Peat decomposition in central Congo was triggered by a drying climate

The world's largest tropical peatland complex is in the central Congo Basin. A drying of the climate between 5,000 and 2,000 years ago triggered decomposition of peat in the Congo Basin and emission of carbon into the atmosphere. The tipping point at which drought results in carbon release might accelerate future climate change if regional droughts become more common.

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The problem

Peat is formed in wet environments when the decomposition of plant matter is so slow that some of it remains partially decayed, often for millennia. These ecosystems are among the most carbon-dense on Earth. The peatlands of the central Congo Basin represent 36% of the world's tropical peatland and hold about 28% of tropical peat carbon — about 29 billion tonnes[1]. These peatlands were only mapped and described[2] in 2017. Little is known, therefore, about the history or dynamics of the peat, its overlying vegetation or its carbon storage over the millennia of its development. Understanding the dynamics of the peatlands and how past environmental changes have affected them will help to determine how vulnerable this ecosystem is to climate change. It could also help to guide policies to assess the risks posed by activities such as logging, oil exploration and agriculture[1,3].

The discovery

To reconstruct the history of the central Congo peatlands, we investigated peat cores (up to 6 metres long) from different locations in Congo and the Democratic Republic of the Congo. We analysed at high resolution a central peat core (called CEN-17.4) and, at lower resolution, two other peat cores 177 kilometres and 274 kilometres from the main core location. We used radiocarbon dating to estimate the age of the peat and chemical indicators to reveal the level of its decomposition. We also analysed pollen grains to construct a picture of the vegetation when the peat formed, and plant-leaf waxes to estimate past rainfall.

We found that peat accumulation in the central Congo Basin began at least 17,500 years ago. Much less peat had accumulated between 7,500 and 2,000 years ago than would be expected — the material was more heavily decomposed than older and younger peat (Fig. 1a). The reduction in peat accumulation in this 'Ghost Interval' is seen in all three cores, indicating a common pattern and driver. Our plant-wax data indicate a drying trend starting about 5,000 years ago and culminating about 2,000 years ago (Fig. 1b), and our pollen analysis suggests a concurrent decline in plant species of the swamp forest in the Congo Basin. We propose that the drying climate led to a regional drop in the water-table level. Our initial estimate is that between 2 metres and 4 metres of peat were lost during the decomposition event at the CEN-17.4 site. After 2,000 years ago, the drying trend stopped, the swamp-forest species returned and rapid peat accumulation resumed.

The implications

Our results indicate that, in the central Congo peatlands, a decrease in rainfall below a certain threshold leads to a drying of the peat, its decomposition and its release of carbon. Our analyses indicate a positive-feedback loop in the global carbon cycle through peat — if anthropogenic climate change results in droughts in the Congo Basin, further carbon could be released. However, our results also indicate that, once climatic conditions stabilize, undisturbed peatlands might recover and sequester carbon again.

The conditions of the central Congo peatlands might lie close to a climate-driven, reversible drought threshold. Indeed, we found that the climate of the central Congo peatlands is drier than that of peatland areas in southeast Asia and the Amazonian lowlands. The central Congo peatlands, therefore, could currently be closer to a drought threshold than other peatlands.

There is evidence that the length of one of the two dry seasons in the Congo Basin is increasing[4], suggesting that the area could be approaching the threshold, but climate models do not agree on whether carbon dioxide emissions from fossil fuels will lead to longer droughts in the region[5]. Studies are therefore needed to understand the contemporary climate of central Africa and how it will change under different scenarios of CO_2 emissions. Research is also needed to understand the past climate of other peatland sites in central Congo and to create predictive models of peatland carbon storage and release.

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EXPERT OPINION

"This is the first investigation into the past dynamics of the peatlands of the Congo Basin and the relationship between the peatland carbon-accumulating function and the hydroclimate. This work is important because the Congo Basin represents the largest intact tropical peatland complex; there are few data on peatland development and resilience in the tropics; and the fate of this peatland complex matters greatly to feedback between the carbon cycle and the climate." (CC BY 4.0)

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FIGURE

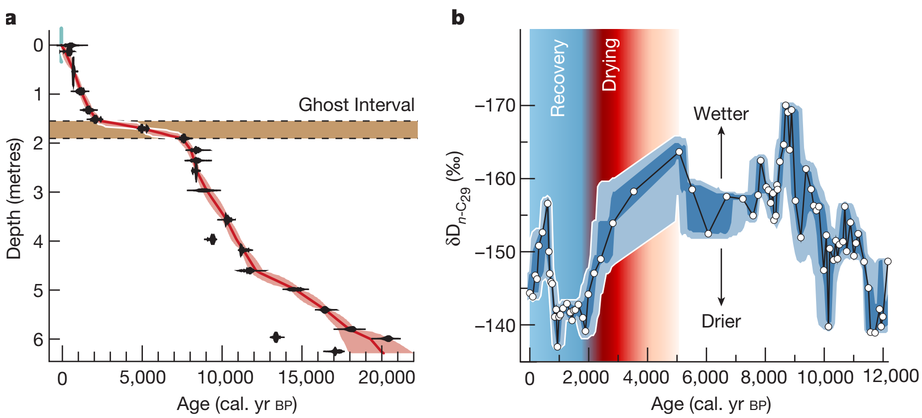

Figure 1 | A peat-core record of the history of the peatland complex in central Congo. **a**, Samples of peat from different depths of a 6-metre-long peat core from the peatland complex in the central Congo Basin were analysed using radiocarbon dating to establish an age–depth model (pink shading represents 95% confidence intervals). Peat that accumulated between 7,500 and 2,000 years ago (the 'Ghost Interval') has decomposed more than peat that accumulated before or after that period. **b**, The *y* axis shows the hydrogen isotopes of n-C_{29} alkane molecules from plant waxes, reflecting rainfall at the time the plant was produced. More-negative values indicate wetter conditions. Shading represents 68% (dark blue) and 95% (light blue) confidence intervals. The vertical red band shows the drying trend that resulted in the Ghost Interval, with darker colours indicating drier conditions. The vertical blue band denotes the subsequent peat recovery. Cal. yr BP, calibrated years before present.

REFERENCES

1. Crezee, B. *et al. Nature Geosci.* **15**, 639–644 (2022).
2. Dargie, G. C. *et al. Nature* **542**, 86–90 (2017).
3. Dargie, G. C. *et al. Mitig. Adapt. Strateg. Glob. Change* **24**, 669–686 (2019).
4. Jiang, Y. *et al. Nature Clim. Change* **9**, 617–622 (2019).
5. Creese, A., Washington, R. & Jones, R. *Clim. Dyn.* **53**, 3583–3602 (2019).

BEHIND THE PAPER

This study is the result of a collaboration between two research groups that started after a seminal publication on the description and mapping of the central Congo peatlands[2]. E. Schefuß was studying marine-sediment cores in the offshore area of the Congo River and was eager to measure hydrogen isotopes in plant waxes in the cores' inland counterparts: the newly described peat cores. Meanwhile, G. Dargie, S. Lewis and I. Lawson had noticed a period of low peat accumulation in peat cores while analysing data for the 2017 paper[2]. Our collaboration and the sampling of peat core CEN-17.4 started in December 2017. An initial visual inspection of this homogeneous peat core did not reveal its rich history. Three years of intensive laboratory analyses later, CEN-17.4 turned out to be a key record of the past climate in central Africa. The CongoPeat project, which started in 2018 and is led by S.L., provided the funding for additional field campaigns and analyses to understand how the drier climate affected the peatlands and resulted in carbon release.

Y.G.

FROM THE EDITOR

This work provides valuable information on the effect climatic change can have on peatland carbon stores. It helps to fill a crucial gap in the data from central Africa — one that makes it difficult to provide well-grounded predictions of the response of key ecosystems to climate and land-use change in an area that hosts the largest tropical peatland and the second largest tropical forest. This information is important for the reporting of countries' commitments to the Paris climate agreement.

Juliane Mossinger, Senior Editor, *Nature*