S.V., Potapov P.V., Loveland T.R., Townshend J.R.G., DeFries R.S., Pittman K.W., Arunarwati B., Stolle F., Steininger M.K., Carroll M., DiMiceli C., 2008b. Humid tropical forest clearing from 2000 to 2005 quantified by using multitemporal and multiresolution remotely sensed data. *PNAS*, 105 (27), pp. 9439-9444.

Harmand J.M., Bale P., 2007. La jachère agroforestière arborée ou arbustive en Afrique tropicale

Hart J., Beyers R., Grossmann F., Carbo M., Dino S., Kahindo F., 2008. La Réserve de Faune à Okapis- distribution et fréquence de la grande faune et des activités humaines: une évaluation de l'impact de 10 ans de conflit : 1996 - 2006, Final report. Wildlife Conservation Society.

Hart J.A., Grossmann F., Vosper A., Ilanga J., 2008. Human Hunting and its Impact on Bonobos in the Salonga National Park, Democratic Republic of Congo. In: Furichi, T and Thompson, J (eds) The Bonobos: Behavior, Ecology and Conservation. Pp 245-271. Springer, New York.

Hathaway T. and Durrell H., 2005. Drought Could Cripple Cameroon's Hydro-Heavy Energy Sector. Available online at: http://www.internationalrivers.org/en/africa/drought-could-cripple-cameroon%E2%80%99s-hydro%E2%80%93heavy-energy-sector (accessed January 5th, 2009).

Hoare A.L., 2007a. The use of non timber forest products in the Congo basin: Constraints and Opportunities. Rainforest Foundation. UK. 55 p. Online at: http://www.rainforestfoundationuk.org/Publications - May 12th, 2009.

Hoare A.L., 2007b. Clouds on the Horizon: The Congo Basin's Forests and Climate Change. Rainforest Foundation. UK. 27 p. Online at: http://www.rainforestfoundationuk.org/Publications May 12th, 2009.

Hooper D. U., Chapin F.S, Ewel J.J., Hector A., Inchausti P., Avorel S , Lawton J.H., Lodge D.M., Loreau M., Naeem S., Schmid B., Setala H., Symstad A.J., Vandermeer J. and Wardle A., 2005. Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. *Ecological Monographs*, 75/1: 3-35.

Horgan G.P., 2002. l'économie du bois énergie. Unasylva 211, vol 53, pp 23-27

Houghton R.A., 2005. Tropical deforestation as a source of greenhouse gas emissions. In: P. Moutinho and S. Schwartzman (Eds.) Tropical Deforestation and Climate Change. pp.13-21. Instituto de Pesquisa Ambiental da Amazônia, *Belém, Pará, Brazil*.

Huijbregts B., De Wachter P., Ndong Obiang S., Ella Akou M., 2003. Ebola and the decline of gorilla Gorilla gorilla and chimpanzee Pan troglodytes populations in Minkébé Forest, north-eastern Gabon. Oryx 37:437-443.

Huttel C. & Berhnard-Reversat F., 1975. Biomasse végétale et productivité primaire, cycle de la matière organique. Recherches sur les écosystèmes de la forêt subéquatoriale de basse Côte d'Ivoire. La Terre et la Vie, 29 : 203-228.

Ibrahima A., Schmidt P., Ketner P. & Mohren G. J. M., 2002. Phytomasse et cycle des nutriments dans la forêt tropicale dense humide du sud Cameroun. The Tropenbos-Cameroon Programme, Kribi, Cameroon. Tropenbos-Cameroon Documents 9, XVI + 81 pp.; 9 fig.; 40 tab.; 233 ref.; 2 Ann.

ICCN et WWF-RDC, 2008. Rapport de la réunion d'actualisation du réseau d'aires protégées et de présentation du draft de la carte de la République Démocratique du Congo. WWF-RDC. Kinshasa

ICCN, 2008. Rapport annuel 2007. ICCN. Kinshasa

IMF, 2008. Republic of Equatorial Guinea: Statistical Appendix. 43 pp. International Monetary Fund. Washington, DC. USA.

Inkamba-Nkulu C., Diahouakou R., 2005. Sondage écologique des mammifères dans la mosaïque foret-savane des plateaux Batéké dans les districts de Lékana, Zanaga et Bambama. WCS-Congo.

Inkamba- Nkulu C., Tsoumou R., 2008. Reconnaissance des éléphants des forets (Loxodonta africana cyclotis, Matschie, 1900) autour des sources de la rivière Nambouli, Reserve de la Léfini. WCS Congo.

Inogwabini B.-I., 2005. Fishes of the Salonga National Park, Democratic Republic of Congo: survey and conservation issues. *Oryx*, 39, pp. 78-81.

Inogwabini B.-I., Sandokan B.M. and Ndunda M., 2006. A dramatic decline in rainfall regime in the Congo Basin: Evidence from a thirty-four year data set from the Mabali Scientific Research Centre, Democratic Republic of Congo, 2006. *International Journal of Meteorology,* 31 (312), pp. 278-285.

Inogwabini B.-I., Matungila B., Mbende L., Abokome M., wa Tshimanga T., 2007. Great apes in the Lake Tumba Landscape, Democratic Republic of Congo: Newly described populations. Oryx, 41(4): 532 – 538.

INS., 2006. Annuaire statistique du Cameroun. Yaoundé, Cameroun, Institute Nationale des Statistiques

Institut National des Statistiques (INS). 2002. Deuxième enquête camerounaise auprès des ménages, pauvreté et santé au Cameroun en 2001. INS. Yaoundé, Cameroun.

IPCC, 2006. *IPCC* Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html April 28th, 2009.

ITTO, 2008. Tropical Timber Market Report 16-30 September 2008

Iyenguet F.C., Malanda G-A.F., Madzoké B., Twagirashyaka F., 2008. Recensement et distribution des grands mammifères et activités humaines dans la zone Impfondo. Wildlife Conservation Society, Brazzaville, République du Congo.

Iyenguet F.C., Mowawa B., Kiminou F., Malanda G-A.F., Madzoké B., Stokes E., Rainey H., 2006. Rapport final de la zone Bailly / Bodinga / Toukoulaka. Wildlife Conservation Society, Brazzaville, République du Congo.

Jackson R.B., Jobbagy E.G., Avissar R., Roy S.B., Barrett D.J., Cook C.W., Farley K.A., le Maitre D.C., McCarl B.A. and Murray B.C., 2005. Trading Water for Carbon with Biological Carbon Sequestration 10.1126/science.1119282. *Science*, 310, pp. 1944-1947.

Jacobs M., 2001. The tropical rain forest. A first encounter. Springer-Verlag.

Jaffré T., de Namur C., Fritsch E., Monteny B. A., Barbier J-M., Omont C., 1983. Contribution à l'étude de l'influence de la déforestation en zone équatoriale sur l'évolution de la concentration en gaz carbonique de l'atmosphère. Rapport interne ORSTOM Centre d'Adiopodoumé, 76p.

Janzen, D. H., Martin, P. S. 1982. Neotropical Anachronisms: The Fruits the Gomphotheres Ate. *Science,* 215**,** 19-27.

Kalkman V., Clausnitzer V., Klaas-Douwe B., Dijkstra A. G., Orr D. R. and Paulson J. V. T., 2008. Global diversity of dragonflies (Odonata) in freshwater. *Hydrobiologia* 595: 351-363.

Kamdem-Toham A., D'Amico J., Olson D., Blom A., Trowbridge L., Burgess N., Thieme M., Abell R., Carroll R. W., Gartlan S., Langrand O., Mikala Mussavu R., O'Hara D. and Strand H., 2003. Biological priorities for conservation in the Guinean-Congolian forest and freshwater region: Report of the Guinean-Congolian forest and freshwater region workshop, Libreville, Gabon, March 30-April 2, 2000. WWF, Libreville, Gabon.

Kamis A., 2006. Recensement de la population des villages de la Reserve Speciale de Dzanga-Sangha. Rapport PDS, 26 p.

Kanmegne J., 2004. Slash and Burn Agriculture in the Humid Forest Zone of Southern Cameroon: Soil Quality Dynamics, Improved Fallow Management and Farmers' Perceptions. PhD thesis Wageningen University and Research Centre, The Netherlands, 184p.

Karesh WB. R., Cook A., Bennett E.L. and Newcomb J., 2005. *Emerg. Infect. Dis.* 11(7):1000-2.

Karsenty A., 2007. Overview of industrial forest *concessions and* concession-based industry*:* Contributions to social *and* economic development *in* Central and West Africa. Rights and Resources Initiative & CIRAD, Montpellier

Karsenty A., 2008. Des communautés locales problématiques In : Méral P, Castellanet C, Lapeyre R (eds) La gestion concertée des ressources naturelles : l'épreuve du temps. Karthala, Paris

Karsenty A., Weber J., 2004. Les marchés de droits pour la gestion de l'environnement. Introduction générale. *Revue Tiers-Monde* 177:7-28

Kasulu V., Hamel O., 2008. Boisements privés sur les plateaux Batéké et terres dégradées du bas Congo pour l'approvisionnement en bois énergie de l'agglomération de Kinshasa. Projet de PIN (Project Idea Note) 19 pp.

Keay R.W.J., 1959. Derived savanna - derived from what? Bull. Inst. Fondam. Afrique Noire, Ser. A, Sci. Nat. 21: 427-438

Kettunen M. and Brink P. ten., 2006. Value of Biodiversity. Documenting EU examples where biodiversity loss has led to the loss of ecosystem services. ENV.G.1/FRA/2004/0081. Institute for European Environmental Policy. Online at: http://conservationfinance.net/Documents/CF_related_papers/Value_of_biodiversity-June_06.pdf. May 12th, 2009.

Kibambe J-P., 2007. Modélisation spatiale multisectorielle des dynamiques territoriales: étude de cas à l'échelle régionale en RDC, DEA, Université catholique de Louvain.

Kingdon J., 1997. The Kingdon Field Guide to African Mammals. Academic Press, UK. 464 p.

Kominou F. A., Malonga R., Moukala G., Nganga I., 2007. Rapport d'inventaire des grands mammifères et des activités humaines dans l'ufa Ngombe (Nord-Congo).

Kuehl H.S., Nzeingui C., Le Duc Yeno S., Huijbregts B., Boesch C., Walsh P.D., submitted. Biological Conservation.

Kuehl H.S., Todd A., Boesch C., Walsh P.D., 2007. Manipulating decay time for efficient large-mammal density estimation: gorillas and dung height. Ecological Applications. 17(8):2403-2414.

Kujirakwinja D., Plumptre A., Moyer D. & Mushenzi N., 2006. Parc National de Virunga. Recensement aérien des grands mammifères*, 2006*. Unpublished report to IUCN, Kinshasa.

Kujirakwinja D., Itegwa B. and Plumptre A., 2008. *Rapport du ranger based monitoring N°4 RBM/LEM 2007.* Unpublished report to ICCN, SYGIAP and WCS.

Ladel J., Nguinda P., Pandi A., Tanania Kabobo C., Tondo B-L., Sambo G., Tellro-Wai N., Buluku Ekwkwa A. and Hoepffner M., 2008. Integrated Water Resources Management in the Congo Basin based on the development of Earth Observation monitoring systems in the framework of the AMESD Programme in Central Africa. (Montpellier, France: 13th World Water Congress).

Lal R., 2005. Soil Carbon Sequestration in Natural and Managed Tropical Forest Ecosystems. *Journal of Sustainable Forestry* Vol. 21, No. 1, 2005, pp. 1-30

Landell-Mills N., Porras IT., 2002 Silver bullet or fool's gold? A global review of markets for forest environmental services and their impacts on the poor. IIED, London.

Languy M. and Demerode E., (eds), 2006. Virunga; survie du premier parc d'Afrique. Lanoo Publishers, Tielt, Belgique. 352 p.

Latour S., 2004. Exploitation forestière sélective et conservation de la faune sauvage en Afrique centrale: Le cas de la région d'Ivindo au Gabon. DEA Environnement, Université de Paris VII, Paris

Le Roy E., Karsenty A., Bertrand A., 1996. La sécurisation foncière en Afrique. Pour une gestion viable des ressources renouvelables. Karthala, Paris

Lescuyer G., 2000. Evaluation économique et gestion viable de la forêt tropicale. Réflexion sur un mode de coordination des usages d'une forêt de l'est-Cameroun. Thèse en socio-économie, Ecole des Hautes Etudes en Sciences Sociales, Paris

Lescuyer G., 2006. Formes d'action collective pour la gestion locale de la forêt camerounaise: organisations "modernes" ou institutions "traditionnelles"? *VertigO* 6(3).

Lescuyer G. ,2006. L'évaluation économique du Parc National de l'Ivindo au Gabon : une estimation des bénéfices attendus de la conservation de la nature en Afrique centrale. Rapport final, CIRAD Forêt, UPR36. Montpellier. 56 p.

Lescuyer G., 2008. Quel usage des massifs forestiers dans la Réserve Spéciale de Forêt Dense de Dzanga-Sangha ? Une analyse prospective des impacts financiers. Satya Development International, Washington D.C.

Lévêque C., 1997. Biodiversity dynamics and conservation: The freshwater fish of tropical Africa. Cambridge University Press, Cambridge, UK.

Lévêque C., Balian E. V. and Martens K., 2005. An assessment of animal species diversity in continental waters. Hydrobiologia 542: 39-67.

Lewis S. O., Phillips L., Baker T. R., Malhi Y. & Lloyd J., 2005. Tropical forests and atmospheric carbon dioxide: current knowledge and future scenarios. Communication presented to the conference "Avoiding dangerous climate change", 1-2/02/2005, Met Office, Exeter, Devon. Online at http://www.stabilisation2005.com/day1/lewis.pdf April 28th,2009.

Likondo C., Mboka D., Mwanza N., 2004. Abondance et distribution de la faune et des activités humaines dans le Landscape Maringa Lopori Wamba. Rapport de collecte des données de base. Report for USAID/CARPE. African Wildlife Foundation.

Likondo C., Mwanza N., Furuichi T., 2007. Rapport d'études de faisabilité d'extension de la réserve scientifique de Luo dans le bloc forestier du groupement d'Iyondje, secteur de Luo, territoire de Djolu, district de la Tshuapa. Report for USAID/CARPE. African Wildlife Foundation.

Likondo C., 2007. Development of the management plan for the controlled hunting zone of Djolu, DRC. Final Report for the US Fish and Wildlife Service. African Wildlife Foundation.

Likondo C., Bekoma A., 2008. Initial Scoping Report. Report for USAID/CARPE. AWF-PERSE.

Lindquist E., Hansen M.C., Roy D.P., Justice C.O., 2008. The suitability of decadal image data sets for mapping tropical forest cover change in the Democratic Republic of Congo: implications for the mid-decadal global land survey, *International Journal of Remote Sensing, 29(24)*, 7269-7275.

Locatelli B. and Karsenty A., 2004. Tropical forest dynamics and climate change. In: D. Babin (Ed.) Beyond tropical deforestation: from tropical deforestation to forest cover dynamics and forest development. UNESCO. Paris. pp.97-120

Losch B., Fusillier J. L., Dupraz P.O.and Ndjoya J., 1991. Stratégies des producteurs en zone caféière et cacaoyère du Cameroun: quelles adaptations à la crise? Collection DSA No 12. DSA-CIRAD. Montpellier. 252 pp.

Lumbwe B., 2001. Contribution de l'exploitation artisanale à la survie du secteur bois en RDC. Thèse. Université de Kinshasa. RDC. 69p.

Lundberg J. G., Kottelat M., Smith G. R., Stiassny M. L. J. and Gill A. C., 2000. So many fishes, so little time: an overview of recent ichthyological discovery in continental waters. Annals of the Missouri Botanical Garden 87: 26-62.

Lusenge T. and Masudi B., 2008. Rapport de l'atelier sur la protection des Okapis dans et autour du Parc National de Virunga. Unpublished report to ICCN, European Union and ZSL.

Madidi J., Dino S., Masanga A., Makana J.R., 2007. Évaluation de l'état de la faune, de la flore et des activités humaines dans la concession forestière de l'ENRA, Paysage de l'Ituri-Aru, nord-est du Bassin du Congo. Final report. Wildlife Conservation Society.

Madzou Y. C., 2006a. Reconnaissance écologique le long du Dja et dans l'UFA Souanké, Rapport WWF.

Madzou Y. C., 2006b. Reconnaissance écologique dans la Forêt de Madjingo - Mts Letioukbala (Districts de Sembe Souanké), Rapport WWF

Maho JP., 2007. Densité, abondance et distribution spatio-temporelle de quelques grands et moyens mammifères diurnes dans la ZICGC n° 9. Rapport Technique WWF & GTZ, 56p.

Maisels F., 2005. Ivindo National Park, Gabon: large mammal & human impact; first results of the transects. WCS Gabon.

Maisels F., Aba'a R., Abitsi G., Bechem M., Bout N., Kuehl H., Latour S., Walsh P. & Ella Akou M., 2006. Gabon's National Park system: baseline wildlife and human impact surveys. In *Society for Conservation Biology*, Annual Conference. San Jose, California, USA

Maisels F., Bechem M., Mihindou Y., 2006. Lopé National Park, Gabon. Large mammals and human impact. Monitoring program 2004-2005. Report to WCS ; 14 pp.

Makana J-R., unpublished data – communicated in June 2008.

Mala W., 2008. Statut de mise à jour des informations disponibles sur l'exploitation des PFNL dans le bassin du Congo. Unpublished report. 54 p.

Malaisse F.P, Freson R., Goffinet G. and Malaisse-Mousset M., 1975. Litter fall and litter breakage in miombo. *In:* Golley, F.B. and Medina, E. (eds) *Tropical ecological systems: trends in terrestrial and aquatic research*, 137-152. Springer-Verlag, New York.

Malanda G-A.F., Iyenguet F.C., Madzoké B., Dos Santos D., Rainey H., Stokes E., 2006. Rapport final de la Réserve Communautaire du Lac Télé. Wildlife Conservation Society, Brazzaville, République du Congo.

Malanda G.-A.F., Iyenguet F.C., Madzoké B., 2007. Recensement des grands mammifères à l'est de la Batanga. Wildlife Conservation Society, Brazzaville, République du Congo.

Mallet B., Marien J.N., 2005. Nouvelles perspectives pour les plantations forestières en Afrique centrale. Bois et Forêts des Tropiques Vol. 58/282, pp. 67-79.

Mallet B., Marien J.N., 2008. Forêts et changements climatiques: Quelles perspectives pour le bois énergie en Afrique ? Présentation à la conférence forêt, bioénergie et changements climatiques IUFRO / SylvaWorld - Casablanca (Maroc) 28 pp.

Malimbwi R.E., Solberg B. and Luoga E., 1994. Estimation of biomass and volume in miombo woodland at Kitulangalo Forest reserve, Tanzania. *Journal of Tropical Forest Science* 7: 230-242.

Malonga R., Kominou F. A., Moukala G., Nganga I., 2007. Rapport d'inventaire des grands mammifères et des activités humaines dans l'UFA Pikounda (Nord-Congo).

Malonga R. and Elende A.G., 2008. Suivi du commerce de la viande de brousse sur le marche de la ville de Ouesso, Departement de la Sangha. Rapport technique, WCS Congo, 32p.

Mamonekene V., 1998. Analyse de la diversité biologique des écosystèmes des eaux intérieures. Stratégie Nationale et Plan d'Action en Matière de Diversité Biologique. Projet (SNPA-DB) PRC/97/G32/B/1G/99, Thème 9, 28 p.

Maniatis D.S.M., 2007. Ecosystem services of the Congo Basin forests. Report for the Global Canopy Programme, Environmental Change Institute, Oxford University. 24 p.

Marien J.N., Bertrand A., du Toit B., Gazull L., Idowu M., Kassambara A., Mallet B., Montagne P., Nkoua M., Ramamonjisoa B. and Swart J., 2008. Foresterie urbaine et périurbaine en Afrique: Quelles perspectives pour le bois énergie ? rapport régional FAO, sous presse. 92pp

Martin R.B., 1974. Structure, biomass and utilization of vegetation in the mopane and miombo woodlands of the Sengwa Wildlife Research Area. Certificate in Field Ecology thesis, University of Rhodesia, Salisbury.

Mathot L., Ikoli F., Missilou B.R., 2006. Rapport annuel de monitoring de la faune du Projet Lésio-Louna, 2006. MEF/ JAF.

Max Planck / WWF, undated. Published data.

Mayaux P., Bartholomé E., Massart M., Van Cutsem C., Cabral A., Nonguierma A., Diallo O., Pretorius C., Thompson M., Cherlet M. et al., 2003. A Land Cover Map of Africa, Joint Research Centre, EUR 20665 EN (European Commission, Luxembourg).

Mayaux P., Bartholome E., Fritz S. & Belward A., 2004. A new land-cover map of Africa for the year 2000. *Journal of Biogeography, 33 (6), 861-877.*

Mbolo M., 2006. Les perspectives de la certification des produits forestiers non ligneux en Afrique centrale. Programme des produits forestiers non ligneux. FAO. 29 p.

McShane T.O., Wells M.P.(eds), 2004. Getting biodiversity projects to work: towards better conservation and development. Columbia University Press, New York.

MECNT, 2008. Conférence de presse de Monsieur le Ministre sur les travaux de la Commission interministérielle de conversion des anciens titres forestiers en contrats de concession forestière. 06 octobre 2008, Hôtel Venus. Kinshasa.

MECNT-FORAF, 2008. Fiche de collecte des données pour le suivi de l'état des forêts d'Afrique Centrale. Niveau national RDC. Projet FORAF, Kinshasha.

MEFEPPN, 2007. Note de conjoncture de la cellule économique. Ministère de l'Economie Forestière, des Eaux, de la Pêche et des Parcs Nationaux (MEFPPN). Libreville Gabon.

MEFEPPN-FORAF, 2008. Fiche de collecte des données pour le suivi de l'état des forêts d'Afrique Centrale. Niveau national Gabon. MEFEPPN, Libreville. Projet FORAF, Kinshasha.

MEF-FORAF, 2008. Fiche de collecte des données pour le suivi de l'état des forêts d'Afrique centrale. Niveau national République du Congo. Ministère de l'Economie Forestière (MEF), Brazzaville, Projet FORAF, Kinshasa.

MEF-IFO-FRM, 2007. Plan d'aménagement de l'UFA Ngombé. Ministère de l'Economie Forestière. Forêt Ressources Management. Brazzaville Rep. du Congo. 459pp + annexes

Mendomo Biang J-D., Nzooh Dongmo Z-L., 2007. Evaluation des potentialités fauniques dans les ZIC GC 01 & 08, relevé des pistes et formation des membres du COVAREF 1 aux méthodes simples de suivi de la faune dans leur ZICGC : Rapport Faune ZICGC 1. Rapport Technique WWF & GTZ, 48p-55p.

Mengamenya Goue A., Nzooh Dongmo Z-L., 2007. Caractérisation de la grande et moyenne faune mammalienne dans la ZICGC n° 3: Potentiel et menaces. Rapport Technique WWF & GTZ, 58p.

Millennium Ecosystem Assessment ,2005. Ecosystems and human wellbeing: synthesis. Island Press, Washington D.C.

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Biodiversity synthesis. 86 p. Online at: http://www.millenniumassessment.org/en/synthesis.aspx January 20th, 2009.

MINEFI, 2001. Enquête Camerounaise auprès des ménages II (ECAM II).

MINFOF, 2007. Rapport annuel de l'Unité Centrale de Lutte Contre le Braconnage (UCLCB). Yaoundé, Cameroun.

MINFOF, 2008a. Programme Sectoriel Forêts Environnement - Rapport annuel d'activités 2007, Une vue globale sur les activités programmées et les principaux résultats atteints au courant de l'année 2007. Observations, limites et recommandations, Février 2008, Cameroun

MINFOF, 2008b. Programme Sectoriel Forêts Environnement – Synthèse état des lieux de la recherche, Février 2008, Cameroun

MINFOF, 2008c. Indicateurs FORAF pour le suivi de l'état des forêts d'Afrique centrale, Cameroun

Ministère de l'Environnement, Conservation de la Nature, Eaux et Forêts, 1997. Etat de la biodiversité en RDC. MECNT, Kinshasa, RDC.

Ministère de l´environnement et de la protection de la nature / UNEP, 2007. Plan d'action national de lutte contre la désertification, Yaoundé, Cameroun.

Ministère de l´environnement et de la protection de la nature/UNEP/APREN, 2006. Etude pour orienter l'opérationnalisation/Révision du PNGE, décembre 2006, Vida Management International, Cameroun

Ministère du plan, de l'aménagement du territoire, de l'intégration économique et du NEPAD, 2005. Schéma Directeur National d'Aménagement du Territoire

Mittermeier R.A., Mittermeier C.G, Pilgrim J., Fonseca G., Konstant W.R. and Brooks T.(eds), 2002. Wilderness. Earth's Last Wild Places. Cemex, Mexico City. 573 p.

Mokany K., Raison R. J. & Prokushkin A. S., 2006. Critical analysis of root: shoot ratios in terrestrial biomes. Global Change Biology 12:84–96

Mpiana N., Belembo G., 2007. Présence, abondance et distribution des grands mammifères et des activités anthropiques dans la RFLY. Report for USAID/CARPE. African Wildlife Foundation.

MPMA-FORAF, 2008. Fiche de collecte des données pour le suivi de l'état des forêts d'Afrique Centrale. Niveau national Guinée Equatoriale. Ministerio de la Pesco y Medio Ambiante, Malabo. Projet FORAF, Kinshasha.

Mpoyi Mbunga A., Way Nana T., 2007. Définition des normes (PCI) et lignes de conduites pour la vérification de la légalité des bois produits en RDC. Rapport produit pour le compte de WWF et TRAFFIC. Avocats Verts. Kinshasa.

Mukheibir P., 2007. Possible climate change impacts on large hydroelectricity schemes in Southern Africa. *Journal of Energy in Southern Africa*, 18.

Mushenzi N., de Merode E., Smith F., Hillman-Smith K., Banza P., Ndey A., Bro-Jorgensen J., Gray M., Mboma G. and Watkin J., 2003. Aerial Sample Count of Virunga National Park, Democratic Republic of Congo. Unpublished report to WCS, DFGFI, ICCN, ORPTN, UWA and PICG.

Myers N., 1996: Environmental services of biodiversity. *Proc. Natl. 1cad. Sci*. 93: pp 2764-2769.

Myneni R. B., Dong J., Tucker C. J., Kaufmann R. K., Kauppi P. E., Liski J., Zhou L., Alexeyev V. & Hughes M. K., 2001. A large carbon sink in the woody biomass of Northern forests *PNAS*, December 18, 2001 vol. 98 no. 26 14784-14789. Online at http://www.pnas.org/content/98/26/14784.full April28th, 2009.

NASA/University of Maryland, 2002. MODIS Hotspot / Active Fire Detections. Data set. MODIS Rapid Response Project, NASA/GSFC [producer], University of Maryland, Fire Information for Resource Management System [distributors]. Available on-line [http://maps.geog.umd.edu].

Nash R., Luttrell C., 2006. Crisis to context : The fuelwood debate. In Forest policy and environment programme. DFID 5pp.

Nasi R., 2005. Potential Methodological Flaw in the Examination of the Effects of Logging. Ecology and Society 10(2): r2

Nasi R., Nguinguiri J-C. et Ezzine de Blas D., 2006. Exploitation et gestion durable des forêts en Afrique Centrale, pp. 403. Paris : L'Harmattan.

Nasi R., Brown D., Wilkie D., Bennett E., Tutin C.E.G., Van Tol G., Christophersen T., 2008. Conservation and use of wildlife-based resources: the bushmeat crisis. . Secretariat of the Convention on Biological Diversity, Montreal, Center for International Forestry Research, Bogor Technical Series no. 33, 50 p.

Ndoye O., Kaimowitz D., 2000. Macro-economics, markets and the humid forest of Cameroon, 1967-1997. The journal of modern African studies. 38:225-253.

Ndoye O. and Tieguhong J.C.,2004. Forest resources and rural livelihoods: the conflict between timber and non timber forest products in the Congo basin. *Scandinavian Journal of Forest Research* 19 (Suppl.4): 36-44

Ndoye O., 2005. Commercial Issues Related to Non-Timber Forest Products. In J-L Pfund, J-L and P. Robinson, eds,. Non-Timber Forest Products. Between poverty alleviation and market forces; InterCooperation, Berne. 50 p. Online at:http://www.intercooperation.ch/offers/download/NTFP-poverty-alleviation-market-forces.pdf/view April 20th, 2009.

Ndoye O. and Awono A., 2005. The Markets of Non Timber Forest Products In The Provinces Of Equateur And Bandundu, Democratic Republic Of Congo. Congo Livelihood Improvement and Food Security Project. CIFOR, Bogor. 56 p. Online at: http://www.confordrc.org/ndoye.pdf April 20th, 2009.

Neba A.S., 1987. Modern geography of the Republic of Cameroon. Neba publishers, 2nd edition, United Kingdom.

Neiland A.E. and Béné C. (eds), 2008. Tropical river fisheries valuation; background papers to a global synthesis. *Studies and Reviews* 1836, WorldFish Center, Penang, Malaysia.

Nganga I., Malonga R., Kominou F. A., Moukala G., 2007. Rapport d'inventaire des grands mammifères et des activités humaines dans la forêt de Ntokou (Nord-Congo).

Nganga I., Inkamba- Nkulu C., Nongamani A., Ampolo A., 2006. Sondage Faunique dans les réserves de la Léfini et de Lesio-Louna. WCS/ JAF/ CNIAF.

Ngobo M., McDonald M. and Weise S., 2004. Impacts of type of fallow and invasion by Chromolaena odorata on weed communities in crop fields in Cameroon. *Ecology and Society* 9(2): 1. Online at: http://www.ecologyandsociety.org/vol9/iss2/art1/ April 20th, 2009.

Niesten E., Rice R., 2004. Sustainable forest management and conservation incentive agreements. *International Forestry Review* 6(1):56-60

Nkoua M., 2008. Rapport d'enquête sur l'approvisionnement de la ville de Pointe Noire en bois énergie (Congo). Rapport 28 pp.

Nkounkou R. R. and Probst J. L., 1987. Hydrology and Geochemistry of the Congo River System. Pages 483-508 in E. T. Degens, S. Kempe, and G. Weibin, eds. *Transport of Carbon and Minerals in Major World Rivers, part 4*. SCOPE/ UNEP Sonderband, Hamburg.

Nogueira E. M., Nelson B. W. & Fearnside P. M., 2006. Volume and biomass of trees in central Amazonia: influence of irregularly shaped and hollow trunks. *For. Ecol. Manag.* 227:14-21

Nye P. H. and Greenland D. J., 1998. NPP Tropical Forest: Kade, Ghana, 1957-1972. Data set. Online at : [http://www.daac.ornl.gov] from Oak Ridge National Laboratory Distributed. Active Archive Center, Oak Ridge, Tennessee, U.S.A. January 8th, 2009.

Nzooh Dongmo, Z-L and Bassama C., 2003. Evaluation préliminaire de l'environnement bioécologique : statut des grands et moyens mammifères et des activités humaines dans l'UFA 10-052. Rapport WWF CCPO - Decolvenaere. 48 p + annexes.

Nzooh Dongmo Z.-L., 2003. Suivi écologique dans le Parc National de Lobéké et sa zone périphérique : données de base sur la dynamique des populations de grands et moyens mammifères et des activités anthropiques. Rapport WWF CPO. 220 p + annexes.

Nzooh Dongmo Z.-L., Bassama C., Kouob S., 2004. Statut des grands et moyens mammifères et des activités humaines dans l'UFA 10-064. Partenariat entre WWF Jengi et le groupe SEFAC-SEBAC-Filière Bois. Rapport WWF CARPO - SEFAC. 58.

Nzooh Dongmo Z-L, Mahop J.P., and Fouda E., 2004. Partenariat entre WWF Jengi et la Société Commerciale Industrielle et Forestière pour la promotion de la gestion durable des forêts: statut des grands et moyens mammifères et des activités humaines dans l'UFA 10-022. Rapport WWF CARPO - SCIFO. 58 p.

Nzooh Dongmo Z.-L., Bassama C., Ndinga H., 2005. Populations des grands et moyens mammifères dans les UFA 10-008, 10-009, 10-010, 10-012 : données de base pour l'aménagement durable des concessions : Partenariat entre WWF Jengi et le groupe SEFAC-SEBAC-Filière Bois. Rapport WWF CARPO – SEFAC, 62 p.

Nzooh Dongmo Z.-L., Bassama.C, Fouda.E., Mahop J-P., Annong V., Kwuong M., 2006. Evolution des populations des grands et moyens mammifères dans le Parc National de Lobéké entre 2002 et 2005. Rapport WWF CARPO.

Nzooh Dongmo Z-L, Kouob Begne S., Annong V., Bassama C., Fouda E., Mahop J-P., 2006. Suivi écologique dans le parc national de Nki et sa zone périphérique : Données de base sur la dynamique des populations de grands et moyens mammifères et des activités anthropiques. Rapport WWF CARPO. 77 p.

Nzooh Dongmo Z-L., Ghogue R., and Ndinga H., 2008. Les Grands et moyens mammifères dans la ZICGC

Nzooh Dongmo Z-L., Kondje P. and Annong V., 2008. Les Grands et moyens mammifères dans la ZICGC 14. Rapport WWF CCPO.

Obama C., 2000. Los productos forestales no maderables en Guinea Ecuatorial. Proyecto de Conservacion y Utilizacion Racional de los Ecosistemas Forestales, Guinea Ecuatorial, CUREF.

Obama C., 2002. Productos Forestales no Maderables en Tres Mercados de Guinea Ecuatorial. Anales Real Jardin Botanico de Madrid 59 (2). pp. 275-285.

Obama C., 2007. Las leyes del sector bosque-medio ambiente de Guinea Ecuatorial : pluralismo y conflictos interinstitucionales. Amigos de la Naturaleza y el Desarollo de Guinea Ecuatorial (ANDEGE). 23 p. (Les lois régissant le secteur forestier et l'environnement en Guinée Equatoriale : pluralisme et conflits interinstitutionnels. Les Amis de la Nature et le Développement de la Guinée Equatoriale).

Office Rwandais du Tourisme et des Parcs Nationaux. 2004. Parc National des Volcans. Plan d'Aménagement et de Gestion 2005-2009. ORTPN, Kigali. 114 p.

Omasombo V., 2004. Situation actuelle des espèces phare dans la réserve proposée de Lomako. Report for USAID/CARPE African Wildlife Foundation.

Omasombo V., Bokelo D., Dupain J., 2005. Current status of Bonobos and other large mammals in the proposed Forest Reserve of Lomako-Yokokala, Equateur Province, Democratic Republic of Congo. Pan African News, 12(2), p 14-17.

Omasombo V., Mpiana N., 2006. Abundance and distribution of large mammals and human activities throughout the Faunal Reserve of Lomako-Yokokala. Report for USAID/CARPE. African Wildlife Foundation.

Omasombo V., In prep. Protocol de monitoring des activités anthropiques et des grands mammifères dans la Réserve de Faune de Lomako Yokokala. Report for USAID/CARPE. African Wildlife Foundation.

Organisation de Coopération et de Développement Economique OCDE, 2007. Perspectives économiques en Afrique, p. 211-227

Otto F., Bondeko G., Mobongo R., Ossou V., 2007. Rapport sur le suivi des ménages dans la Réserve Communautaire du Lac Télé, WCS. Brazzaville, République du Congo.

Ouedraogo B., 2008. Évaluation des politiques de prix du bois-énergie dans la région d'Ouagadougou : évidence empirique du modèle AIDS en absence d'information sur les prix. Note. 13pp.

Oyono R., 2005. Profiling local-level outcomes of environmental decentralizations: The case of Cameroon's forests in the Congo Basin. *Journal of Environment and Development* 14:317–337

Paeth H. and Thamm H.P., 2007. Regional modelling of future African climate north of 15°S including greenhouse warming and land degradation. *Climatic Change*, 83, pp. 401-427.

Pagiola S., Bishop J., Landell-Mills N. (eds.), 2002. *Selling forest environmental services*. Earthscan, London

Pagiola S., Arcenas A., Platais G., 2005. Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America. *World Development* 33(2):237-253

Palm C. A., Woomer P. L., Alegre J., Arevalo L., Castilla C., Cordeiro D. G., Feigl B., Hairiah K., Kotto-Same J., Mendes A., Moukam A., Murdiyarso D., Njomgang R., Parton W. J., Ricse A., Rodrigues V., Sitompul S. M. and van Noordwijk M., 2000. Carbon sequestration and trace gas emissions in slash-and-burn and alternative land-uses in the humid tropics. ASB Climate Change Working Group final report, Phase II, Nairobi, Kenya, 33p. Online at: http://www.asb.cgiar.org/publications/wgreports/wg_climatechange.asp April 28th, 2009.

Palm C. A., Woomer P. L., Alegre J., Arevalo L., Castilla C., Cordeiro D. G., Feigl B., Hairiah K., Kotto-Same J., Mendes A., Moukam A., Murdiyarso D., Njomgang R., Parton W. J., Ricse A., Rodrigues V., Sitompul S. M. and van Noordwijk M., 2000a. Appendix 1: Carbon stock (t ha-1) dataset for the ASB benchmark sites. Online at: http://www.asb.cgiar.org/PDFwebdocs/Appendex%201-climatechangephaseIIreport.pdf - April 20th, 2009.

Patz J.A. and Confalonieri U.C.E., 2005. Human Health: Ecosystem Regulation of Infectious Diseases. In Millenium Ecosystem Assessment, Current State and Trends. pp 393-415. Online at: http://www.millenniumassessment.org/documents/document.283.aspx.pdf April 20th, 2009.

Pearce D. and Pearce C., 2001. The Value of Forest Ecosystems*:* A Report to the Secretariat Convention on Biological Diversity. University College London, London.

Peltier R., Harmand J.M., Ntoupka M., Njiti C.F., Sibelet N. and Smektala G., 2007. Pour une gestion intentionnelle de l'arbre par les agropasteurs du nord Cameroun: du champ au paysage 2007: in « Sols de Tunisie » *Bulletin de la direction générale de l'aménagement et de la conservation des terres agricoles* (2, sp) : 103-114. Séminaire Territoires et aridité au nord et au sud du Sahara, 2005-06-13, Tunis, Tunisie.

Perthuisot N. et Durrieu de Madron L., 2008. Etude comparative des législations forestières des pays du bassin du Congo. Rapport d'étude COMIFAC. TEREA, Libreville. 98 p.

PFBC (Partenariat pour les forêts du Bassin du Congo), 2006. Les forêts du bassin du Congo. Etat des forêts 2006. COMIFAC 256 pp.

Pilsbry H. A. and Bequaert J., 1927. The aquatic mollusks of the Belgian Congo, with a geographical and ecological account of Congo malacology. *Bulletin of the American Museum of Natural History* 53: 69-602.

Plouvier D., Eba'a Atyi R., Fouda T., Oyono R. and Djeukam R.,2002. Etude du sous-secteur sciage artisanal au Cameroun. AGRECO. Yaoundé, Cameroon, Ministry of Environment and Forests.

Plumptre A., Kujirakwinja D. and Matunguru J., 2008. Survey of Chimpanzees in the Virunga Park and an assessment of a potential corridor *to Mt Hoyo*. Unpublished report to USFWS, ICCN and WCS.

PNUD, 2005. Programme des Nations-Unis pour le Développement. Online at : http://hdr.undp.org/en/statistics/ November 11th ,2008.

PNUD, 2006. Rapport sur la pauvreté rurale au Cameroun. PNUD, Yaoundé

PNUD, 2007. Rapport mondial sur le développement humain 2007/2008*, pp. 391.* New York : Programme des Nations-Unies pour le Développement.

PNUD/FAO, 1973. Planification de la mise en valeur des ressources de la zone Sibiti-Zanaga.

Poulsen J.R., Clark C.J., 2002. Rapport d'étude de faisabilité de la Réserve Communautaire du Lac Télé. Wildlife Conservation Society, New York.

Poulsen J.R., Clark C.J. and Mavah G., 2007. Wildlife management in a logging concession in Northern Congo: Can livelihoods be maintained through sustainable hunting? In: G. Davies and D. Brown (eds.), Bushmeat and Livelihoods. Blackwell Publishing, Oxford, UK. pp 140-157.

PROGEPP, 2005. Etudes Démographiques UFAs Kabo, Pokola, Toukoulaka et Loundoungou . Rounded figures.

Rapport annuel de la Direction de la Faune et des Aires Protégées, 2007.

Rapport annuel de l'ICASEES (Institut Centrafricaine des Statistiques et des Etudes Economiques et Sociales), 2007.

Rapport annuel du Centre de Données Forestières CDF, 2007.

Rapport annuel du Parpaf, 2007.

Reid H. and Huq S., 2005. Climate change – Biodiversity and livelihood impacts. In *Carmenza Robledo, Markku Kanninen, Lucio Pedroni (eds)*,. Tropical forests and adaptation to climate change: In search of synergies. CIFOR. Bogor. pp 57-70. Online at : http://www.cifor.cgiar.org/publications/pdf_files/Books/BCarmenza0501.pdf April 20th, 2009.

Reinartz G.E., Guislain P., Bolinga T.D.M. et al., 2008. Ecological factors influencing bonobo density and distribution in the Salonga national park: Applications for population assessment. In: *Furuichi T., & Thompson J., (eds).* The Bonobos: Behavior, Ecology, and Conservation. Pp:167-188. Springer, New York.; unpublished data

Reinartz G.E., Inogwabini B.I., Mafuta N., Lisalama W.W., 2006. Effects of forest type and human presence on bonobo (Pan paniscus) density in the Salonga National Park. *International Journal of Primatology 27(2): 603-634*.

Ridder B., 2008. Questioning the ecosystem services argument for biodiversity conservation. *Biodiversity Conservation* 17:781-790

Robbins M. and Williamson L., 2008. *Gorilla beringei*. In: IUCN 2008. 2008 IUCN Red List of Threatened Species. Online at: www.iucnredlist.org. April 20th, 2009.

Roberts T. R., 1975. Geographical distribution of African freshwater fishes. *Zoological Journal of the Linnean Society* 57: 249-319.

Rokotondranisa D., Katumpwe R. and Cowles P., 2006. "Etude des filières des produits agricoles et forestiers non-ligneux" Prepared by Pact Congo for WWF-DRC.

Ruitenbeek H.J., 1990. The Korup Project: Plan for Developing the Korup National Park and its Support Zone. WWF-UK, London

Sahin V. and Hall M.J., 1996. The effects of afforestation and deforestation on water yields. *Journal of Hydrology* 178: 293-309.

Sanderson, E. W., Jaiteh, M., Levy, M. A., Redford, K. H., Wannebo, A. V. & Woolmer, G. 2002. The human footprint and the last of the wild. *Bioscience,* 52**,** 891-904

Sayer J.A., Harcourt C.S. & Collins N.M.,1992. The Conservation Atlas of Tropical Forests: Africa. Macmillan Publishing Ltd., London.

Schaffner Cappello R. and Ibata S., 2004. Prospection de forêt de Souanké - Garabinzam-Ivindo, rapport WWF.

Schaffner Cappello R. and Zebene J., 2005. Mise en œuvre du plan de travail WWF/CARPE Odzala, Espace TRIDOM Interzone Congo. Rapport WWF. Rapport WWF.

Schiermeier Q., 2008. A Long Dry Summer. *Nature*, 452, pp. 270 - 273.

Shahin M., 2002. Hydrology and water resources of Africa, Water Science and Technology Library, Volume 41, *Kluwer Academics Publishers*, *Dordrecht, The Netherlands*

Sheil D. and Salim A., 2004. Forest Tree Persistence, Elephants and Stem Scars. *Biotropica* 36(4):505-521

Shem W.O. and Dickinson R.E., 2006. How the Congo Basin deforestation and the equatorial monsoonal circulation influences the regional hydrological cycle. Paper presented at the 86th Annual AMS Meeting. January 2006. 32 p. Online at: http://ams.confex.com/ams/pdfpapers/98765.pdf April 20th, 2009.

Simpson R.D., Sedjo R.A., Reid J.W., 1996. Valuing biodiversity for use in pharmaceutical research. *Journal of Political Economy* 104, 163–185

Simula M., 2008. Mapping of existing and emerging sources of forest financing. Study report presented at the "First Design Meeting on the Forest Investment Program". Climate Investment Fund. October 16-17, 2008. Washington, DC.

Smektala G., Hautdidier B., Gautier D., Peltier R., Njiemoun A., Tapsou, Construction de tarifs de biomasse pour l'évaluation de la disponibilité ligneuse en zone de savanes au Nord-Cameroun *in Jamin J.Y., Seiny Boukar L., Floret C.* (éditeurs scientifiques), 2003. Savanes africaines : des espaces en mutation, des acteurs face à de nouveaux défis. Actes du colloque, mai 2002, Garoua, Cameroun. Prasac, N'Djamena, Tchad - Cirad,

Smithsonian Institution, undated. Smithsonian Monte Mitra Expedition Report.

Sonwa D.J., 2004. Biomass management and diversification within cocoa agroforest in the humid forest zone of Southern Cameroon. PhD thesis. Faculty of Agriculture. University of Bonn. Germany. Cuvillier Verlag, Goettingen. 112 pp

Starkey M., 2004. Commerce and subsistence: the hunting, sale and consumption of bushmeat in Gabon. PhD thesis, Cambridge University. 249 p.

Stednick J. D., 1996. Monitoring the effects of timber harvest on annual water yield, *Journal of Hydrology*, vol. 176, pp. 79-95, 1996

Steel L., 2007. Summary Results of WWF Biological Surveys: 2006-2007. WWF-DRC report submitted to CARPE/USAID as Means of Verification.

Stella N., 2007. Central Africa's "Most Beautiful Waterfall" Under Threat. Online at: http://www.internationalrivers.org/en/node/3278 (accessed February 24th, 2009.) and http://www.afrika.no/Detailed/15379.html (accessed February 24th, 2009).

Stephens B. B., Gurney K. R., Tans P. P., Sweeney C., Peters W. *et al.*, 2007. Weak northern and strong tropical carbon uptake from vertical profiles of atmospheric CO_2. *Science* 316: 1732–1735.

Stern N., 2006. Stern Review on the Economics of Climate Change. Report for the UK Cabinet Office, HM Treasury. 576 p. Online at: http://www.hm-treasury.gov.uk/sternreview_index.htm April 20th, 2009.

Stewart K.M., 2003. The African cherry (Prunus africana): from hoe handles to the international herb market. *Economic Botany* 57(4): 559-569

Stiassny M. L. J., Teugels G. G and Hopkins C. D., 2007. The Fresh and Brackish Water Fishes of Lower Guinea, West-Central Africa Poissons d'eaux douces et saumâtres de la Basse-Guinée, Afrique de l' Ouest et Central. *IRD Éditions, Paris*.

Stokes E., 2007. Ndoki-Likouala Ecological Landscape Monitoring Program: Summary of Results. WCS Report.

Sunderland T.C.H., Defo L., Ndam N., Abwe M. and Tamnjong I., 2002. A socio-economic profile of the commercial rattan trade in Cameroon. In: T.C.H. Sunderland and J.-P. Profizi (Eds.) New Research on African Rattans. Proceedings of the International Expert Meeting on the Rattans of Africa, Limbe Botanic Gardens, Cameroon. 1-3 Feb., 2000. International Network for Bamboo and Rattans (INBAR). pp. 115-14.

Tabu A., 2008. Rapport de la mission de l'évacuation des produits agricoles du landscape MLW. Report for USAID/CARPE. African Wildlife Foundation.

Taylor L. H., Latham S.M. and Woolhouse M. E. J., 2001. Risk factors for human disease emergence. Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences 356: 983–989.

Tchatat M., 2002. Quelques études effectuées au programme Tropenbos Cameroun relatives à la gestion durable des produits forestiers non-ligneux. In: MINEF (eds). 2002. *Rapport de l'atelier sur l'état des lieux des produits forestiers non ligneux au Cameroun.* Chambre d'Agriculture, Yaoundé. Cameroun.

Tchiofo R., 2008. Potentialities of payment mechanisms for environmental services in the Congo Basin forests: the case of biodiversity conservation. Dissertation, University of Göttingen.

Teugels G. G and Guégan J. F., 1994. Diversité biologique des poissons d'eaux douces de la Basse-Guinée et de l'Afrique Centrale in Biological Diversity in African Fresh-and Brackish water Fishes, Geographical reviews, Symposium PARADI. *Annales du Musée royal de l'Afrique Central, Sciences Zoologiques* 275: 67-85.

Thieme M. L., Abell R. A., Stiassny M. L. J., Skelton P., Lehner B., Teugels G. G., Dinerstein E., Kamdem Toham A., Burgess N. and Olson D., 2005. *Freshwater ecoregions of Africa: A conservation assessment. Island Press, Washington, DC*.

Tilman D., 1999. The ecological consequences of changes in biodiversity: a search for general principles. *Ecology,* 80(5), 1999, pp. 1455–1474.

Toison V., 2008. *Pratiques paysannes et aménagement forestier dans l'Est du Cameroun*. Mémoire de Master, AgroParisTech, Paris.

Transparency International, 2007. Global Barometer of Corruption 2007, Transparency International - Secretariat International, Berlin

Trefon T., 1997. Pour une exploitation durable des produits forestiers par les citadins d'Afrique centrale : une gageure ? *in* Villes du sud et environnement. Travaux de la Société d'Ecologie humaine. *Editions de Bergier*, 183 pp.

Trefon T. et Cogels S., 2007. Espaces périurbains d'Afrique centrale et gouvernance environnementale. ULB/GEPAC - Université Libre de Bruxelles. 72 pp.

UICN, 1994. *Lignes directrices pour les catégories des gestion des aires protégées.* CPNAP avec l'assistance du WCMC. UICN, Gland, Suisse et Cambridge, Royaume-Uni. x + 261pp.

UNDP, 2008. Human Development Report 2007/2008 http://hdr.undp.org/en/media/HDR_20072008_EN_Complete.pdf April 20th, 2009.

UNEP, 2006. United Nations Environment Programme. Africa Environment Outlook 2. Online at: http://www.unep.org/dewa/Africa/publications/AEO-2/content/085.htm April 20th, 2009.

UNEP, 2007. Biodiversity and Climate Change. Convention of Biological Diversity. 48 p.Online at: http://www.cbd.int/convention/convention.shtml April 20th, 2009.

UNEP, 2008. Afrique : Atlas d'un environnement en mutation

UNFPA, 2008. United Nations Population Funds. Online at : http://www.unfpa.org/ November 10th, 2008.

UNHCR ,2008. *Comment répondre aux besoins en énergie des déplacés du nord Kivu. Communiqué de presse.*

United Nations, 2005. Energy Statistics Yearbook 2005. United Nations, Department of Economic and Social Affairs.

United Nations, 2006. World Population Prospects : The 2006 Revision Population Database. http://esa.un.org/unpp/ March 3rd,2009.

United Nations, 2007. World Population Prospects: the 2006 Revision. (http://esa.un.org/unpp)

UNPP, 2006. World Population Prospects : The 2006 Revision population database. http://esa.un.org/unpp

UNPP, 2008. United Nations Population Prospects. Online at : http://esa.un.org/unpp/ November 10th, 2008.

USFS, 2008. U.S. Forest Service Guide to Integrated Landscape Land Use Planning in Central Africa. September, 2008. 23 pp.

Usongo L., Defo L., Nzooh-Dongmo Z., Ngniado A., Kamdem Toham A. and Tchamba M., 2007. Orientations stratégiques pour la gestion du massif de Ngoyla-Mintom. WWF-CARPO, Yaoundé.

Van de Ven N., 2008. La filière bois en RDC. Présentation à l'atelier « Chatham house » sur les nouveaux mécanismes de financement de la gestion forestière - Kinshasa.

Van den Berg J. and Biesbrouck K., 2000. The social dimension of rainforest management in Cameroon*:* Issues for co-management. Tropenbos Foundation, Wageningen.

Van Dijk A.I.J.M. and Keenan R.J., 2007. Planted forests and water in perspective. Forest Ecology and Management: Planted Forests and Water - Including selected papers from a special session of the World Congress of the International Union of Forest Research Organisations, Brisbane 8-13 August 2005, 251, pp. 1-9.

Van Dijk H. and Wiersum F., 1999. NTFP resource management as an option for multiple-use forest management in South Cameroon. In Mirjam A.F. Ros Tonen (Ed.) NTFP research in the Tropenbos Programme: Results and perspectives. Tropenbos International pp 115-122. Online at: http://www.tropenbos.nl/files/VanDijk.PDF January 20th, 2009.

Vande weghe J-P., 2004. Forests of Central Africa. Nature and Man. Lanoo Publishers, Tielt, Belgique. 365 p.

Vandenhaute M. et Doucet J-L., 2006. Etude comparative de 20 plans d'aménagement approuvés au Cameroun. Yaoundé, Cameroon, German Technical Cooperation (GTZ).

Vanleeuwe H., 2008. Recensements des grands mammifères et d'impacts humains au PNCD, Juillet 2008.

Walker S. M. & Desanker P. V., 2004. The impact of land use on soil carbon in Miombo Woodlands Malawi. Forest Ecology and Management 203(1–3): 345–360.

Ward H.K. and Cleghorn W.B., 1964. The effect of ring-barking trees in *Brachystegia* woodland on the yield of veld grasses. *Rhodesia Agricultural Journal* 61: 98-107.

WCS-DRC, IMU., 2006. Biodiversity Surveys in the Salonga National Park 2003 – 2006 Faunal distribution and abundance and impact of hunting: A Summary of major findings and recommendations. Inventory and Monitoring Unit (IMU), Technical Report No 7 WCS-DRC Program.

Wertz-Kanounnikoff S., 2006. Payments for environmental services - A solution for biodiversity conservation. *IDDRI, Paris*

Westcor, 2008. Inputs to Business Planning. Western Power Corridor (PTY) Limited).

White F., 1983. The vegetation of Africa: a descriptive memoir to accompany the UNESCO/AETFAT/UNSO vegetation map of Africa. UNESCO Natural Resource Research, 20, 356p, 27 maps, UNESCO, Paris.

White F., 1986. La végétation de l'Afrique. ORSTOM-UNESCO. Paris, 384p.

Wilkie D.S., 2001. Bushmeat Hunting in the Congo Basin: A Brief Overview. In: M.I. Bakarr, G.A.B. da Fonseca, R. Mittermeier, A.B. Rylands and K.W. Painemilla (Eds.) Hunting and Bushmeat Utilization in the African Rain Forest: Perspectives Toward a Blueprint for Conservation Action. Conservation International, Washington D.C. pp. 17-20.

Wilkie D.S. and Carpenter J., 2002. Can nature tourism help finance protected areas in the Congo basin? *Oryx* 33 (Issue 4): 333-339.

Wilkie D. S., Starkey M., Abernethy K., Effa Nsame E., Telfer P. and Godoy R., 2005. Role of prices and wealth in consumer demand for bushmeat in Gabon, Central Africa. *Conservation Biology* 19:1-7.

Wilks C. & Issembé Y., 2000. Les arbres de la Guinée Equatoriale: Guide pratique d'identification: région continentale. Projet CUREF, Bata, Guinée Equatoriale. 546 pp.

Williams M., Ryan C.M., Rees R.M., Sambane E., Fernando J. and Grace J., 2008. Carbon sequestration and biodiversity of re-growing miombo woodlands in Mozambique. *Forest Ecology and Management* 254: 145-155.

WRI/GFW, 2007. Atlas forestier interactif du Congo

Wunder S., 2005. Payments for environmental services: Some nuts and bolts. CIFOR Occasional Paper No. 42, Bogor

Wunder S., 2006. Are direct payments for environmental services spelling doom for sustainable forest management in the tropics? *Ecology and Society* 11(2): 23

WWF, 2006. The Socioeconomic Aspects of Natural Resource use and Management by Local Communities in the Salonga-Lukenie-Sankuru Landscape: Guidelines for Conservation and Livelihood Improvement. WWF-DRC.

WWF, 2007. Le WWF plante le 10 millionième arbre pour protéger les gorilles de montagne communiqué de presse.

WWF, 2008. Lac Tumba Project – Technical Progress Report 2008.

WWF, unpublished a. Unpublished analysis of data collected by Ella Akou Marc, WWF survey leader.

WWF, unpublished b. Unpublished analysis of data in WWF data base, surveys done by Koumbi, Patrick, Ella Akou Marc and Edou Edzang.

Yaron G., 2001. Forest, Plantation Crops or Small-scale Alternatives? An Economic Analysis of Alternative Land Use Options in the Mount Cameroon Area. *J. of Environmental Planning and Management,* 44(1), 85-108

Zobi I.C., 2002. Contribution à la gestion sylvicole des forêts humides ivoiriennes à travers l'analyse des dispositifs permanents de Mopri et Irobo. Thèse de Doctorat, Université Claude Bernard - Lyon 1, Lyon, 161p. + annexes.

Further Readings

Adebu C., Luyombo W., Chiriiswa M., Ndeke S., Kanda P., Mbatu V., Bogumbi B., 2008. Mission de prospection en cartographie participative - Programme territorial du Territoire de Mambasa, RRN (Kinshasa).

AGRECO, Août 2005. Audit organisationnel des structures de l'administration forestière. II. Stratégies d'évolution. PURAC, République du Congo, 89 p.

AGRECO, Juin 2005. Audit organisationnel des structures de l'administration forestière. I. Bilan-diagnostic. PURAC, République du Congo, 147 p.

Arnold J.E.M., Köhlin G., Persson R., 2006. Woodfuels, livelihoods, and policy interventions: Changing Perspectives. World Development Vol.34, N°3, pp.596-611

ASB, 2000. Alternatives to slash-and-burn: Summary report and synthesis of phase II in Cameroon. ASB Coordination Office, ICRAF-Nairobi. 72 pp.

Bayol N., 2006. Amélioration des pratiques d'exploitation forestière sur le Landscape Maringa.

Bayol N., Chabbert J., Jourget J., Martinez Plaza S., 2006-2008. Rapports d'inventaire d'aménagement sur 7 garanties d'approvisionnement en RDC. FRM, groupe NST.

CBFP, 2006. Les forêts du Bassin du Congo, Etat des Forêts 2006.

Chézeaux E., 2003. Assistance à la revue économique du secteur forestier en RDC : analyse du potentiel forestier et des pratiques de gestion forestière. Rapport technique, Forêt Ressources Management.

Cooke P, Köhlin G., Hyde W.F., 2008. Fuelwood, forests and community management – evidence from household studies. Environment and Development Policy 13 :103-135

Essama-Nssah B. and Gockowski J.J., 2000. Cameroon forest sector development in a difficult political economy. Operations Evaluation Department, World Bank, Washington D.C. 123 pp.

FAO, 2008. Forêts et énergies. Questions principales. Etude FAO forêts n°154 ; 61 pp.

Faunal Baseline Surveys. Part 1. Central Sector « Zone Verte », Final report. Wildlife Conservation Society.

Gartlan S., 1989. La conservation des écosystèmes forestiers au Cameroun. IUCN. Cambridge, UK. 136pp.

Girard P. ,2002. Quel futur pour la production et l'utilisation du charbon de bois en Afrique ? Unasylva 211, vol 53 pp 30-35

Grossmann F., Hart J., Dino S., 2006. La Réserve de Faune à Okapi, Post Conflict

Ilstedt U., Malmer A., Verbeeten E. and Murdiyarso D., 2007. The effect of afforestation on water infiltration in the tropics: A systematic review and meta-analysis. Forest Ecology and Management: Planted Forests and Water - Including selected papers from a special session of the *World Congress of the International Union of Forest Research Organisations*, Brisbane 8-13 August 2005, 251, pp. 45-51.

IUCN/IIED, 2008. Evaluation de la contribution des forêts dans le revenu des ménages et implications politiques, Projet « BNPP-Environmenet-Mainstreaming Forests in PRSPS » PROFOR,

Lebrun J., 1936. Répartition de la Forêt Equatoriale et des Formations Végétales Limitrophes, Ministère des Colonies, publication de la direction générale de l'agriculture et de l'élevage, 7 place royale, Bruxelles.

Malele Mbala S., 2007. Intégrer les questions de genre dans le secteur forestier en Afrique. Cas de la République Démocratique du Congo. FAO, Rome.

MEFE, 2004. Directives nationales d'aménagement durable des forêts naturelles du Congo.

MEFE, 2004. Plan de convergence pour la conservation et la gestion durable des forêts tropicales d'Afrique centrale. Actions prioritaires du Congo.

MINFOF and FAO, 2005. Évaluation des ressources forestières nationales du Cameroun. Yaoundé, Cameroun, Ministère des Forêts et de la Faune (MINFOF) and FAO.

Mino-Kahozi B. And Mbantshi M., 1997. Pollution and degradation of African aquatic environments and consequences for inland fisheries and aquaculture; the cse of the Republic of Zaire. In: K. Remane (ed.), *African Inland Fisheries, Aquaculture and the Environment*, Blackwell.

Nkole E.D., 2007. Exploitation des bois, paradoxe de la pauvreté et conflits dans le territoire de Mambasa (Ituri-Nord-Est de la RDC), IKV PAX CHRISTI (Pays Bas).

SPIAF, 1992. Carte forestière synthèse du Zaïre. MINAFFET

Trossero M.A. ,2002. La dendroénergie: quelles perspectives ? Unasylva 211, vol 53 pp 3-12

United Nations, 2007. United Nations Statistics Division http://unstats.un.org/UNSD/environment/envpdf/Country%20Snapshots_apr2007/Cameroon.pdf - May 12th, 2009.

Uschi E., 2004. Gestion forestière durable dans le bassin du Congo, n'est-il pas trop tard ? Agriculture et développement rural. Revue d'information sur la coopération au développement. p16-17.

Vancutsem C., Pekel J-F., Evrard C., Malaisse F. et Defourny P., 2006. Carte de l'occupation du sol de la République Démocratique du Congo au 1 : 3 000 000 - Presses Universitaires de Louvain.

Acronyms

AAC	Annual Cutting Range
ACF	African Conservation Fund
ADB	Asian Development Bank
ADCP	Acoustic Doppler Current Profilers
ADF/NALU	Allied Democratic Front
AFD	French Development Agency
AFLEG	African Forest Law Enforcement and Governance
AFOLU	Agriculture, Forestry and Other Land Use
AfriMAB	African Network for MAB
AG	Aboveground
AGB	Aboveground Biomass
ALPICAM	Alpi Pietro et Fils Cameroun
AMESD	African Monitoring of the Environment for Sustainable Development
AMNH	American Museum of Natural History
ANAFOR	National Agency for Forest Development
ANDEGE	Amigos de la Naturaleza y Desarrollo de Guinea Ecuatorial
ANPN	National Parks Agency
APDS	Dzanga-Sangha Protected Areas
APRA	Aprovechamiento Productos Agrícolas
APREN	Appui à la protection et la régénération des ressources naturelles
AR	Abanga River
ASB	Alternatives to Slash-and-Burn
ATIBT	Association Technique Internationale des Bois Tropicaux
ATO	African Timber Organization
AWF	African Wildlife Foundation
AWG-KP	Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol
AWG-LCA	Ad Hoc Working Group on Long-term Cooperative Action under the Convention
BAD	African Bank for Development
BCTF	Bushmeat Crisis Task Force
BG	Below ground
BGB	Belowground biomass
BIVAC	Bureau Inspection Veritas Academie Consiquency
BNGE	Bosque Nacional Guinea Ecuatorial
BREAD	Bureau de REcherche Appui au Développement
BW	Biomass expressed in dry matter by unit area
CamIron	Cameroon Iron Ore Company
CAR	Central African Republic
CARPE	Central African Regional Program for the Environment
CARPO	Central African Regional Program Office
CASCADe	Crédits carbone pour l'agriculture, sylviculture, conservation et l'action contre la déforestation
CAS-DFT	Compte d'Affectation spéciale pour le Développement forestier et touristique
CAS-DT	Compte d'Affectation spéciale pour le Développement touristique
CAT	Management and Processing Conventions
CAWHFI	Central Africa World Heritage Forest Initiative
CBFF	Congo Basin Forest Fund
CBFP	Congo Basin Forest Partnership
CBG	Compagnie des Bois du Gabon
CBNRM	Community-Based Natural Resource Management
CBO	Community-Based Organisations
CDF	Centre de Données Forestières
CDM	Clean Development Mechanism
CDNP	Conkouati Douli National Park
CEB	Compagnie équatoriale des Bois
CEC	Cation Exchange Capacity
CEFDHAC	Conference on Dense Humid Forests Ecosystems of Central Africa
CEMAC	Communauté économique et monétaire de l'Afrique centrale
CENAREST	National Center for Scientific and Technological Research
CF	Community Forests
CFA	Communauté financière d'Afrique
CFAD	Forestry Concession under Sustainable Management
CFC	Companie forestière du Cameroun
CFT	Compagnie forestière et de Transformation
CHZ	Community Hunting Zones
CI	Conservation International
CIA	Central Intelligence Agency
CIB	Congolaise industrielle des Bois
CIBC	Companie industrielle des bois du Cameroun
CIBN	Congolaise industrielle de Bois du Niari
CICOS	International Commission for the Congo-Oubangui-Sangha Basin
CICTE	Consejo de Investigaciones Científicas y Tecnológicas

CIFOR	Center for International Forestry Research
CIRAD	Centre de Coopération internationale en recherche agronomique pour le Développement
CIRMF	Centre international de Recherches médicales de Franceville
CITES	Convention on International Trade in Endangered Species
CMEC	China National Machinery and Equipment Import and Export Corporation
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CNA	Centre national Antipollution
CNDP	Congrès national de Défense du Peuple
CNIAF	Centre national d'Inventaire et d'Aménagement des Ressources forestières et fauniques
CNSEE	Centre national de la Statistique et des Études économiques
CoCoSi	Comité de coordination de site
COMIFAC	Forestry Commission of Central Africa
CONAMA	Comisión Nacional del Medio Ambiente
COP	Conference of the Parties
COP/MOP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
COVAREF	Comité de valorisation des ressources fauniques
CP	Conférence des Parties
CPAET	Management, Exploitation and Processing Provisional Convention
CREF	Centre de Recherche en Écologie et Foresterie
CREF	Réseau pour la conservation et la réhabilitation des écosystèmes forestiers du Nord-Kivu
CRESA	Centre Régional d'Enseignement Spécialisé en Agriculture
CSF	Climatically Stable Forest
CTDR	Collège technique de Développement rural
CTFC	Centre rechnique de la Forêt communale
CTFS	Center for Tropical Forest Science
CTI	Industrial Processing Convention
CUF	Cameroon United Forest
CUREF	Conservación y Utilización Racional de los Ecosistemas Forestales
CW	Carbon stocked in woody plants
DACEFI	Développement d'alternatives communautaires à l'exploitation forestière illégale
DAF	Development Adjustment Factor
DC	Developing Countries
DD	Degradation and Deforestation
DEPFOR	Département de Formation forestière
DF	Direction des Forêts
DFAP	Direction de la Faune et des Aires protégées
DFGFI	Dian Fossey Gorilla Fund International
DFID	Department for International Development
DGEF	Direction générale de l'Environnement
DGF	Direction de Gestion forestière
DGRAD	Direction générale des Recettes administratives, judiciaires, domaniales et de Participation
DGRST	Direction générale de la Recherche scientifique et technique
DIAF	Direction des Inventaire et Aménagement forestier
DIARF	Direction des Inventaires, de l'Aménagement, et de la Régénération des Forêts
DLH	Dalhoff Larsen and Horneman
DRC	Democratic Republic of Congo
DSCRP	Strategy Paper for Growth and Reduction of Poverty
EC	European Commission
ECOFAC	Conservation et utilisation rationnelle des écosystèmes forestiers d'Afrique centrale
EFC	Eucalyptus Fibers Congo
EG	Equatorial Guinea
ENCRO	École nationale des Cadres ruraux d'Oyem
ENEF	École nationale des Eaux et Forêts
ENRA	Enzyme Refiners Association
ERAIFT	Ecole régionale post-universitaire d'Aménagement et de Gestion intégrés des Forêts et Territoires tropicaux
ERPA	Emissions Reductions Purchase Agreement
ERZ	Extractive Resource Zone
ETM+	Enhanced Thematic Mapper Plus
ETS	Emission Trading System
EU	European Union
EUFOR	European Union Forces
FAO	Food and Agriculture Organization
FARDC	Forces armées de la République démocratique du Congo
FASA	Faculté d'Agronomie et des Sciences agricoles
FC	Congolese Franc
FCCC	Framework Convention on Climate Change
FCPF	Forest Carbon Partnership Facility
FD	Forêt domaniale
FDLR	Forces démocratiques de Libération du Rwanda
FEP	Forest Environnement Program
FF	Forestry Fund

FFEM	Fonds français pour l'Environnement mondial
FIB	Fédérations des Industriels du Bois
FIRMS	Fire Information for Resource Management System
FLEGT	Forest Law, Enforcement, Governance and Trade
FLU	Forest Logging Units
FMU	Forest Management Units
FONAMA	Fondo Nacional de Medio Ambiente
FORABOLA	Société forestière et agricole de la Mbola
FORAF	Forêt d'Afrique
FRA	Forest Ressource Assesment
FRCF	Fonds de Reconstitution du Capital forestier
FRED	Fund for the Reduction of Emissions from Deforestation
FRM	Forêt Ressources Management
FSC	Forest Stewardship Council
FSDF	Special Fund for Forestry Development
FSF	Special Fund for Wildlife
FTI	Forest Transparency Initiative
FUPROCAM	Fédérations des Unions de Producteurs de Cacao du Mbam et Inoubou
FZS	Frankfurt Zoological Society
GACC	Global Agreement on Climate Change
GDP	Gross domestic product
GEF	Global Environment Facility
GFA	Global Forest Alliance
GFBC	Groupement de la filière bois au Cameroun
GFW	Global Forest Watch
GHGs	Greenhouse Gas Emissions
GIC	Gilman International Conservation
GIS	Geographic Information System
GLC	Global Land Cover
GNI	Gross National Income
GNP	Gross National Product
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GRASP	Great Apes Survival Partnership
GRUMCAM	Grumes du Cameroun
GTZ	German Society for Technical Cooperation
GWZ	Gebroeders Wijma & Zonen B.V.
HCP	Heartland Conservation Process
HDI	Human Development Index
HIPC	Heavily Indebted Poor Countries
HIV	Human Immunodeficiency Virus
IAK	Indices of Kilometer Abundance
ICASEES	Institut centrafricain des Statistiques et des Études économiques et sociales
ICCN	Institut congolais pour la Conservattion de la Nature
ICRA	Institut centrafricain de Recherche agronomique
ICRAF	International Centre for Research in Agroforestry
IDA	International Development Association
IDP	Internally Displaced People
IDR	Institut de Développement rural
IFB	Industries forestières de Batalimo
IFIA	Interafrican Forest Industries Association
IFL	Industrie forestière de Lambaréné
IFO	Industrie forestière de Ouesso
IGA	Income-Generating Activities
IGCP	International Gorilla Conservation Programme
IJZBC	Institut des Jardins zoologiques et botaniques du Congo
IMCS	International Media, Conseils & Services
IMF	International Monetary Fund
IMPM	Institute of Medical Research and Medicinal Plants
IMU	Inventory and Monitoring Unit
INADES	Institut africain pour le Développement économique et Social
INC	Institut national de la Cartographie
INCEF	International Conservation and Education Fund
INCOMA	Instituto Nacional de Conservación del Medio Ambiente
INDEFOR-AP	Instituto Nacional de Desarrollo Forestal y Gestión de Áreas Protegidas
INERA	Institut national pour l'Étude et la Recherche agronomique
INS	National Statistic Institute
IO	Independent Observer
IPACC	Indigenous Peoples of Africa Coordinating Committee
IPCC	Intergovernmental Panel on Climate Change
IPHAMETRA	Institut de Pharmacopée et de Médecine traditionnelle
IRAD	Institute of Agricultural Research for Development
IRAF	Institut de Recherche agronomique forestière
IRC	International Rescue Committee
IRD	Institut de Recherche pour le Développement
IRET	Institut de Recherche en Écologie tropicale

IRISH	Institut de Recherche en Sciences sociales
IRM	Innovative Resources Management
IRT	Institut de Recherche technologique
ISDR	Institut supérieur de Développement rural
ISEA	Institut supérieur d'Études agronomiques
ISO	International Standards Organisation
ITA	Institut technique agricole
ITB	Industries de Transformation de Bois
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
IWRM	Integrated Management of Water Resources
JERS	Japanese Earth Resources Satellite
JRC	Join Research Centre
Kg	Kilogram
KMM	Kougouleu-Medouneu-Mbe
KP	Kyoto Protocol
LCMNR	Local Committees for the Management of Natural Resources
LTCR	Lake Tele Community Reserve
LULUCF	Land Use, Land Use Change and Forestry
MA	Monte Alén
MAB	Man and the Biosphere
MAE	Ministère des Affaires étrangères
MBG	Missouri Botanical Garden
MC	Monts de Cristal
MDGs	Millennium Development Goals
MDRI	Multilateral Debt Relief Initiative
MEA	Millennium Ecosystem Assessment
MECNEF	Ministère de l'Environnement, Conservation de la Nature, Eau et Forêt
MECNT	Ministère de l'Environnement, Conservation de la Nature et Tourisme
MEF	Ministère de l'Économie Forestière
MEFCPE	Ministère des Eaux, Forêts, Chasses et Pêches et de l'Environnement
MEFE/CAB	Ministère de l'Économie forestière et l´Environnement
MEFEPA	Ministère de l'Économie forestière, des Eaux, de la Pêche et de l'Aquaculture
MEFEPPN	Ministère de l'Économie forestière, des Eaux, de la Pêche et des Parcs nationaux
MERIS	Medium Resolution Imaging Spectrometer
MFA	Ministère des Forêts et de l'Agriculture
MIKE	Monitoring of the Illegal Killing of Elephants
MINEF	Ministère de l´Environnement et des Forêts
MINEP	Ministère de l'Environnement et de la Protection de la Nature
MINFOF	Ministère des Forêts et de la Faune
MINRESI	Ministère de la Recherche scientifique et de l´Innovation
MLW	Maringa Lopori Wamba
MMT	Mbou-Mon-Tour
MODIS	Moderate Resolution Imaging Spectroradiometer
MOP	Meeting of the Parties to the Kyoto Protocol
MOU	Memorandum of Understanding
MPMA	Ministerio de la Pesca y del Medio Ambiente
MTKB	Maiko Tayna Kahuzi-Biega
MTN	Mobile Telephone Network
MW	MegaWatt
MWH	MegaWattHour
N/A	Not Available
NASA	National Aeronautics and Space Administration
NEPAD	New Partnership for Africa's Development
NGO	Non Governmental Organization
NN	Nouabalé Ndoki
NOAA	National Oceanic and Atmospheric Administration
NP	National Park
NPV	Net Present Value
NQAP	National Quota Allocation Plan
NR	Nature Reserve
NST	Nord Sud Timber
NTFP	Non-Timber Forest Products
OCEAN	Organisation for Economic Cooperation and Development
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OECD	Organisation de Coopération et de Développement Economique
OFAC	Observatoire des Forêts d'Afrique centrale
OFR	Okapi Faunal Reserve
OLB	Origine et Légalité du Bois
OLNP	Ogooué-Lékéti National Park
ONADEF	Office national de Développement des Forêts
ONADER	Office national du Développement rural
ONFi	Office national des Forêts international
ORTPN	Office rwandais du Tourisme et des Parcs nationaux
OSFAC	Observatoire satellital des Forêts d'Afrique centrale

PA	Protected Area
PAFC	Pan African Forest Certification
PAP	Pilot Action Program
PAPPFG	Projet d´Aménagement des petits Permis forestiers
PARN	Projet d'Aménagement des Ressources Naturelles
PARPAF	Projet d'Appui à la Réalisation des Plans d'Aménagement forestiers
PBNP	Plateaux Batéké National Park
PCBP	Timber Cutting Permits for Plantations
PDD	Project Design Document
PDS	Parc Dzanga-Sangha
PEA	Exploitation and Management Permit
PERSE	Protection des Écosystèmes et des Espèces rares du Sud de l'Équateur
PES	Payments for Environmental Services
PFA	Associated Forestry Permit
PGDRN	Programme de gestion durable des ressources naturelles
PGG	Permit by Mutual Consent
PGTCV	Projet de gestion des terroirs de chasse villageoise
PIN	Project Idea Note
PK	Kilometric Point
PNAF	Plan Nacional de Acción Forestal
PNAN	Altos de Nsork National Park
PNFoCo	National Forest and Conservation Program
PNKB	Kahuzi-Biega National Park
PNMA	Monte Alén National Park
PNMC	Monts de Cristal National Park
PNOK	Odzala-Kokoua National Park
PNVi	National Park of Virunga
PPG	Projet protection des gorilles
PRA	Participative Rural Assesment
PRGF	Poverty Reduction and Growth Facility
PROGEPP	Projet de gestion des écosystèmes en périphérie du Parc national de Nouabalé-Ndoki
PS	Special Permit
PSC	Harvesting Special Permit
PSFE	Forest Environment Sectoral Program
PTY	Propriety
PWS	payment for watershed services
R/S	Root/shoot Ratios
RAPAC	Network of Protected Areas of Central Africa
REDD	Reducing Emissions from Deforestation and Degradation
REM	Resource Extraction Monitoring
RFA	Redevance forestière annuelle
RFLY	Lomako Yokokala Faunal Reserve
RGC	Reférentiel Géographique Commun
RHD	Rutshuru Hunting Domain
RIGC	Renforcement des initiatives pour la gestion communautaire
RMMC	Monts de Cristal Military Reserve
ROC	Republic of Congo
R-PIN	Readiness Plan Idea Note
RS	Remote sensing
RVF	Régie des Voies fluviales
RVM	Régie des Voies maritimes
SAFBOIS	Société africaine de Bois
SAP	Sylvo-Agro-Pastoral
SAR	Synthetic Aperture Radar
SARS	Severe Acute Respiratory Syndrome
SBSTA	Subsidiary Body for Scientific and Technical Assistance
SCAD	Société centrafricaine de Déroulage
SCAF	Société centrafricaine forestière
SCEVN	Service commun d'Entretien des Voies navigables
SCPFFEI	Service de Contrôle des Produits forestiers et fauniques à l'Exportation et à l'Importation
SDR	Special Drawing Rights
SDSU	South Dakota State University
SEBAC	Société d'Exploitation des Bois d'Afrique centrale
SEBO	Société des Élevages du Bandundu Occidental
SEBOCA	Société d'Exploitation des Bois de Centrafrique
SEDAF	Société d'Exploitation-Développement agricole et forestier
SEEF	Société équatoriale d'Exploitation forestière
SEFAC	Société d'Exploitation forestière et agricole du Cameroun
SEFCA	Société d'Exploitation forestière centrafricaine
SESAM	Société d'Exploitation forestière de Sangha Mbaéré
SETRAF	Société d'Études et des Travaux forestiers
SFCS/TTS	Société forestière de Commerce et de Service/ Transformation tropicale du Sud
SFID	Société forestière et industrielle de la Doumé
SGS	Société générale de Surveillance

SI	Smithsonian Institute
SIBAF	Société industrielle des Bois Africains
SICOBOIS	Société industrielle congolaise de Bois
SIFORCO	Société industrielle et forestière du Congo
SLS	Salonga-Lukenie-Sankuru
SNBG	Société nationale des Bois du Gabon
SNP	Salonga National Park
SNR	National Reforestation Service
SNV	Netherlands Development Organisation
SOC	Soil Organic Carbon
SODECAO	Société de Développement du Cacao
SODEFOR	Société de Développement forestière
SOF	State of the Forest
SOFIL	Société forestière et industrielle de Léboulou
SOFORMA	Société forestière du Mayumbe
SOTER	Soil and Terrain (Database)
SPIAF	Service permanent d'Inventaire et d'Aménagement Forestier
SRTM	Shuttle Radar Topography Mission
STBK	Société de Transformation de Bois de la Kadey
TAF	The Aspinal Foundation
TCA	Thanry Centrafrique
TCCB	Tayna Center for Conservation Biology
TED	Turtle Excluding Device
TEREA	Terre Environnement Aménagement
TFAP	Tropical Forestry Action Plan
TL2	Tshuapa-Lomami-Lualaba
TLTV	Timber Legality and Traceability Verification
TM	Thematic Mapper
TMC	Technical Management Committee
TNS	Sangha Tri-National
TOE	Tonnes of Oil Equivalent
TRABEC	Transformation des Bois exotiques du Congo
TRC	Transformation REEF Cameroun
TSR	Total Sub-Region
UAM	Universidad Autónoma de Madrid
UCL	Université catholique de Louvain
UFA	Unité forestière d'aménagement
UGADEC	Union des associations de conservation des gorilles pour le développement communautaire
UMD	University of Maryland
UNDP	United Nation Development Programme
UNEP	United Nation Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	UN Framework Convention on Climate Change
UNFPA	United Nations Population Funds
UNGE	Universidad Nacional de Guinea Ecuatorial
UNHCR	United Nations High Commission for Refugees
UNPP	United Nations Population Prospects
UPARA	Unité pilote d'Afforestation, de Reboisement et d'Aménagement
UPF	Urban and peri-Urbain Forestry
US	United States
USA	United States of America
USAID	United States Agency for International Development
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USLAB	Surveillance and Anti-Poaching Units
USTM	Université des Sciences et Techniques de Masuku
VMA	Maximum Annual Volume
VPA	Voluntary Partnership Agreements
WCBR	Wamba Commitee for Bonobo Research
WCMC	World Conservation Monitoring Center
WCS	Wildlife Conservation Society
WD	Wildlife Direct
Westcor	Western Power Corridor
WFC	World Fish Center
WRI	World Resource Institute
WWF	World Wildlife Fund for Nature
ZIC	Zone d'Intérêt cynégétique
ZICA	Zone d'intérêt cynégétique amodiée
ZICGC	Zone d'intérêt cynégétique à gestion communautaire
ZSL	Zoological Society of London
ZSM	Zoological Society of Milwaukee

Annexes

Annex 1: Data for Cameroon

Contribution of the forestry sector to the national economy

Economic data	Value	Year
Contribution to GDP (%)	6.00	2004
Contribution to tax revenues (%)		
Direct employments (N)	13,000	2006
Indirect employments (N)	150,000	2006

Log production in 2006: 2,296,254 m^3

Main species harvested in the formal sector in 2006

Species	Volume harvested (m^3)	%
Ayous/Obéché	799,820	34.84
Sapelli	377,142	16.43
Tali	159,788	6.96
Azobé/Bongossi	117,265	5.11
Iroko	89,658	3.90
Okan/Adoum	87,762	3.82
Fraké/Limba	86,449	3.77
Movingui	50,870	2.22
Kossipo/Kosipo	45,367	1.98
Padouk	45,252	1.97
Total others species (11 to 120)	436,635	19.02
Total	**2,296,008**	**100.00**

Production by type of logging title (m^3)

Type	2005	2006
Timber recovery permit (timber salvage authorization and timber removal authorization)	141,743	154,830
Timber concession	1,683,045	1,866,228
Sales of standing volume	157,336	275,195
Total	**1,982,124**	**2,296,253**

Production of the 10 most important companies (m^3)

Company	2005	2006
GRUMCAM	N/A	105,893
PALLISCO	67,742	97,943
STBK	N/A	93,386
CFC	71,744	91,767
CUF	N/A	85,436
SEFAC	99,918	84,972
GWZ	90,744	71,857
CIBC	N/A	66,757
SIBAF	64,535	65,848
SFID	79,634	65,194
ALPICAM	75,183	N/A
CAMBOIS	102,119	N/A
Ing F	81,057	N/A
PLACAM	61,172	N/A
Total	**793,848**	**829,053**

N/A: Not available

Processed products (m^3)

Product type	2005	2006	2007
Plywood	23,000	18,000	22,000
Veneer	63,000	57,000	64,286
Sawn wood	660,000	601,000	613,000
Planed sawn wood	4,980	4,290	3,204
Others			64,000
Total	**750,980**	**680,290**	**766,490**

Exports by type of products (m^3)

Products	2005	2006	2007
Plywood	23,000	18,000	22,000
Logs	146,000	316,000	266,000
Veneer	63,000	57,000	64,286
Sawn wood	660,000	601,000	613,000
Planed sawn wood	4,980	4,290	3,204
Total	**896,980**	**996,290**	**968,490**

Export destinations (m³)

Region	2006	2007
Africa (excluding COMIFAC countries)	43,384	50,518
North America	19,435	26,906
Asia	277,956	215,503
Other destinations	19,530	34,609
COMIFAC countries	3,804	8,184
European Union	632,020	632,690
Total	**996,129**	**968,410**

Management of forest concessions

Management status	Number	Area (ha)	Year
Annual cutting range (total)	91	247,758	2007
Under definitive agreement (management plans approved)	65	4,207,862	2008
Under provisional agreement (management plan in preparation)	38	1,866,171	2008
Total concessions allocated	**103**	**6,074,033**	**2008**

Processing units

Type of unit	Number of units	National capacity (m³)	Year
Sawmill	51	519,941	2007
Peeling plant	10	128,572	2007

Protected areas in 2007

Protected area type	IUCN category	Number	Total area (ha)
National park	II	15	2,682,407
Wildlife reserve	Ib	6	702,995
Zoological garden		3	8
Botanical garden	Ia	1	44
Wildlife sanctuary	III	4	94,811
Forest reserve	Ia	77	880,496
ZICGC	VI	22	1,396,382
ZIC	VI	46	4,680,193
Total		**174**	**10,437,336**

Annex 2: Data for Gabon

Contribution of the forestry sector to the national economy

Economic data	Value	Year
Contribution to GDP (%)	4.30	2007
Contribution to tax revenues (%)	1.80	2007
Direct employments (N)	12,868	2007
Indirect employments (N)		

Log production in 2005: 2,769,902 m^3

Main species harvested in the formal sector in 2007

Species	Volume harvested (m^3)	%
Okoumé/Ozigo	2,144,434	64.00
Others species	1,206,244	36.00
Total	**3,350,678**	**100.00**

Production by type of logging title(m^3)

Type	2007
Temporary Logging Permit	1,128,147
Others	611,565
Associated Forestry Permit	566,275
Forestry Concession under Sustainable Management	527,478
Industrial Permit	508,056
Lots Railway Development Zone Permit	9,157
Total	**3,350,678**

Production of the 10 most important companies (m^3)

Company	2007
Rougier Gabon	390,778
Compagnie équatoriale des Bois	323,975
HTG	195,506
Compagnie forestière des Abeilles	132,023
Bois et Sciages de l'Ogooué	119,794
Compagnie des Bois du Gabon	118,930
Toujours Vert	107,747
GEB	87,308
Exploitation gabonaise des Grumes	82,681
Cora Wood	78,896
Total	**1,637,638**

Processed products (m^3)

Product type	2005	2006	2007
Plywood	81,922	32,900	84,795
Peeled veneer	237,501	180,717	180,516
Sliced veneer	2,856		1,285
Sawn wood	200,151	200,239	296,406
Total	**522,430**	**413,856**	**563,002**

Exports by type of products (m^3)

Products	2005	2006	2007
Plywood	67,177	29,906	58,439
Logs	1,586,228	1,768,080	1,938,079
Peeled veneer	121,899	194,150	163,048
Sliced veneer	2,256	1,582	1,347
Sawn wood	152,724	164,537	253,227
Total	**1,930,283**	**2,158,255**	**2,414,139**

Management of forest concessions

Management status	Number	Area (ha)	Year
Annual cutting range (total)	12	74,392	2007
Under definitive agreement (management plans approved)	10	3,025,173	2007
Under provisional agreement (management plan in preparation)	33	6,018,597	2007
Total concessions allocated	**10**	**3,025,173**	**2007**

Processing units

Type of unit	Number of units	National capacity (m^3)	Year
Industrial sawmill	60	1,013,487	2007
Plywood plant	4	236,000	2007
Peeling plant	12	673,600	2007
Slicing plant	1	10,000	2007

Protected areas in 2007

Protected area type	IUCN category	Number	Total area (ha)
National park	II	13	2,191,367.37
Hunting zone		2	220,000
Wildlife reserve		1	20,000
Arboretum		1	
Total		**17**	**2,431,367.37**

Annex 3: Data for Equatorial Guinea

Contribution of the forestry sector to the national economy

Economic data	Value	Year
Contribution to GDP (%)	0.22	2007
Contribution to tax revenues (%)	0.20	2007
Direct employments (N)	2,000	2006
Indirect employments (N)		

Log production in 2007: 524,799 m^3

Main species harvested in the formal sector in 2007

Species	Volume harvested (m^3)	%
Okoume	247,133	48.04
Dabema	57,541	11.19
Okan	33,020	6.42
Ilomba	31,313	6.09
Azobe	28,387	5.52
Tali	22,212	4.32
Padouk	17,878	3.48
Sapelli	15,005	2.92
Kosipo	8,189	1.59
Eyong	5,693	1.11
Total others species (11 to ...)	48,055	9.34
Total	**514,424**	**100.00**

Production by type of logging title (m^3)

Type	2007
Community forest	84,262
Rental contract for logging	420,074
Timber concession	20,462
Total	**524,799**

Production of the 10 most important companies (m^3)

Company	2005	2006	2007
Shimmer Internacional	216,466	286,702	309,369
Sofmal	64,226	63,188	102,628
Rio Muni Timberland	N/A	7,856	32,036
Comali	N/A	20,357	31,838
Chilbo	13,494	15,755	23,457
Sinosa	15,848	4,153	12,541
Sijifo	N/A	2,913	9,991
ATO	6,000	3,089	1,816
Matroguisa	505	1,782	1,123
SAFI	N/A	187	N/A
Total	**316,540**	**405,983**	**524,799**

N/A: Not available

Processed products (m^3)

Product type	2005	2006	2007
Plywood			293
Sliced veneer	29,331	25,989	27,644
Sawn wood		1,432	784
Total	**29,331**	**27,421**	**28,721**

Exports by type of products (m^3)

Products	2005	2006	2007
Logs	384,946	450,061	547,299
Sliced veneer	33,068	31,819	31,101
Sawn wood	954	403	600
Total	**418,968**	**482,283**	**579,000**

Management of forest concessions

Management status	Number	Area (ha)	Year
Under provisional agreement (management plan in preparation)	1	50,000	1998

Processing units

Type of unit	Number of units	National Capacity (m^3)	Year
Sawmill	1		2007
Slicing plant	4	27,471	2006

Protected areas in 2007

Protected area type	IUCN category	Number	Total area (ha)
National park	II	3	303,000
Natural monument	III	2	39,000
Scientific reserve	I	2	51,500
Natural reserve	IV	6	192,500
Total		**13**	**586,000**

Annex 4: Data for the Central African Republic

Contribution of the forestry sector to the national economy

Economic data	Value	year
Contribution to GDP (%)	6.30	2007
Contribution to tax revenues (%)		
Direct employments (N)		
Indirect employments (N)		

Log production in 2007: 537,998 m³

Main species harvested in the formal sector in 2007

Species	Volume harvested (m³)	%
Sapelli	295,954	55.01
Ayous	81,279	15.11
Longhi aniégré	34,506	6.41
Kossipo	24,033	4.47
Iroko	22,458	4.17
Sipo	21,098	3.92
Tiama	14,561	2.71
Various red wood	11,110	2.07
Dibétou Bibolo	8,390	1.56
Padouk	6,195	1.15
Bossé	5,122	0.95
Doussier	3,059	0.57
Acajou	1,926	0.36
Paorosa	1,107	0.21
Bété	840	0.16
Total others species (16 to 34)	6,360	1.18
Total	**537,998**	**100.00**

Production by type of logging title (m³)

Type	2005	2006	2007
Exploitation and Management Permit	454,402	617,578	526,122
Harvesting Special Permit		7,283	11,875
Total	**454,402**	**624,861**	**537,998**

Main species harvested in the formal sector in 2007

Species	Volume harvested (m³)	%
Sapelli	295,954	55.01
Ayous	81,279	15.11
Longhi aniégré	34,506	6.41
Kossipo	24,033	4.47
Iroko	22,458	4.17
Sipo	21,098	3.92
Tiama	14,561	2.71
Various red wood	11,110	2.07
Dibétou Bibolo	8,390	1.56
Padouk	6,195	1.15
Bossé	5,122	0.95
Doussier	3,059	0.57
Acajou	1,926	0.36
Paorosa	1,107	0.21
Bété	840	0.16
Total others species (16 to 34)	6,360	1.18
Total	**537,998**	**100.00**

Production of the 10 most important companies in 2007

Company	2005	2006	2007
SEFCA	131,493	222,351	177,377
VICA	76,922	120,540	88,595
IFB (Batalimo, Ngotto et Léssé)	67,429	87,489	85,415
SCAF	36,339	44,153	72,552
Thanry	16,665	32,411	54,547
SCAD	56,003	69,746	47,637
SEBOCA	N/A	7,283	11,875
SEFACA	4,229	N/A	N/A
SESAM	8,688	N/A	N/A
SOFOKAD	56,635	40,888	N/A
Total	**454,402**	**624,861**	**537,998**

N/A: Not available

Processed products (m^3)

Product	2005	2006	2007
Plywood	1,434	805	740
Logs	454,402	624,861	537,998
Peeled veneer	4,686	6,293	4,300
Sawn wood	71,386	84,304	97,001
Total	**531,909**	**716,263**	**640,039**

Exports by type of products (m^3)

Product	2005	2006	2007
Plywood	5	475	513
Logs	145,912	192,259	193,213
Peeled veneer	4,686	6,293	4,300
Sawn wood	52,940	70,779	76,042
Total	**203,543**	**269,806**	**274,068**

Management of forest concessions

Management status	Number	Area (ha)	Year
Under definitive agreement (management plans approved)	8	1,739,055	2008
Under provisional agreement (management plan in preparation	3	582,789	2008
Total concessions allocated	**11**	**221,844**	**2008**

Processing units

Type of unit	Number of units	National capacity (m^3)	Year
Sawmill	7	500,000	2007
Slicing plant	2		

Annex 5: Data for the Republic of Congo

Contribution of the forestry sector to the national economy

Economic data	Value	year
Contribution to GDP (%)	5.60	2006
Contribution to tax revenues (%)	2.68	2007
Direct employments (N)	7,424	2007
Indirect employments (N)	14,848	2007

Log production in 2006: 1,330,980 m³

Main timber species harvested in the formal sector in 2007

Species	Volume harvested (m³)	%
Sapelli	575,591	43.87
Okoumé	295,221	22.50
Sipo	80,076	6.10
Bossé	45,146	3.44
Kossipo	29,641	2.26
Wengué	25,862	1.97
Acajou	24,633	1.88
Iroko	16,983	1.29
Moabi	5,167	0.39
Aniégré	2,199	0.17
Total others species (11 à ...)	211,386	16.11
Total	**1,311,905**	**100.00**

Production by type of logging title (m³)

Type	2005	2006	2007
Management and processing conventions	1,300,209	1,264,267	915,624
Industrial processing convention	36,617	58,055	50,776
Total	**1,336,826**	**1,322,322**	**966,400**

Production of the 10 most important companies in 2007

Company	2005	2006	2007
Congolaise industrielles des Bois	341,681	359,546	374,510
Congolaise industrielle des Bois du Niari	170,330	154,522	188,459
Industrie Forestière de Ouesso	175,648	163	163,639
Mokabi S.A.	74,043	98,848	126,099
Likouala Timber	165,728	67,124	94,618
Société Thanry Congo	20,319	42,247	57,231
Taman Industrie	78,239	167,703	53,715
Bois et Placages de Lopola	45,574	48,636	53,403
FORALAC	57,086	41,139	32,337
Industrie de Transformation des Bois de la Likouala	37,045	35,386	19,892
Total	**1,165,693**	**1,015,314**	**1,163,903**

Processed products (m^3)

Products	2005	2006	2007
Sawn wood	219,932	258,679	212,719
Plywood	6,390	7,456	8,665
Peeled veneer	14,376	2,224	44,826
Others		173,136	259,948
Total	**240,698**	**441,495**	**526,158**

Exports by type of products (m^3)

Products	2005	2006	2007
Plywood	1,974	2,980	1,755
Logs	709,710	632,665	522,497
Sliced veneer	13,040	3,968	15,307
Sawn wood	163,075	181,365	209,122
Others	17,731	135,282	250,746
Total	**905,530**	**956,260**	**999,427**

Management of forest concessions

Management status	Number	Area (ha)	Year
Annual cutting range (total)	26	181,687	2007
Under definitive agreement (management plans approved)	3	1,907,843	2007
Under provisional agreement (management plan in preparation)	22	6,371,718	2008
Total concessions allocated	**52**	**11,975,670**	**2007**

Processing units

Type of unit	Number of units	National Capacity (m^3)	Year
Sawmill	25	1,000,000	2007
Plywood plant	4	30,000	2007
Peeling plant	6	210,000	2007

Protected areas in 2007

Protected area type	IUCN category	Number	Total area (ha)
National park	II	3	2,189,161
Wildlife reserve	V	4	87,855
Sanctuary	IV	3	280,300
Hunting reserve	VI	2	346,301
Biosphere reserve	VI	1	148,006
Community reserve	VI	1	461,815
Total		**14**	**3,513,438**

Annex 6: Data for the Democratic Republic of Congo

Contribution of the forestry sector to the national economy

Economic data	Value	Year
Contribution to GDP (%)	1.00	2003
Contribution to tax revenues (%)		
Direct employments (N)	15,000	2006
Indirect employments (N)		

Log production in 2007: 310,000 m³

Main timber species harvested in the formal sector in 2007

Species	Volume harvested (m³)	%
Sapelli	60,914	19.65
Wenge	51,971	16.77
Afrormosia	31,138	10.05
Sipo	26,952	8.69
Tola	24,134	7.79
Iroko	24,036	7.75
Acajou	13,576	4.38
Bomanga	13,370	4.31
Tiama	10,986	3.54
Tchitola	9,385	3.03
Total others species (44)	43,514	14.04
Total	**309,976**	**100.00**

Production by type of logging title (m³)

Type	2005	2006	2007
License for cutting firewood and charcoal			
Artisanal cutting permit	49,422	60,813	24,966
Ordinary cutting permit/ACIBO	409,425	620,951	309,976
Private woodlots exploitation permit			
Special cutting permit			
Total	**458,847**	**681,764**	**334,942**

Production of the 10 most important companies (m³)

Company	2005	2006	2007
SIFORCO	37,709	69,005	65,740
SODEFOR	N/A	N/A	48,699
TRANS M	7,288	17,816	48,442
ITB	2,294	12,013	36,259
SEDAF	20,591	24,358	18,794
FORABOLA	3,591	11,700	17,184
SAFBOIS	9,922	N/A	14,643
SOFORMA	1,470	7,004	14,417
Bimpe Agro	N/A	N/A	13,794
SICOBOIS	N/A	N/A	8,063
CFT	1,092	2,114	N/A
Compagnie de Bois	1,343	N/A	N/A
RIBACONGO	N/A	1,924	N/A
SAFO	7,179	N/A	N/A
SAFO-K	N/A	2,684	N/A
SOEXFORCO	N/A	4,313	N/A
Total	**92,478**	**152,931**	**286,034**

N/A: Not available

Exports by type of products (m^3)

Products	2005	2006	2007
Plywood		5,525	6,762
Logs	111,243	150,883	208,087
Sliced veneer	1,171	2,549	1,392
Sawn wood	25,704	26,192	30,382
Planed sawn wood	5,134	891	1,152
Others	785	890,748	1,152
Total	**144,037**	**1,076,788**	**248,927**

Management of forest concessions

Management status	Number	Area (ha)	Year
Forests already classified	28	22,653,178	2006
Under provisional agreement (management plan in preparation)	46	6,590,628	2007
Total concessions allocated	**156**	**22,200,962**	**2006**

Protected areas in 2007

Protected area type	IUCN category	Number	Total area (ha)
National park	II	7	8,240,000
Hunting zone		24	
Natural reserve		11	
Wildlife reserve		2	2,372,626
Biosphere reserve		3	
Forestry reserve		5	
Scientific reserve		1	
Total		**53**	**10,612,626**

Annex 7: Plot-based aboveground biomass estimates

Country	Land use type	AGBM	AGB trees	AGB other	BGB root	Litter	Source
Cameroon (south)	Chromolaena fallow 2-3 years	69	54	15	16		Kanmegne, 2004
Cameroon (south)	Chromolaena fallow 4 years	6					Palm *et al.*, 2000
Cameroon (south)	Chromolaena fallow 4 years	8					Palm *et al.*, 2000
Cameroon (south)	Chromolaena fallow 4 years	9					Palm *et al.*, 2000
Cameroon (south)	Chromolaena fallow 4 years	13					Palm *et al.*, 2000
Cameroon (south)	Chromolaena fallow 4 years	15					Palm *et al.*, 2000
Cameroon (south)	Chromolaena fallow 4 years	22					Palm *et al.*, 2000
Cameroon (south)	Cocoa agroforest mature	159	158	1	45		Kanmegne 2004
Cameroon (south)	Cocoa agroforest mature	280					Palm *et al.*, 2000
Cameroon (south)	Cocoa agroforest mature	115					Palm *et al.*, 2000
Cameroon (south)	Cocoa agroforest mature	130					Palm *et al.*, 2000
Cameroon (south)	Cocoa agroforest mature	206					Palm *et al.*, 2000
Cameroon (south)	Cocoa agroforest mature	183	170	13	18	37	Sonwa, 2004
Cameroon	Crop (plantain field)	9	7	1	20		Kanmegne, 2004
Cameroon (south)	Crop (swidden)	68	67	1	13		Kanmegne, 2004
Cameroon	Crop (swidden)	46	45	1	25		Kanmegne, 2004
Dem. Republic of Congo	Evergreen monodominant Limbali		525				Makana (unpublished data 2008)
Cameroon	Evergreen rainforest	310					CTFT, 1969 in Brown, 1997
Côte d'Ivoire	Evergreen rainforest	510					Huttel and Berhnard-Reversat, 1975
Côte d'Ivoire	Evergreen rainforest	470					Huttel and Berhnard-Reversat, 1975
Côte d'Ivoire	Evergreen rainforest	450					Huttel, 1969 in Jaffré *et al.*, 1983
Cameroon	Evergreen rainforest	582	581	1	10	4	Ibrahima *et al.*, 2002
Cameroon	Evergreen rainforest logged	541	540	1	11	3	Ibrahima *et al.*, 2002
Cameroon (south)	Fallow 25 years	274					Palm *et al.*, 2000
Côte d'Ivoire	Fallow 10 years	62	56	6			Jaffré *et al.*, 1983
Cameroon (south)	Fallow 10 years	77					Palm *et al.*, 2000
Cameroon (south)	Fallow 11 years	190					Palm *et al.*, 2000
Côte d'Ivoire	Fallow 14 months	9	6	3	9	5	Jaffré *et al.*, 1983
Côte d'Ivoire	Fallow 15 years	78	67	11			Jaffré *et al.*, 1983
Cameroon (south)	Fallow 15 years	210					Palm *et al.*, 2000
Cameroon (south)	Fallow 15 years	270					Palm *et al.*, 2000
Cameroon (south)	Fallow 15 years	300					Palm *et al.*, 2000
Côte d'Ivoire	Fallow 2 years	15	12	2	9	7	Jaffré *et al.*, 1983
Cameroon (south)	Fallow 20 years	223					Palm *et al.*, 2000
Cameroon (south)	Fallow 20 years	230					Palm *et al.*, 2000
Côte d'Ivoire	Fallow 4 years	22	19	3	14	7	Jaffré *et al.*, 1983
Côte d'Ivoire	Fallow 6.5 years	38	29	10	26	5	Jaffré *et al.*, 1983
Cameroon	Fallow 8-10 years	96	90	6	23		Kanmegne, 2004
Cameroon (south)	Fallow 9 years	131					Palm *et al.*, 2000
Cameroon (south)	Fallow 9 years	140					Palm *et al.*, 2000
Cameroon (south)	Fallow 9 years	143					Palm *et al.*, 2000
Cameroon (south)	Fallow 9 years	243					Palm *et al.*, 2000
Dem. Republic of Congo	Fallow regrowth 17-18	152			31		Bartholomew *et al.*, 1953 in Jaffré *et al.*, 1983

Country	Land use type	AGBM	AGB trees	AGB other	BGB root	Litter	Source
Dem. Republic of Congo	Fallow regrowth 5	102			26		Bartholomew *et al.,* 1953 in Jaffré *et al.,* 1983
Dem. Republic of Congo	Fallow regrowth 8	144			23		Bartholomew *et al.,* 1953 in Jaffré *et al.,* 1983
Côte d'Ivoire	Guinean savanna 120 trees/ha		7.5				Abbadie *et al.,* 2006
Côte d'Ivoire	Guinean savanna 160 trees/ha		22				Abbadie *et al.,* 2006
Côte d'Ivoire	Guinean savanna 300 trees/ha		33				Abbadie *et al.,* 2006
Côte d'Ivoire	Guinean savanna 800 trees/ha		55				Abbadie *et al.,* 2006
Zambia	Miombo dry		85				Chidumayo, 1981
Zambia	Miombo dry		76				Chidumayo, 1981
Zambia	Miombo dry		91				Chidumayo, 1981
Zambia	Miombo dry		79				Chidumayo, 1981
Zambia	Miombo dry		81				Chidumayo, 1981
Zambia	Miombo dry	71	70	1	39		Chidumayo, 1993
Zambia	Miombo dry		28				Chidumayo, 2002
Zambia	Miombo dry		19				Chidumayo, 2002
Zambia	Miombo dry		5				Chidumayo, 2002
Zambia	Miombo dry		26				Chidumayo, 2002
Zimbabwe	Miombo dry	44	42	1		3	Frost, 1996
Zimbabwe	Miombo dry		23				Guy, 1981
Zimbabwe (Zambezian domain)	Miombo dry	56	55	1			Desanker *et al.,* 1997
Tanzania	Miombo dry		37				Luoga *et al.,* 2002
Tanzania	Miombo dry		14				Luoga *et al.,* 2002
Tanzania	Miombo dry		26				Malimbwi *et al.,* 1994
Zimbabwe	Miombo dry		22				Martin, 1974
Zimbabwe	Miombo dry	39	38	0			Ward and Cleghorn, 1964
Mozambique	Miombo dry		38				Williams *et al.,* 2008
Mozambique	Miombo dry		31				Williams *et al.,* 2008
Zambia	Miombo wet		93				Chidumayo, 1987; 1990
Zambia	Miombo wet		47				Endean, 1968
Dem. Republic of Congo	Miombo wet		144				Freson *et al.,* 1974; Malaisse *et al.,* 1975
Zambezian domain	Miombo wet	92	90	2			Desanker *et al.,* 1997
Dem. Republic of Congo	Miombo wet		66				Malaisse, *et al.,* 1975
Ghana	Moist deciduous forest	395					Alder, 1982 in Brown, 1997
Cameroun	Moist deciduous forest	312					Brown *et al.,* 1989
Dem. Republic of Congo	Moist deciduous forest	375	375				Makana (unpublished data 2008)
Cameroon (south)	Moist deciduous forest (logged)	409					Palm *et al.,* 2000
Cameroon (south)	Moist deciduous forest (logged)	437					Palm *et al.,* 2000
Cameroon (south)	Moist deciduous forest (logged)	510					Palm *et al.,* 2000
Cameroon (south)	Moist deciduous forest (logged)	528					Palm *et al.,* 2000
Cameroon (south)	Moist deciduous forest (logged)	536					Palm *et al.,* 2000
Côte d'Ivoire	Oil palm 15 years		50				Jaffré *et al.,* 1983
Côte d'Ivoire	Oil palm 21 years		50				Jaffré *et al.,* 1983
Côte d'Ivoire	Oil palm 3 years		8				Jaffré *et al.,* 1983

Country	Land use type	AGBM	AGB trees	AGB other	BGB root	Litter	Source
Côte d'Ivoire	Oil palm 4 years		11				Jaffré *et al.,* 1983
Côte d'Ivoire	Oil palm 7 years		24				Jaffré *et al.,* 1983
Côte d'Ivoire	Oil palm 9 years		34				Jaffré *et al.,* 1983
Côte d'Ivoire	Secondary forest 40 years	230	224	6			Jaffré *et al.,* 1983
Ghana	Secondary forest old	236			54		Nye and Greenland, 1998
Cameroon	Secondary forest mature	380	376	4	45		Kanmegne, 2004

AGBM: Total aboveground biomass (Mg/ha); AGB trees: Aboveground biomass tree (Mg/ha); AGB other: Aboveground biomass tree (Mg/ha); BGB root: Below ground biomass other than trees (Mg/ha); Litter: Litter biomass (Mg/ha)

Annex 8: Carbon stock estimates (aboveground and belowground vegetation) from forest inventory data

Forest Types	Country	Surveyed area	Regression (tC/ha)	IPCC (tC/ha)
Young secondary forest from recolonization including savanna (Sangha river interval)	Congo	30	143	133
Young secondary forest resulting from the recolonization of savannas	Cameroon	284	128	128
Young secondary forest resulting from the recolonization of forest burned in the 70s (Sangha river interval)	Congo	101	99	156
Regrowth in savannas, *Aucoumea klaineana,* plateau formation (Upper Ogooué)	Gabon	287	157	144
Aucoumea klaineana young forest	Gabon	1,867	178	159
Marantaceae and *zingiberaceae* forest	Congo	843	83	135
Degraded forest	Congo	159	118	148
Millettia laurentii dense forest	Congo, DRC	1,643	108	179
Strombosiopsis tetrandra dense forest	DRC	1,467	109	137
Strombosia grandifolia and *pustulata* dense forest	Congo, DRC	5,391	146	172
Petersianthus macrocarpus and *Uapaca guineensis* dense forest	DRC	1,734	137	146
Triplochiton scleroxylon dense forest	Cameroon	688	203	196
Aucoumea klaineana dense forest	Gabon	7,505	200	170
Celtis mildbraedii and *zenkeri* semi-deciduous dense forest	Congo	2,142	166	185
Undifferentiated semi-deciduous dense forest	Cameroon	197	166	164
Manilkara spp. dense forest	Congo	8,232	178	153
Manilkara spp. and *Entandrophragma cylindricum* dense forest	Congo	1,685	174	204
Undifferentiated dense forest	Congo, Cameroon	1,076	166	178
Drypetes spp. dense forest	DRC	1,122	144	169
Gilbertiodendron dewevrei or *Brachystegia laurentii* dense forest	Congo, DRC, Cameroon	2,766	153	163
Swamp forests	Congo, DRC, Cameroon, Gabon	2,363	111	136
Dense forest on steep slope	Gabon	328	227	198

Source: Bayol, N. et al., 2008.

Annex 9: Carbon stock estimates using GIS modeling

Region	Forest type	TBM	TAGB	Source	Range
Tropical Africa	Lowland moist		299	Brown, 1997	
Tropical Africa	Lowland seasonal		141	Brown, 1997	
Tropical Africa	Lowland dry		60	Brown, 1997	
Tropical Africa	Lowland very dry		20	Brown, 1997	
Tropical Africa	Montane moist		105	Brown, 1997	
Tropical Africa	Montane seasonal		37	Brown, 1997	
Tropical Africa	Lowland moist	178		Gaston *et al.,* 1998	
Tropical Africa	Lowland seasonal	91		Gaston *et al.,* 1998	
Tropical Africa	Lowland dry	49		Gaston *et al.,* 1998	
Tropical Africa	Lowland very dry	17		Gaston *et al.,* 1998	
Tropical Africa	Montane moist	68		Gaston *et al.,* 1998	
Tropical Africa	Montane seasonal	25		Gaston *et al.,* 1998	
Tropical Africa	Tropical rainforest		310	IPCC, 2006	130-510
Tropical Africa	Tropical moist deciduous forest		260	IPCC, 2006	160-430
Tropical Africa	Tropical dry forest		120	IPCC, 2006	120-130
Tropical Africa	Tropical shrubland		70	IPCC, 2006	20-200
Tropical Africa	Tropical mountain			IPCC, 2006	40-190
Tropical Africa	Tropical equatorial forest	211		Gibbs and Brown, 2007	
Tropical Africa	Tropical seasonal forest	81		Gibbs and Brown, 2007	
Tropical Africa	Tropical dry forest	36		Gibbs and Brown, 2007	

TBM: Total biomass (Mg/ha); TAGB: Total aboveground biomass (Mg/ha)

Annex 10: Plot-based soil organic carbon estimates

Land use	Age	SOC	Source
Crop	1	56	Palm *et al.*, 2000
Crop	1	41	Palm *et al.*, 2000
Crop	1	18	Palm *et al.*, 2000
Crop	1	23	Palm *et al.*, 2000
Crop	1	38	Palm *et al.*, 2000
Fallow	1	72	Jaffré *et al.*, 1983
Fallow	2	89	Jaffré *et al.*, 1983
Fallow (chromolaena)	4	21	Palm *et al.*, 2000
Fallow (chromolaena)	4	43	Palm *et al.*, 2000
Fallow (chromolaena)	4	31	Palm *et al.*, 2000
Fallow (chromolaena)	4	30	Palm *et al.*, 2000
Fallow (chromolaena)	4	52	Palm *et al.*, 2000
Fallow (chromolaena)	4	58	Palm *et al.*, 2000
Humid forest fallow	4	82	Jaffré *et al.*, 1983
Humid forest fallow	7	88	Jaffré *et al.*, 1983
Humid forest fallow	9	30	Palm *et al.*, 2000
Humid forest fallow	9	36	Palm *et al.*, 2000
Humid forest fallow	9	40	Palm *et al.*, 2000
Humid forest fallow	9	37	Palm *et al.*, 2000
Humid forest fallow	10	55	Palm *et al.*, 2000
Humid forest fallow	11	40	Palm *et al.*, 2000
Humid forest fallow	15	36	Palm *et al.*, 2000
Humid forest fallow	15	45	Palm *et al.*, 2000
Humid forest fallow	15	61	Palm *et al.*, 2000
Humid forest fallow	15	79	Jaffré *et al.*, 1983
Humid forest fallow	20	48	Palm *et al.*, 2000
Humid forest fallow	20	32	Palm *et al.*, 2000
Humid forest fallow	22	51	Palm *et al.*, 2000
Humid forest fallow	25	33	Palm *et al.*, 2000
Cocoa agroforest	25	50	Palm *et al.*, 2000
Cocoa agroforest	25	53	Palm *et al.*, 2000
Cocoa agroforest	25	33	Palm *et al.*, 2000
Cocoa agroforest	25	40	Palm *et al.*, 2000
Cocoa agroforest	25	42	Palm *et al.*, 2000
Cocoa agroforest	25	37	Sonwa, 2004
Logged forest		37	Palm *et al.*, 2000
Logged forest		46	Palm *et al.*, 2000
Logged forest		38	Palm *et al.*, 2000
Logged forest		57	Palm *et al.*, 2000
Logged forest		49	Palm *et al.*, 2000
Mature forest		75	Jaffré *et al.*, 1983
Mature forest		64	Jaffré *et al.*, 1983

European Commission

The Forests of the Congo Basin - State of the Forests 2008

Luxembourg: Publications Office of the European Union

2010 — 416 p. — 21.5 x 28 cm

ISBN 978-92-79-13210-0
doi: 10.2788/32259

LB-30-09-123-EN-C

How to obtain EU publications ?

Publications for sale:

- via EU Bookshop (http://bookshop.europa.eu);
- from your bookseller by quoting the title, publisher and/or ISBN number;
- by contacting one of our sales agents directly. You can obtain their contact details on the Internet (http://bookshop.europa.eu) or by sending a fax to +352 2929-42758.

Free publications:

- via EU Bookshop (http://bookshop.europa.eu);
- at the European Commission's representations or delegations. You can obtain their contact details on the Internet (http://ec.europa.eu) or by sending a fax to +352 2929-42758.

Publications Office

The 2008 State of the Forest report benefited from financial support from the European Union, France, Germany and the United States, as well as the ECOFAC Program and UNESCO.

It represents the collaborative effort of over 100 individuals from a diversity of institutions and the forestry administrations of the Central African countries.

The process to elaborate the 2008 State of the Forest (SOF) report began with the selection and definition of indicators relevant to monitoring the state of forests in Central Africa. The indicators are structured around three thematic areas: (i) forest cover; (ii) management of production forests; and (iii) conservation and biodiversity. They are presented in a hierarchical structure at the regional, national and management unit (i.e. logging concessions and protected areas) levels. The indicators were vetted by a representative panel of stakeholders during a workshop held in Kribi in February 2008.

The indicators were used to guide the collection of data from April to August 2008, by national groups of four to ten individuals working within the forestry administrations. The majority of data collected is from 2006 and 2007. Results were validated in national workshops attended by government officials as well as representatives of environmental non-governmental organizations, the private sector and development projects. The entire report was reviewed by a scientific committee of international renown.

Federal Ministry for Economic Cooperation and Development

European Commission

ISBN 978-92-79-13210-0