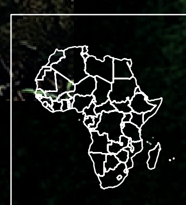
RÉPUBLIQUE
FRANÇAISE
Liberté
Égalité
Fraternité

FONDS FRANÇAIS POUR
L'ENVIRONNEMENT MONDIAL

IN FOCUS

TOWARDS MORE SUSTAINABLE MANAGEMENT OF CENTRAL AFRICAN PRODUCTION FORESTS



INNOVATE | EXPERIMENT | SHARE

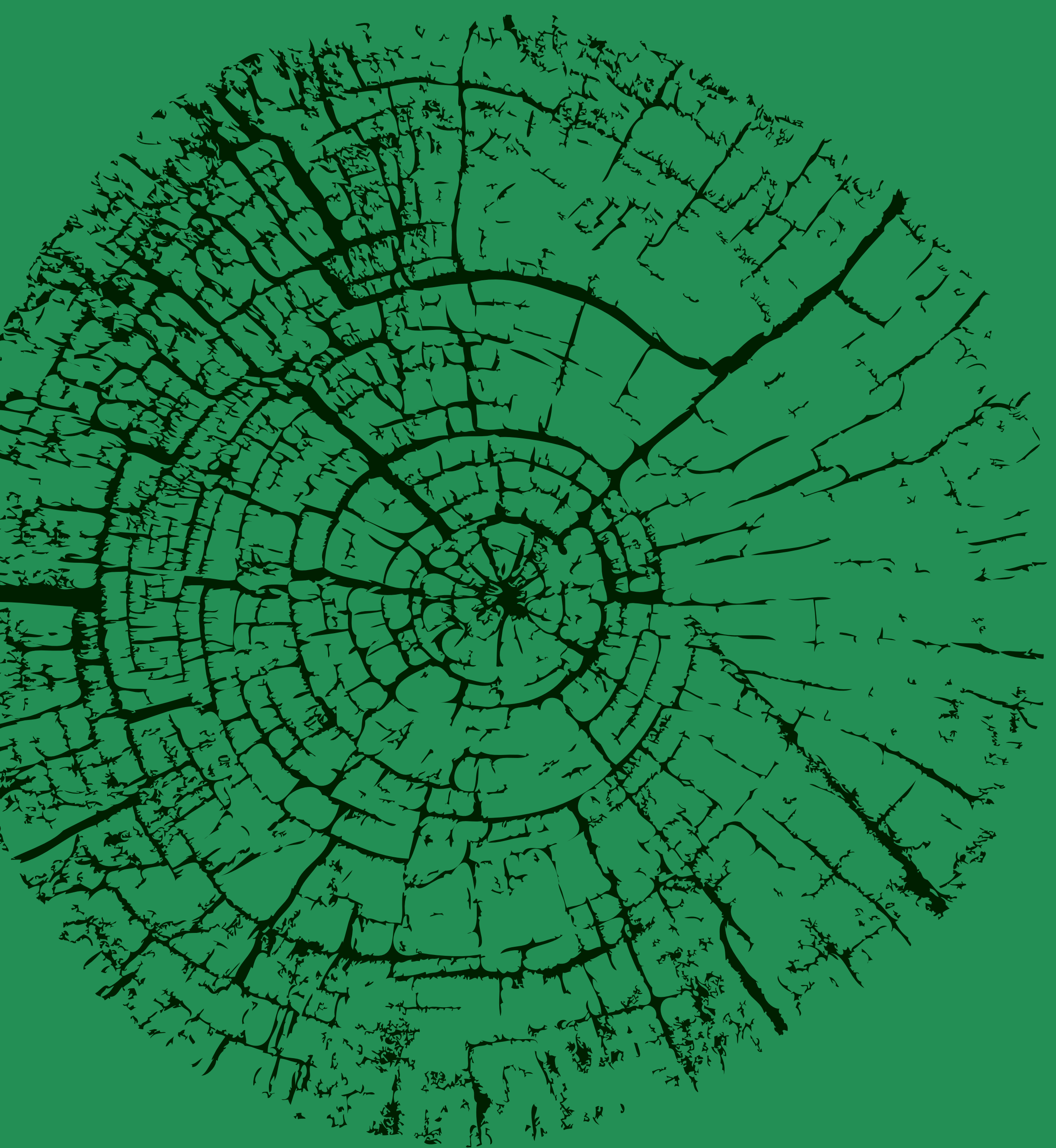
IN FOCUS is a series of reports on the French Facility for Global Environment's (FFEM) capitalisation projects. The aim of these projects is to share solutions and initiate large-scale change.

Since it was created by the French government in 1994, the FFEM has supported innovative projects combining environmental protection and socio-economic development in countries with developing and emerging economies.

Once evaluated and capitalised, these initiatives highlight technical and scientific knowledge, local expertise and novel ways of working.

Biodiversity, aquatic ecosystems, forestry and agriculture, resilient cities, the transition to a low-carbon economy, pollution – the IN FOCUS reports cover a wide range of topics and are aimed at anyone who puts innovation at the heart of their actions: development professionals, public and private actors, civil society organisations, funding partners and international organisations, and curious minds.

Happy reading!



ACKNOWLEDGEMENTS

This report would not have been possible without the support and contribution of the teams on the DynAfFor (Structure et Dynamics of Central African Forests) and P3FAC (The Public-Private Partnership for the Sustainable Management of Forests in Central Africa) projects. These project teams and their partners work under the umbrella of the DYNAFAC collective, which brings together:

- the Central Africa Forests Commission, a regional organisation under whose aegis these projects have been undertaken;
- two organisations, the International Tropical Timber Technical Association (ATIBT) and Nature+, which coordinated the projects;
- educational and research institutes which have led or contributed to forest dynamics research programmes: in France, CIRAD, the French agricultural research and international cooperation organisation; in Belgium, Gembloux Agro-Bio Tech at the University of Liège (GxABT) and the Free University of Liège (ULB); in Cameroon, the Agricultural Research Institute for Development (IRAD) and the University of Yaoundé; in Gabon, the Tropical Ecology Research Institute (IRET) and the Masuku University of Science and Technology; in the Central African Republic, the Central African Institute of Agricultural Research and the University of Bangui; in the Democratic Republic of the Congo, the National Institute of study and research in Agroeconomics (INERA) and the University of Kisangani (UNIKIS); in Congo, the National Forestry Research Institute (IRF) and Marien Ngouabi University;
- forestry companies, who agreed to data collection taking place in their concessions and helped to finance it: ALPICAM-GRUMCAM, Congolaise Industrielle des Bois (CIB) – An Olam Group Company, l'Industrie Forestière de Ouesso (IFO), PALLISCO, Precious Woods CEB, Rougier;
- national administrations which contributed to the governance of and strategic dialogue about project outcomes: the Cameroon Ministry of Forestry and Wildlife, the Gabon Ministry of Water and Forests, the Sea and Environment, the Central African Republic Ministry of Water, Forests, Hunting and Fishing, the Congo Ministry for the Forest Economy and the Democratic Republic of the Congo Ministry for the Environment and Sustainable development.

For their contributions to, and work in revising, this report, we especially want to thank: Jean-Louis Doucet (Gembloux Agro-BioTech), Eric Forni (CIRAD), Vivien Rossi (CIRAD), Cecilia Julve (Nature+), Benoît Jobbé-Duval (ATIBT), Isaac Zombo Dikélé (CIB Congo), Stevy Nna Ekome (CEB Precious Woods) and Alain Karsenty (CIRAD).

We pay tribute to Sylvie Gourlet-Fleury who set up and led the DynAfFor and P3FAC projects for CIRAD, who recently passed away in January 2023.

Lastly, we would like to thank our funding partners who invested jointly in these projects with the FFEM, most notably the KfW Investment and Development Bank (KfW) Programme for Promotion of Certified Logging (PPECF) and the Belgian Fund for Scientific Research (FNRS).

NOTE:

This publication summarises the capitalisation on more than 10 years of scientific research into the management of Central African forests supported by the French Facility for Global Environment (FFEM) but outsourced by the FFEM Secretariat to independent consultants. The views expressed are those of the consultants and do not necessarily reflect those of the FFEM. The publication reports on a sample of that work. The aim is to share as widely as possible the knowledge gained from the projects in this sample and is therefore not a comprehensive state-of-the-art report nor a full set of rules for the preservation and management of these tropical forests.

INTRODUCTION

This report is the combined result of more than ten years of research into the dynamics of Central African forests with the aim of improving their management. It shows the result of work undertaken by the DynAfFor and P3FAC projects, and more widely by the DYNAFAC collective, since 2012. It highlights the main results obtained over the duration of these projects, completed in 2022, which were the subject of a summary report and a set of recommendations directed at policy decision-makers and regional forestry administrations[1].

The aim of this new document is to make these results and recommendations from the DynAfFor and P3FAC projects more accessible to a wider audience. To this end, we have included an introduction giving the context of the current international debate on the exploitation of forests and the specific challenges facing Central Africa as well as an expanded conclusion on the prospects for the sector's future and the directions we need to take to ensure its sustainability. It also includes numerous photographs and illustrations, retaining the readers interest right up to the last page.

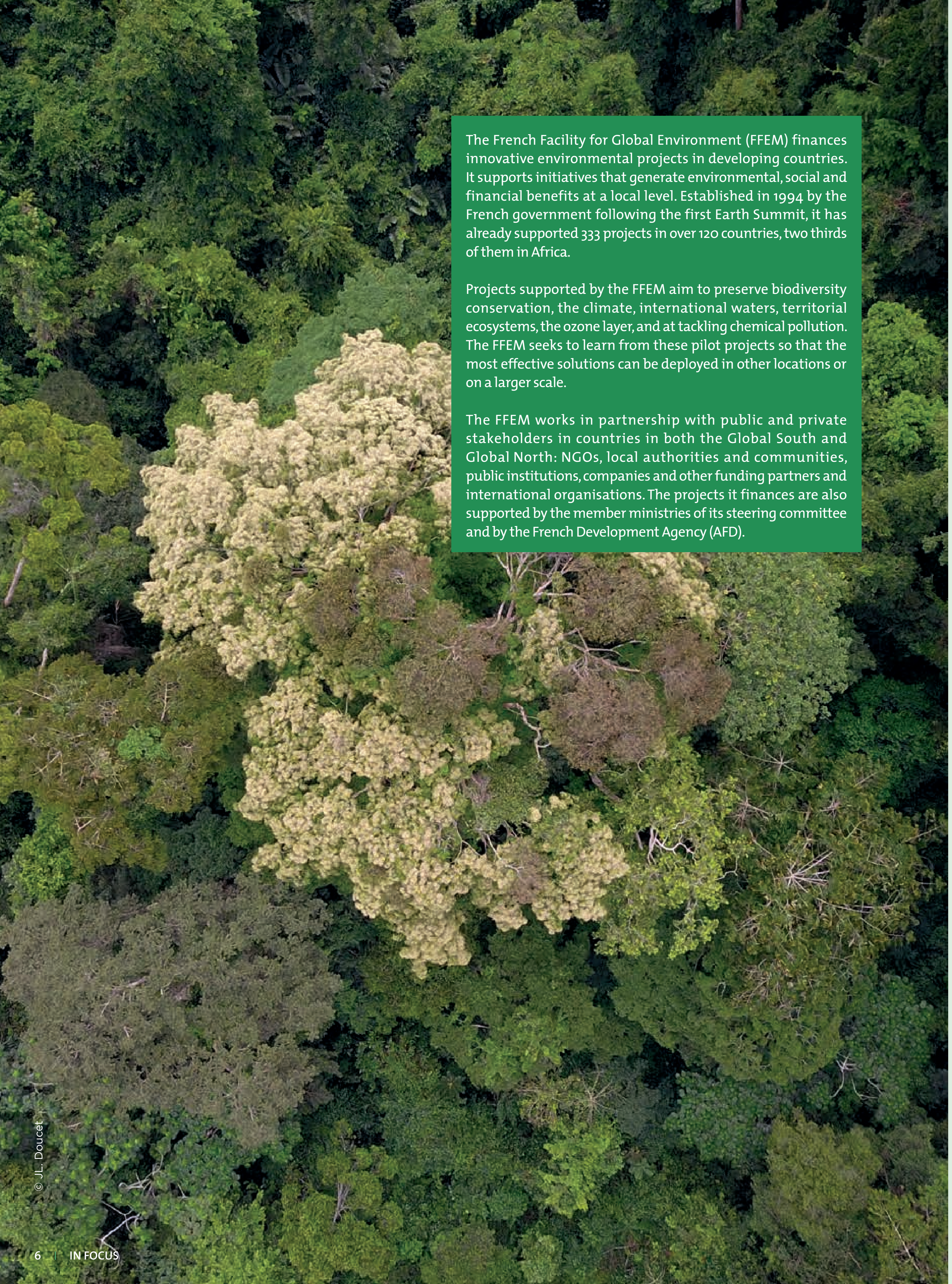
We offer our sincere thanks to the FFEM for the chance to publish these results in its IN FOCUS Capitalisation series. Our thanks also go to the reports' authors, who responded so effectively to the challenge of re-writing the reports for a wider audience.

This document does not deliver any outcomes in itself but is a report on progress so far. These research tools have not yet fully had the chance to prove their worth and reveal all their secrets. Long may they last! It is up to stakeholders and, above all, to administrative organisations in Central Africa to ensure the longevity of their use.

The DYNAFAC collective

1-https://www.dynafac.org/fr/media/59/documents-de-synthese-dynafac

© JL. Doucet



© JL. Doucet

The French Facility for Global Environment (FFEM) finances innovative environmental projects in developing countries. It supports initiatives that generate environmental, social and financial benefits at a local level. Established in 1994 by the French government following the first Earth Summit, it has already supported 333 projects in over 120 countries, two thirds of them in Africa.

Projects supported by the FFEM aim to preserve biodiversity conservation, the climate, international waters, territorial ecosystems, the ozone layer, and at tackling chemical pollution. The FFEM seeks to learn from these pilot projects so that the most effective solutions can be deployed in other locations or on a larger scale.

The FFEM works in partnership with public and private stakeholders in countries in both the Global South and Global North: NGOs, local authorities and communities, public institutions, companies and other funding partners and international organisations. The projects it finances are also supported by the member ministries of its steering committee and by the French Development Agency (AFD).

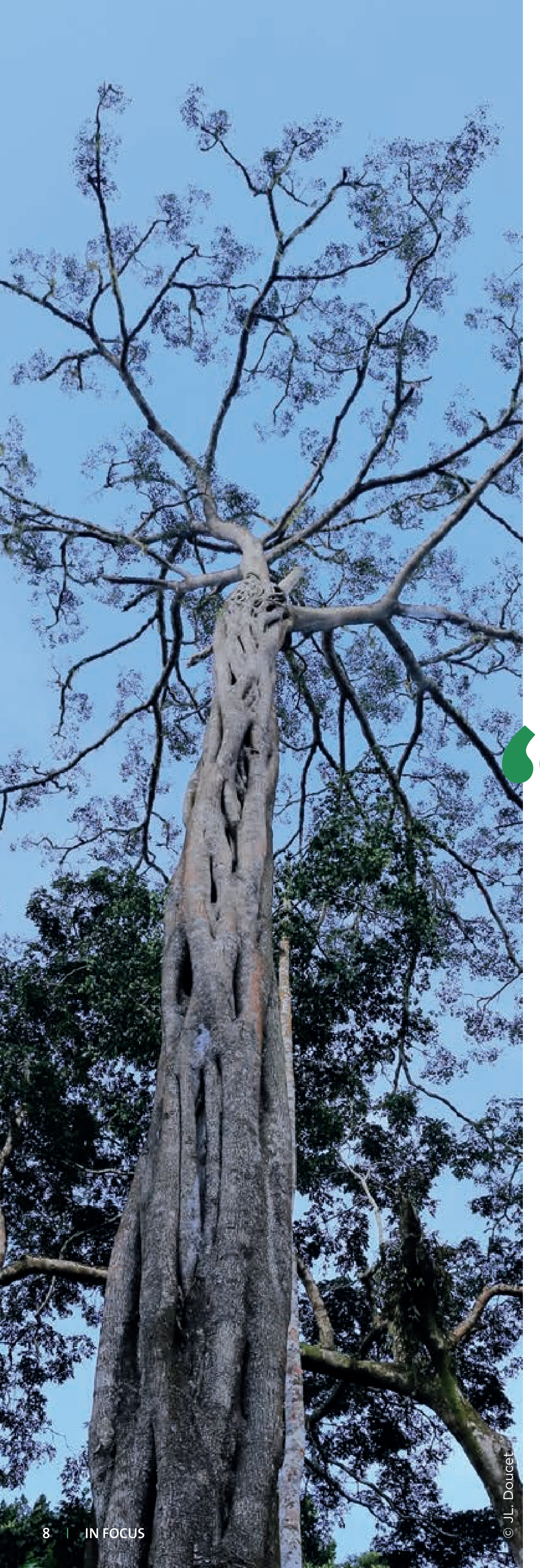
PREFACE

Project evaluation and capitalising on project outcomes are key steps in showcasing scientific and technical understanding, local knowledge and innovative practices to inform future action. Tapping into the interplay between experience gained and forward thinking, coupled with the multi-dimensional and dynamic nature of this capitalisation, based on many projects, allows for diverse contexts, past experience and field-proven solutions all to be taken into account. This results in a collaborative, participatory approach to sharing the lessons learned, involving many different parties – project sponsors, field staff, civil society organisations, research and other institutions in France and elsewhere.

© Jean-Yves De Vleeschouwer

“The challenge is to learn not only from successes and good practices, but also from failures, so that the most relevant solutions can be shared with different stakeholders and rolled out in other locations or at larger scale. The ability to test potential solutions, necessary for any innovation, is an integral part of the evaluation-capitalisation process because overcoming challenges leads to greater knowledge for all. Launched in 2021, the FFEM's new IN FOCUS series, under the theme of 'Innovate, Experiment, Share', aims to spread knowledge of the most significant of these socio-environmental innovations as widely as possible. Through the publication of in-depth reports, briefing notes for decision-makers and short films aimed at a wide audience, the series gives project sponsors an innovative platform to tell their stories.”

Clémentine Dardy,
Capitalisation Lead at the FFEM



© JL. Doucet

EDITORIAL

Christophe Bories,
Chair of the FFEM Steering Committee

Sustainable management of Central African production forests must be at the heart of our international response

“The second-largest area of tropical forest after the Amazon, the forests of Central Africa are a significant site for biodiversity and carbon storage, and provide numerous services to the people who depend on them. Today, more than ever before, they are subject to increasing pressures. Human activities such as agriculture expansion, mining, non-sustainable forest exploitation and infrastructure construction all threaten their survival.

It is essential that we maintain the best possible balance between economic development and the conservation of these forests which provide such invaluable services. The international community therefore puts promotion of sustainable supply chains and of responsible soil and forest management at the heart of its commitment to help.

The Alliance for the Preservation of Forests and the Congo Basin Forest Partnership are the main organisations driving this work. More recently, France and the European Union have passed new regulations to better combat imported deforestation.

The One Forest Summit, held in Gabon in March 2023, drew attention to the necessity for better management and financing of these forests, highlighting in particular the need for changes to the current economic models in the context of worsening climate change. The discussions also emphasised that forest research is still the keystone of cooperation at an international level. If we can improve our knowledge of these forests, we can improve our protection of them and ensure our shared future.”

Why support for projects such as Structure and Dynamics of Central African Forests (DynAfFor) and The Public-Private Partnership for the Sustainable Management of Forests in Central Africa (P3FAC) are at the heart of the FFEM’s strategy

“The FFEM has been supporting work on biodiversity conservation and awareness and on sustainable management of agricultural and forest areas for close to 30 years. Our new 2023-2026 strategy renewed our commitment to these two key areas of intervention. The Central African research and forest management projects which we have supported for ten years are in line with this strategy. Experimental in their nature, DynAfFor and P3FAC are powerful environmental initiatives which have shown the value of long-term trials and provided unique approaches to sustainable management of these industrial timber forests. The relationship between humanity and nature is key to the very structure of these pilot projects: the socio-economic status of these forest areas is studied just as much as their environmental status, while taking particular account of human activities and the future of local communities and Indigenous peoples living in and depending on these ecosystems.

The multi-partner approach fostered by DynAfFor and P3FAC is also a strong base for the projects supported by the FFEM, where the views of the public and private sectors, researchers, civil society organisations and citizens all converge and intertwine. It also provides a foundation for long-term, innovative solutions which progress to wider trials and then large-scale adoption. As a funding partner, we make sure that technical, scientific and policy outcomes are widely shared so that they can be adopted effectively by further projects. It is hoped that this leads to continuous improvement, enabling ever-growing impact from future projects.”

Stéphanie Bouziges-Eschmann,
Secretary-General of the FFEM

Sébastien Treyer,
Chair of the FFEM Scientific and Technical Committee

The importance of the research-action approach championed by this capitalisation on the forests of Central Africa

“This capitalisation report celebrates the result of 30 years of research in the forests of Central Africa. This in itself is cause for celebration at a time when, more than ever, the challenge is to strengthen knowledge of forest systems so that all the stakeholders involved can best protect and appreciate them. Our knowledge of the ecology of forest systems has increased enormously. This allows us to be much more ambitious but also more detailed and practical in deciding how best to manage these forests and the industries which rely on them for the good of biodiversity and the climate. The protection of both biodiversity and the climate is a key issue for the FFEM and justifies its significant investment in this research. The added scientific value of this work also plays a fundamental role in guiding improvements in policy and practical measures on sustainable forestry planning and management in the region. Thanks to this capitalisation-based approach, research feeds into action on the ground feed into each other, resulting in better forest conservation.

The results of this work apply as much to innovation in the field (for example, the introduction of surveys and monitoring of forest concessions) as to the improvement of national and international regulations regarding sustainable management and control of imported deforestation. In effect, this capitalisation report is in part an entreaty to policy makers. It is a way of spreading this knowledge to a wider audience – from the people on the ground to decision makers – raising awareness of regulatory changes that will improve balance and equity between stakeholders, and the sharing of natural resources.

Lastly, the mutual exchanges between researchers, forestry companies, public authorities and funding partners lead to a richly informed, collective discussion on the future of these forests, identifying strengths but also difficulties to be overcome in the short-, medium- and long-term, in particular, the challenges involved in the reinvention of economic models at the start of the second rotation of forest management plans for the region.”

CONTENTS

Acknowledgements 4
Introduction 5
Preface 7
Editorial 8

01 THE TROPICAL FORESTS OF CENTRAL AFRICA – A TREASURE WE MUST PRESERVE

— About the tropical forests of Central Africa 14
— Why it is essential to preserve the forests of Central Africa 16
— Reasons and ways to sustainably manage these forests 18
— The Forest Management Plan (FMP) – a vital tool in sustainable forest management 20
— Sustainable forest management and forest dynamics research - 30 years of FFEM support 22

02 RESEARCH ON FOREST DYNAMICS IN CENTRAL AFRICA: METHODS AND FINDINGS

— Project fundamentals: DynAfFor and P3FAC 26
— About the partners in the DYNAFAC collective 28
— A network of forest research sites for a better understanding of forests and their diversity 29
— Sampling routes, accessible research sites providing valuable results 30
— Plot sites, supplementary research sites providing important data 32
— Innovative technology aiding forestry research 34
— Dynamics of growth and mortality rates of the most common trees 36
— The fundamentals of forest regeneration dynamics 38
— The important role of the forests of Central Africa in mitigating climate change 40
— DafSim and DafSim-C, multi-rotation forest management simulation tools to aid improvements in sustainable forest management 42

03 SIX RECOMMENDATIONS FOR MORE SUSTAINABLE FOREST MANAGEMENT IN CENTRAL AFRICA

— Tailor forest management in each of the 10 major forest types of Central Africa 46
— Introduce a standard 30-year rotation period 47
— Set up sampling route sites in all concessions of more than 50,000 hectares 47
— Improve recovery rates for species logged for timber 48
— Specify region-wide standard Minimum Felling Diameters tailored to the local ecosystem 49
— Promote forest regeneration 50

04 CONCLUSION AND OUTLOOK

— Creating a network of researchers and key players in the forestry sector: DYNAFAC and R2FAC, successes and prospects 56
— The need for an effective communication and advocacy system 58
— The future of forest dynamics research sites 60
— Plantation forestry in managed concessions: risks and prospects 62
— Advances in sustainable management: how new methods and economic models are essential to the future of production forests 63

APPENDICES

Glossary 65
Bibliography 67
Authors' comments 68
Our partners 69
Presentation of the projects 70

01

THE TROPICAL FORESTS OF CENTRAL AFRICA – A TREASURE WE MUST PRESERVE

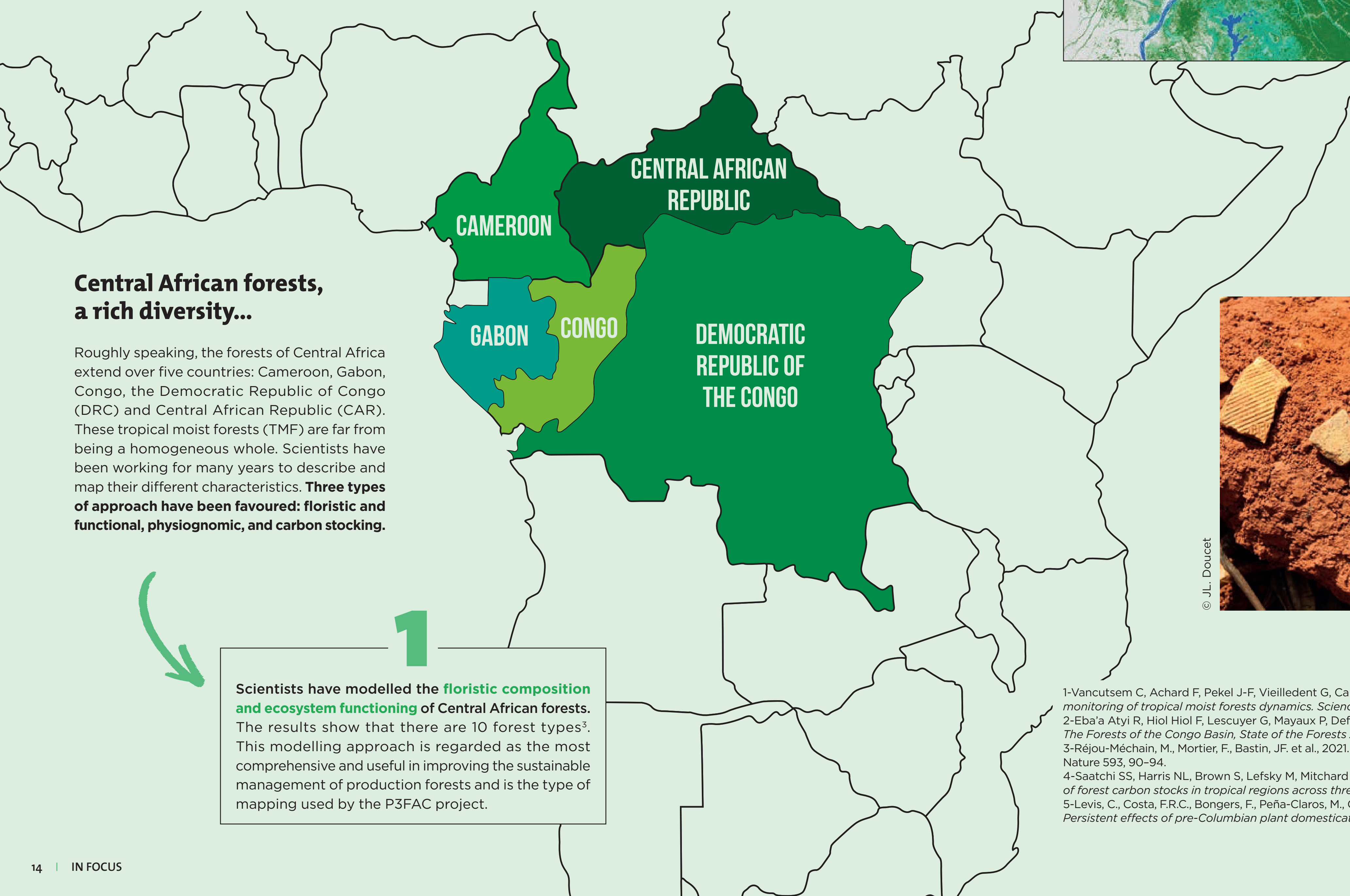
© Yorick Van Hoef

© Yorick Van Hoef

© ATIBT

About the tropical forests of Central Africa

The tropical forests of Central Africa extend over an area of more than 200 million hectares[1], making them second only to the Amazon in area of continuous massifs of dense rainforest. As well as being an exceptional carbon sink and reservoir of biodiversity for the countries where they are located and for the international community, they also provide the means of subsistence for 60 million people[2]. When they are sustainably managed and their timber is exploited responsibly, they are of major economic importance and contribute wealth, employment and tax revenues to their respective states. They are therefore an essential resource at all levels: ecological, economic, social and cultural.



Central African forests, a rich diversity...

Roughly speaking, the forests of Central Africa extend over five countries: Cameroon, Gabon, Congo, the Democratic Republic of Congo (DRC) and Central African Republic (CAR). These tropical moist forests (TMF) are far from being a homogeneous whole. Scientists have been working for many years to describe and map their different characteristics. **Three types of approach have been favoured: floristic and functional, physiognomic, and carbon stocking.**

1

Scientists have modelled the floristic composition and ecosystem functioning of Central African forests. The results show that there are 10 forest types[3]. This modelling approach is regarded as the most comprehensive and useful in improving the sustainable management of production forests and is the type of mapping used by the P3FAC project.

2

The use of high resolution satellite imagery (Sentinel-1 et -2), enabled the different types of forest in the Congo basin to be mapped at a resolution of 20m.

3

There are many studies which focus on the carbon stocks and carbon flux of Central African forests. Although as a whole these forests hold 40 Gt of carbon[4], the distribution of these stocks at a regional level is still largely unknown, mainly because of the lack of reliable field data and the time required to extrapolate accurate carbon stocks from remote sensing data.

...shaped by the climate and human activity

The spread of these Central African forest ecosystems is the result of the slow and complex process of evolution and of environmental and anthropogenic factors.

At a regional level, **the forests have undergone periods of expansion and regression associated with the main climatic periods**. Their heterogeneity is also due to the different geological substrates which result in different soil types.

Like phenomena recorded in the Amazon[5], characteristics of the Central African forests have been shaped by the history of human activity for the last three millennia. Researchers have been able to reconstruct some of the turbulent history of human contact within these forests by using palaeoecological and anthracological evidence. Far from being unspoilt by human intervention, the forests of this region have to a certain extent been "cultivated" by human communities for millennia. For example, the distribution of several heliophytes, some of them with major commercial value (ayous, afrormosia, limba, tali), is in part due to human activity, and agricultural activity in particular. The slave trade (depopulation of some areas) and colonisation (forced displacement) also had an impact on these forests, notably evidenced in the contemporary decrease in traditional slash and burn activity.

© JL. Doucet

1-Vancutsem C, Achard F, Pekel J-F, Vieilledent G, Carboni S, Simonetti D, Gallego J, Aragao L, Nasi R., 2020. *Long-term (1990-2019) monitoring of tropical moist forests dynamics. Science Advances*. 7: eabe1603.
2-Eba'a Atyi R, Hiol Hiol F, Lescuyer G, Mayaux P, Defourny P, Bayol N, Saracco F, Pokem D, Sufo Kankeu R and Nasi R., 2022. *The Forests of the Congo Basin, State of the Forests 2021*. Bogor, Indonesia: CIFOR.
3-Réjou-Méchain, M., Mortier, F., Bastin, JF. et al., 2021. *Unveiling African rainforest composition and vulnerability to global change*. Nature 593, 90–94.
4-Saatchi SS, Harris NL, Brown S, Lefsky M, Mitchard ET, Salas W, Zutta BR, Buermann W, Lewis SL, Hagen S., 2011. *Benchmark map of forest carbon stocks in tropical regions across three continents. Proceedings of the National Academy of Sciences.* 108(24):9899-9904.
5-Levis, C., Costa, F.R.C., Bongers, F., Peña-Claros, M., Clement, C.R., Junqueira, A.B., Neves, E.G., Tamanaha, E.K., Figueiredo, F.O.G., Salomão, R.P., 2017. *Persistent effects of pre-Columbian plant domestication on Amazonian forest composition.* Science 355, 6328: 925-931.

Why it is essential to preserve the forests of Central Africa

The forests of Central Africa are an invaluable resource for the local inhabitants who depend on them, and for humanity as a whole. Their exceptional biodiversity and their role in mitigating climate change mean that we must act to preserve them, especially in the face of existing threats to their future.

FORESTS THAT... PEOPLE CALL HOME

The forests of Central Africa have always been home to human communities. Nowadays, the majority of people living in the forests of Central Africa depend directly or indirectly on the forest for essential services such as water (springs and rivers), food (meat, fish, fruit, grains, edible plants, edible fungi etc.) and wood for heating, cooking, building and navigation.

© ATIBT

...ARE RICH IN BIODIVERSITY

These forests include a range of high conservation value (HCV) areas, which between them contain more than 10,000 plant species and more than 400 mammalian species. Many of these species are endemic and some are facing extinction. We often hear about iconic and threatened mammals such as the gorilla, the chimpanzee, the elephant, the forest buffalo and the big cats but innumerable bird, reptile and amphibian species, most of which are endemic, are also at risk.

...ARE VITAL CARBON SINKS AND STOCKS

The forests of Central Africa hold about **40 Gt of carbon**[6]**, the equivalent of more than four years of man-made, fossil fuel emissions** from oil, gas and coal. Unlike the forests of South America which ceased sequestering carbon in the early 1990s, the forests of Central Africa are still sequestering carbon. It is estimated that they can sequester 0.66 tCO_2/ha/year, equating to approximately 132 MtCO_2/year over the 200 Mha of forest in the region[7]. It is therefore vital that these high carbon stock (HCS) forests are preserved so that they can continue to contribute to climate change mitigation.

© JL. Doucet

DID YOU KNOW?

Deforestation and forest degradation

Deforestation is defined as a reduction in the land area covered by forest. If the area lost is not replaced by plantations or reforestation, it is termed permanent deforestation.

Forest degradation is defined as a reduction in the quality of forest cover (number of trees, biodiversity, ecosystem services). It is possible to reverse this degradation progressively over the medium- to long-term.

...ARE SLASHED AND BURNED FOR FARMING

In tropical regions, man has always used slash and burn as a method of agriculture. This method, in which the forest is cut and burned before planting of crops, is still widely used for the production of manioc, yams, bananas and other basic crops forming the basic diet of the Central African population. Population growth and the resulting increase in demand for food lead to the clearance of more land, especially in suburban areas and along major roads. Developing and implementing alternative sustainable agricultural methods is the only way to protect these forests while also allowing local people to grow their own food.

© Jean-Yves De Vleeschouwer

...ARE THREATENED BY AGRO-INDUSTRIAL PLANTATIONS

Just as is already the case in South America and South-East Asia, there is strong interest from agro-industries in the enormous potential of Central Africa. While there are not yet many large agricultural commodity plantations (palm oil, rubber, soya beans, coffee, cocoa etc.) in the region, the land is well suited for them and there is growing interest from international investors. This type of development often results in deforestation.

© ATIBT

...ARE EXPLOITED FOR THEIR TIMBER

Lastly, the forests of Central Africa are exploited for their timber by small- and large- scale industry. Large-scale logging in forestry concessions is mostly driven by international demand for tropical timbers valued for their aesthetic appeal and durability. These qualities add to their value for use in joinery, cabinetmaking and veneers. In forests close to large urban areas, timber felling for local use can also reach damaging levels.

6-Saatchi SS, Harris NL, Brown S, Lefsky M, Mitchard ET, Salas W, Zutta BR, Buermann W, Lewis SL, Hagen S., 2011. *Benchmark map of forest carbon stocks in tropical regions across three continents*. Proceedings of the National Academy of Sciences. 108(24):9899-9904.
7-Hubau, W., Lewis, S.L., Phillips, O.L. et al., 2020. *Asynchronous carbon sink saturation in African and Amazonian tropical forests*. Nature 579, 80–87. https://doi.org/10.1038/s41586-020-2035-0.

Reasons and ways to sustainably manage these forests

Although countries in Central Africa want to protect their forests from deforestation and degradation, this clashes with the need to develop their economy. In fact, the value of this timber resource contributes significantly to the economy of these countries, to their tax revenue, and to job creation. Sustainable management of production forests is a way to realise this value while still protecting the forest ecosystems from other, more reckless, uses of the land. According to the International Tropical Timber Organisation, the aim of managing production forests sustainably is "to continue to provide sought-after goods and services, without unnecessary damage to the natural quality of the forest or its future productivity and without any unwanted or unnecessary effects on the environment or social conditions".

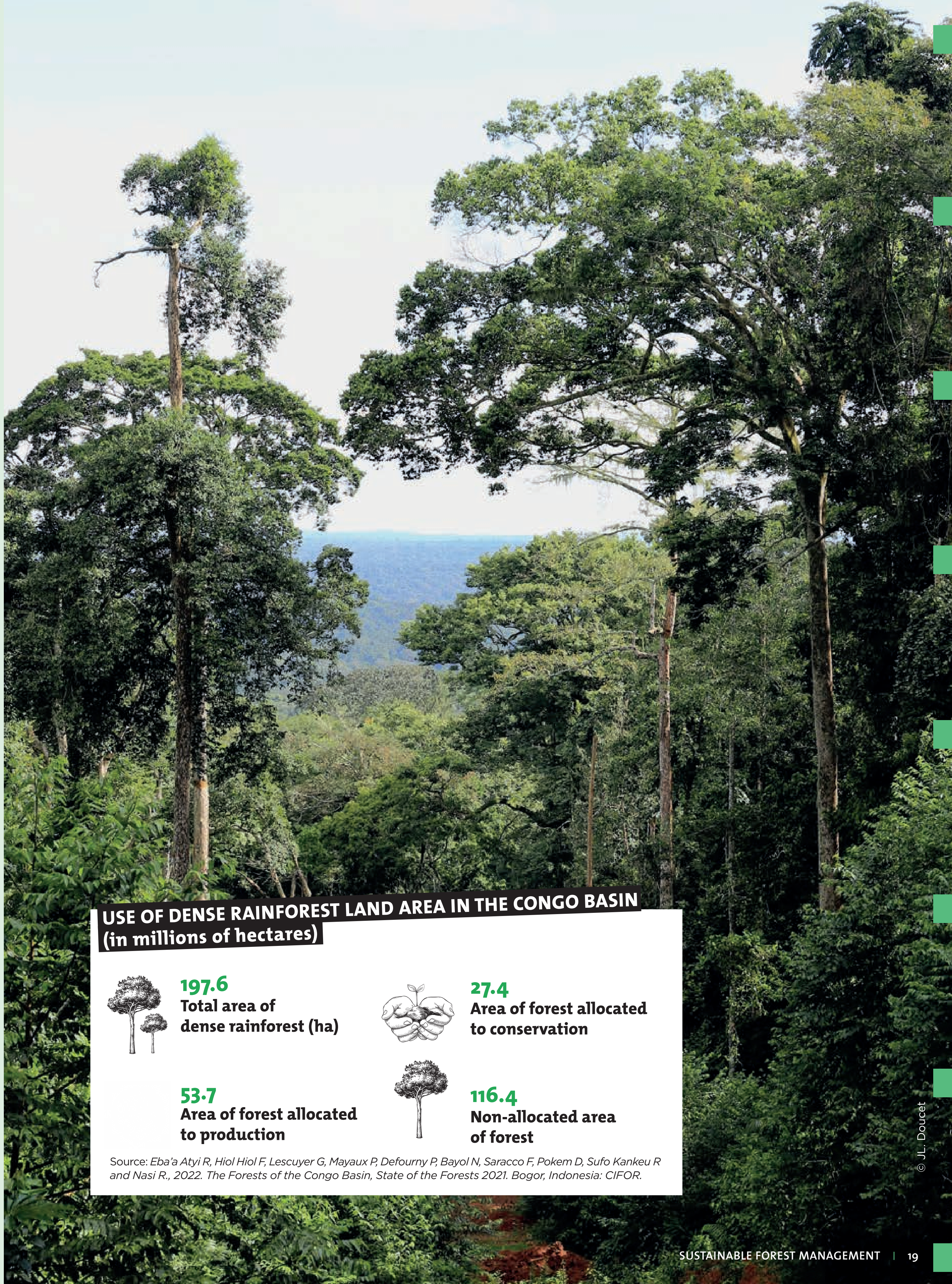
Living forests

A forest is a dynamic ecosystem and the natural, regenerative cycles of the trees within it must be a basis of its management. Just like most living things, stands of trees are made up of individuals which interact with each other. They reproduce, germinate, grow (in height and diameter) and die (either naturally or as a result of external shock) according to different rhythms and in response to more or less predictable factors (climate, infection, insects etc.). In the context of the natural forests of Central Africa, **sustainable management consists of profiting from these ecosystems (in this case, by harvesting timber) without disrupting the balance and main functions of the forest**. Put another way, forest managers must only harvest trees which have reached a certain size, on a felling cycle that results in the adequate renewal of the resource. A sustainably managed forest is able to provide its economic, social and environmental services over the long term.

The Forest Management Plan (FMP) – a tool to improve forestry

In Central Africa, a forest management plan (FMP) has been the foundation of sustainable forest management since the 1990s. Each country has, little by little, included the concept of sustainable management and an FMP protocol into their legislation, and adopted the protocol to various degrees. Today, forest concessions managed with an approved FMP cover almost 40.4 million hectares of Central Africa. This represents almost 75% of the total area used for production forestry. For concessions of more than a few hundred thousand hectares, the FMP stipulates zoning, based on surveys, which enables a **balance between the need for conservation (protected zones), social needs (zones allocated to the local population) and economic needs (timber harvest zones)**. A timber harvest zone must be managed sustainably so that species abundance and the composition of the forest are not compromised once the timber has been harvested. It is the responsibility of forest management to specify the "sustainable" harvest rate and cycle, allowing for local legislation, production targets and the trees' rates of growth, mortality and natural or human-assisted regeneration. The concept is simple but the reality is far more complex than one would imagine.

© Yorick Van Hoef



USE OF DENSE RAINFOREST LAND AREA IN THE CONGO BASIN (in millions of hectares)

197.6
Total area of dense rainforest (ha)

27.4
Area of forest allocated to conservation

53.7
Area of forest allocated to production

116.4
Non-allocated area of forest

Source: *Eba'a Atyi R, Hiol Hiol F, Lescuyer G, Mayaux P, Defourny P, Bayol N, Saracco F, Pokem D, Sufo Kankeu R and Nasi R., 2022. The Forests of the Congo Basin, State of the Forests 2021. Bogor, Indonesia: CIFOR.*

© JL. Doucet

The Forest Management Plan (FMP) a vital tool in sustainable forest management

Each forest concession should refer to an FMP, approved by the relevant forest administration and containing all the assessment data and plans for its sustainable management over a 20 to 35 year rotation. As well as extensive sections about the concession's biodiversity and social importance, the FMP contains a section on "forest productivity" which analyses the pre-harvest available timber resource and sets out the parameters for managing and harvesting the forest according to legal, scientific and technical criteria. This ensures the forest will be sustainable at the end of the rotation period.

© ATIBT

RESPECT THE LOCAL COMMUNITY

More often than not, there will be a village in a forest concession or at least nearby. The FMP will include a clear description of the areas currently occupied by the local community and those that will be occupied at the end of the FMP's duration. The forest management team must also ensure that cultural sites such historic burial grounds, sacred areas or sacred trees are respected. Additionally, local communities often have certain customary rights, such as for traditional hunting (non-commercial) and the gathering of non-wood forestry products (NWFPs).

LIMIT ANY LOSS OF FOREST COVER

Although harvesting timber causes forest degradation (access roads, tracks, lumberyards etc.), it is usually temporary and the forest regenerates well after harvesting if the harvested areas are left to regenerate properly. Without controls, the presence of workers in a concession can lead to deforestation for local agriculture (in theory this is contained to allocated areas but can sometimes spread further) and can encourage an increase in hunting for bushmeat. Forest managers must ensure forest cover loss is contained and limited by minimising the impact of harvesting and by ensuring the regeneration of affected areas.

RESTORE CARBON STOCKS

In harvesting trees from the forest, forest managers immediately reduce the biomass and therefore the amount of carbon stored in the harvested area. However, a significant amount of the carbon removed from the forest remains sequestered in the resulting timber products for years or even decades. As for the forest, it can restore its stocks of carbon within as little as 20 years.

© Yorick Van Hoef

PROTECT LOCAL FAUNA

Forestry concessions in Central Africa are home to an often rich and diverse fauna which depends on the forest for its survival. When an FMP is set up, the forest managers undertake to limit any negative impacts on the local fauna, and particularly to control poaching and to protect areas designated for conservation. As a result, some concessions even become a refuge for wildlife such as elephants, apes, antelope, panthers etc.

© JL. Doucet

© JL. Doucet

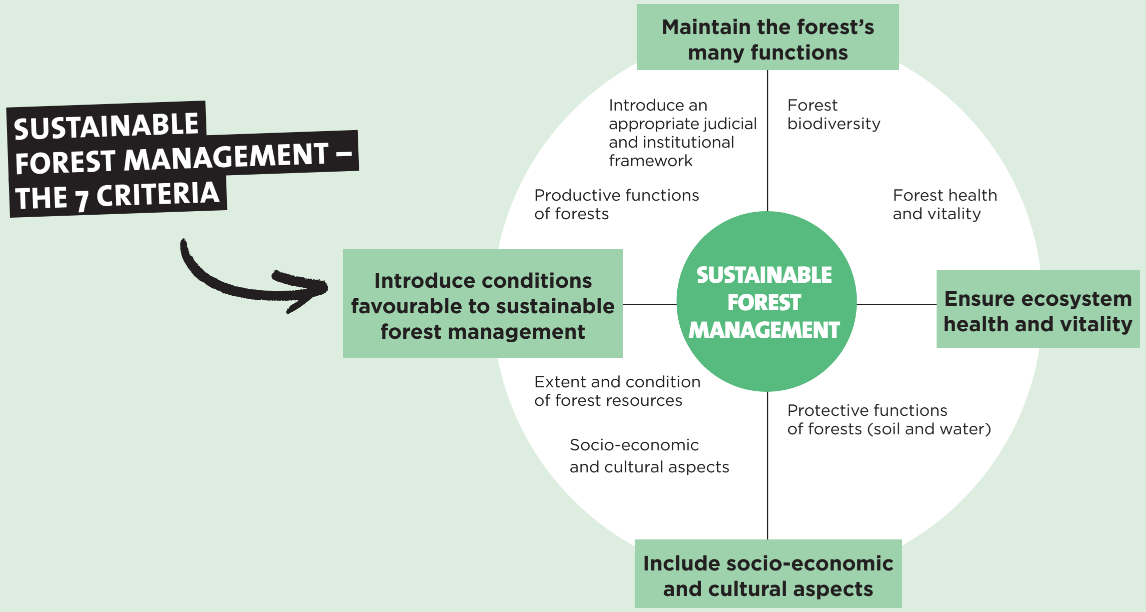
RESTORE HARVESTED FOREST

As a rule, forest managers harvest only 5 to 20 commercial tree species. To ensure economic viability and a sustainable harvest, it is essential to have good data on the forest's composition (number, size and quality of trees) and dynamics (the rate of regeneration, growth and mortality). This data includes the target tree species, the rotation period, the minimum felling diameter (MFD), the target restoration rate for each harvested species and group of species and the propagation programmes for those species which do not readily regenerate naturally. It is used to specify the way the forest is managed. It was a lack of such data, essential to detailed planning, which led the FFEM to finance projects that can provide better understanding in these areas. These projects are carried out by the DYNAFAC collective and bring together researchers, government representatives, forestry associations and forestry companies.

© ATIBT

A MATTER OF TIME

The responsibility for ensuring forest sustainability should rest at state level because forestry companies are usually only granted a concession for 20 to 30 years, a length of time that is roughly the same as the rotation period (indeed concessions are often for a shorter term than the period) while long-term sustainable management must look at least 100 years ahead. Because companies have no guarantee that their concession will be renewed, they therefore have no incentive to invest in long-term sustainability.



Source: *Étude sur le plan pratique d'aménagement des forêts naturelles de production tropicales africaines.* Volet 1 Production Forestière, ATIBT, 2007.

Sustainable forest management and forest dynamics research - 30 years of FFEM support

Since its establishment, the FFEM has been supporting the protection and better use of tropical forests. In line with its mandate for both environmental conservation and economic development in the Global South, it considers these forests as a whole, both as a treasure that must be preserved and as a resource for local inhabitants. Through the projects it supports, the FFEM prioritises several objectives: the promotion of sustainable forest management, itself a means of protecting biodiversity and providing social and economic services, and the promotion of wider appreciation of these forests and the ecosystem services they provide. To this end, it supports innovative, science-based approaches involving the local community and multi-stakeholder dialogue.

Support for better forest management

The French Development Agency and the French Facility for Global Environment have been cooperating in various ways since the 1990s in support of sustainable management of Central African forests. Working alongside the AFD, the FFEM has added extra value through its financial support of initiatives focussed on monitoring forest biodiversity and on the social aspects of these vast forest management projects. Since 2003, the FFEM has also supported the first pilot eco-certification projects in the region.

In addition, the FFEM has contributed to numerous projects managing protected areas and their peripheries with the aim of reconciling biodiversity conservation and the needs of the local people. Since 2010, when climate policies started addressing deforestation and the REDD+ framework was established, the FFEM has allocated additional funding to projects which contribute to the setting up of national strategies and the prerequisite actions required by the REDD+ framework.

Today, the FFEM continues to support biodiversity, climate action and sustainable forest management, putting into practice the knowledge gained from years of experience, including in parts of the world where this approach has never been tested. These projects tackle issues such as the collaborative management of forest and resources, the development of payments for environmental services, the development of new financial tools based on the value of the many services provided by the forests and the restoration of degraded forest landscapes.

Innovate, experiment, share

The standout feature of FFEM's involvement in these forests is its use of innovation, a feature of all FFEM projects.

Since the early 2000s, FFEM has championed a social, community and co-operative style of forest management with the aim of involving the local inhabitants as much as possible. This is the best way to guarantee good practices continue once they are in place. These projects support local, decentralised initiatives and promote economic development based on the sustainable use of forest resources, under local, collaborative governance. They place particular emphasis on recognising the rights of the local population with respect to ownership of land and forest resources.

At the same time, the FFEM recognised that research into forest dynamics is important for improvements in the long-term use and reliability of forest management plans. The driving concept has always been to understand the forest better in order to manage it better. These were the reasons behind the establishment in 2013 of the DynAfFor project, which uses an innovative approach that brings together in dialogue researchers, forestry companies and administrations. The P3FAC project (The Public Private Partnership for the Sustainable Management of Forests in Central Africa) continued to build on the initial results of the DynAfFor project.

"The FFEM, alongside other organisations, threw its support into the sustainable management of the production forests of Central Africa. It might seem counter-productive to authorise the felling of trees in order to protect these tropical forests. However, sustainable felling, adhering to detailed management plans, contributes to a fair balance between the forests' preservation, the needs of the local people and economic development. This balance is still precarious and more knowledge of these forests is needed to ensure better management."

Aurélie Ahmim-Richard,
Head of Forestry and Sustainable Agriculture at the FFEM

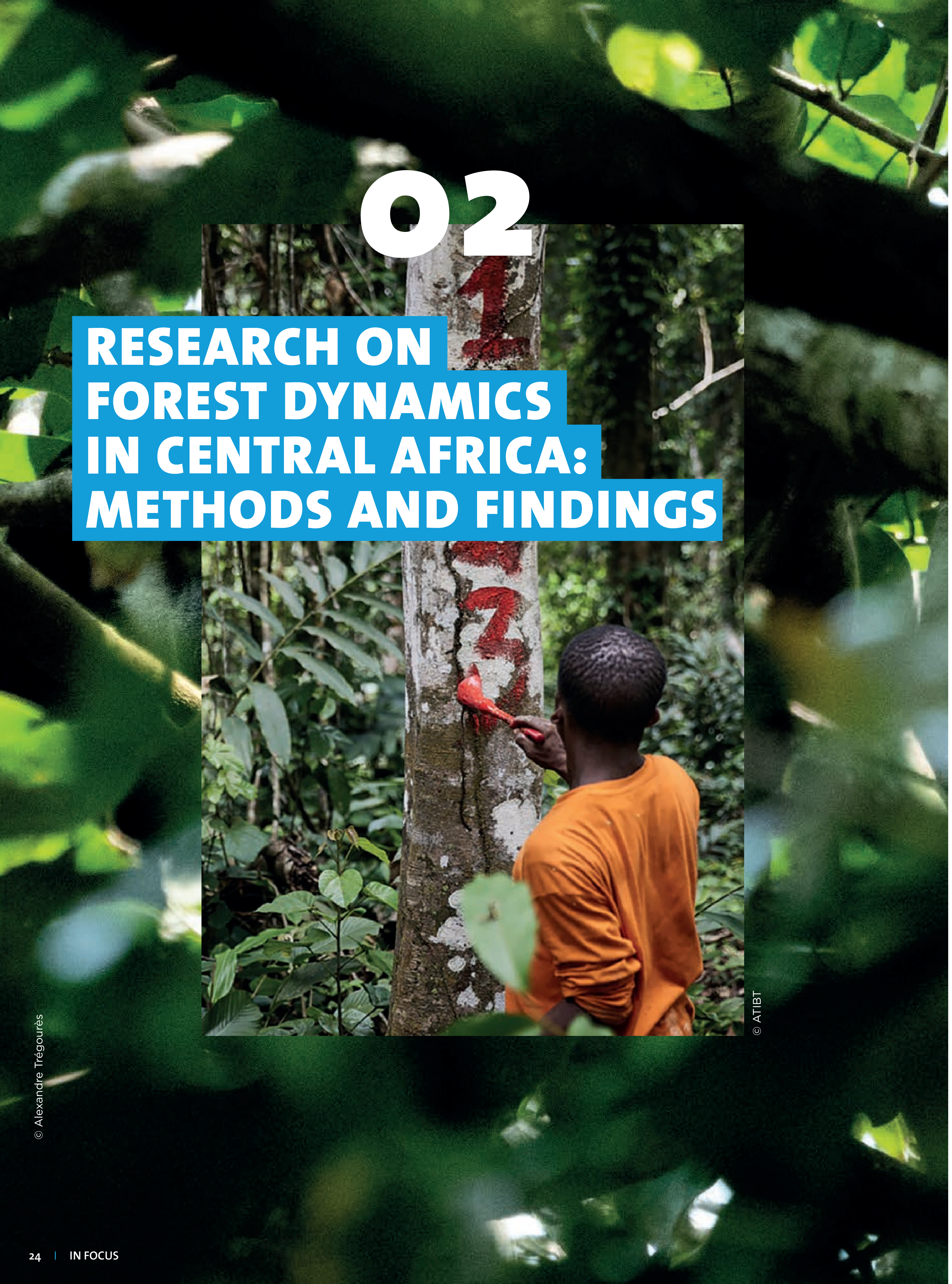
THE THEORY OF CHANGE AT THE FFEM

Increase the impact of effective, relevant solutions

PLAN FOR SCALING-UP
- Final objective
- Stakeholder commitment
- Risks and obstacles
- Timetable and stages

THE ROUTE TO SUCCESS
- Cooperative governance
- Communication, education, training, awareness raising
- Monitoring-evaluation, demonstration

DESIRED OUTCOMES
- Removal of obstacles to change
- Public policies and private activities committed to the change
- Solutions adopted by local populations and stakeholders



© Alexandre Trégourès

02

RESEARCH ON FOREST DYNAMICS IN CENTRAL AFRICA: METHODS AND FINDINGS

© ATIBT

© ATIBT

© ATIBT

© J.L. Doucet

Project fundamentals: DynAfFor and P3FAC

FMPs need to be updated...

Sustainable management of Central African production forests requires a balance between the quantity of timber harvested and the growth rate of the relevant tree species. **The challenge is to ensure the long-term survival of the timber resource and the social and environmental services provided by the forest, while still maintaining commercial viability** for forest managers and for the state (tax revenue).

The key to this balance is the post-harvest regeneration rate of the forest. Ideally, this will be calculated based on scientific data such as the mortality rate, the natural rate of regeneration, the harvest losses and the average increase in trunk diameter of the harvested species. The forest managers can use this information to adjust the harvesting specifications in the FMP, refining such details as the FMP-specific minimum felling diameter limit (FMP-MFD) for each species and the time between successive harvesting in the same location (rotation perod).

The oldest FMPs currently being used in Central Africa are more than 20 years old. Some are already being reviewed while others are due for review in the next few years. The scientific data used in the first round of FMPs was incomplete, both because of the small number of species which had been surveyed and because of the limited area covered.

...based on the natural regeneration rate

Natural regeneration rates were not taken into account in the first FMPs due to lack of data and of knowledge of the underlying mechanisms.[1] A lack of cost-benefit analysis and technical feasibility studies meant that it was not possible to account for any assisted regeneration necessary (i.e. the planting of clearings, lumber stacking areas and degraded areas) of in-decline species.

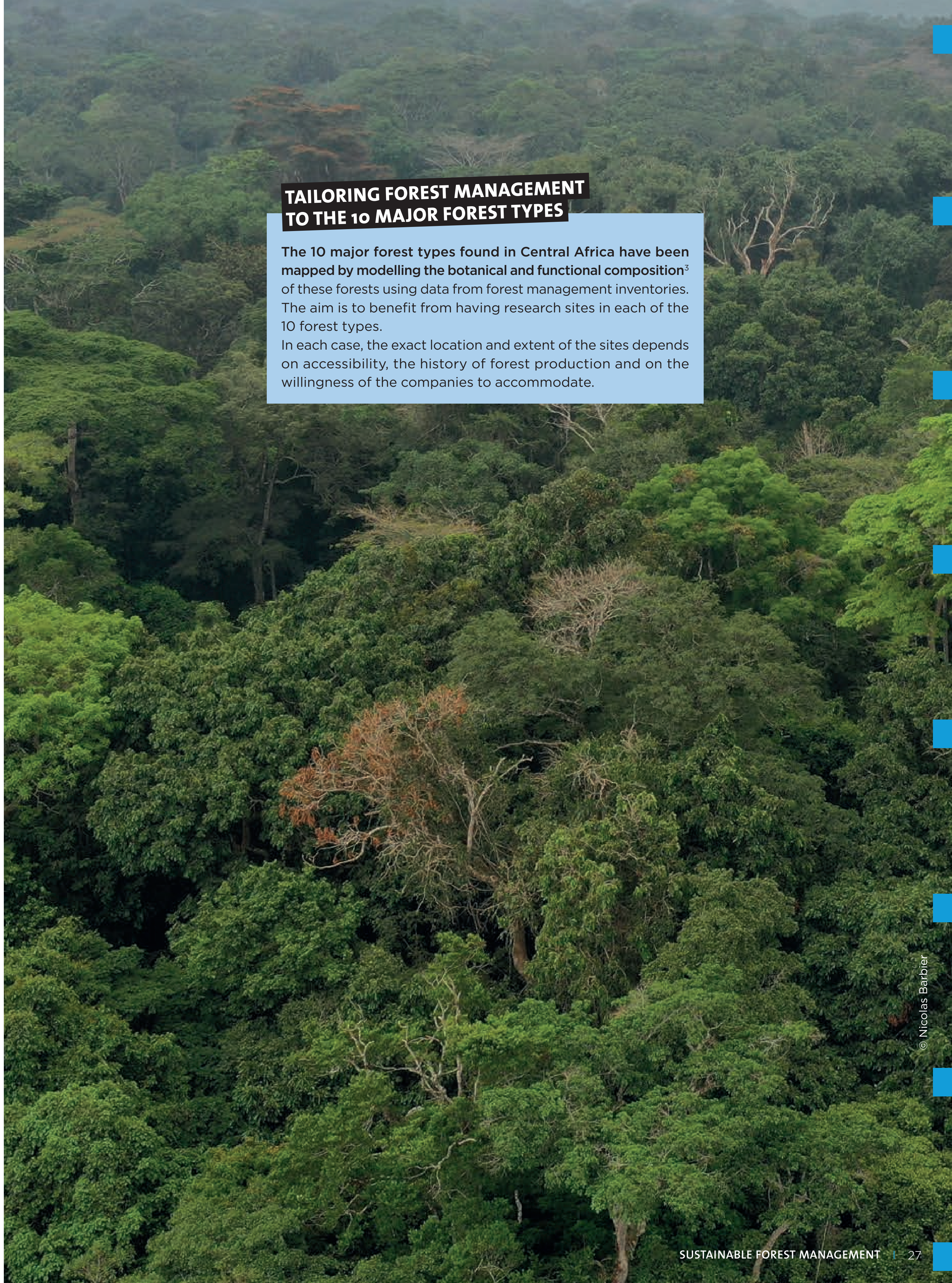
For certain species of tree, if regeneration, whether entirely natural or assisted, is not taken into account, sustainable harvesting is not guaranteed beyond the first few rotations. At the time of the first management plans, the impacts of timber harvesting on the dynamics of forest regeneration were little understood or arbitrarily defined.

DYNAFAC: a collective aiming to improve FMPs

By the early 2010s, various actors in the forestry sector became aware of gaps in scientific data and set up a research project to respond to these issues. Jointly financed by the FFEM and other funding partners (the PPECF programme of the KfW, the FNRS, forestry companies and partners in the DYNAFAC collective), the Structure and Dynamics of Central African Forests project (DynAfFor [2]) was launched in five countries (Cameroon, Gabon, the Central African Republic, Congo and the Democratic Republic of the Congo) between 2013 and 2018. Its main objective was to complete scientific research into the structure and dynamics of Central African forests. In particular, the project supported the introduction of forest inventory research sites and the collection of data. Then, between 2017 and 2022, the Public-Private Partnership for the Sustainable Management of Forests in Central Africa (P3FAC) was established to prolong data collection using the DynAfFor research tools and also to expand the research to include different forest types and other related topics. These included silviculture techniques, assisted natural regeneration, quantifying carbon sequestration and the impacts of human activity.

The work of the people involved in the DynAfFor and P3FAC projects (concluded at the end of 2022), grouped under the "DYNAFAC" collective, has produced robust data, analyses and recommendations which will contribute to more sustainable forest management in Central Africa in the future.

1-Notably the seed bank, animal seed dispersal, regenerative fruiting diameter and the impacts of human activity.
2-"The Structure and dynamics of Central African forests : moving towards timber processing rules that integrate the ecological functioning of tree populations and the variability of environmental conditions."
3-Botanical composition: list and relative abundance of species in the ecosystem.
Functional composition: type and relative abundance of groups of species showing similar characteristics (nitrogen uptake, survival and growth rate at low light levels etc.)



TAILORING FOREST MANAGEMENT TO THE 10 MAJOR FOREST TYPES

The 10 major forest types found in Central Africa have been mapped by modelling the botanical and functional composition[3] of these forests using data from forest management inventories. The aim is to benefit from having research sites in each of the 10 forest types.
In each case, the exact location and extent of the sites depends on accessibility, the history of forest production and on the willingness of the companies to accommodate.

© Nicolas Barbier

About the partners in the DYNAFAC collective

The DYNAFAC collective is a group of organisations involved in the ongoing collection of forest dynamics data from a network of sites in the Central African forest. The collective includes an international organisation (COMIFAC), the national forest administrations of five countries, two trade associations (ATIBT and Nature+), national and international research institutes (CIRAD, GxABT, IRAD, the University of Yaoundé 1, IRET, UNSTM INSAB, ICRA, the University of Bangui, INERA, UNIKIS, IRF, ULB and UMN) and private forestry companies (ALPCAM-GRUMCAM, IFO, Pallisco, Precious Woods CEB, Rougier).

→ **La Commission des forêts d'Afrique centrale (COMIFAC)** is responsible for guiding, coordinating and monitoring forestry and environmental policy in Central Africa. The DynAfFor and P3FAC projects which gave rise to the DYNAFAC NETWORK came under the guidance of COMIFAC.

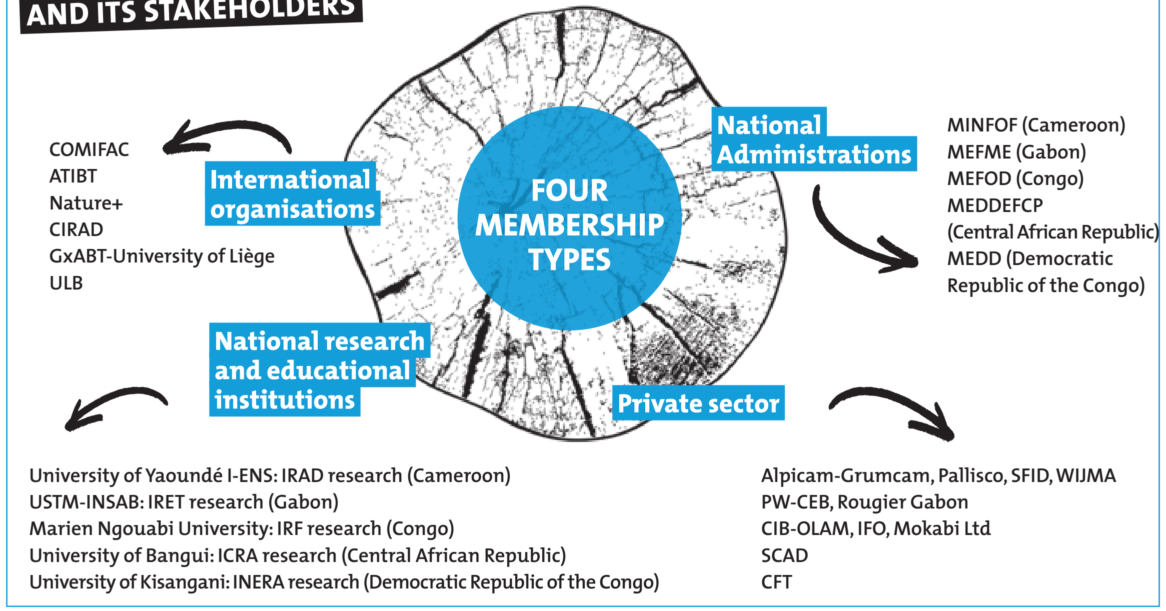
→ **The national forest administrations** of the five countries concerned are fundamental to the DYNAFAC collective: the objective of the collective's research is to provide data to inform debate and reform of each country's national forestry legislation.

→ **The ATIBT and Nature+ trade associations** have complimentary mandates within the DYNAFAC collective. The ATIBT represents the private forestry sector in Central Africa and has the genuine aim of implementing sustainable practices. Nature+ oversees the relationship between tropical forestry research and work on the ground. It works closely with forestry companies to increase the consideration given to aspects such as biodiversity, social benefit, and forest protection and management. It does this by proposing practical and concrete solutions which contribute to sustainable forest management. Nature+, in close collaboration with GxABT, reports on these results, making them as widely accessible as possible to all those involved.

→ **The international, regional and national research institutions** of Central Africa have designed and implemented scientific protocols for the collection of data from forest inventory research sites. Numerous scientific papers have been published on data collected from DYNAFAC research sites.

→ **Private sector companies** and partner companies of the DYNAFAC collective grant access to these research sites on their forestry concessions. They contribute financially and logistically to the collection of data from these sites. The private sector's role is central to this work.

THE DYNAFAC COLLECTIVE AND ITS STAKEHOLDERS



A network of forest inventory research sites for a better understanding of forests and their diversity

The difference in the types of forest found in Central Africa is due, at least in part, to changes in climate over time, to geology and to the intensity of past and current human disturbance. The question that researchers on the DynAfFor and P3FAC projects sought to answer was how much these factors influence the dynamics of these forests and their ability to regenerate after logging.

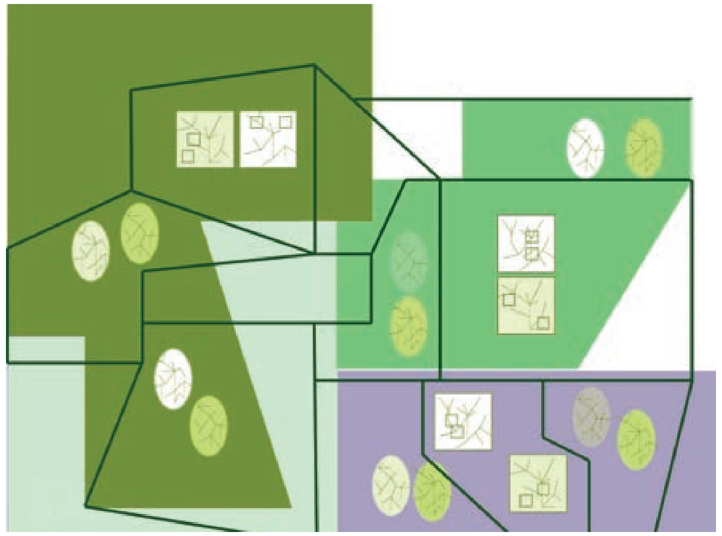
None of the research carried out prior to the DynAfFor project had answered this question. Even though tens of research sites had already been set up for biodiversity research, they were usually too small (less than a hectare) and therefore unsuitable for the detailed study of the dynamics of locally sparse commercial timber species or for the assessment of the impact of timber harvesting. Since 1982, only the Mbaïki research site in the Central African Republic, the oldest in Central Africa, has been reporting on pre- and post-harvesting forest dynamics. This pioneering site was useful in adapting the network of research sites for the DynAfFor and P3FAC projects.

Route and plot sites: complimentary research tools

Under the DynAfFor and P3FAC projects, two complimentary types of data collection site were established: **simplified sampling route sites and more complex plot sites. Sites known as combination sites, utilising routes and plots**, were set up in some forestry concessions. Whichever type was used, sites with different forest types were selected, pre- and post-harvest data was collected and then reviewed after harvesting, in order to quantify the environmental effects of forestry operations. By the end of 2022, seven forest types were covered by the DYNAFAC, network of research sites, leaving Atlantic coastal forest types as yet un-researched. The network of research sites includes about 20 sampling routes and 5 plots (including the combination sites) and is an invaluable research tool for future research into topics well beyond the basic questions of forest dynamics.

DIAGRAMMATIC REPRESENTATION OF THE DYNAFFOR NETWORK OF RESEARCH SITES

The network contains sampling route sites (ovals with branching lines) and combination sites (two 400 ha areas shown by the outer squares) containing sampling routes and plots (inner squares) within a forestry concession (solid black lines). These encompass various environmental conditions (large colour blocks) and both harvested and unharvested areas (paired route sites or complete sites of different colours within a concession). The colours within the ovals and squares represent areas where the growth and mortality rate are similar. These are not necessarily consistent within zones with the same environmental conditions. Observed similarities allow assumptions to be made about small areas, thanks to the results from combination sites covering a larger area.



Source: Collectif DYNAFAC, *Dynamique des forêts d'Afrique centrale. Pour une amélioration de la durabilité des plans d'aménagement forestier.*

Sampling routes, accessible research sites providing valuable results

A complex but necessary process

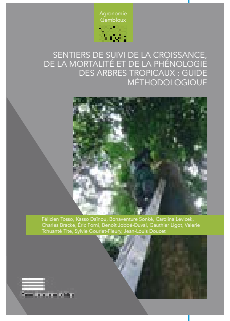
In principle, production forestry is ecologically sustainable if the trees which are removed from the forest have been completely replaced by the end of a rotation period, which in Central Africa is 20 to 30 years.
To quantify this regeneration, it is necessary to monitor, over time, the growth and mortality of each commercial species. This involves monitoring a large number of trees at different stages of growth. These species are usually sparsely distributed, making it necessary to survey a large area to obtain a big enough sample. For efficiency reasons, an area of no more than 400 ha is recommended. Wherever possible, at least 20 individual trees, each with a diameter of more than 10cm, should be monitored for each species. Ideally, 20 individuals in each diameter classes ranging from 10-20 to 90-100 and above 100cm should be monitored, a total of 200 trees in all. **The course connecting the trees selected for monitoring comprises the "sampling route"**.

© JL. Doucet

Specifications of data required

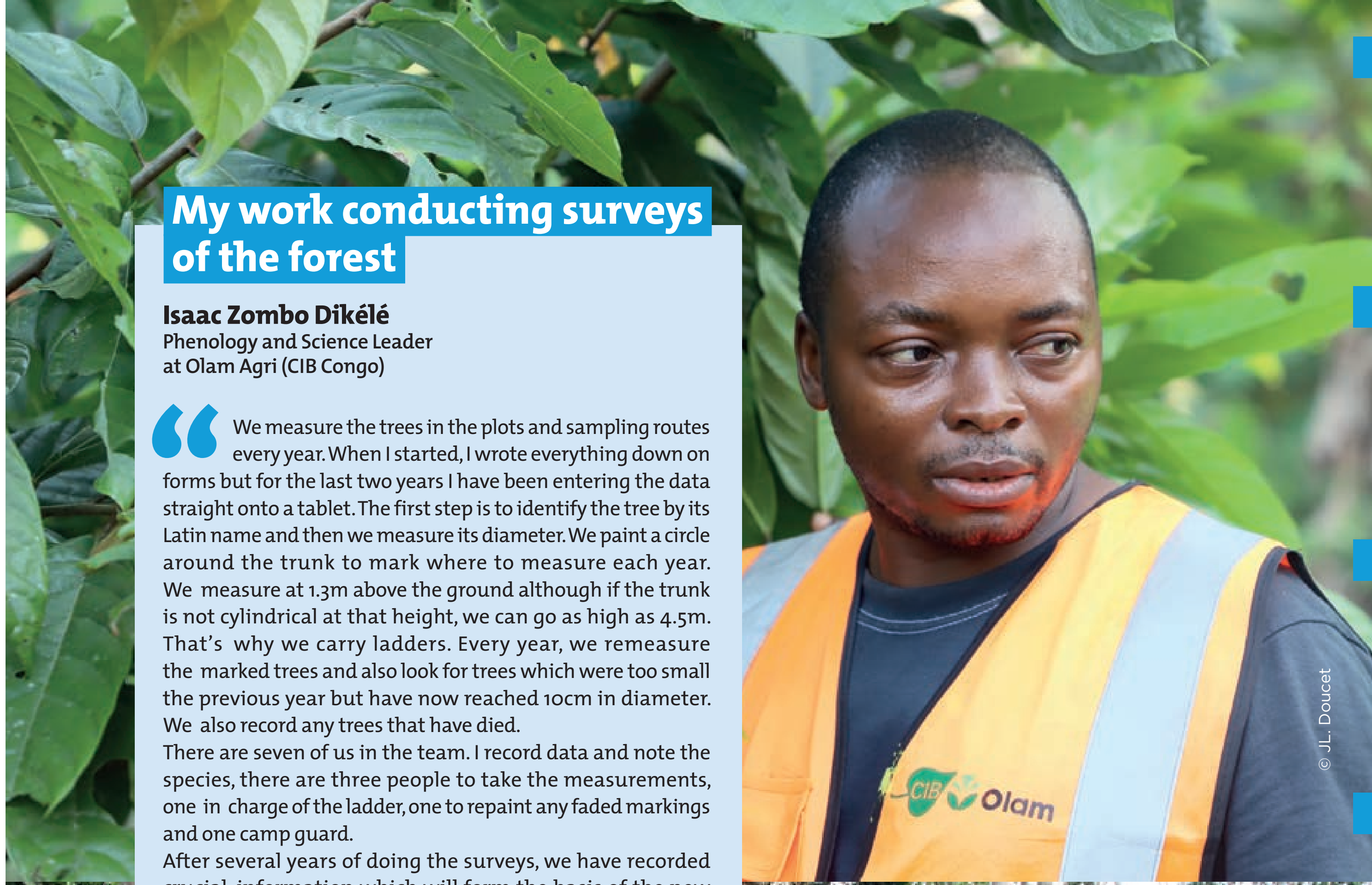
For each monitored tree, the information to be collected annually for at least five years is the diameter at breast height, used to calculated annual growth, and, if appropriate, a note of the death of the tree. Reported deaths are used to calculate the annual mortality rate and its causes. Phenological data – new leaf growth, flowering and fruiting of the trees along the route – can also be recorded monthly. This can be used to determine the species' effective fruiting diameter (EFD), the stage at which this species has at least a 50% chance of regeneration. The impact of logging (on annual growth and mortality, for example) must also be quantified on a sampling route. This can be done by surveying the same route before and after logging or by monitoring two separate routes – one in a recently harvested area (about a year after logging), the other in an unlogged area.

Sampling routes can therefore be used to quantify the annual growth, mortality rate and the EFD of commercial species but not their recruitment (saplings which have a diameter of more than 10cm). To quantify a species' recruitment, a systematic, regular inventory of all the individuals in a large, clearly delimited area must be undertaken. This is not possible in a sampling route site. Data collected from a sampling route site is invaluable but not enough to establish the changes in abundance and composition in the long term (more than two or three rotation periods).



Produced by the PPECF with co-financing from KfW, the "Guide méthodologique d'installation des dispositifs de type « sentier »" was published in 2020.

It is an illustrated, practical and detailed guide to setting up and using sampling routes.



© JL. Doucet

My work conducting surveys of the forest

Isaac Zombo Dikélé
Phenology and Science Leader
at Olam Agri (CIB Congo)

"We measure the trees in the plots and sampling routes every year. When I started, I wrote everything down on forms but for the last two years I have been entering the data straight onto a tablet. The first step is to identify the tree by its Latin name and then we measure its diameter. We paint a circle around the trunk to mark where to measure each year. We measure at 1.3m above the ground although if the trunk is not cylindrical at that height, we can go as high as 4.5m. That's why we carry ladders. Every year, we remeasure the marked trees and also look for trees which were too small the previous year but have now reached 10cm in diameter. We also record any trees that have died.
There are seven of us in the team. I record data and note the species, there are three people to take the measurements, one in charge of the ladder, one to repaint any faded markings and one camp guard.
After several years of doing the surveys, we have recorded crucial information which will form the basis of the new forest regulations."

© JL. Doucet

A survey team measuring a tree on a sampling route.

Plot sites, supplementary research sites providing important data

Plot sites in more detail

Plot sites are research sites which supplement sampling route sites. Plot surveys encompass, for a clearly defined area, all trees above a specified size (usually 10cm in diameter at breast height). Plot sites can therefore be used to study the natural regeneration process (which leads to the eventual restoration of the tree population) and to establish the forest density (expressed in number of trees per hectare), the basal area (in m^2/ha), the amount of carbon stock (in t/ha) and forest structure and diversity (list of species, species abundance, number per hectare).

The fact that this type of survey includes all trees in the plot, including species not currently harvested, increases the data available on species under consideration for commercialisation in the future. Plot sites thus make it possible to model changes in tree species abundance and composition over the long term.

Ideally, a plot survey results in a complete inventory[5] of approximately 20 hectares, from two plots of 9 ha or five plots of 4 ha. Just as with sampling routes, plots should ideally be set up in pairs, with one plot where trees are harvested and one where they are untouched. Plots smaller than the recommended size should be avoided for two main reasons: (i) the cost of maintenance and (ii) their unsuitability for monitoring the effect of the selective type of harvesting practised in Central Africa (an average of one to two trees per hectare).

5- Picard et Gourlet-Fleury, 2008.

A necessary combination of research sites for accurate data

Mixed research sites containing plots and sampling routes can also be set up to improve the quality of data obtained. In this case, the plots should be within the 400 hectare area containing the sampling route sites.

As well as providing data on forest dynamics, **plot sites can be used to collect the scientific data needed to answer other research related questions**. As an example, some plot sites set up as part of the DynAfFor and P3FAC projects were used in research into the naturally occurring seed bank, forest regeneration processes (exchange of genes between trees, relationships with and impacts of fauna in regeneration etc.), the specific dynamics of Maranta forest and the occurrence of vine species on certain trees.

The structure and work of survey teams

Stévy Nna Ekome,
Team leader, forestry monitoring and assessment, research and forest management (CEB Precious Woods)

"Each monitoring programme begins with some team training in data recording and management before we head out into the field.
We record the data on site using the Open Foris Collect Mobile smartphone app. For each tree we record the species, previous diameter, measurement height, the status of the tree (alive or dead), cause of death where applicable, current diameter. We also make other observations such as the estimated useable length of the trunk and the tree's social significance. We also take photos of any recent anomalies.
A team of five people consisting of a team leader and four team technicians is needed to collect the data.

The team leader does the map reading and locates the trees. He plans the route, which he tries to optimise. He records the data and helps with the measurements. He ensures that any tree with faded measurement marks or code numbers is repainted and that measurement bands are repositioned where necessary.

Two technicians measure the tree's diameter. They locate the trees to be measured with the help of GPS. They also maintain the tracks on sampling routes and in plot sites.

Each tree on a sampling route is measured following these steps: (i) clean around the measurement mark of the tree; (ii) in the case of sampling routes, wind masking tape around the trunk, perpendicular to its axis; (iii) position the tape measure on the sticker in the case of sampling routes or on the measurement mark in the case of plots, ensuring that the two line up exactly; (iv) record the diameter to the nearest millimetre and the mark's height to the nearest centimetre; (v) raise the measurement mark height if the trunk is damaged or deformed. In the case of buttressed trees, the measurement can be taken at a height between 130cm and 450cm.
In sample plots, we measure at least 115 trees per day. It takes more than 2 and a half months work to measure the 12,273 trees on a 16 ha plot. It also takes 2 and a half months to measure the 3,563 trees on the sampling routes."

© JL. Doucet

Innovative technology aiding forestry research

New technology is enabling increasing improvements in forestry management by providing extra data that cannot be collected in the field at research sites. In particular, we note the use of remote sensing and satellite imagery, of increasingly high-performance drones and of LiDAR (*Laser Imaging Detection and Ranging*).
The use of these technologies can be limited in ground operations and the cost can be prohibitive at the scale of forest concessions of tens or hundreds of thousands of hectares. **However, forest researchers in Central Africa are adopting them at an increasing rate.** The following is an overview of their potential use.

Remote sensing and satellite imagery

Aware of the significance of satellite imagery in the understanding and management of Central African forests, the FFEM co-financed the "Capacity building and access to earth observation satellite data for monitoring forests in Central and Western Africa" (GEOFORAFRI) project from 2011 to 2014. Subsequently, the AFD continued and indeed increased this support via the OSFT and then OSFACO projects. Today, the new generation of high-resolution satellite imagery (Sentinel 1 and 2, SPOT 5 and 6, Planet, etc.) provides a source of vital information enabling the monitoring at large scale of these often difficult to access tropical forests[6]. While these images are still not adequate for the large-scale evaluation and mapping of forest biomass, the reliability of large-scale mapping of aboveground biomass is expected to improve thanks to NASA's GEDI project on the Space Station (2020-2022) and to the expected launch in 2022 of the ESA's Biomass satellite utilising P-band synthetic aperture radar (SAR). Unlike previous data capture systems, these have been specifically designed to map forest biomass[7].

Drone-captured aerial imagery

The use of drones to obtain high-resolution aerial images is an important advance in remote sensing and provides an improvement on satellite imagery.
Drones provide the following advantages:
- choice of resolution down to the centimetre,
- imaging can take place even when there is cloud cover,
- the ease of scheduling drone flights to capture images in the required areas at the required time.

Drone aerial imagery has been used several times on DynAfFor and P3FAC projects, notably in the Loundoungou, Bambidie and Yoko survey sites. The drone images were used to create an orthomosaic of the imaged areas and to generate a digital surface model (DSM). Several studies on the relationship between canopy size and the tree's increase in diameter have been undertaken[8]. Of note is that these studies have shown that certain species can be identified from the texture and colour of their canopy. The main operational uses for drones are the surveillance of forest areas and the quantification of the impact of forest exploitation.

LiDAR

Thanks to terrestrial LiDAR technology, it is now possible to use three-dimensional reconstruction to measure the exact basal area at a height of 1.3m of irregularly shaped tree trunks (difficult to measure in the field). However, it is still onerous and costly to implement this technology and it is therefore unlikely to be used in monitoring programmes on research sites. LiDAR machines can be used on drones. The resulting LiDAR images can be used to generate detailed digital terrain models (DTM) and, for example, identify termite mounds present on the site. As another example, LiDAR can be used to generate canopy height models (CHM) for different tree height calculations and for assessing damage created by logging.

We do not have the space here to discuss the potential uses and limits of these technologies and tools. However, it is worth noting that the DynAfFor and P3FAC projects have played a role in testing research applications of some of them and in demonstrating their limits and potential.

6-Eba'a Atyi et al., 2021.
7-Minh et al. 2016.
8-Cheliout, 2019; Ndamiyehe Ncutirakiza et al., 2020.

Drone images (A) of the DYNAFAC camp at Loundoungou in a stand of limbali and (B) of the canopy in one of the sample plots.

Dynamics of growth and mortality rates of the most common trees

The data collected from research sites, especially from sampling route sites, has revealed important information on the annual growth and mortality rates of the main Central African commercial tree species. On some sampling routes, it was also possible to observe the effect of forestry operations on species' growth rates.

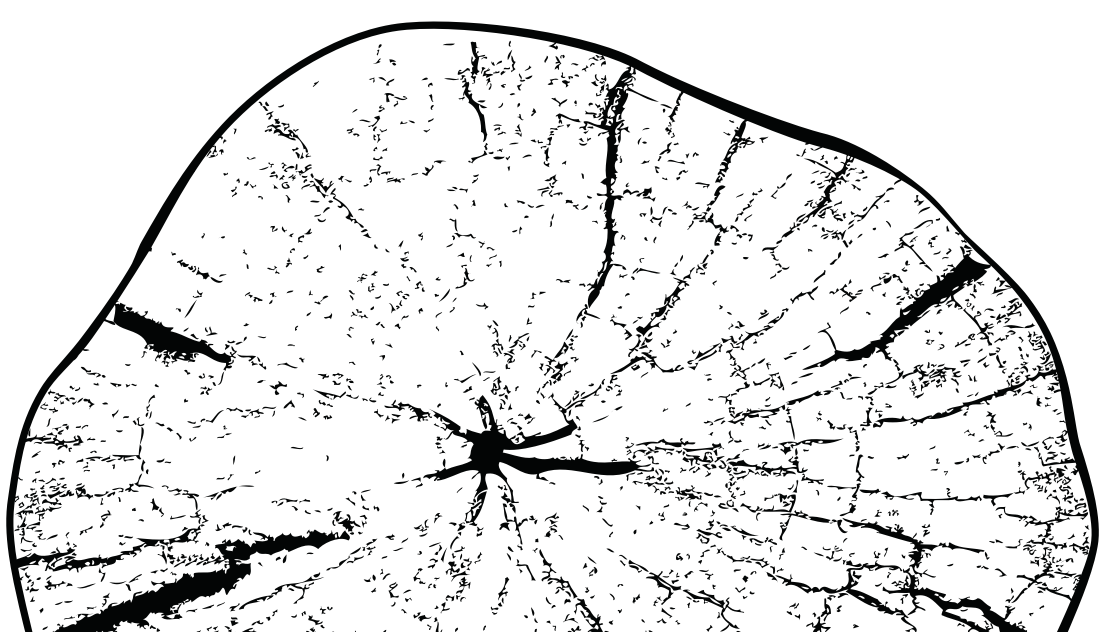
Growth rates

Researchers have recorded the average annual growth rate of the main tree species harvested on the different research sites. A key and unexpected result was that a single specie's behaviour varies much more according to the site than that of the total ecosystem (all species) which is relatively homogeneous across the different research sites. There is no single sampling route site for which the recorded annual growth rate for all monitored species was consistently higher or lower. This demonstrates that tree growth rate is not only linked to the soil and climate but also to other factors. In particular, the optimum ecological niche for each species and competition between individuals both play a role in determining growth.

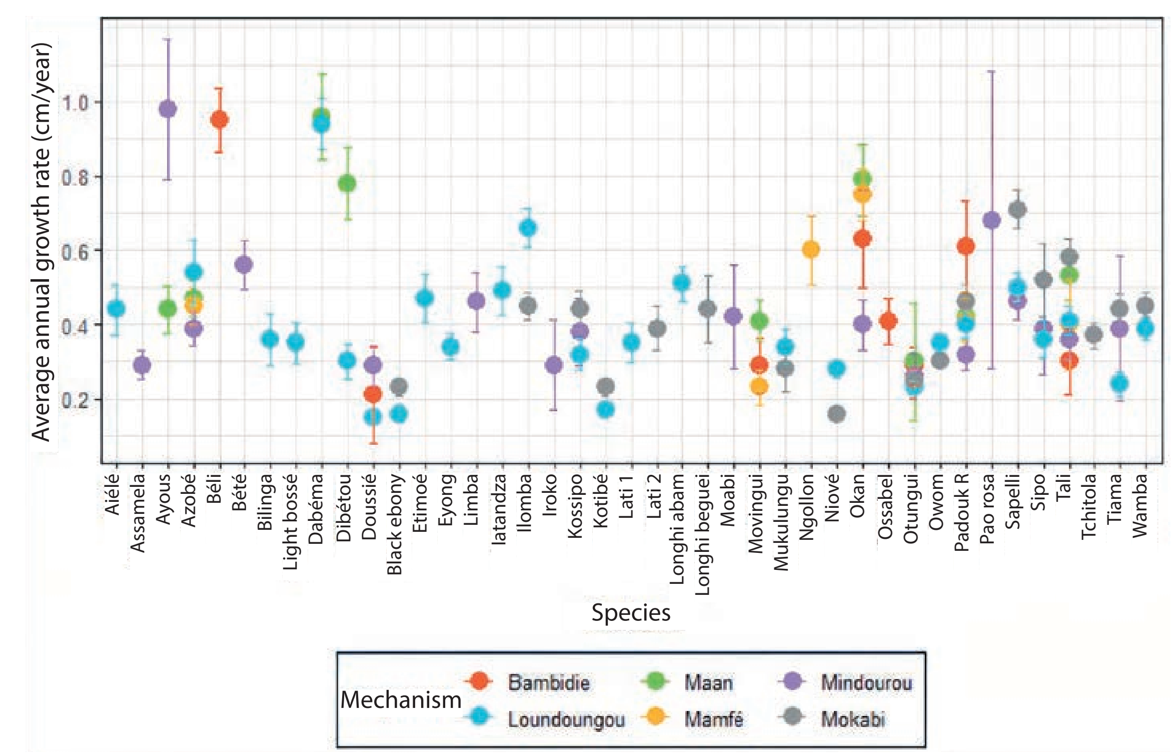
The impact of forestry operations, even though logging is very selective and only reduces the canopy by 6% to 10%, is, overall, positive for annual growth and this effect can last for between 10 and 20 years, depending on the species and the site. This "*boost*" effect is not as powerful on all sites or for all species. Added to that there is the wide variability of logging practices used by forestry companies. The intensity of logging will lead to a lesser or greater impact on the post-harvest *boost*. In the spirit of conservation, and until more detailed knowledge of post-harvest forest dynamics is available, forest managers should base their decisions on the data from unharvested control sites.

Mortality rate

For sites with a sufficient number of individuals of a species (at least 100) and a survey period of at least 3 to 4 years, the annual overall mortality rate is estimated to be 0.6% in unharvested forest. It is interesting to compare this with the default rate of 1% used by all forest managers, apart from some exceptions. What is more, this average mortality rate of 0.6%, which is a priori less than the historically utilised default rate of 1%, does not allow for the additional mortality caused by harvesting.
As a precaution, forest managers should therefore continue to use the 1% rate.



DIAMETER GROWTH RATES



Average diameter growth rates for commercial species recorded by the DynAfFor and P3FAC projects. Because this recent scientific data was not available at the time the first generation of FMPs were drawn up, default or approximate values were used. These FMPs are now progressively coming up for review. The use of these new research findings in future FMPs will mark significant progress in their precision and therefore their long-term deployment.

Source: Collectif DYNAFAC, *Dynamique des forêts d'Afrique centrale. Pour une amélioration de la durabilité des plans d'aménagement forestier.*

The fundamentals of forest regeneration dynamics

Over the long term, the changing state of a forest stand is highly dependent on each species' natural regeneration. Natural regeneration is a continuous process in which trees must be able to flower and produce seed, that seed must be dispersed and then some of that seed must germinate and produce saplings. Some of those saplings will eventually become mature, exploitable trees. Understanding and defining the different mechanisms involved in regeneration is fundamental to guaranteeing sustainable management beyond the first rotation period.

Fine-tuning minimum felling diameter (MFD) specifications

Quantifying the size at which trees become reproductive is a key step in determining the minimum felling diameter (MFD). In order to guarantee the natural composition of the forest over the long term, each MFD must take into account the ecological characteristics of each species. **Phenology is the science of the effect of climatic and seasonal variations on the biology and behaviour** of living things, both animal and vegetal. In the context of tree regeneration, phenology provides information on flowering and seed production. Phenological data collected from sampling route sites was used to calculate the effective fruiting diameter (EFD), an estimate of the trunk diameter at which at least 50% of a species' individuals will produce viable seed.

Complementing this phenological research, some studies also investigated gene flow (between stands of trees). The results of this work demonstrated that, contrary to expectations, the trees which contribute most to forest regeneration are not the largest individuals (variously known as monumental, notable or gigantic trees). Studies comparing the gene flow between harvested and non-harvested areas did not find conclusive evidence that harvesting has a negative impact. On the other hand, it can cause a reduction in the number of productive individuals in species which struggle to regenerate[9]. Planting to support natural regeneration can compensate for the negative impact of harvesting.

The presence of fauna is essential to the survival of tree species

Research has also shown that in terms of vegetation type and composition, **60 to 90% of trees in dense rainforests rely on animals for seed dispersal.** Studies on the impact of defaunation in areas where there is poaching have shown that for some commercial species of tree (moabi and doussie) seed dispersal is mainly by small rodents or human activity. In contrast, in areas with no poaching, it is the big animals (elephants, chimpanzees) which contribute most to this process. Different species of duiker also contribute significantly to seed dispersal for some species (iroko, bilinga, tali).

Long-term studies as well as more plot-type sites are needed before the data required for precise results on tree recruitment can be integrated into the forest composition models in FMPs. While we can make the first practical recommendations on the protection of reproductive trees and fauna and on methods to assist natural regeneration (planting and other forest management activities), more research into natural regeneration must be carried out.

9-Especially species requiring strong sunlight, because harvesting does not remove enough forest canopy to allow regeneration of these species.

© JL. Doucet

Fauna plays an important role in dispersing the seed of commercial tree species, especially large mammals such as elephants, great apes and duiker. Here, seedlings emerging from elephant dung demonstrate how these creatures disperse seed.

The important role of the forests of Central Africa in mitigating climate change

Trees sequester carbon over the course of their life. It is generally accepted that almost 50% of the biomass produced by trees via photosynthesis consists of carbon. The forests of Central Africa contain about **40 Gt of carbon[10], more than four times the amount emitted world-wide each year from burning fossil fuels**. While they are growing, trees sequester carbon. Once they are dead, they release carbon. A forest is a “carbon sink” when the amount of carbon it sequesters is greater than the amount it emits.

The studies into the state of the forests undertaken by the DynAfFor and P3FAC projects provide invaluable information on the carbon stocks and sinks that these forests represent. While tree growth and mortality affect the state of the biomass and therefore the amount of carbon in a forest, **the size of the trees also has an effect**. Although big trees continue to grow and to store a large biomass, their contribution to the carbon sink of the whole tree population is small compared to that of smaller trees which, on average, grow more quickly, are more numerous and occupy more space. In some cases, such as during episodes of mass mortality like the one seen in the Amazon, the balance between the sequestration and emission of carbon reverses and the forest switches from carbon sink to carbon emitter. However, this is not the case in Central Africa, where the tree species are, as a whole, more resilient to climate change.

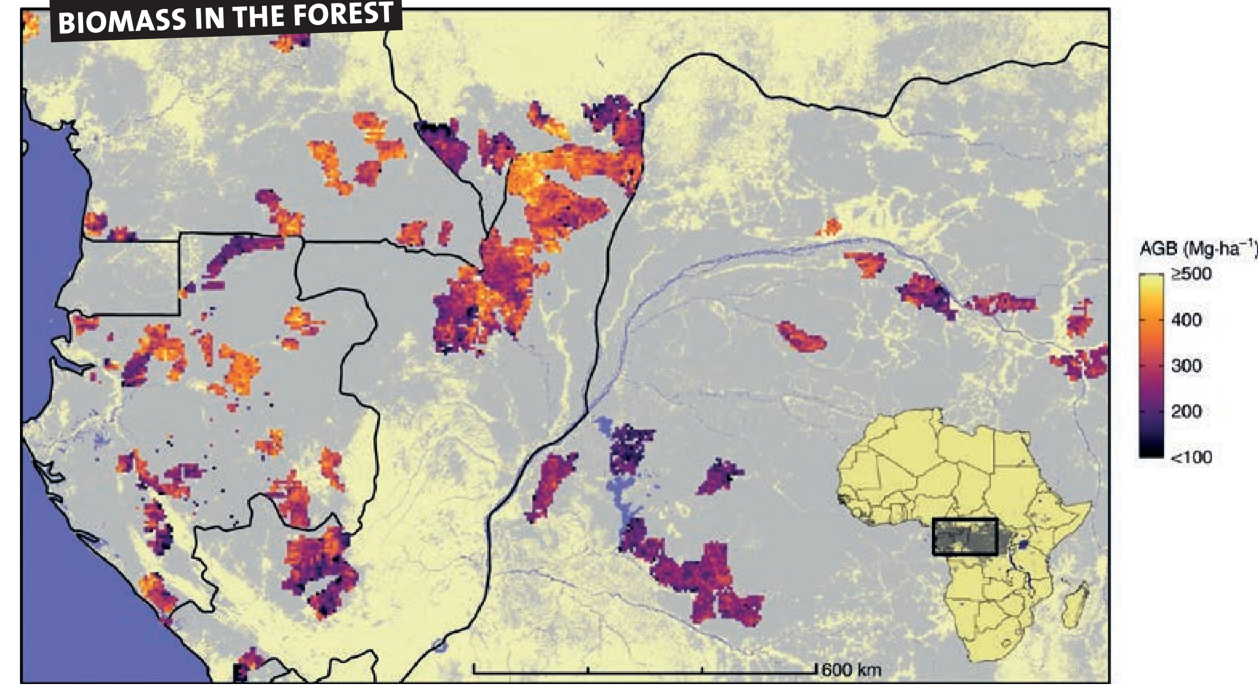
The DynAfFor and P3FAC projects have also studied the amount of carbon stored in the biomass by analysing important but rarely considered factors. In particular, they looked at trees with a diameter of less than 10cm at breast height and at dead trees. At the Loundoungou research site in Congo, the percentages of the biomass in these three categories – living trees with a trunk diameter between 1 and 10cm DBH, dead trees with a diameter greater than 10cm DBH and living trees with a diameter greater than 10cm DBH – are 2.6%, 10.2% and 87.2% respectively. The results from all plots show high spatial variability and no correlation between the different categories.

The forests of Central Africa are still sequestering carbon at the significant rate of an estimated 0.66 t CO_2/ha/year, which is greater than that in the Amazon basin (0.24 t CO_2/ha/year)[11]. Researchers have used climate change models to predict the progress of changes already under way over the next 20 years. The models show that **the forest decline seen in the Amazon basin will also occur in the forests of Central Africa but at a slower rate**. The impact of forest exploitation on this process has not yet been measured accurately but the research sites established by the DynAfFor and P3FAC projects will provide answers in the years to come. It is known that the amounts of carbon removed by harvesting will start to be replenished after 20 years although the mix of species storing the carbon will have evolved.

The Central African forest’s huge carbon stocks and the forest’s capacity to increase these stocks over time make these ecosystems precious allies in our fight against climate change. **Sustainable harvesting of these forests can be conducted while maintaining carbon stocks which might otherwise be at threat under other uses of the land** (industrial-scale agriculture, mining etc.).

10-Saatchi SS, Harris NL, Brown S, Lefsky M, Mitchard ET, Salas W, Zutta BR, Buermann W, Lewis SL, Hagen S., 2011. *Benchmark map of forest carbon stocks in tropical regions across three continents.* Proceedings of the National Academy of Sciences. 108(24):9899-9904.
11-Hubau, W., Lewis, S.L., Phillips, O.L. et al., 2020. *Asynchronous carbon sink saturation in African and Amazonian tropical forests.* Nature 579, 80–87. https://doi.org/10.1038/s41586-020-2035-0.

DISTRIBUTION OF ABOVEGROUND BIOMASS IN THE FOREST



Source: Ploton, P., Mortier F., Réjou-Méchain, M. et al., 2020. *Spatial validation reveals poor predictive performance of large-scale ecological mapping models.* Nat Commun 11, 4540. https://doi.org/10.1038/s41467-020-18321-y

The role of Central African forests in mitigating climate change

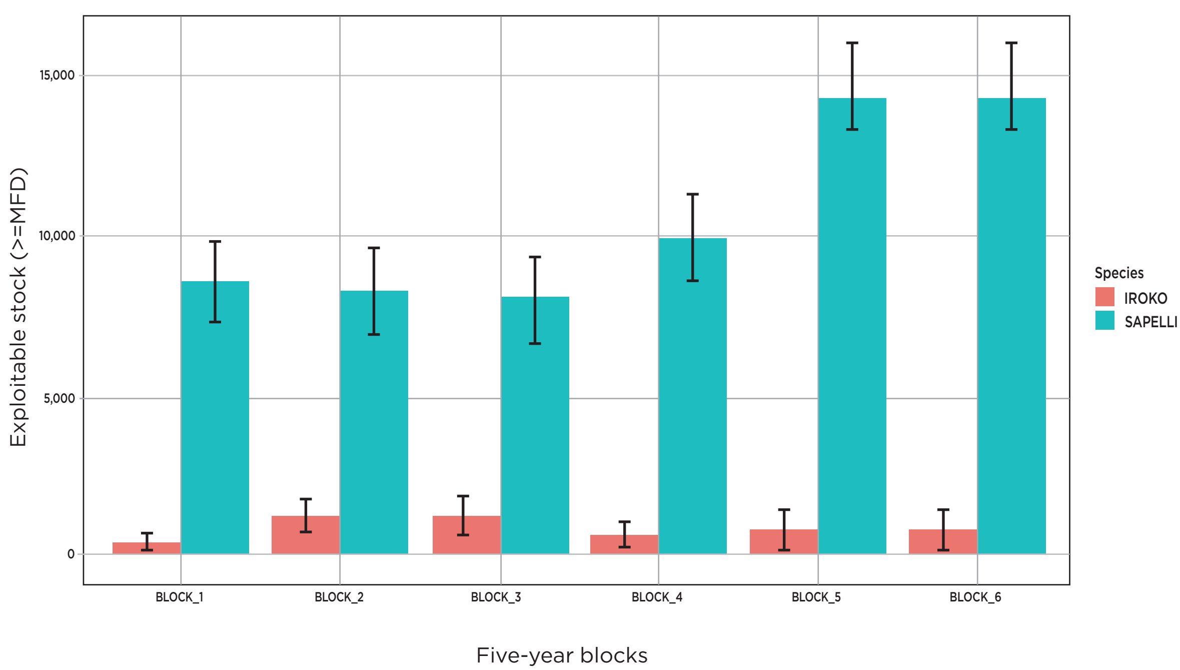
Vivien Rossi,
CIRAD researcher, Marien Ngouabi University

“There are many different forest types within the wider forests of Central Africa. Each of these, because of its environmental condition, its mix of plants and its level of disturbance, has a different role with respect to climate change: for example, peat forests are carbon sinks, undisturbed non-peat forests are more likely to be carbon neutral while exploited forests will emit carbon. On a global scale, the forests of Central Africa are considered a carbon sink. Locally they provide a cooling microclimate.
Today, the health of these different forest types is threatened by global warming and forests which were permanently humid are now dry at certain times of the year. They are also becoming more prone to forest fires. If nothing is done, in the medium term, the forests of Central Africa will become a source of carbon emissions and will add to the warming of the planet.
Added to this threat is the current increase in deforestation caused by population growth. Forests are being cleared for agriculture, which reduces the carbon storage capacity of the massif. It is absolutely imperative that more efficient types of agriculture are adopted in order to limit deforestation, especially until population growth stabilises.”

DafSim and DafSim-C, multi-rotation forest management simulation tools to aid improvements in sustainable forest management

As part of the DynAfFor project, a forest management simulation package was developed. This *open source* software application is called DafSim[12] or DynAfForSIMulateur. Its purpose is to assist in forest management modelling at plot scale.
A new version, DafSim-C, was developed for use at forest concession scale during the P3FAC project.
DafSim-C uses FMP inventory data, collected from the whole of a concession, to refine its management plan and the annual logging inventory to plan future annual harvests. DafSim-C can be used to **quantify and map commercial timber stocks and volume for all or part of a concession** and to estimate other indicators commonly used in forest management. These indicators can include the rate of stock regeneration, required to specify the FMP-specific felling diameter (FMP-MFD) for each commercial species.

DISTRIBUTION OF COMMERCIAL STOCK (BY BLOCK OR LOGGING AREA)



Quantity of commercial stock (by five-year block or annual logging area)

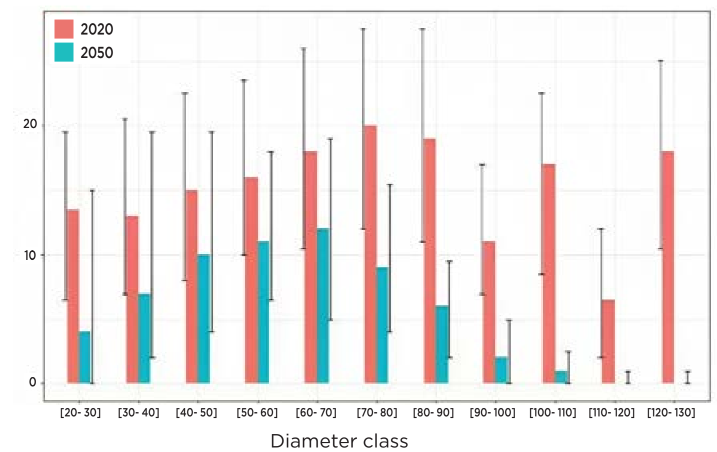
12- https://www.dynafac.org/fr/p/138/outils-daide-a-la-gestion-forestiere

The software can also be used to **assess the sustainability of a logging scenario**. Once the parameters for each species (growth rate, mortality rate and, in some cases, recruitment rate) for each species have been entered, it is possible to estimate and visualise, over one or more rotations, changes in the diametric structure of each species as well as the commercially usable stock and volume.

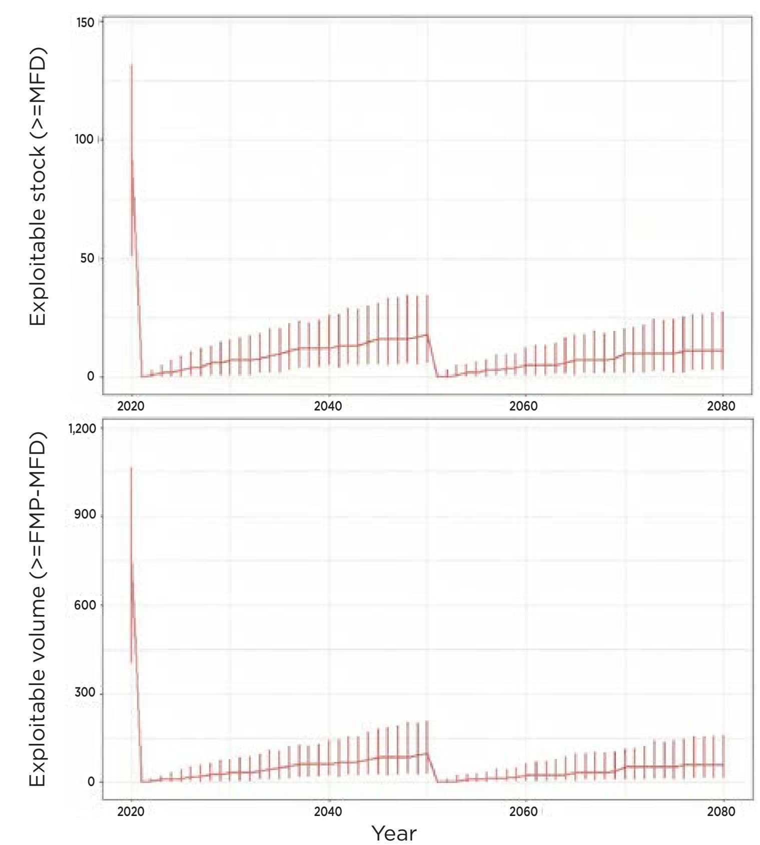
Plotting a logging scenario

- Forest dynamic parameters: standard or site-specific values
- Logging parameters: logging intensity by diameter and quality, logging waste by diameter

CHANGES IN DIAMETRIC STRUCTURE

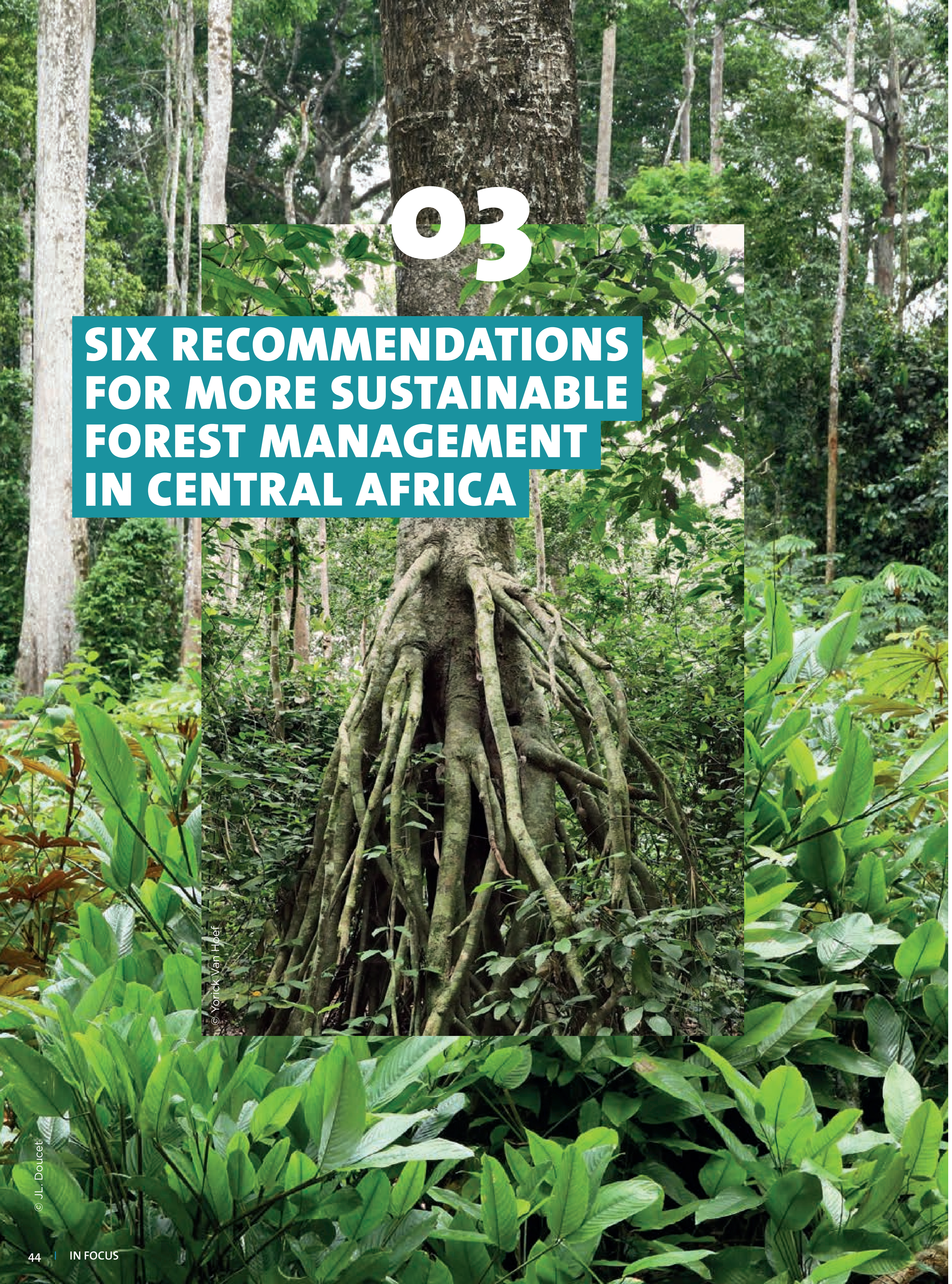


INDICATOR CHANGE (BY LOGGING AREA OR OVERALL)



Assessing logging scenario sustainability

DafSim-C can thus be used as **a tool to assist in the validation of forest development plans** by administrative bodies responsible for forest management. The software can also be used by companies to model changes in forest composition when creating or revising their management plans.



© JL. Doucet

© Yorick Van Hoef

03

SIX RECOMMENDATIONS FOR MORE SUSTAINABLE FOREST MANAGEMENT IN CENTRAL AFRICA

© G. Ligot

© G. Ligot

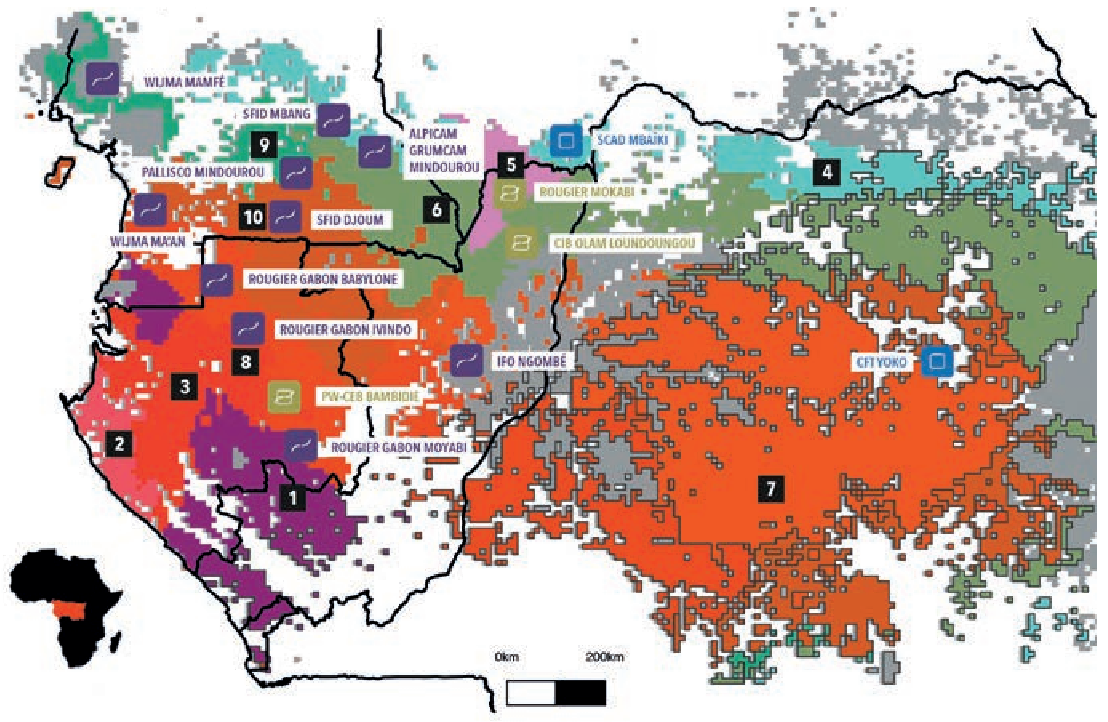
© G. Ligot

01

Tailor forest management to each of the 10 major forest types in Central Africa

In 2021, a major scientific publication[1] identified 10 major forest types in Central Africa. Reliable data on the dynamics of about half of these forest types are now available for use.

FMPs should take this variety in forest types into account by making use of the scientific data specific to each forest type, if it is available. Adjustments should be made to management practices and cutting limits for all commercial species.



Data collection sites

- Sampling Routes
- Plots
- Plots and routes

Major Central African forest types

1. High-altitude evergreen forests on the Atlantic coast
2. Evergreen forests on the Atlantic coast
3. Inland Atlantic evergreen forests
4. Semi-deciduous forests on the northern edge of the forest massif
5. Forests in transition from evergreen to semi-deciduous on sandstone
6. Semi-deciduous forests
7. Evergreen forests in the centre of the forest massif
8. Mixed evergreen forests
9. Degraded semi-deciduous forests
10. Forests in transition from semi-deciduous to evergreen

1- Réjou-Méchain et al., 2021. Nature.

02

Introduce a standard 30-year rotation period

A forest logged for timber needs a period of rest – a "rotation" – to allow for partial or complete replacement of the removed trees. The current rotation period in Central Africa varies between 20 and 30 years.

In most cases, modelling shows that a **30-year rotation period provides the best compromise between replacement of harvested stock and operational economic viability**, as long as the amount of timber extracted is correctly tailored to the model data.

However, in some particularly fast-growing forests (for example, in immature predominantly okoumé forests) shorter rotations of 20-25 years might be appropriate.

03

Set up sampling routes in every concession of more than 50,000 hectares

© JL. Doucet

The scientific data used in setting forest management parameters varies between forest types but can also vary within the same forest type. To make FMPs more reliable, forest companies managing over 50,000 hectares should therefore simplify survey sites and sampling routes, to refine the parameters used for management of their particular concessions.

04

Improve recovery rates for species logged for timber

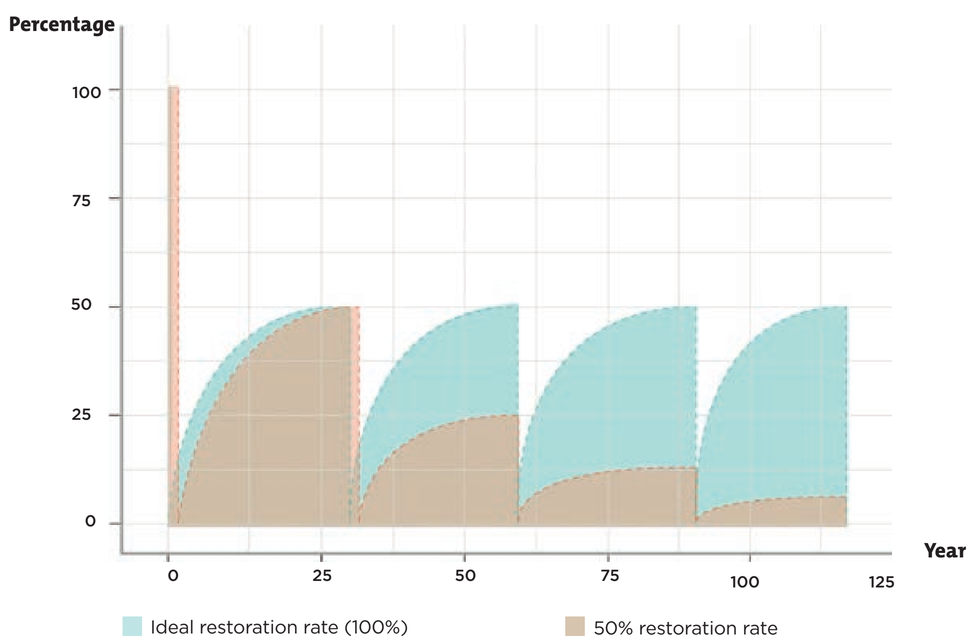
The recovery rate is the proportion of the number of trees restored by the start of the next rotation relative to the number of trees logged. A 100% rate signifies that every tree felled has been replaced by another before the next logging operation. This is the ideal scenario, which should be the aim wherever possible.

A standard target of 100% should therefore be adopted for the group of species harvested by each concession, to ensure the sustainability of this same group of species for future harvesting.

However, a 100% rate is difficult to achieve on the first rotation, as the harvested trees have been produced by the forest over several centuries. It should therefore be applied from the second rotation.

A 100% rate will still be difficult to achieve on the second rotation for certain tree species whose natural regeneration rate is too low even without logging. This is particularly true of species requiring direct sunlight, which makes a 100% recovery rate difficult to achieve even on the second rotation. **Therefore, a minimum recovery rate of 50% per species logged, starting from the second rotation, has been proposed.**

GRAPH SHOWING THEORETICAL CHANGES IN FOREST STANDS OVER 4 ROTATIONS



05

Specify region-wide Standard Minimum Felling Diameters tailored to the local ecosystem

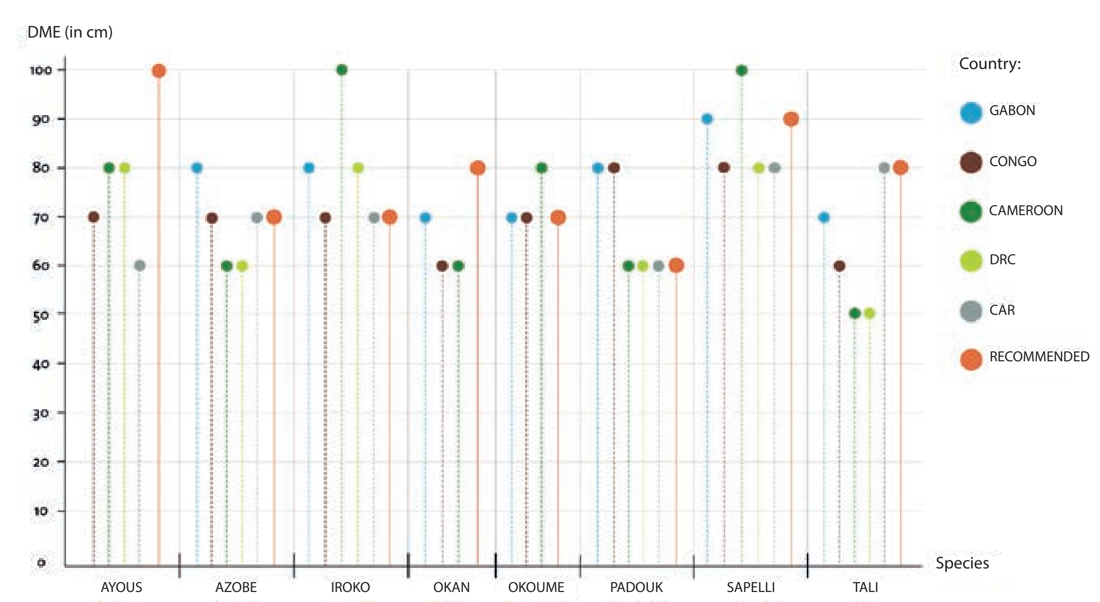
The current different minimum felling diameters (MFD) for the same species in the different countries of Central Africa are not justifiable from an ecological perspective. The MFD should instead **be based on the biological characteristics of the species. Among other things, it should ensure that a sufficient number of seed-bearing trees are retained** to guarantee seed dispersal and natural regeneration of the species.

Phenological, genetic and ecological studies undertaken by the DynAfFor and P3FAC projects have identified the minimum diameter for each species above which at least 50% of trees in a stand produce seeds capable of germination. Thus, MFDs that reflect the ecology of species and their capacity for natural regeneration have been proposed and should be applied in all Central African countries. These minimum diameter limits will eventually be tailored for each concession, taking the local forest dynamics into account.

From a commercial viewpoint, standardising MFDs at the regional level would reduce competition between countries.

MFD (IN CMS) BY COMMERCIAL SPECIES

for which phenology and/or gene flow were studied using the DynAfFor research sites



06

Promote forest regeneration

Tree planting

Even without logging, the abundance of many timber species is sub-optimal, resulting in poor natural regeneration. **Human interventions can help to improve the long-term regeneration of these species.**

Experimental planting to improve forest regeneration has been carried out in several concessions, leading to an assessment of the feasibility of planting and of the benefits to those species with a low natural regeneration rate. The number of tree species involved makes it difficult to develop propagation and planting plans for every species but the results of all the experiments undertaken over the last few decades can be used in the design of restoration programmes that are viable and valuable at a socio-economic level.

In 2021, as part of the P3FAC project and the PPECF project co-financed by the KfW, a practical guide, *Guide pratique des plantations d'arbres des forêts denses humides d'Afrique*, was published in French. It describes the stages, methods, species and management required for sustainable forestry management in Central Africa.

Wildlife conservation

Depending on forest type, 70-90% of tree species require animals to support seed dispersal and, consequently, natural regeneration. It is therefore essential to protect large and medium-sized mammals (elephants, great apes, duikers) in forest concessions. **The wildlife management techniques encouraged by the FSC and PEFC certification standards have proved their worth**: similar levels of biodiversity have been observed in forestry concessions to those found in protected areas. It is hoped that these results will provide inspiration to national administrations.
With this in mind, a report, also in French, entitled *Élaboration et mise en œuvre d'un plan de gestion de la faune. Guide technique à destination des gestionnaires des forêts de production d'Afrique centrale* was published through the financial support by KfW of the PPECF project. It describes the process of creating a wildlife management plan and putting it into practice, starting with a legal and regulatory framework and ending with a review of its success.

© J.L. Doucet

© Alexandre Trégourès

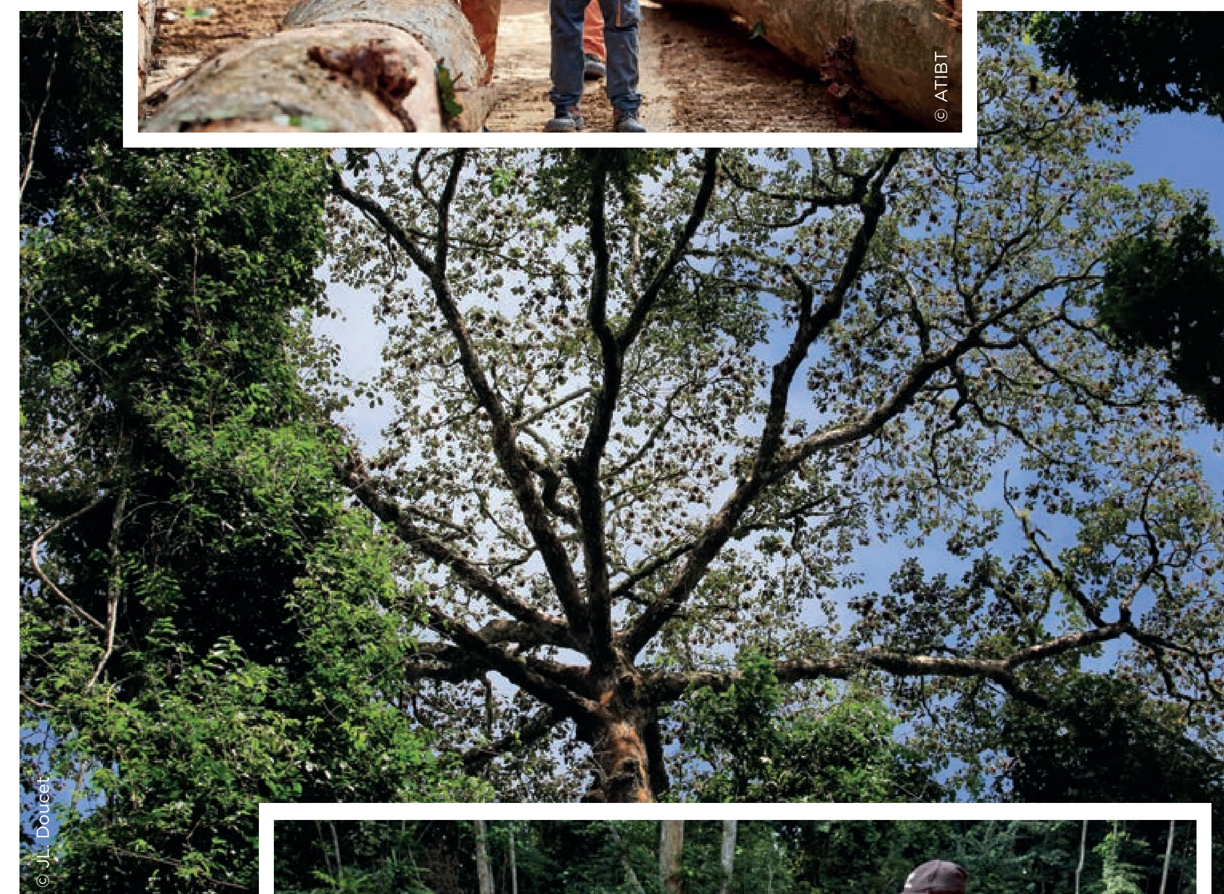
04

CONCLUSION AND OUTLOOK

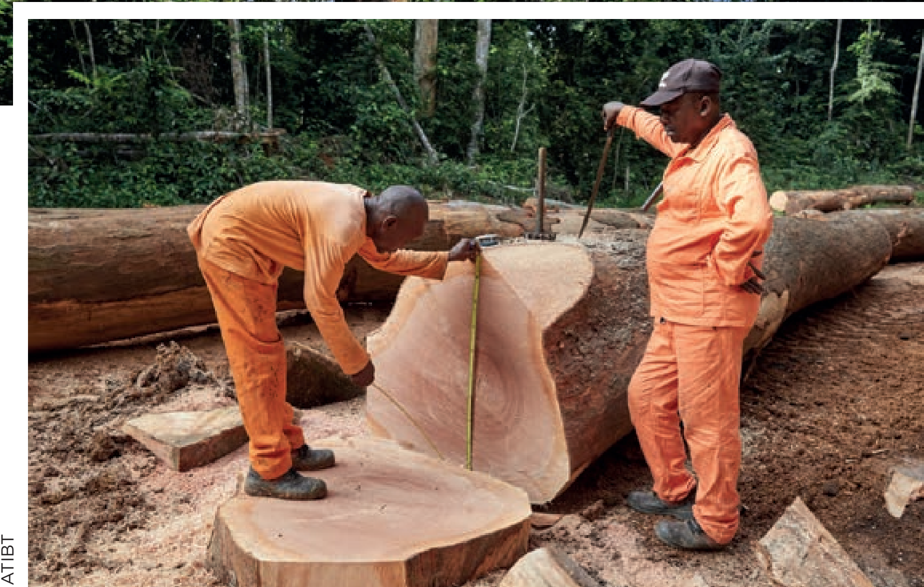
© Alexandre Trégourès

© Alexandre Trégourès

© ATIBT



© JL. Doucet



© ATIBT

If we are to make improvements in their sustainable management, we must have a better understanding of the functioning and dynamics, among other things, of Central African forests. Forestry research therefore has an important role to play in collecting and analysing data to inform options for forest management plans that are better tailored to each type of harvested forest.

In co-financing the DynAfFor and P3FAC projects for almost 10 years, the FFEM has helped to support this forest dynamics research. This support has, notably, enabled the establishment and surveying of research sites (sampling routes and plots). Analysis of the data from these sites has led to the issue of recommendations which are particularly useful in the review of Central African forest management plans.

These projects also contributed to the setting up of the DYNAFAC collective, which brings together different forestry interests – national administrations, industry associations, national and international research bodies, forestry companies – under one regional organisation (COMIFAC). Capitalising on the research results, the collective made six key recommendations.

- **Tailor** forest management to the 10 major forest types.
- **Standardise** regional rotation periods to 30 years, with the exception of certain immature fast-growing forests.
- **Set up** sampling route sites in all concessions of more than 50,000 hectares.
- **Promote** forest regeneration.
- **Improve** the restoration rate of harvested species.
- **Review** and standardise a region-wide minimum felling diameter (MFD).

Some members of the collective have also published **technical guides which are particularly useful for sustainable management work** in forests operated by the private sector under the national forestry administration of the country in question. The following documents deserve particular mention:

- *Guide méthodologique d'installation des dispositifs de type « sentier » (2020).*
- *Guide d'élaboration et mise en œuvre d'un plan de gestion de la faune (2020).*
- *Guide pratique des plantations d'arbre des forêts denses humides d'Afrique (2021).*
- *Guide de synthèse et de recommandations clés à destination des aménagistes forestiers et des administrations en Afrique centrale (publication prévue en 2023).*

As well as producing scientific results, the DynAfFor and P3FAC projects had the goal of showcasing these results in order to encourage revision of the Central African countries' national forestry regulations. Although the representatives of these forestry administrations have attended various meetings and presentations on the subject, the 6 key recommendations mentioned above are, by and large, still not included in national forestry regulations. It is therefore vitally important for COMIFAC and DYNAFAC collective members to increase their awareness raising of these recommendations so that the forestry administrations of the countries concerned take them into account.

The private sector has been highly involved at every stage of the DynAfFor and P3FAC projects. The effort of some forestry companies has been truly remarkable and has led to the installation of a significant number of research sites. In return, these companies benefit from more reliable data about their concessions which can be used when reviewing their FMP. **These committed companies aside, the private forestry sector must also commit to these recommendations**, and to this end the DYNAFAC collective will continue to produce practical guides available to help in the drive towards more sustainable management of Central African forest concessions.

The primary objective of a forest management plan is to ensure that the forest is harvested sustainably and, for that to happen, it is essential to establish the right balance between logged timber and forest restoration. Any reduction in economic profitability resulting from the application of these recommendations could be compensated by the introduction of differential tax systems to encourage companies' sustainability efforts, and by introducing other sources of income such as payments for environmental services (PES). Meanwhile, the reduction in volumes of flagship species should be offset by greater appreciation of, and diversification into, other species now better understood thanks to the research results.

The following sections address these different issues: the future of research into forest dynamics in the region, the uptake of certain key recommendations and the resulting impact on forestry concession systems which must evolve to ensure their own long-term survival and their capacity to preserve and benefit from the forests of Central Africa.

© Alexandre Trégourès

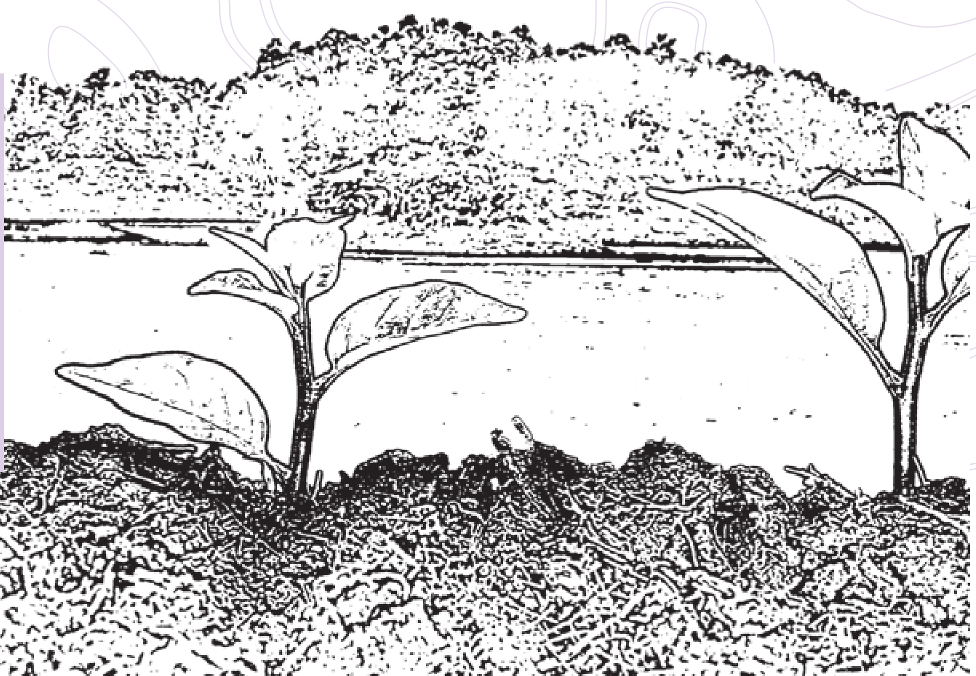
Creating a network of researchers and key players in the forestry sector: DYNAFAC and R2FAC, successes and prospects

FFEM projects are funded for a limited time to produce the results they are set up for under specific budget limitations. The DynAfFor and P3FAC projects adhered to this model and were completed in 2022 after having achieved their main objectives in a little under 10 years of operation.

At the beginning of the DynAfFor project a Steering Committee (COPIL) was set up under the aegis of the COMIFAC, with representatives from all interested parties. Additionally, a Scientific and Technical Committee (STC) was set up to advise the Steering Committee. This enabled effective decision-making for the duration of the DynAfFor and P3FAC projects. From this arose the goal of establishing permanent regional structures for the study of Central African forest dynamics under the COPIL and the STC. The DYNAFAC collective was therefore established, encompassing researchers, Central African forestry administrations and the companies who were partners in the DynAfFor and P3FAC projects. Although these two projects have reached completion, the DYNAFAC collective is still active and assists in setting up many collaborative research studies.

To ensure a strong, collaborative relationship between the participating countries, the DynAfFor and P3FAC projects also created the Central African Forest Research Network (R2FAC), bringing together, in particular, national and international research institutions on research and development work. An important objective for the **R2FAC** network is to secure ongoing funding for research into sustainable management of the environment and the forest ecosystems of Central Africa, that goes beyond basic research into forest dynamics. To this end, the network now provides for potential ongoing research work following the conclusion of the DynAfFor and P3FAC projects.

The DYNAFAC and R2FAC networks provided numerous doctoral candidates and interns with opportunities to train and connect with each other. The DynAfFor project alone gave 250 students and researchers from Central African countries such an opportunity.



THE FACTS

The P3FAC and DynAfFor projects represent

10 years of work in the field

250 students and researchers in the network

Sylvie Gourlet-Fleury with her colleagues and the CIB team at the Loundoungou research site in 2013.
From left to right. Standing: Jean-François Gillet, Martial Mokobo, Isaac Zombo, Yasmin Zadouaka.
Seated: Ati Ngouabi, Vivien Rossi, Alain Ndassongo, Sylvie Gourlet-Fleury, Jean Lamba.

The DynAfFor project's Scientific and Technical Committee (Libreville, 2016).
From left to right: Alfred Ngomanda, Jean de Dieu Nzila, Jean-Joël Loumeto, Bonaventure Sonké, Charles Bracke, Sylvie Gourlet-Fleury, Antoine Mitte Mbeang Beyeme, Mathurin Tchatat, Jean-Louis Doucet, Faustin Boyemba, Hervé Mokossesse, Gaston Limba, Alain Souza.

Tribute to Sylvie Gourlet-Fleury

Doctor of Science and research scientist in tropical forest ecology

"Sylvie Gourlet-Fleury passed away on 22 January 2023. A research scientist on forest ecology for CIRAD, Sylvie was the driving force behind the instigation in 2012 of the DynAfFor and P3FAC projects in Central Africa. Her contribution to these projects was enormous. A tireless worker and an enthusiastic communicator, she was able to train and motivate her colleagues and numerous students from both hemispheres to become invaluable partners in the scientific research taking place in Central Africa.

Her numerous publications and conference speeches are testament to her contribution to ecology and tropical forest management in Central Africa.
Sylvie's death is a huge loss to the tropical forest ecological science community. In honour of her memory, her many tropical forest science colleagues are determined to continue her more than 30-year battle to conserve the tropical forests of Central Africa and, indeed, the forests of the world."

The need for an effective communication and advocacy system

Like other projects supported by the FFEM, the DynAfFor and P3FAC projects operated on the *science to policy* principle on the issue of sustainable management of production forests in Central Africa. **In general terms, this policy consists of acquiring scientific information and then using that information to guide and improve public policy in the countries concerned.** Even though the DYNAFAC collective has made a start on this work, there is still a long way to go.

The first challenge is to summarise the research results in an understandable way and then put forward concrete and realistic proposals. The second challenge is to persuade governments and forestry administrators to discuss and adopt these proposals. This challenge is harder to overcome than the first one. Finally, the third challenge is to ensure that the proposals and outcomes of the research, are put into practice in the field and monitored over the long term.

In this publication we have described the structure of the DYNAFAC collective, its research framework and the main informative publications it has produced. We believe the first challenge of making the research accessible, putting it into practice and producing recommendations has, for the most part, been achieved. This includes the publication and distribution of this document.

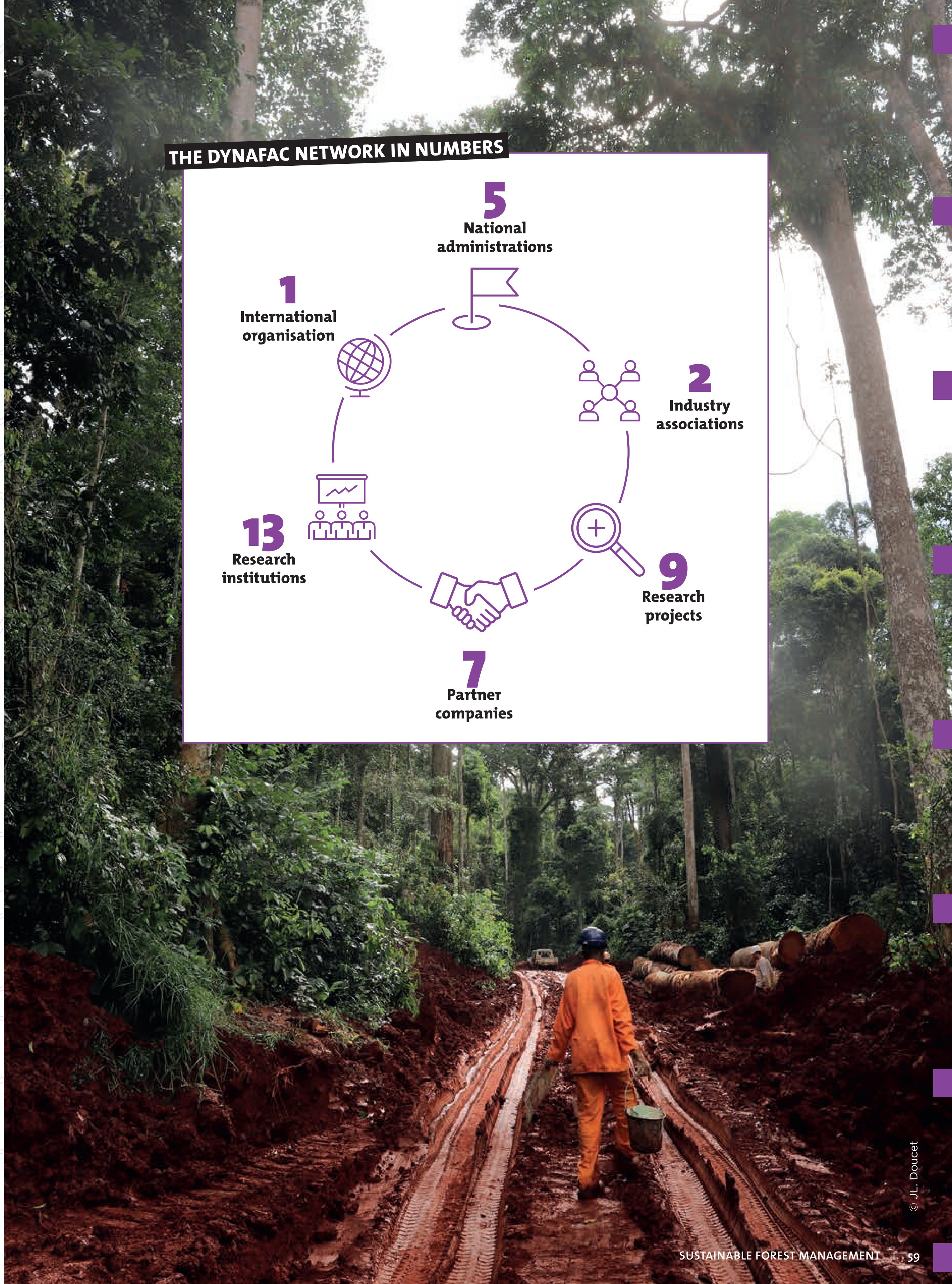
The next stage, already under way as part of these projects, consists of sharing the research results and recommendations in an accessible way with forestry administrations and private forestry companies. The most important potential outcome is for these organisations to understand, adopt and, wherever possible, support and instigate these recommendations. Regional (under the aegis of COMIFAC) and national workshops, face to face meetings and other formal or informal meetings could be used to raise the awareness of governments and the private sector.

Some resistance and even opposition is to be expected, both from governments who have their own national forestry legislation and from the private sector who may be concerned that some of the recommendations will impact their profitability. The economic aspects of the recommendations are therefore central to these discussions and further work on the economic modelling associated with this is therefore essential.

The structure of the DYNAFAC collective, comprising one international organisation (COMIFAC), five national forestry administrations, 13 research institutions, seven private forestry companies and two industry associations, is undeniably a powerful platform for the development and implementation of a communication strategy and framework, from which to advocate effectively.

To this end, DYNAFAC has robust scientific data, existing quality documentation, a website designed to raise awareness and increase knowledge, good working relationships within the collective and a network of international and regional contacts to draw on.

The collective must now determine its priorities and establish a realistic roadmap, with funding for the short and medium term, for its campaign for more sustainable Central African forestry legislation and forest management methods.



© J.L. Doucet

The future of forest dynamics research sites

Put simply, the results from the DynAfFor and P3FAC projects show that the factors with the greatest impact on local tree diameter growth and mortality can differ from the ones which affect each of the 10 main forest types taken as a whole. It is therefore the case that **populations of tree species behave differently** in different forest types, as a result of different factors such as the gene pool, the local environment and competition, the history of the site etc.

Because of this, average diameter growth rates and mortality rates of exploited tree species cannot be assumed from forest type nor used as a standard for all the FMPs in that type of forest, even when such data is available. In fact, there is still not enough data from the sampling routes in the DYNAFAC network to identify differences in species population and dynamics in Central Africa forest types.

For these reasons, and while we wait for the results of more long-term research, it is recommended that at least one sampling route should be established and monitored in each concession of more than 50,000 hectares. This will enable the forest managers to quantify each species' annual growth and mortality rate in conditions as representative as possible of the concession for which they are responsible.

For concessions of less than 50,000 ha, the data from neighbouring concessions of more than 50,000 ha could be used. At least five years data is necessary for the results to be of value, while acknowledging that long-term monitoring (every year, with no time limit) remains the ideal. This would allow variations over a longer term, especially those associated with climate change, to be integrated into the plan. It costs about 10 million CFA francs to install a sampling route, a cost which can be absorbed by forest concessionaires. National governments should encourage private companies to install sampling routes, and even introduce legislation making it compulsory.

Research plots, on the other hand, enable every aspect (carbon stocks, basal area etc.) of the trees in a stand to be recorded and the different tree species' natural recruitment to be monitored. This data can be used to model long-term changes in forest composition. It can therefore be used to research climate change based on measurable effects.

It is therefore vital to collect this data from research sites over a period of several decades. Given these extended time periods and the costs associated with plot-type sites, responsibility for research sites should rest at national government level and not with private companies which, at best, only hold a lease for 20 to 30 years[1]. **Mixed partnerships** should be sought for every research site, bringing together investors, research teams, various technical partners and national government departments. Given the funding amounts required, partnerships for periods of 10 years or more should be possible. Such partnerships are needed for the many forest types still without a plot-type research site.

As far as topics that require further research on the sampling routes and plots are concerned, it would be useful to study the impact of higher logging rates per hectare. It is possible that, in some cases, profitability can be improved by increasing the number of species harvested in a concession because this could result in a greater number of trees per hectare being extracted.

1-During the life of the DynAfFor and P3FAC projects, several research sites could not be surveyed as hoped because the operating companies filed for bankruptcy and were bought out by investors unwilling to engage in forest dynamics research. This shows that the granting of a concession for a 20 to 30 year period does not guarantee that the research site within it will be surveyed and monitored.

SAMPLING ROUTE DIAGRAM

Based on Tosso et al. (Presses Universitaires de Liège, 2020)

Sustainable forestry concession management: what is at stake?

Benoît Jobbé-Duval, Managing Director, ATIBT

"The ATIBT association, with more than 30 years' experience of forest management in Central Africa and latterly of sustainable management certification, now recognises that its forest concession responsibility includes preserving biodiversity, protecting local ecosystems, fighting against deforestation, providing fair employment and combatting climate change. The challenges inherent in this are largely in the contexts of good governance, transparency, sustainable management of resources and local community participation. Possible future innovations include improved use of knowledge, whether Indigenous or not, and the use of new technologies to expand and reinforce forestry certification. We must also succeed in establishing a system of payments for environmental services as part of long-term sustainable management of tropical forests. This will combine ecosystem conservation and responsible use of forest resources."

The value of research sites in international research programmes

Éric Forni,
Regional Co-ordinator of the DynAfFor and P3FAC - CIRAD projects

"Given how difficult it is for a national government or a private company to manage research sites on their own, an ideal solution would be to make these sites part of international research programmes. The existence of these rare – and almost unparalleled in Central Africa – research sites could be of great interest and use to other research teams investigating topics beyond the initial questions which inspired the installation of these sites. One example of this is the Loundoungou site in Congo, where a number of studies (LiDAR measurement, research on vines and on the role of termites) were carried out in addition to the standard annual measurement of tree growth. With the support of the concessionaire, this site now has a good chance of becoming a reference site or super-site for the *One Forest Vision* programme. Sites for this programme are being identified following the *One Forest Summit* at Libreville."

How to ensure sustainable forest management in Central Africa

Cecilia Julve,
Manager, Nature+

"In order to ensure the sustainable management of Central African forests, we must first understand how they function. Changes in the composition of the forest are influenced by various processes such as growth, mortality and recruitment as well as the biological and physical factors which cause variations in their behaviour.

Experience tells us that for any given species, these processes can vary significantly from site to site. Therefore, using only one set of research results to calculate a given species' demographic processes gives a distorted result. It is therefore advisable to use data based on local forest dynamics. This information is provided by research sites.

There is no question that the logging rate per hectare has an impact on the surrounding forest dynamics. In the economic context of a change towards harvesting other tree species – which could lead to higher logging rates – it is advisable to continue studying the impact of logging on forest dynamics.

However, this research requires funding and it is essential that we establish solid partnerships between the various stakeholders to spread the cost of, and responsibility for, forest research. This will enable maximum use of available resources and promotion of a collaborative approach towards the shared objectives of forest preservation and sustainable development.

At the end of the day, forest dynamics research should be viewed as a long-term investment contributing to a better understanding of forest ecosystems, to conservation of biodiversity and to promotion of sustainable forest management in the Congo Basin.

It is therefore in the interest of all stakeholders to contribute to this effort, while recognising the many benefits that responsible management of forestry resources can bring to society as a whole."

Plantation forestry in managed concessions: risks and prospects

Many experts in the forestry sector have pointed out that any country which wants to increase the economic return from forestry resources cannot do this sustainably without also considering plantation forestry.

National, regional and international current and future requirements for timber in Central Africa cannot be fully guaranteed by sustainable management alone. The slash and burn agriculture practised in Central African forests results in deforestation. In some circumstances this could be reduced by the use of alternative agroforestry systems. Similarly, even though it is controversial, the struggle against climate change is encouraging both public and private investors in Central Africa to plant trees for their carbon storage capacity and thereby earn carbon credits and/or to gain environmental and social responsibility credentials (CSR). Such planting does not always take into account the associated social and financial costs or resulting lack of biodiversity. In the future, green chemistry may come up with novel uses for wood fibre, especially as a fuel. For these reasons, significant development of forestry plantations across Central Africa are likely to increase in the coming decades.

In complement to this, reforestation programmes in degraded forest and cleared areas of forestry concessions could, in the medium to long term, help to manage the resource more sustainably and demonstrate the viability of the system. The work of the DYNAFAC collective in forestry concessions has shown that former timber storage areas and degraded forest areas along access roads can be reforested once logging has finished. The viability of replanting in areas where felling has occurred is less certain because of the survival rate of plantings and the costs to maintain the immature plants.

Methods for sustained forest regeneration

Jean-Louis Doucet, Professor of tropical forestry at Gembloux Agro-Bio Tech (University of Liège)

“ Pragmatic reforesting solutions are necessary to maintain a rich balance of commercial species in the forest. Gembloux Agro-Bio Tech and its partners have conducted numerous studies on this subject for some 20 years. This work has led to several recommendations which are published in the previously mentioned *Guide pratique des plantations d'arbres des forêts denses humides d'Afrique* practical guide.

Planting trees in a forest concession is not as easy as one might think. This is because trees need light to grow, so open areas are needed for planting. Sustainable logging removes only one or two trees per hectare, each leaving a gap in the canopy of 300 to 1,000 m at most. A gap that size closes very quickly and competition between pioneer plants is very stiff. Added to that, concessionaires are required to close access roads after logging in order to limit poaching, making access for maintenance much more difficult. The other possibility is to plant in large areas where natural cover is scarce. This is the case in previously farmed areas – although the occurrence of such areas varies considerably by region – and on areas of savannah, although areas of savannah are usually rare, they already support their own biodiversity. The growing conditions in them are also unsuitable for commercial species as well as having a high forest fire risk. Lastly, if elephants are abundant in the area, they can cause significant damage to the plantation.

The UFA-Reforest project, financed by the EU and coordinated by the ATIBT, aims to build on the gains made by our work so far. The goal is to plant more than 240,000 trees within four years in the four concessions in Cameroon. Two types of planting schemes are used. Where there are gaps in the canopy, species such as limba (also known as fraké, Terminalia superba) are planted. This species grows very quickly at first and therefore requires little maintenance and they are not attractive to wildlife. Also, plots are planted on the sides of main highways to facilitate their maintenance, which avoids damaging areas with high biodiversity. Groups of multiple species requiring direct sunlight, such as ayous (Triplochiton scleroxylon) and azobé (Lophira alata) are planted and thrive in such settings. ”

Advances in sustainable management: how new methods and economic models are essential to the future of production forests

The forested countries of Central Africa are in the process of developing and diversifying their economies in response to the drive to rely less on non-renewable natural resources (oil, minerals etc.).

Historically, economic development in most countries around the world has resulted in a loss of forest cover, largely for the development of agriculture. Central Africa faces the same risk, especially from the development of agro-industrial economies.

Sustainably managed production forests offer an alternative which also guarantees the future of the goods and services provided by the forests. However, after the first rotation (possibly, in the case of coastal forests, after one or two more), the number of trees of flagship species suitable for logging is significantly reduced. The profitability of the forest concession system beyond the first rotation period is therefore in serious doubt. Changes in companies' bottom lines, from Europe to Asia, point to this reduction in profits in the forestry industry. Some companies attempt to improve profitability by resorting to less sustainable or even illegal practices. While this looks better on their bottom line, it damages the economic and/or social balance of the concession system.

The results and recommendations discussed in this publication tend overall to imply further constraints on concessionaires without, at this stage, giving concrete solutions for how the concession system can remain economically viable. For example, it is said that minimum felling diameters have not been increased above 100cm because of economic constraints. However, there is nothing to back up these constraints and therefore no justification of the 100cm limit. By the same token, there is no robust economic analysis of the loggable stock that will be restored for a second rotation at restoration rates between 50% and 100%. The DynAfFor and P3FAC projects have so far not researched and analysed the forestry concession economic model. This could be the subject of further research leading to recommendations for changing future methods and economic models.

In the meantime, the possible drop in profitability under the forestry concession economic model, perhaps partly due to the taking up of lessons learnt from the DYNAFOR project, could be compensated for with tax incentives. These would encourage companies to work more sustainably which, hand in hand with the introduction of other revenue sources such as payments for environmental services (PES), would increase the value of the many services provided by the forests.

Lastly, other strategic documents published at regional level[2] have identified changes that the forestry sector could make to improve economic sustainability. These include separating the downstream processing of timber from on-site sawlog production by moving it to specialised factories off-site. This would optimise the cost of forestry production and create commercial value from currently unexploited species.

2-Eba'a Atyi R, Hiol Hiol F, Lescuyer G, Mayaux P, Defourny P, Bayol N, Saracco F, Pokem D, Sufo Kankeu R and Nasi R., 2022. The Forests of the Congo Basin, State of the Forests 2021. Bogor, Indonesia: CIFOR. African Development Bank (2019). *Rapport Stratégique Régional - Développement intégré et durable de la filière bois dans le Bassin du Congo : opportunités, défis et recommandations opérationnelles.* p 308. https://www.afdb.org/en/documents/document/rapport-strategique-regional-developpement-integre-et-du-rable-de-la-filiee-bois-dans-le-bassin-du-congo-109428.

Towards far reaching change: forestry governance that allows for community and industry rights

Alain Karsenty, Research economist at CIRAD

“ Industrial forestry concessions have existed in Africa for more than a century. Criticised for their limited contribution to rural development and lack of respect for customary rights, they do not always have a good reputation. In Central Africa, concessions are managed as dedicated spaces where concessionaires and the local population are kept apart. An alternative could be a new type of multi-use and multi-user forestry concession: “Concession 2.0”. Under this arrangement customary use areas within and around the concession would be mapped cooperatively. It would specify the distribution of revenue from timber exploitation according to the value of culturally important species and to contracts negotiated with local communities. It would allow for the economic development of resources other than timber in association with local communities. Governance would be shared between the various stakeholders. Ultimately, it would enable the parallel development of community concessions, dedicated areas offering the potential to work in association with the industrial concession. To achieve this new version of forest development, combining inclusive management and exclusive rights, we need the support of international public funding and the revision of legislation. ”

05 APPENDICES

© Alexandre Trégourès

© Alexandre Trégourès

GLOSSARY

AFD	French Development Agency
ATIBT	International Tropical Timber Technical Association
CAR	Central African Republic
CHM	Canopy Height Model
CIRAD	The French Agricultural Research and International Cooperation Organization
COMIFAC	Central Africa Forests Commission
COPIL	Steering Committee
CSR	Environmental and Social Responsibility
DBH	Diameter at Breast Height
DRC	Democratic Republic of the Congo
DTM	Digital Terrain Model
DynAfFor	Structure and Dynamics of Central African Forests Project
EFD	Effective Fruiting Diameter
ESA	European Space Agency
FFEM	French Facility for Global Environment
FMP	Forest Management Plan
FMP-MFD	FMP-Specific Minimum Felling Diameter
FNRS	Fonds de la Recherche Scientifique (Belgian Fund for Scientific Research)
FSC	Forest Stewardship Council
GEOFORAFRI	Capacity Building and Access to Earth observation Satellite Data for Monitoring Forests in Central and Western Africa
Gt	Gigatonne
GxABT-ULg	Gembloux Agro-Bio Tech – University of Liège
ha	Hectare
HCS	High Carbon Stock
ICRA	The Central African Institute of Agricultural Research (CAR)
INERA	National Institute for the Study and Research of Agroeconomics (DRC)
IRAD	Agricultural Research Institute for Development (Cameroon)
IRET	Tropical Ecology Research Institute (Gabon)
IRF	National Forestry Research Institute (Congo)
KfW	Kreditanstalt für Wiederaufbau
LiDAR	Laser Imaging Detection and Ranging
Mha	Million Hectares
MFCFA	Million CFA Franc
MFD	Minimum Felling Diameter

NASA	National Aeronautics and Space Administration
N+	Nature+
OSFACO	Observation Spatiale des Forêts d'Afrique Centrale et de l'Ouest
OSFT	Observation Spatiale des Forêts Tropicales
P3FAC	The Public-Private Partnership for the Sustainable Management of Forests in Central Africa
PEFC	Programme for the Endorsement of Forest Certification
PES	Payments for Ecosystem Services
PFNL	Non-Wood Forestry Products
PPECF	The Programme for Promotion of Certified Logging
R2FAC	Central African Forest Research Network
REDD+	Reducing Emissions from Deforestation and forest Degradation, sustainable management of forests and the conservation and enhancement of forest carbon stocks.
STC	Scientific and Technical Committee
tCO_2	Tonne of CO_2 (carbon dioxide)
ULB	Free University of Brussels
UMG	Marien Ngouabi University (Congo)
UNIKIS	University of Kisangani (DRC)
UNSTM	Masuku University of Science and Technology (Gabon)

BIBLIOGRAPHY

African Development Bank, *Rapport stratégique régional, développement intégré et durable de la filière bois dans le bassin du Congo : opportunités, défis et recommandations opérationnelles,* 2019.

Cheliout Amélie, *Modélisation de l'accroissement diamétrique des arbres d'une forêt du Nord Congo à l'aide de données de télédétection acquises par drone en apport aux mesures de terrain.* Université de Montpellier, AgroParisTech, 2019.

Eba'a Atyi R., Hiol Hiol F., Lescuyer G., et al., *The Forests of the Congo Basin: State of the Forests.* Bogor, Indonesia: CIFOR, 2021..

Étude sur le plan pratique d'aménagement des forêts naturelles de production tropicales africaines. Volet 1 "Production Forestière". ATIBT, 2007.

Haurez et al., *Élaboration et mise en œuvre d'un plan de gestion de la faune*. Les presses agronomiques de Gembloux, Belgium, 2020.

Hubau W., Lewis S.L., Phillips O.L. et al., *Asynchronous carbon sink saturation in African and Amazonian tropical forests*. "Nature" 579, 80–87, 2020.

Levis C., Costa F.R.C., Bongers F., Peña-Claros M. et al., *Persistent effects of pre-Columbian plant domestication on Amazonian Forest composition.* Science 55, 6328: 925-931, 2017.

Ligot G., Gourlet-Fleury S., Dainou K. et al., *Tree growth and mortality of 42 timber species in central Africa*. "Forest Ecology and Management", 505, 119889, 2022.

Morin-Rivat J., Fayolle A., Favier C., Bremond L., Gourlet-Fleury S., Bayol N., Lejeune P., Beeckman H., Doucet J.L., *Present-day central African forest is a legacy of the 19th century human history*. eLife 6: p. 18, 2017.

Ndamiyehe Ncutirakiza Jean-Baptiste, Lejeune Philippe, et al., *Quantifier les dimensions des houppiers à l'aide d'images aériennes à haute résolution pour estimer l'accroissement diamétrique des arbres dans les forêts d'Afrique centrale.* "Bois et Forêts des Tropiques", 343: 67-81, 2020.

Picard Nicolas, Gourlet-Fleury Sylvie, *Manuel de référence pour l'installation de dispositifs permanents en forêt de production dans le Bassin du Congo*. Yaoundé: COMIFAC, p. 265, 2008.

Réjou-Méchain M., Mortier F., Bastin JF. et al., *Unveiling African rainforest composition and vulnerability to global change*. "Nature" 593, 90–94, 2021.

Saatchi S.S., Harris N.L., Brown S. et al., *Benchmark map of forest carbon stocks in tropical regions across three continents*. "Proceedings of the National Academy of Sciences", 2011.

Tosso Félicien, Daïnou Kasso, Sonké Bonaventure et al., *Sentiers de suivi de la croissance, de la mortalité et de la phénologie des arbres tropicaux: guide méthodologique*. Presses agronomiques de Gembloux, 2020.

Vancutsem C., Achard F., Pekel J-F. et al., *Long-term (1990-2019) monitoring of tropical moist forests dynamics*. "Science Advances", 2020.

Ploton P., Mortier F., Réjou-Méchain M. et al., *Spatial validation reveals poor predictive performance of large-scale ecological mapping models.* Nat Commun 11, 4540 (2020). *https://doi.org/10.1038/s41467-020-18321-y.*

AUTHORS' COMMENTS

"We have spent the last 15 years working passionately for the sustainable management of the forests of Central Africa. While working in various roles on different missions we have learnt about the complexities of the forest concession system, about forest management and about the concept of sustainability, from the perspective of all the parties involved (forestry administrations, forestry companies, local communities, NGOs, researchers, international funding partners etc.).

Unlike the controversial practice of clear felling or the agro-industrial large plantation system, both of which often result in deforestation, the forest management system in Central Africa, when it is applied correctly, usually preserves the fundamental forest ecosystem and its ecosystem services. The system only permits a few trees per hectare to be removed, in rotations of two to three decades. Even though the system is not perfect, we have been able to observe its many benefits under operational conditions. These benefits include improvements in the producing country's economy (tax revenue, industrialisation, employment, local development etc.) as well as biodiversity conservation and the preservation of the enormous carbon stocks held in these forests.

Of course, there are still many complex challenges and problems to overcome, especially in the application of sustainable forest management. Nearly 30 years after the introduction of forestry management in Central Africa, we have seen too few changes in the forestry concession model. With some rare exceptions, the practice of forestry management still focusses on a few species of timber for niche markets. The FFEM and its partners in the DYNAFAC network have supported research work which has provided vital knowledge on the dynamic functioning of Central African forests. These first steps have highlighted the, already suspected, limits of environmental sustainability under the forestry concession model. More innovation will be needed to apply DYNAFAC's recommendations to change a dying economic model focussed on a limited resource into one which involves many different resources and many different stakeholders.

Beyond the management model itself and the changes it needs, the main challenge in Central Africa is still to ensure a sustainable model is applied effectively and, in countries with weak governance, that activities are controlled.

At a time when many crises of anthropogenic origin (climate change, loss of biodiversity etc.) pose current and future threats, we can only encourage the FFEM and all its partners to keep up their commitment to supporting innovative solutions for the improvement of sustainable forest management Central African forests."

Baptiste Marquant
An agricultural and forestry engineer, Baptiste Marquant has been working in tropical forest management for almost 15 years. From the very beginning of his career, Baptiste has been interested in ways to manage the characteristic three-way conflict between forest, agriculture and development that is typical of tropical forest ecosystems. Working as an independent consultant since 2019, he has been involved in the development, implementation, monitoring and evaluation of numerous sustainable Central African forest management projects.

Anis Chakib
A forestry engineer, Anis Chakib is a partner and expert in agro-forestry and the environment at the SalvaTerra research company. Passionately committed, he has been travelling and working in the world's three main tropical forest regions for almost 15 years. He provides expertise and technical assistance on various aspects of rural development, sustainable management of natural resources, and on climate change adaptation and mitigation. He is convinced that the only way to find and implement realistic and sustainable solutions to the many challenges facing the world is to adopt holistic and integrated approaches involving all stakeholders and all sectors at every level.

OUR PARTNERS

The ATIBT (International Tropical Timber Technical Association) promotes sustainable and ethical development of the tropical forest timber trade from forest to market.

In particular, it represents forestry companies and the forestry industry, mostly that based in Africa, which provide tropical timber products, as well as other supply chain participants engaged in ethical forest management. To this end, it promotes ethically sourced tropical timber products on world markets. From its role as part of the DYNAFAC collective, it is able to facilitate dialogue between political and scientific interests.

The Belgian non-profit organisation Nature+ has been specialising in community and inclusive approaches to natural resource management since 2000.

Focussing mainly on Central Africa, it works largely in the area of social forestry, providing technical assistance to foresters (including the inclusion of wildlife management and social benefits in management plans) and the management of non wood forestry products (vegetal and animal). To this end, it works in close collaboration with the Central Africa research group at Gembloux Agro-Bio Tech (University of Liège, Belgium).

Gembloux Agro-Bio Tech is a faculty of the University of Liège, working exclusively in the fields of the natural sciences and biological engineering.

Part of the Terra Teaching and Research Centre, the Forest is Life research and education laboratory hosts a team of specialist tropical forestry researchers. In Central Africa, the team collaborates with many research and education institutions as well as several forestry companies engaged in sustainable management.

CIRAD, the French agricultural research and international cooperation organization, set up to further sustainable development in Mediterranean and tropical regions.

The multi-disciplinary "Forest and Society" research team, in particular, is involved in the DYNAFAC collective. Its main objective is to conserve, restore and enhance the use of tropical forests by promoting and implementing sustainable management of the resources they provide, to the benefit of rural communities and wider society.

DYNAFFOR AND P3FAC PROJECTS UNDER THE COMIFAC UMBRELLA

COMIFAC, the Central Africa Forests Commission, is an international organisation recognised for its role in promoting coordinated, sustainable forest ecosystem conservation through sub-regional collaboration.

COMIFAC ensured that the DynAfFor and P3FAC projects were consistent with other regional initiatives in order to benefit as widely as possible from project outcomes which contribute to better forest management.
It chaired the various steering committees and advocated for project results to be integrated into regional forestry policies. It helped spread awareness of the results and of new products developed by these projects among regional stakeholders.

© Yorick Van Hoef

The DynAfFor project Towards more sustainable forest management to protect biodiversity

Rich in important biodiversity, the dense forest of the Congo basin is under serious threat from human activities. Supported by the FFEM, the innovative DynAfFor project seeks to implement sustainable, responsible and coordinated management of this ecosystem.

KEY FACTS

Project start date: May 2012

Project end date: December 2020

Sector: biodiversity, agriculture and sustainable forests

Location: Cameroon, Congo, Central African Republic, Democratic Republic of the Congo

Funding model: grant

Programme budget: €3,940,000

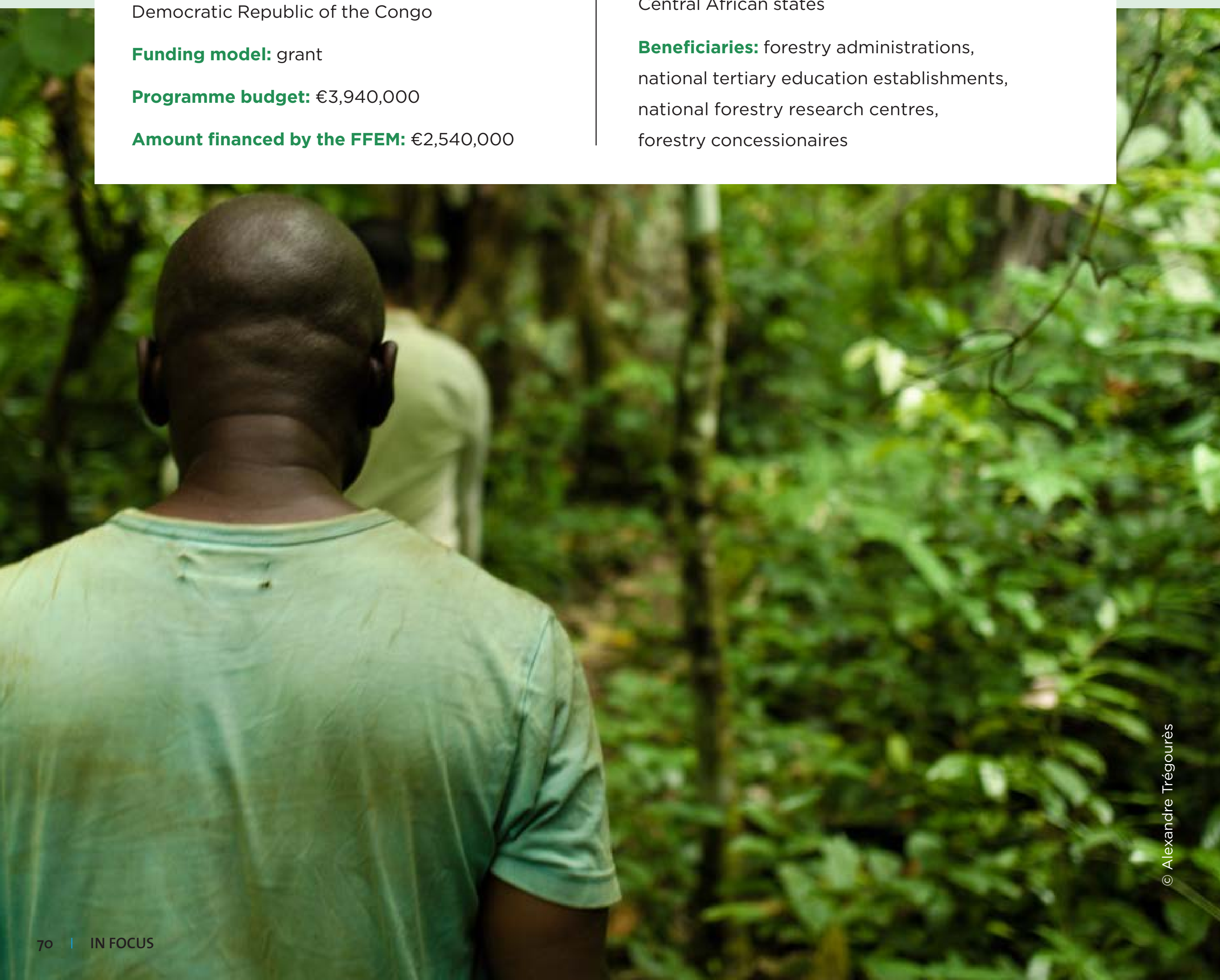
Amount financed by the FFEM: €2,540,000

Project owner ATIBT

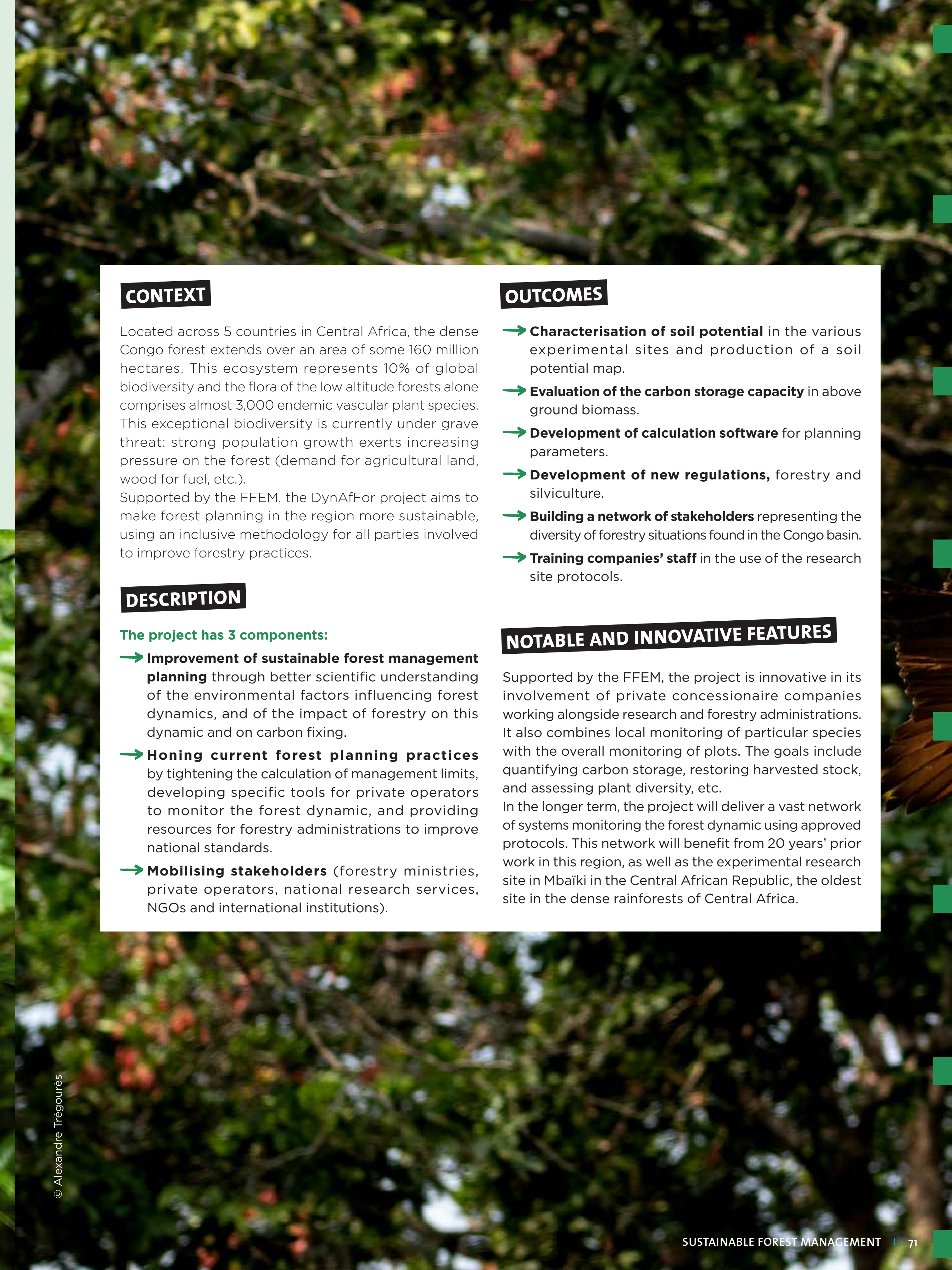
Member institutions sponsoring the project: French Development Agency

Co-financers: Private sector, CIRAD, Gembloux Agro-Bio Tech, Nature+, Central African states

Beneficiaries: forestry administrations, national tertiary education establishments, national forestry research centres, forestry concessionaires



© Alexandre Trégourès



© Alexandre Trégourès

CONTEXT

Located across 5 countries in Central Africa, the dense Congo forest extends over an area of some 160 million hectares. This ecosystem represents 10% of global biodiversity and the flora of the low altitude forests alone comprises almost 3,000 endemic vascular plant species. This exceptional biodiversity is currently under grave threat: strong population growth exerts increasing pressure on the forest (demand for agricultural land, wood for fuel, etc.).
Supported by the FFEM, the DynAfFor project aims to make forest planning in the region more sustainable, using an inclusive methodology for all parties involved to improve forestry practices.

DESCRIPTION

The project has 3 components:

- **Improvement of sustainable forest management planning** through better scientific understanding of the environmental factors influencing forest dynamics, and of the impact of forestry on this dynamic and on carbon fixing.
- **Honing current forest planning practices** by tightening the calculation of management limits, developing specific tools for private operators to monitor the forest dynamic, and providing resources for forestry administrations to improve national standards.
- **Mobilising stakeholders** (forestry ministries, private operators, national research services, NGOs and international institutions).

OUTCOMES

- **Characterisation of soil potential** in the various experimental sites and production of a soil potential map.
- **Evaluation of the carbon storage capacity** in above ground biomass.
- **Development of calculation software** for planning parameters.
- **Development of new regulations,** forestry and silviculture.
- **Building a network of stakeholders** representing the diversity of forestry situations found in the Congo basin.
- **Training companies' staff** in the use of the research site protocols.

NOTABLE AND INNOVATIVE FEATURES

Supported by the FFEM, the project is innovative in its involvement of private concessionaire companies working alongside research and forestry administrations. It also combines local monitoring of particular species with the overall monitoring of plots. The goals include quantifying carbon storage, restoring harvested stock, and assessing plant diversity, etc.
In the longer term, the project will deliver a vast network of systems monitoring the forest dynamic using approved protocols. This network will benefit from 20 years' prior work in this region, as well as the experimental research site in Mbaïki in the Central African Republic, the oldest site in the dense rainforests of Central Africa.

The P3FAC project
A public-private partnership to improve the sustainability of forestry planning

Central Africa is home to around 10% of global biodiversity.
The FFEM supports the public-private partnership for the sustainable management of forests in Central Africa (P3FAC), with a view to making forest exploitation in the region more sustainable while taking its rich biodiversity into account. The overall objective of the P3FAC project is to improve the sustainability of forestry planning by involving the public and private sector in making best use of the combined results of forest dynamics research.

KEY FACTS

Project start date: February 2017

Project end date: December 2022

Sector: sustainable forestry and agriculture

Location: Cameroon, Congo, Central African Republic, Democratic Republic of the Congo

Funding model: grant

Programme budget: €8,402,000

Amount financed by the FFEM: €2,000,000

Project owner: ATIBT, Nature+

Member institutions sponsoring the project: French Ministry of Ecological Transition, French ministry of Agriculture and Food

Cofinancers: CIRAD, AFD, FNRS, Gembloux Agro-Bio Tech, Nature+, PPECF2, KfW, private sector and other sponsors

Beneficiaries: forestry administrations, national tertiary education establishments, national forestry research centres, forest concessionaires

© Alexandre Trégourès

© Alexandre Trégourès

CONTEXT

Spanning Cameroon, Congo, Gabon, the Central African Republic and the Democratic Republic of Congo, the total dense forest area in the Congo basin covers an estimated 160 million hectares. Forestry planning projects have been in place since the 2000s. They are fine-tuned on a regular basis, ensuring the ongoing sustainable management of these areas. The longest-standing projects, however, frequently encounter difficulties that cast doubt on their effectiveness and the extent to which they factor in sustainability.
Launched in 2013, the purpose of the DynAfFor project was to preserve the structure and dynamics of Central African forests by establishing timber processing rules combining the ecological functioning of stand abundance and composition with the variability of environmental conditions. The P3FAC project follows on from DynAfFor. It broadens the scope of research into forestry techniques, regeneration, fauna and non-wood forestry products (NWFPs) to better integrate local populations and mobilise forestry administrations.

FEATURES

The project has five components:

- → **Increasing the amount of data collected** on forest dynamics (installing new sites, biomass quantification, publishing results).
- → **Analysing the impact of anthropogenic activities on organic and ecological processes** affecting the demographic dynamics of commercial stands and NWFPs.
- → **Proposing forestry and silviculture plans** adapted to different forest types to improve the sustainability of forest management.
- → **Incorporating the outcomes of research into sustainable forest management** and practical methods for applying them into policy decisions.
- → **Organising a scientific workshop** for technical discussions on the three tropical basins (Africa, Asia, the Americas).

OUTCOMES

- → **Improvement in the spatial coverage and diversity of the types of forest habitat** studied by using the research strategy on forest dynamics arising from the DynAfFor project.
- → **Assessing and reducing the impact of anthropogenic activities** on ecological and organic systems.
- → **Improvement in the regulations for planning and managing** different forest types and disseminating good practice.
- → **Incorporation of research results** into forest policies.
- → **Exchange of information and sharing** of experience between the three tropical basins.

NOTABLE AND INNOVATIVE FEATURES

The P3FAC project is innovative in its implementation and promotion of applied research methods and provides an example for others to follow. Its objective is to learn more about the forest dynamic characteristics to enable better forecasting of the consequences of forest exploitation. As such, the P3FAC project complements DynAfFor, already regarded as an innovative project in terms of its methods and objectives. The project is also pioneering in its ambition to do further research into the harvesting of certain NWFPs and the resulting impact on ecosystems and their dynamics.
Once the project has concluded, lessons must be drawn from its innovative operational approach, an approach which includes various collaborative arrangements between international research bodies.

Authors: SalvaTerra, Baptiste Marquant, Anis Chakib

Management: FFEM – Stéphanie Bouziges-Eschmann

FFEM team members: Aurélie Ahmim-Richard, Séverine Barde-Carlier

Photo credits: ATIBT, Nicolas Barbier, Edouard Coenraets, CIRAD, Jean-Yves De Vleeschouwer, Jean-Louis Doucet, IMAGEO, Nature+, Sylvafrica, Alexandre Trégourès, Yorick Van Hoef

Graphic design: bearideas

Legal deposit: April 2024

Member institutions of the FFEM Steering Committee

French Ministry of Economics, Finance and Industrial and Digital Sovereignty
Directorate-General of the Treasury
139 rue de Bercy
75 572 Paris Cedex 12
www.economie.gouv.fr

French Ministry for Europe and Foreign Affairs
Directorate-General for Globalisation, Culture, Education and International Development
Sub-directorate for Development and Climate
27 rue de la Convention • CS 91 533
Paris Cedex 15
www.diplomatie.gouv.fr

French Ministry of Ecological Transition and Territorial Cohesion
Department of European and International Affairs
Arche Sud, 92 055 La Défense Cedex
www.ecologique-solidaire.gouv.fr

French Ministry of Higher Education, Research and Research
Directorate-General for Research and Innovation
1 rue Descartes • 75 005 Paris
www.enseignementsup-recherche.gouv.fr

French Ministry of Agriculture and Food Sovereignty
General Directorate of Commercial Sector Economic and Environmental Performance
International Sub-directorate
3 rue Barbet-de-Jouy
75 349 Paris 07 SP
www.agriculture.gouv.fr

French Development Agency
5 rue Roland Barthes • 75 598
Paris Cedex 12
www.afd.fr

in partnership with the **DYNAFAC** collective

FFEM Secretariat

French Development Agency

5 rue Roland Barthes • 75 598 Paris
Tel: +33 1 53 44 42 42
Fax: +33 1 53 44 32 48
contact: ffem@afd.fr

Follow us on social media

@FFEM_FR

FFEM - Fonds français pour l'environnement mondial