CongoPeat

NEWSLETTER #4
SEPTEMBER 2020

Introduction

by S Lewis, University of Leeds

Lockdowns in response to Covid-19 in Republic of Congo (RoC), Democratic Republic of Congo (DRC) and UK have disrupted CongoPeat plans. When the March 2020 Congo River expedition was cut short by a week, it allowed the DRC team to catch the last internal flights home, but Greta Dargie was stuck in Kinshasa for two weeks waiting for a return flight. The good news is that in September, after the DRC lockdown came to an end, the local Mbandaka team were able to finish the expedition.

In RoC, monthly fieldwork has continued, thanks to the local team, with special permission to travel. Remarkably, so far. we have no data gaps from the intensive measurements due to Covid-19. The June 2020 RoC extensive field campaign to the Cuvette department unfortunately had to be cancelled. Safety concerns and constraints on time available for the palaeo and other teams to analyse the data within the scope of their contracts leave us without a current option to reschedule.

Various laboratory activities have been delayed, but labs are open now, and thanks to huge efforts by the CongoPeat team we are catching up fast. One very positive outcome of the restrictions is that online CongoPeat meetings are working really well, giving us a way to work together more equally across the three countries. We will continue meeting online even when travel restrictions cease. Finally, data analysis goes from strength to strength, with our first paper published, using a fixed-wing drone to estimate the topography of the peatlands (see page 2).

ECR update

by G Dargie, University of Leeds

The CongoPeat Early Career Researcher (ECR) group met in September 2020, allowing us to continue work on our ECR review paper, entitled *Programme de recherche pour le complexe de tourbières de la Cuvette Centrale* (*Research programme for the Cuvette Centrale peatland complex*). Early in Summer 2020 each member of the group contributed a section towards the paper, which is now in the final editing phase. ECRs next meet online in May 2021 before the main CongoPeat meeting.

NEXT PROJECT MEETING ONLINE:

10 -13 May 2021
Agenda items: please send to admin@congopeat.net

CONTENTS:

PROJECT OFFICE:

School of Geography,
University of Leeds. LS2 9JT
https://congopeat.net
Email: admin@congopeat.net
Twitter: @CongoPeat

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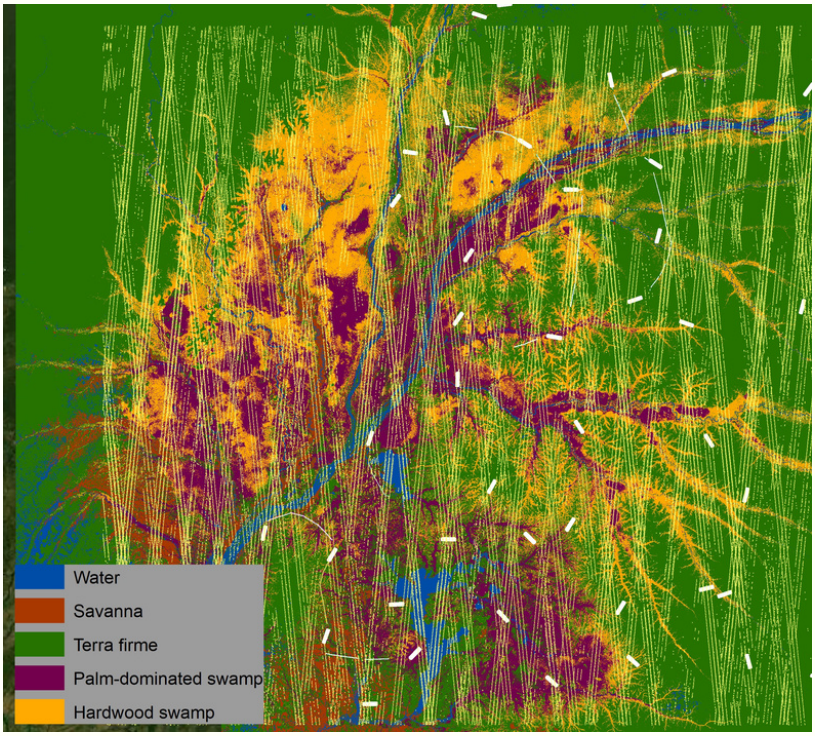
Progress in peat elevation estimation from remote sensing

by I Davenport, University of Edinburgh

The paper (doi.org/10.3390/rs12142196) analysing our UAV LiDAR data to show the first evidence of a 2 m high dome structure in the peatlands between Ekolongouma and Epena was published in Remote Sensing on 9th July, and the full-text downloaded 200 times in its first month.

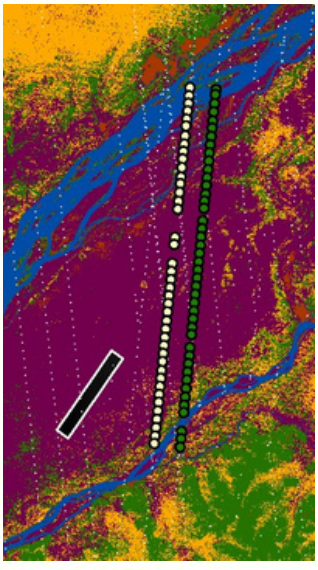
Focus now moves to building a Digital Terrain Model of the wider basin, so we can see if every patch of peat is domed, and assess the height of these domes. This will help the carbon stock quantification and modelling components of CongoPeat. We have acquired all the available ICESat-2 photon returns from the basin between October 2018 and May 2020, producing a set of north-south tracks (above right), along with patches of airborne LiDAR data in DRC.

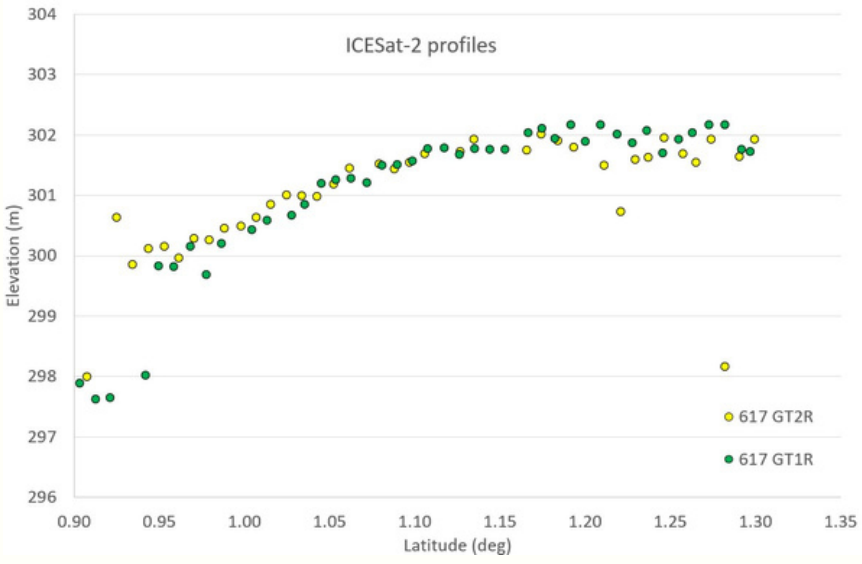


ICESat-2 (yellow) and DRC LiDAR (white) coverage

Returns from clouds and apparent multiple reflections produce a lot of anomalous photons requiring filtering, but the below profiles show the level of accuracy we should be able to expect once this is complete. Once we have a set of high confidence profiles, the gaps between tracks will be interpolated using TanDEM-X canopy measurements and the airborne LiDAR data acquired in the DRC in 2014.

In the longer term it may be possible to redeploy the UAV to acquire high accuracy topography in different areas, and use a helicopter-based airborne electromagnetic method (AEM) system to measure peat depth on a wider scale.





ICESat-2 profiles and airborne LiDAR in DRC – first evidence of a peat dome in DRC?

Mapping peat depth

by B Crezee, University of Leeds

Corneille Ewango, Greta Dargie and Bart Crezee measuring peat depth in Mpeka, DRC. Credit: Caroline Thirion

When estimating the amount of carbon stored in the Congo Basin peatlands, a big source of uncertainty lies in estimating the depth of the peatland. Up until now, we used around 200 direct field measurements of peat depth from the Republic of Congo when estimating the total carbon stocks across the entire basin. But those measurements may be biased, because most of our field sites are located close to the edge of peatland areas and do not cover the peatland's interior.

In order to have a more representative estimate of peat depth, I have been working on a spatial model of peat depth across the region. This model takes into account the distance to the edge of the peatland, as well as various topographic and hydrologic variables. It is trained on a larger dataset of peat depth measurements, which now also includes new field data from the Democratic Republic of Congo. The results are promising, as the model accurately predicts the peat depth of known field sites. This model feeds into our new estimates of peat carbon stocks, which will be published in a paper that we are currently drafting.

Insights into the vegetation of the Congo Basin peatlands

by C Ewango & J Kanyama, University of Kisangani

The January to March 2020 Congo River expedition, involving Joseph Kanyama (U. of Kisangani), Pierre Bola and Ovide Emba (both ISP-Mbandaka), Greta Dargie (U. of Leeds), Corneille Ewango (U. of Kisangani) and Simon Lewis (U. of Leeds), was interrupted in response to the Covid-19 pandemic with only 2km of data collection left to complete on the final 6km long transect, in Ipombo. However, we are able to observe that the physiognomy of the forests of the white-water Congo River seems to differ from that of the black-water Ruki and Ikelemba rivers.

The flora which borders the Congo River is diverse. Herbaceous plants and shrubs such as *Commelina sp*, *Eichhornia crassipes*, *Ficus sp* and trees such as *Lophira alata*, *Irvingia smeathii*, *Alstonia congensis*, *Englerophytum sp.*, are the best represented. In the Arecaceae family, clustered robust rattan palm climbing to 30 m high and raffia (*Raphia sese*, *Raphia laurentii*) are found in both open areas and closed-canopy forest. The rattan palm recorded are *Laccosperma sp*, *Eremospatha* and *Oncocalamus robustus*, an endangered

species with just two specimens collected in DR Congo.

Tree species such as *Anthocleista sp*, *Uapaca hedeulotii*, and the herbaceous *Vossia cuspidata*, *Alchornea cordifolia* are common to the various rivers where data was collected. The species *Aphanocalyx sp* (*A. djumaensis* and *A. jenseniae*), *Cynometra sp*, *Diospyros sp*, *Xylopia sp*, *Prioria oxyphylla*, found deep in the forests of Bolengu, Bondamba (Ruki), Boboka and Ipombo (Congo River), appear to be characteristic of peatland forests in the Congo Basin. Botanical data are currently being processed and validated against the available botanical references, chorological lists and flora.

These preliminary observations lead us to predict an East-West gradient of peatland flora demarcated by the Congo River. Subsequent analyses integrating the various environmental factors (physical and chemical) will be decisive in differentiating the main floristic groups present in the Congo Basin peatlands.

Four Xylopia species

Laccosperma secundiflorum

Calamus wendleana?

Eremospatha laurentii

Eremospatha haullevilleana

Oncalamus robustus

Oncalamus deërratus

Matteo Sciumbata and Richard Molayi extracting roots from peat for the installation of the ingrowth cores. Credit: Dafydd Crabtree

Measuring root production in the peatlands

by M Sciumbata, Vrije Universiteit Amsterdam

In February 2020, I arrived in the Republic of Congo (RoC) to carry out my MSc thesis in the peatlands of the Congo Basin. After landing in Brazzaville, I was soon on a plane heading for Impfondo, where I spent the next five months. From there, I accessed the forest of Ekolongouma every month, trekking out to reach the GEM plots with the rest of the RoC team.

The goal of my MSc thesis was to test two new methodologies for measuring root production in a tropical peat environment, where root production estimation is hampered by challenging conditions and a lack of methods. The two methods I applied were the minirhizotron and a modified ingrowth core.

The minirhizotron is a small-diameter tube permanently inserted in the soil that allows root production to be recorded through an additional, camera-carrying tube, inserted into it. This tool is used to take pictures at different depths and angles of the root environment surrounding the tube. Successive analyses of the recorded changes in root length and width over time enable the estimation of root production. I also applied a new ingrowth core methodology, which consisted of installing a 6-cm-diameter ingrowth core tube into the soil. The tube was filled with homogenised peat from lower layers, to overcome the difficulty of dealing with the intricate root mat, which hinders the estimation of root production in this environment. Minirhizotron and ingrowth core measurements were carried out every month and every three months, respectively. The RoC team will follow up on the work with data collection on a quarterly basis.

Greenhouse gas measurements

by J Jovani Sancho, U of Nottingham

After several months of university closure due to COVID-19, laboratory work resumed at Nottingham in mid-August 2020. Getting the Gas Chromatography equipment ready by analysing standard gas samples took most of the first couple of days. Thereafter, we focused on processing the last remaining samples from the incubation experiments. In the meantime, and thanks to a massive team effort, over 4000 vials filled with greenhouse gases from the Congo peatlands, collected at the GEM plots, arrived in Nottingham safely. We are currently focusing on analysing the samples from the GEM plots and we are keeping the Gas Chromatography equipment running round-the-clock by loading up vials twice a day.

In July Hayley Curran (U of Nottingham) submitted her MSc thesis looking at how peat chemistry regulates greenhouse gas production across the Cuvette Centrale. In addition, Hayley conducted additional greenhouse gas sampling from her incubation experiments just before the lockdown. This third round of measurements will strengthen her dataset and allow for a higher impact publication in due course. The pantropical peat temperature sensitivity study led by Nick Girkin (Cranfield University) continues and we are planning to conduct further greenhouse gas sampling in September. The first papers from this work are currently in development.

Training week

by M Mbemba & E Mampouya, Marien N'GOUABI University

Data collection in the Republic of Congo GEM plots has continued uninterrupted over the past six months. A programme of data analysis sessions from 1-5 June 2020 marked a focal point in our work out of the field. The sessions were led by Prof Simon Lewis and Dr Greta Dargie (U of Leeds), in consultation with Dr Suspense Averti Ifo, Prof Joel Loumeto and Prof Felix Koubouana (Marien N'GOUABI University).

The main objective was to allow us to gain a better understanding of the methods and tools for processing and analysis of field data, following GEM protocols and using the data collected over the course of the first year of our PhDs.

At these sessions, the following recommendations were made: (i) commence monthly data processing sessions (two days per month until the end of the project) as well as sessions on structuring and initial writing of some thesis chapters; (ii) give a first presentation on the results at the CongoPeat network meeting of 6 July 2020, and raise our questions about analysis methods, mainly in relation to processing data from the gas analyser (EGM) and determining the best photo for estimating leaf area index (LAI); (iii) develop a data processing guide, particularly how to use the Hemisfer software for estimating LAI.

In addition to the recommendations made by our supervisors, we decided to do the following from now on to make maximum progress in our work: (i) We will process data in stages as it is collected; (ii) we will provide a quarterly summary on the progress of the work and the results obtained.

It was an extremely valuable experience as it allowed us to define the objectives of the theses more clearly, and, most importantly, to recognise the significance of each piece of field data and how it relates to the objectives of the theses.

Vulnerability assessment launch workshop in Brazzaville, ROC. Credit: Destin

Protecting fragile rainforest ecosystems

by H Plante, U of Leeds

Research led by CongoPeat is contributing to the peatlands component of a climate change vulnerability assessment aimed at protecting fragile rainforest ecosystems (peatlands and mangroves) in the Republic of Congo.

The vulnerability assessment is led by France's International Forest Office (ONFi), working with CongoPeat researchers Dr Suspense Averti Ifo (Marien N'GOUABI University) and Dr Greta Dargie (U of Leeds), supported by CongoPeat bilingual communications lead Helen Plante (U of Leeds). Funded by the French Development Agency (AFD), the assessment will provide an in-depth analysis of vulnerability within the ecosystems and identify climate change adaptation options.

A launch workshop took place in June 2020, attended in Brazzaville by ministerial and regional representatives and scientific experts, with international experts and observers from ONFi, AFD and CongoPeat participating remotely.

Palaeo-environmental update

by D Hawthorne, U of St Andrews

Postdoc Donna Hawthorne has begun work on the central palaeoenvironmental peat core at Bondamba, DRC, to explore the formation of peat at this site and its vegetation history. The palaeoenvironmental history of this site will be compared to the central peat core at Ekolongouma, where analysis is largely complete. Comparisons between the sites may illuminate similar or contrasting mechanisms and timing of peat formation, peat accumulation and vegetation cover, and increase our understanding of the long-term history of the peatlands. Following an uncertain few months, the labs have now partially reopened in St. Andrews and progress is continuing with the palaeoenvironmental analysis, focusing to date on the pollen analysis from Bondamba. Future work will include analysis of the inorganic geochemistry (U of Nottingham) and testate amoebae from both the Ekolongouma and Bondamba cores, and remaining analyses on the Bondamba core such as charcoal, particle size, and magnetic susceptibility. Three radiocarbon dates have also been submitted from the Bondamba core and we await the results.

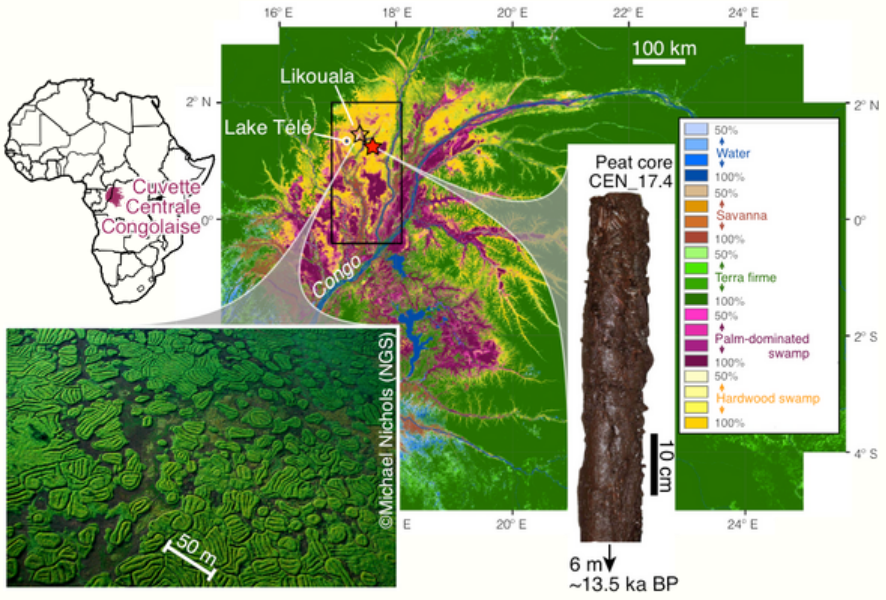
PhD student George Biddulph has continued to conduct palaeoenvironmental analyses on three spatial cores from Ekolongouma, RoC. The work conducted thus far has consisted mainly of pollen analysis and other sedimentary analyses such as loss-on-ignition, magnetic susceptibility and dry bulk density. Future work will consist of more pollen analysis as well as investigation of both the organic and inorganic geochemistry of the peats. Working on cores along a transect from the edge of the peatland toward the centre will provide us with insights on how these peatlands have developed over space as well as time.

ORACLE: Holocene Hydroclimate and Carbon Cycle Dynamics in the Central Congo Basin

by E Schefuss, U of Bremen

The German Research Council (DFG) in conjunction with France's National Research Agency (ANR) have awarded funding to ORACLE: Holocene Hydroclimate and Carbon Cycle Dynamics in the Central Congo Basin. The project, led by Yannick Garcin (CEREGE, Aix-en-Provence) and Enno Schefuß (MARUM, Bremen), is a cooperation of French, German, American and Congolese researchers working on geochemistry, palaeo-ecology, hydrology and archaeology.

The project will investigate the Holocene environmental evolution of the peatlands



Map of the Cuvette Centrale Congolaise peat swamp forest (adapted from Dargie et al., 2017). Bottom left picture, example of vestiges of intensive human activity in the Cuvette showing ancient raised fields. Centre right picture, example of a peat core: the 6 m long core CEN_17.4.

in the Cuvette Centrale Congolaise, with a particular focus on past human-environment interactions. ORACLE aims to reconstruct the regional history of the peatlands of the Cuvette Centrale Congolaise to (i) better understand a key region of carbon cycling in the tropics, (ii) provide a detailed record of regional peat accumulation/loss, and (iii) resolve the drivers (natural and anthropogenic) of these changes.

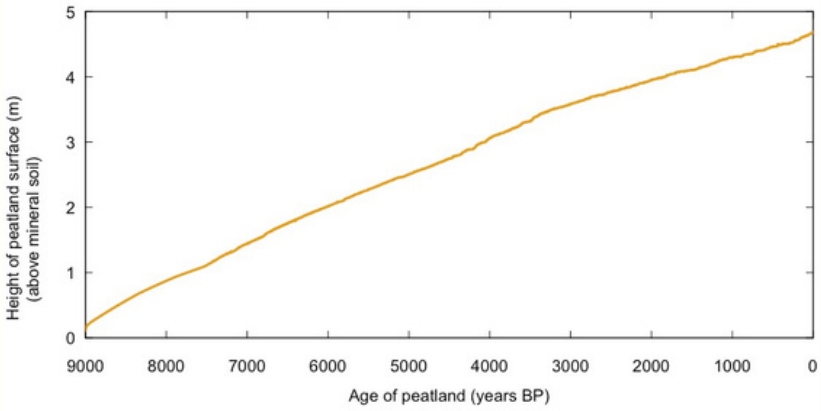
To address these aims, we will follow a pluridisciplinary approach combining classical carbon-accumulation determinations with novel molecular and isotopic techniques, such as δD, δ13C, and Δ14C of lipid biomarkers derived from terrestrial higher plants together with analysis of peat-derived branched glycerol dialkyl glycerol tetraether membrane lipids (GDGTs). These analyses will be flanked by archaeological studies including dating of artefacts combined with remote sensing to map the vestiges of past human activity.

A sampling expedition was planned to the Republic of Congo but currently is delayed due to travel restrictions. It is planned to conduct the expedition at a later stage. Initial material is available from prior expeditions. ORACLE includes funding for one 3-year PhD student and one 2-year Postdoc.

DigiBog update

by D Young, U of Leeds

The version of DigiBog currently used for northern peatlands is being modified to represent the peatlands of the Congo Basin. Currently there are three main strands to this work; (i) modification of surface litter addition of leaves and wood and the sub-surface input of roots for tree and palm plant functional types; (ii) development of new decomposition functions for the three different peat fractions above; and (iii) development of a new function for hydraulic conductivity. To develop a first useable version of the new model before CongoPeat data are available, the functions from HPMTrop (Kurnianto et al., 2014) are being implemented and tested. A systematic map of the literature is also being created to find other evidence to support the development of these model functions.



Peatland height from a 9,000 years model run of the first version of DigiBog_Congo. The model currently has a single palm PFT with leaf, wood and root litter fractions and has yet to be fully validated.

An overland flow model is being developed and tested by Hester and Andy Baird. There is evidence that peatland water tables are higher than those in nearby rivers. Given that hydraulic gradients in intact peatlands are very low, it seems more likely that excess water from net rainfall (precipitation minus evapotranspiration) will be lost via overland flow rather than through sub-surface drainage. Overland flow is not explicitly represented in DigiBog (surface water above a specified ponding depth is lost from the model domain) and so the aim is to integrate the two models. This may allow the use of 1-D versions of DigiBog for intact peatlands whereas the 2-D version will be needed for land use simulations (where sub-surface flow is likely).