Plant available soil water

Carnot sandstone soils

Carnot sandstone soils are well represented in the study area of CoForChange. These sandy soils (87% sand, 11% clay) are *a priori* poorly adapted to the installation of a forest as they are very acidic (pH = 4.1), the sum of exchangeable bases is very low (0.3 cmol+/kg) and the available water capacity is low (80 mm between 0 and 130 cm depth). Yet they exhibit favourable characteristics for good rooting: the red and spotless characteristics of an aerated environment, exchange acidity due to H+ that prevents aluminium toxicity, and the lack of gravelly layers that impede root penetration. Unconstrained in these soils, tree rooting could be very deep.

This would lead to an available water capacity globally larger than that in the other soils of the study area and explain forest continuity. This hypothesis will be tested in 2011 by a study in the Central African Republic on the rooting depth of trees on Carnot sandstone (Ngotto) vs. quartzite sandstone (Mbaiki).

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CAR Mission

During their mission in the Central African Republic in early December 2010, A. Laraque and V. Freycon studied comparatively a site on quartzite sandstone (Mbaiki) and another on Carnot sandstone (Ngotto) to (i) identify the depth of water tables and install piezometric sensors to measure their vertical variations in rainfall cycles, (ii) collect data on rainfall and water, and (iii) conduct a preliminary study on the roots of trees.

Four boring augers up to five meters deep were made (those in Mbaiki were fitted with a PVC pipe strainer for manual bimonthly monitoring of the water), four wells were located in the village of Mbaiki, and an automatic twice-daily-recording piezometric sensor was installed in one of them; the other three will be monitored manually bimonthly by an electrical sensor operated by an observer on site. Preliminary results show differences between quartzite sandstone and Carnot sandstone on the average depth of the water tables (8 vs 25 m) and maximum depth of rooting (2 vs 5 m).

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Mapping tree communities

Identifying homogenous forest types

To map simultaneously tree communities and their functional properties, the team developed a method for identifying homogeneous forest types characterized by biological traits that have a similar response to environmental variables. A model-based clustering technique derived from a finite mixture of models is proposed. Finite mixture modeling involves predicting a set of response variables (here the biological traits) by a mixture of K regression models relying on predictor variables (here the environmental variables). Each component of the mixture corresponds to a forest type, and each plot can be assigned to a type. Finite mixture models simultaneously classify the plots into K forest types and define the particular response, for each forest type, of the biological variables to the environmental variables. To infer parameters the team developed an expectation-maximization algorithm.

First results are promising but need further analysis.

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Drought – Light

Trait measurement campaign

The field experiment launched in May 2010 in Pointe-Noire (see *Newsl.* No 3) was carried out during the dry season and ended in September/October 2010 by a one-month measurement campaign headed by S. Coste and B. Engelbrecht. In this campaign, four students and a technician from the University of Bayreuth (Germany), helped by the CRDPI team in Pointe-Noire, measured more than 20 plant traits related to drought and/or shade tolerance in seedlings of 38 tree species.

Following the campaign, S. Coste, M. Swaine and B. Engelbrecht met A. Fayolle, F. Mortier and S. Gourlet-Fleury in Montpellier in November 2010 to review the data analysis plan and organize the end of the greenhouse experiments in Pointe-Noire. Results will be used to characterize drought tolerance strategies of tree species and link them to distribution patterns, and to test for a possible trade-off between shade and drought tolerance.

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Members of the field campaign in Pointe-Noire.

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CoForChange Newsletter
No 4 - January 2011
PREDICTING THE EFFECTS OF GLOBAL CHANGE ON FOREST BIODIVERSITY IN THE CONGO BASIN

Converging efforts for better management of tropical forests

Involve research in the negotiation process

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FSC Certification Workshop in Cameroon in 2009

How can researchers, technicians, administrations, managers, non-governmental organizations (NGOs) merge efforts towards sustainable management of tropical forests? The Forest Stewardship Council (FSC) referential for the Congo Basin could be an excellent opportunity for collaboration. The referential, under negotiation since March 2008, should end all disputes on these certifications, and ensure a base whereby certified companies meet the requirements of some, while respecting the imperatives of others. The next two years will be crucial in the negotiations and it is essential at this stage to prepare for research involvement in the talks, in particular the participation of the CoForChange project. "How and according to which modes" are questions which will enable the new International Technical Tropical Timber Organization (ATIBT) to assert its position as a catalyst for the tropical timber subsector. Current discussions are orchestrated by two international constraints that need to be kept in perspective.

Changes in FSC International rules

Under pressure from NGOs, FSC International needs to improve some of its indicators, in particular those relating to forests of high conservation value (HCVF, see CoForChange *Newsl.* No 3). A new revision of the FSC International referential is underway, in parallel with the workshops on the development of a regional referential adapted to the context of the Congo Basin. These revisions both at the regional and international levels will necessarily have major impacts on forest management. The FSC system is particularly vulnerable to attacks by NGOs and pressure on topics such as Intact Forest Landscapes. A context wherein scientists have been, until now, little involved in the very political discussions. This is the place, however, where contributions such as that of the CoForChange project can help speed up real issues, in the service of conserving forests and their biodiversity, away from partisan bickering, but based on unbiased substantiated research. For these reasons, ATIBT supports maximum involvement of scientists in the oncoming debates.

Setting up FLEGT Action Plan

The European Commission is setting up the Action Plan for "Forest Law Enforcement Governance and Trade" (FLEGT) to fight against illegal timber trade. The Plan has two tools for verifying the legality of wood products throughout the commodity chain. They consist in the Voluntary Partnership Agreements (VPA) and the regulation on illegal timber, formerly known as Due Diligence Regulation. Thus, the FLEGT Action Plan has impacts on the entire timber sector – tropical timber included. States who commit themselves to the plan show their willingness to move towards responsible management of their resources and leave the door open to scientific research that can help establish modalities. An important issue is to give the stakeholders of FSC and FLEGT referentials the opportunity for mutual recognition, empowering thus the efforts of all concerned to improve forest management.

On this enthusiastic note, which proposes a close collaboration between the various specialists, the *Newsletter* wishes everyone a motivating and exciting year.

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2011 International Year of Forests

On the occasion of this special year for forest professionals, our organizations are mobilizing resources to make known the results of research in general and of CoForChange in particular. In France, two major events are planned: 1) at Paris International Agricultural Show, from 19 to 27 February 2011, CIRAD devotes its stand to tropical forests; on 21-22 February, four round tables will discuss the issue "Should we pay for tropical forests", and one of them is dedicated to the theme "Forest dynamics, climate change and adaptation"; 2) from 15 to 18 November 2011 in Montpellier, an international workshop on the silviculture of rainforests is organized by CIRAD[1], CIFOR[2] and ECOFOR[3], under the auspices of IUFRO[4]. Other events will take place, and we will announce them through CoForChange website or the *Newsletter* next issue.

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[1] French Agricultural Research Centre for International Development
[2] Center for International Forestry Research
[3] Public Interest Group on Forest Ecosystems
[4] International Union of Forestry Research Organizations

Focus on

Present-day forests' team

Jean-François Gillet is a PhD student at Gembloux Agro-Bio Tech (University of Liege, Belgium). He specializes in the dynamics of forest ecosystems in relation with ancient and/or recent anthropic activities in Central Africa. As part of his thesis, a multidisciplinary approach for a particular forest type is considered: open canopy vegetation type with giant herbaceous understory (*Marantaceae* and *Zingiberaceae*). In 2010 within CoforChange, he carried out field inventories and collected botanical, pedological, anthracological as well as archaeological samples.
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Jean-Louis Doucet is professor at Gembloux Agro-Bio Tech (University of Liege, Belgium) where he is head of the laboratory of Forestry of Tropical Regions since 2003. His work focuses on the ecology of woody species, their silviculture, and sustainable management methods of production forests. To this end, he collaborates with many logging companies committed to obtaining certification. Within CoForChange he coordinates the workpackage on the ongoing development of tree communities.
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Ongoing development of tree communities

Relations between today's plants and past disturbances

To study the dynamics of the semi-deciduous forest in Central Africa and its origin, researches were divided into sixteen main sites, located within the forest concessions of partner companies and previously identified by mapping studies. The sites lay in the north of the Republic of the Congo, where sandstone and alluvium, top layer formations of the Tertiary and Quaternary, are predominant, and in the southeast of Cameroon, made up of the Precambrian craton (Map).

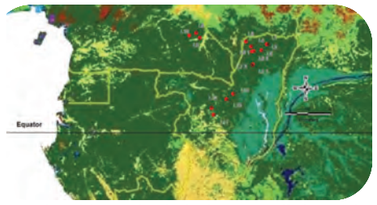
Three vegetation strata were identified during the normalized inventory: trees over 10 cm in diameter, the woody understory (regeneration included) and giant herbaceous plants (*Marantaceae*, *Zingiberaceae* and *Commelinaceae*). Repeated auger boring was performed and a reference soil pit used to study the soil of each site. In addition, the abundance of charcoal and the presence of any artefacts (burnt palm-nuts, ceramics, slags, carved stones) were systematically recorded according to the depth level.

During inventories, 376 woody taxa were identified on 3.3 ha for the trees and 4224 m^2 for the woody understory strata. Different types of land forests were surveyed: dense forests with stands of Owom (*Manilkara mabokeensis*), Ayous (*Triplochiton scleroxylon*) and Limbali (*Gilbertiodendron dewevrei*), as well as open canopy types with *Marantaceae* with different degrees of openness.

Large variations in the structural parameters of the different forest types studied were observed: densities of the trees and of the woody understory strata, and recovery rates of tall herbaceous plants. Charcoal was present in all the soils studied, but very variable in abundance, and artefacts were found in over one third of the sites.

Statistical analyses showed significant correlations among the variables and with the indices of past disturbances for the three vegetation strata; in particular, the tree density is positively correlated to the woody understory density, the tall herbaceous plant density is positively correlated to the degree of openness of the canopy and negatively to the understory density, and finally, to a lesser extent, charcoal abundance is positively correlated to the density of herbaceous plants and negatively to that of the woody understory strata.

When the remains of ancient fires – omnipresent in the study area – are combined with artefacts, their anthropic origin (slash-and-burn agriculture, ancient villages and encampments…) is confirmed. These fires shaped the forests over time and might have promoted the expansion of open canopy types with *Marantaceae* and stands of currently logged heliophilous commercial species.



Location of the 16 sites in the forest massif of Central Africa (adapted from Mayaux et al., 2004).

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Tree formation with Haumania liebrechtsiana *and* Afromomum sp. *on sandstone; the two most abundant trees are* Markhamia tomentosa *and* Millettia laurentii.

Complementary soil analysis, charcoal dating and botanical identifications are underway. They will serve to define better the evolution of semi-deciduous forests in Central Africa.

Jean-François Gillet
Jean-Louis Doucet

Past disturbances

A coherent history of vegetation and past disturbances

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A basis of two sediment cores extracted from Ndjombi wetland was dated to 20,000 years BP.

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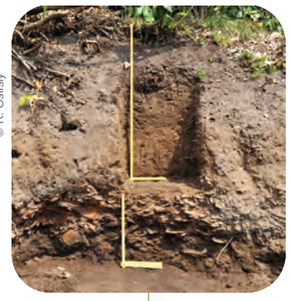
The iron metallurgy site of Djembe on the Sangha in Lobeke National Park was excavated and dated to 1800 years BP.



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Archaeological site of Bai Bolo showing a layer of potsherds piled on 40 cm thick.

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Finely decorated pottery from the archaeological site of Bali, associated with wood coal and discovered in July 2010 in Mindourou forest concession (dating soon).

Over the last millennia, deep disturbances have affected tropical rainforests of Central Africa and may have shaped the current characteristics of these forests. Are these changes linked to climate modifications or to human activity? To highlight some of the answers, CoForChange palaeoecological team (workpackage 4) investigates climates, environments and societies during the last 4000 years BP, using a transversal (temporal and spatial) and interdisciplinary (ecology, archeology, biogeochemistry) methodology. The team accumulates observations on past conditions, using biological or geological tools (proxies) contained in archives on climates and environments, crosses tools and interprets results. Proxies bear the imprints of a climate, an environment or human action. The qualitative or quantitative results will be compared with models results or used to force models (see workpackage 7).

Since 2009, several field missions helped to cover areas not previously explored in the Congo Basin rainforests. In the Central African Republic, two new lakes and a swampy area were cored, soil profiles sampled and litter samples collected to calibrate proxies. The analyses showed an excellent relationship between vegetation proxies (phytoliths, pollens and carbon isotopes) measured on the litters, and the leaf area index (Aleman et al., submitted), authorizing the application of this relationship to fossil records of the region. In the Republic of the Congo, several cores collected by the Oxford team (K. Willis) are under study.

The analysis of wood coals should help to describe further the dynamics of fires.

Following the 2009 missions conducted in Southeastern Cameroon, during which archaeological sites were revealed and new areas to explore located, two campaigns were conducted in the forest concessions of the Alpicam group. On the Moulundu-Socambo road, samples were taken from five soil profiles to analyse the soil, ^{13}C and ^{14}C isotopes, and anthracological findings; a coal layer at 50 cm depth in an Ayous (*Triplochiton scleroxylon*) forest was dated to 300 years BP. The isotopic results of the younger layers of the five study sites suggest a dense forest cover type. Beyond a certain depth, the isotopic profiles vary between signs of semi-deciduous and evergreen forests. However, these isotopic changes may be related to soil texture. Additional geochemical analyses will be needed to interpret these profiles. For the moment, the few sites studied have not revealed the presence of savannas in these regions. In January 2011, four new swamps have been cored and litter samples were completed. One of the swamps, located in a glade strewn with forest patches, Bai Bolo in Lobeke National Park, released a wealth of amazing archaeological material.

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