Drought – Light

Quantifying tree species shade tolerance

To assess tree response to light availability and provide a quantitative index of shade tolerance, controlled experiments were conducted in Pointe-Noire (see *Newsl.* No 3). Shadehouses were equipped with neutral shade cloth and bamboo slats to create two treatments representing understory shade and optimal growth conditions (2 and 30% of full irradiance, respectively). Seedlings of 67 species (65 trees and 2 herbs) were grown in these contrasting treatments for at least five months. Experiments were conducted for 30 species from January to July 2010, and for 42 species from September 2010 to February 2011 (with overlap of 5 species between the experiments).

For all seedlings, growth (relative growth rate for biomass, height and basal diameter) and traits related to shade and drought tolerance of species (leaf mass per area, ^{13}C, leaf N and C…) were measured. Results will allow us to quantify shade tolerance, compare the experimental assessments of species shade tolerance with expert opinion (compiled in the trait database of CoForChange), and test the trade-off hypothesis between drought and shade tolerance.

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Mapping tree communities

CoForChange database, a future reference tool

A database compiling the life traits of woody species is a fundamental tool for researchers. It helps to explain the distribution patterns of species and to model their evolution in response to climate change. A recent publication (Kattge et al., 2011) identifies and compiles nearly a hundred of such databases. It appears that very little information is available on the trees of Central Africa. To correct this situation, Gembloux Agro-Bio Tech hired a bioengineer, Damien Vincke, whose task is to compile more than twenty traits for more than a thousand tree species of the lower Guinea (from Nigeria to the Republic of Congo), based on reference documents. He works closely with F. Benedet to structure the database. Missing information, primarily in terms of ecological preferences, will be completed by consulting reference experts. After a validation process, the database will be published online and a paper on its practical applications will be submitted.

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Soil fertility determinants

We compared the soil fertility of the CoForChange project study area by studying 21 pits that were set up based on geology, the vegetation type (dense *vs* open forests) and a NE-SW climate gradient. Pit soil samples were used to perform physicochemical analyses. Preliminary results show, on one hand, that geology is the main factor that determines soil texture and cation exchange capacity. However, the effect of geology on total exchangeable bases is little noticeable, probably because of an acidification process that has affected all the soils of the region over time. On the other hand, we found that the soil plant-available phosphorus depends on the type of vegetation, the highest values being observed in some Marantaceae or *Macaranga* open forests. Additional soil analyses will be carried out to study the intra-site variability of the chemical fertility and confirm these results.

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Past disturbances

Recording past fires from sediment charcoals

Three lakes located in three ecosystem types were sampled in the Central African Republic in December 2011: in a forest (Mbaiki), in forest/savanna mosaics (Bimbo), and in a savanna (Boali). The charcoal contents of the recent sediments from each lake were analysed. The influx in number and charcoal surface area (in num. cm-2 yr-1 and mm2 cm-2 yr-1, respectively) helps to differentiate easily forests from savannas. In addition, the charcoal shape indicates the fuel type: grass charcoals are very elongated (width by length ratio (W/L) < 0.5), whereas wood charcoals are rather square (W/L > 0.5). This variable allows us to study changes in the fuel type involved and thus the vegetation around the lakes. W/L changed drastically in Bimbo in the 1990s: the forest around the lake was destroyed. Over the last 200 years, the vegetation around Boali site always remained savanna, whereas in Mbaiki some forest openings (fields around the villages?) have occurred.

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Paleofires

An anthraco-archaeological study was carried out in association with floristic inventories in the Northern Republic of Congo and Southeastern Cameroon. Old disturbances associated with fires and human settlements seem to have had and still have today a substantial impact on the physiognomy and composition of vegetation types (see *Newsl.* No 4). Twenty-two radiocarbon datings were performed in the major disturbed layers of each vegetation type studied. Most of the datings (45%) are comprised between 2262 and 1403 cal. years BP. This period of intense disturbances encompasses the entire semi-deciduous area. It is a continuation of the last major arid phase around 2500 BP and might be linked to major movements of Bantou populations. The 678 to 302 cal. BP period represents another important grouping of dates (27%). It is also associated with artefacts, mainly potsherds, ant it might be linked to a dry phase, contemporaneous with the Little Ice Age.

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PREDICTING THE EFFECTS OF GLOBAL CHANGE ON FOREST BIODIVERSITY IN THE CONGO BASIN

Rio+20: Urgency of new approaches to forestry research

Tropical forests and green economy

© R. Nasi

Kongoue Falls, Ivindo National Park, Gabon.

A green economy should result in improved human well-being and social equity, while significantly reducing environmental risks. Rooted in sustainable development concepts it distinguishes from other prior economic regimes in the (direct or not) valuation of natural capital and the realization that ecological services have economic value. It is founded on a full cost accounting regime, where costs externalized onto society via ecosystems are reliably traced back to, and accounted for as liabilities of the entity that does the harm or neglects a natural capital asset.

Green economy is one of the two themes of the next United Nations Conference on Sustainable Development "Rio+20: the Future we want". Unfortunately, a quick reality check shows us that overexploitation of forests and of their resources continues, even though sustainable forest management principles have been acknowledged and accepted for decades. Forest biodiversity continues to decline rapidly despite the fact that legally-established protected areas cover an estimated 13% of the world's forests. At the same time, millions of people living in and around biodiversity-rich forests continue to suffer from poverty and even reduced income from these dwindling resources.

In the context of climate change it is even more necessary to understand the status of and threats to populations of priority species and, in parallel, to identify best approaches for their conservation and improved livelihoods. Many of these important but vulnerable species are not conserved in protected areas and it is essential that viable populations be maintained in production forests. Forest genetic resources of tree species producing timber or fruits are of utmost importance for human well-being as sources of materials, nutrients, income and future domestication activities.

New approaches to forestry research are urgently needed to understand why the accepted principles and practices do not produce expected outcomes where sustainable forest management is applied, and the reasons for non-implementation where it is not applied. Research is also needed for continuing development of new management approaches to achieve sustainable production from forests and trees that benefit the rural poor. A project like CoForChange bringing together several disciplines and methods to answer questions about the future of production forests in the Congo Basin by looking at their past, their current state under exploitation and their possible future in a changing world climate, likely to be drier, is one of the innovative approaches needed to provide essential information to the world leaders and ensure informed decision-making in events such as Rio+20.

It remains however to be seen whether the world leaders are willing to listen: the dire fact that forests seem to be side-lined in Rio+20 does not bode well for their future.

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Regional workshop in Brazzaville

The first workshop on CoForChange results will be held from 21 to 25 May 2012 in Brazzaville. It will bring together representatives of the stakeholders in forest management in Central Africa: administrators, loggers, teachers, researchers, members of NGOs for nature preservation, certifiers, and local community and civil society members. The objectives of the workshop are: 1) to share knowledge, 2) to discuss the priorities of the different stakeholders, and 3) to define the decision support tools to be provided at the end of the project. Talk time will be shared between project partners and the various representatives, and these talks will be followed by group work sessions. The programme is being finalized and will be available on the project site (http://www.coforchange.eu/).

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Focus on

Past disturbances

Julie Morin-Rivat is a PhD student at the Tropical and Subtropical Forestry Laboratory (Gembloux Agro-Bio Tech - ULg), and at the Laboratory for Wood Biology of the Royal Museum for Central Africa (MRAC). As part of her Master's (EPHE – CBAE UMR 5059), she analysed the wood charcoals collected in the soil pits dug for the CoForChange project. She identified tree species from wood charcoals in relation with recent disturbances.
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Anthracology: past disturbances and vegetation evolution

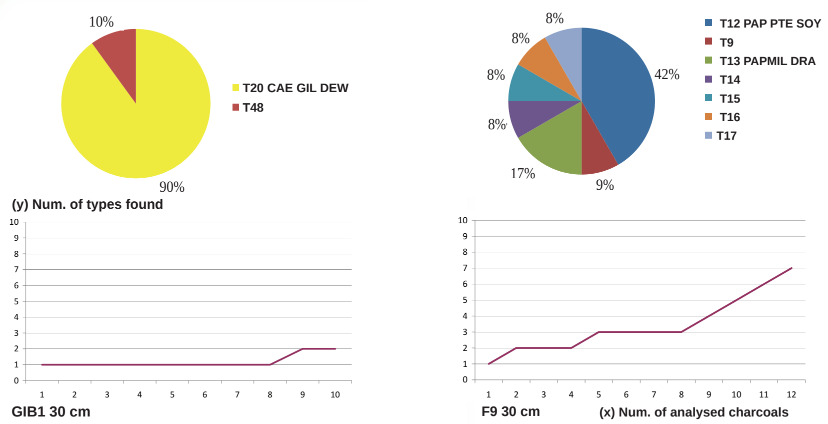
One of CoForChange aims is to highlight the relationship between human settlement and plant distribution. Recent studies show that anthropogenic disturbances have had an impact on vegetation, including enabling the expansion of light-demanding species (see *Newsl.* No 4). To contribute to this analysis in a context of deep scarcity of anthracological data in Africa, we have been studying the charcoals from nine soil pits of the CoForChange project as part of a Master's. The objective was to understand past and present species composition of the forests in relation with past disturbances.

Two anthracological protocols of identification were tested: 1) at species level, by describing the anatomical characteristics of charcoals, by carrying investigations with InsideWood online database, and by comparing anatomical data at Xylarium Tervuren; 2) at community level, by searching for statistical relationships between ecological traits of species and wood anatomy.

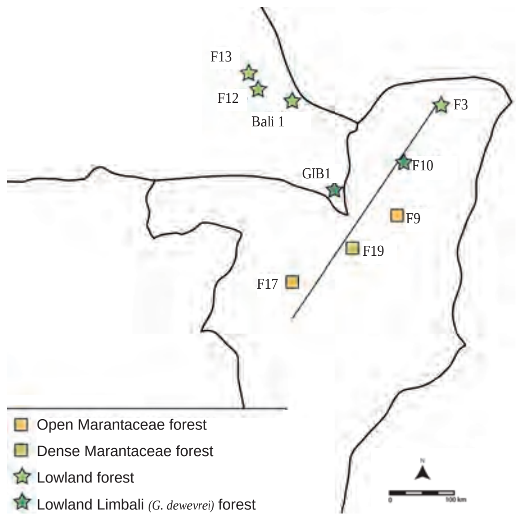
The results show that the taxonomic diversity is greater in Marantaceae forests than in lowland forests. Three identifications were obtained from 48 described taxa: *Gilbertiodendron dewevrei* under *G. dewevrei* monodominant forest (GIB1 at 40 cm depth, 1510 ± 30 years cal. BP), *Millettia drastica* and *Pterocarpus soyauxii* in Marantaceae open forests (F9 at 40 cm, 1200 ± 30 cal. BP). Our hypothesis is that monodominant stands of *G. dewevrei* are relatively stable. With regard to *P. soyauxii*, the proportion of this light-demanding species seems to be decreasing over time (at levels from 20 to 40 cm) for the benefit of Marantaceae. Another result highlights the absence of *Triplochiton scleroxylon* under *T. scleroxylon*, which may confirm the hypothesis of the recent settlement of this species. Results on the relationship between wood anatomy and functional traits are still preliminary, and further research will be conducted through a PhD programme.

The on-going developments of anthracology in tropical Africa will help to identify a larger number of collected samples, and thus to understand better the evolution of tropical forests.

Julie Morin-Rivat



The pie charts represent the proportion of taxa in the sample. Effort and yield curves: on the Y-axis, order of appearance of a new species; on the X-axis, rank of appearance of new species in all the coals analyzed in the sample.



Locations of the studied samples: soil pits and associated vegetation (Cameroon, Congo).

Focus on

Past disturbances

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Millennial-scale climate forcing of vegetation and human occupancy in Central Africa

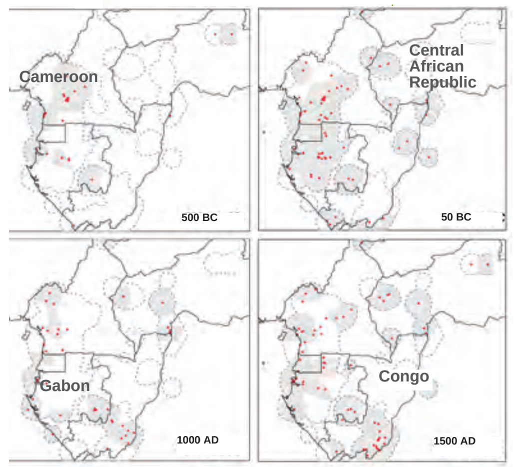
During the past 5000 years, dramatic changes in ecosystem structure and human occupancy have been highlighted by palaeoenvironmental and archeological studies in Atlantic Central Africa. The simultaneity of an important forest disturbance event and the spread of iron metallurgy in the area about 2500 years ago led to two alternative hypotheses: either human-induced forest degradation or a climate cause common to both events. The objective of this study is to trace back up to 6000 years BP the history of climate vegetation and human occupancy to determine whether climate change or human disturbance has been the primary determinant of vegetation changes.

From a review of about 900 radiocarbon datings, we reconstructed the spatio-temporal frame of human occupancy: a first spread of Iron Age populations from 1000 BC to 1 AD, their progressive disappearance from the forest area until 1000 AD, followed by recolonisation.

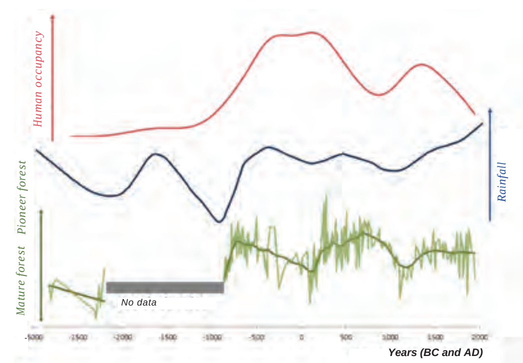
These millennial-scale variations of human occupancy were compared with pollen sequences, interpreted with the database on the functional traits of tree species compiled by CoForChange. Synchronous recurrent events with different consequences depending on the site were recorded: increases in pioneers or forest conversion to savanna. The vegetation changes are contemporaneous with changes in rainfall regimes recorded in lake and oceanic sediments.

The comparison between the evolution of climate, human occupancy and vegetation structure is consistent with the hypothesis of vegetation changes primarily driven by climate changes. Depending on the site, these changes appear reversible (changes in the relative abundance of pioneers in the forest vegetation) or irreversible (forest degradation or savannisation). Major changes in human occupancy are contemporaneous with only some of the vegetation changes. This suggests that past climate changes and associated vegetation changes had a significant impact on human history.

Charly Favier



Maps of human occupancy in Central Africa at different times.



Compared evolution of human occupancy, rainfall (inferred from Lake Ossa diatoms pieced together by F. Nguetsop in Cameroon), and index of forest structure in Gabon over the last 5000 years.