CHAPTER 9

Peatlands of the Central Congo Basin, current realities and perspectives

Authors : Denis Jean Sonwa,[1] Simon L. Lewis,[2] Suspens Ifo Averti,[3] Corneille Ewango,[4] Edward T.A. Mitchard,[5] Greta C. Dargie,[2] Ian T. Lawson,[6] Sylvie Gourlet-Fleury,[7] Charles Doumenge,[7] Valéry Gond,[7] Julie Betbeder,[7] Andre Kamdem Toham,[8] Julie Van Offelen,[8] Dianna Kopansky,[8] Rémi D'Annunzio,[9] Raoul Monsembula,[10] Maria Nuutinen,[9] Laura Villegas,[9] Kai Milliken,[9] Nathalie Philippon,[11] Sylvain Bigot,[11] Olivia E. Freeman,[12] Jean-Jacques Bambuta,[13] Quentin Jungers,[14, 15] Rosa Román Cuesta[1, 16]

[1]CIFOR-ICRAF, [2]University of Leeds, [3]Marien Ngouabi University, [4]UNIKIS, [5]University of Edinburgh, [6]University of St. Andrews, [7]CIRAD, [8]PNUE, [9]FAO, [10]University of Kinshasa, Greenpeace Afrique, [11]University of Grenoble Alpes-IGE, [12]USFS, [13]Ministry of Environment and Sustainable Development (DRC), [14]FRMi, [15]Université Catholique de Louvain, [16]Wageningen University & Research

Photo by Axel Fassio/CIFOR

Introduction

Globally peatland ecosystems -- wetlands with an accumulation of partially decomposed organic matter in the soil -- store the largest amount of terrestrial carbon per unit area (Rydin and Jeglum 2006; Leifeld and Menichetti 2018). Globally peatlands cover almost three percent of the global land surface (Yu et al. 2010; Page et al. 2011; Dargie et al. 2017), representing more than the total carbon stored in Earth's vegetation and almost twice as much carbon as found within the world's forests (Crump 2017). Drained and degrading peatlands are a major source of greenhouse gas emissions, annually releasing 5 percent of global anthropogenic greenhouse gas emissions (IPCC 2014), which is expected to increase. Therefore, protection and sustainable management of peatlands and urgent action to restore peatlands including through rewetting can avoid carbon emissions and maintain the carbon stored in the peatland ecosystem (Leifeld and Menichetti 2018; FAO 2020b).

Healthy peatland ecosystems are important to populations everywhere not only for the carbon they store, but also for their significant role in hydrological and nutrient cycling and storage, including the provision of clean drinking water, mitigating flood and climate risks, and supporting the livelihoods of communities living within these landscapes (Crump 2017).

In Central Africa, the Central Congo peatlands are estimated to cover 145,500 km^2, located across both the Republic of the Congo (RoC) and the Democratic Republic of the Congo (DRC), making them the world's largest tropical peatland complex (i.e., near contiguous peatland) (see Figure 9.1) (Dargie et al. 2017). They are estimated to store approximately 30 gigatonnes of carbon (Dargie et al. 2017) which is approximately as much carbon as all of the above-ground forest biomass in Congo Basin (Verhegghen et al. 2012; Saatchi et al. 2011b), or equivalent to 15 years of the carbon emissions from the US economy.

To date, this vast peatland area has remained relatively intact, but several potential pressures threaten to disturb these highly sensitive ecosystems (Dargie et al. 2019). Increases in logging, hydrocarbon exploration, and expansion of agriculture all have the potential to cause degradation and destruction of these critical habits (Dargie et al. 2019). Disturbances and drainage will not only release a large amount of greenhouse gases into the atmosphere contributing to global heating, but can also have severe impacts on the regional climate. Once disturbed, it is challenging and costly to restore such ecosystems, particularly in the tropics, as evidenced by experiences in Indonesia (Suryadiputra et al. 2005; Crump 2017; Hansson and Dargusch 2017).

Given the ecological importance regionally and globally, the sustainable management and good governance of the Central Congo peatlands is of paramount importance. Identifying strategies to protect the peatlands and facilitate low-emission and biodiversity-friendly economic development for the two Congos is essential for the provision of sustainable, long-term community livelihoods and protection of these vast peatland areas and the freshwater ecosystem of the Congo River basin.

This chapter outlines the current state of knowledge of Central Congo peatlands including: their extent and characterization, ecological importance and socio-economic status; current research approaches and gaps; threats; governance and policy frameworks; current initiatives and programs; and key management challenges. This overview aims to help guide future research, investment in, and management of, the world's largest tropical peatland complex.[1]

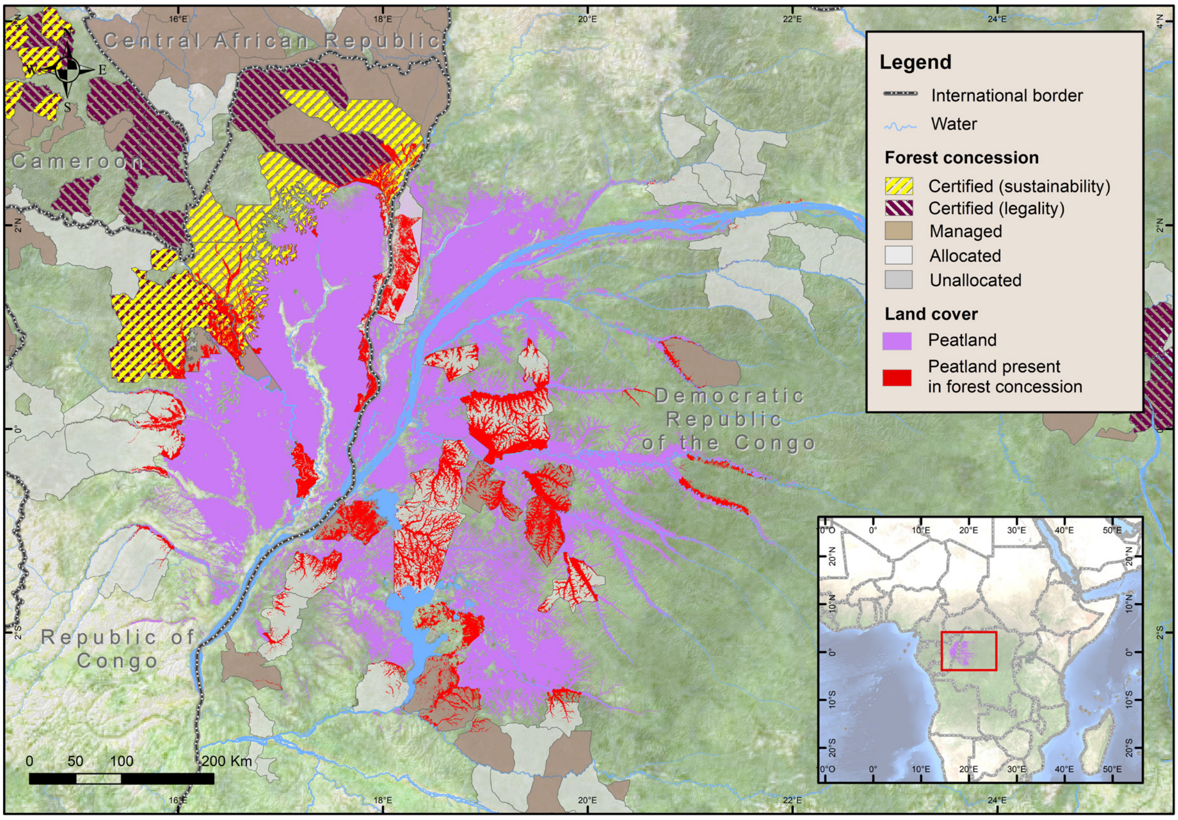

Figure 9.1: Map of the Central Congo peatlands (areas in purple and red) spanning the RoC and the DRC

Source: OFAC 2020; Dargie et al. 2017

1 Indonesia has a larger overall area of peatland, but these are spread across several islands.

9.1 Central Congo peatlands

9.1.1 Characterization and extent

The Congo Basin drains an area of approximately 3.7 million km^2, within which lies a central depression, known as the Cuvette Centrale overlaid mostly by swamp forest, with smaller areas of herbaceous swamp, seasonally flooded forest, *terra firme* forest and savanna (Léonard 1952; Evrard 1957; Kadima et al. 2011; Dargie et al. 2017; Betbeder et al. 2013).

Over this region, the Congo River drops just 115 m over 1,740 km, with year-round waterlogging. Mean annual rainfall in the Cuvette Centrale is just 1700 mm yr^{-1} (varying from 1600 to 2200 mm yr-1) (Mohymont and Demarée 2006), markedly lower than the 2000-3500 mm yr^{-1} and 2000-4000 mm yr^{-1} in the peatland regions of Western Amazonia and South East Asia, respectively (Dargie et al. 2017). Precipitation inside the Cuvette Centrale is an important element of the hydrological balance of the Congo river, accounting for more than 30 percent of its water supply during low water periods (Datok et al. 2020).

The spatial pattern and spatial extent of peat was mapped in 2017, with field samples showing deep peat deposits for the first time (Dargie et al. 2017). This spatially explicit map of peatlands in the Central Congo Basin reveals it to be the most extensive tropical peatland complex (i.e., near contiguous), with a 95 percent confidence interval of 131,900–156,400 km^2. This work builds on past efforts mapping vegetation, from the 1950s onwards (Evrard 1957; Betbeder et al. 2013; Kadima et al. 2011; Dargie 2015; Bwangoy et al. 2010). The peatland area occupies about 40% of the total wetland area of the Cuvette Centrale, using Bwangoy et al. (2010) for wetland area. Maps using satellite data and no ground observations of peat have also been published (Gumbricht et al. 2017; Xu et al. 2018).

Ground sampling shows that the peatlands that occupy large interfluvial basins form modest domes (Davenport et al. 2020), with peatlands beginning to form in the very early Holocene, at least 10,500 years B.P. (Dargie et al. 2017). The peatlands have actively sequestered carbon including the past 2,000 years (Dargie et al. 2017). Peat also forms "corridors" of peat, adjacent to rivers flowing east to west into the Congo River in the DRC (Figure 9.1; Dargie, Ewango, Lewis, *pers. obs.*).

Extensive peat deposits have, so far, been discovered under two common vegetation types: hardwood swamp forest (in which *Uapaca spp.*, *Carapa procera* and *Xylopia rubescens* are common) and a palm-dominated, *Raphia laurentii* swamp forest. Peat was also usually found under a much rarer palm-dominated, *Raphia hookeri* swamp forest that occupies some old river channels (Dargie et al. 2017; Bocko et al. 2017; Bocko 2018). Peat was not found beneath *terra firme* forest, seasonally flooded forest or savanna. The peatlands are largely intact, as local peoples' impact on this ecosystem is broadly sustainable and is still low at present (Dargie et al. 2019).This large freshwater ecosystem plays a crucial role in provisioning water, nutrients and food locally and downstream.

The vast Central Congo peatland complex contains the highest densities of western lowland gorillas (*Gorilla gorilla gorilla*) in the world, as well as chimpanzees (*Pan troglodytes*), forest elephants (*Loxodanta cyclotis*) and endemic bonobos (*Pan paniscus*) (Fay and Agnagna 1992; Rainey et al. 2010) and Allen's swamp monkeys (*Allenopithecus nigroviridis*), the latter which is found only in swamp and inundated forests (Gautier-Hion et al. 1999; McGoogan et al. 2007).

These peatlands also harbour a diversity of fish, crabs, freshwater molluscs and other water species such as Odonata (Brooks et al. 2011); it is estimated to shelter more than 200 fish species,

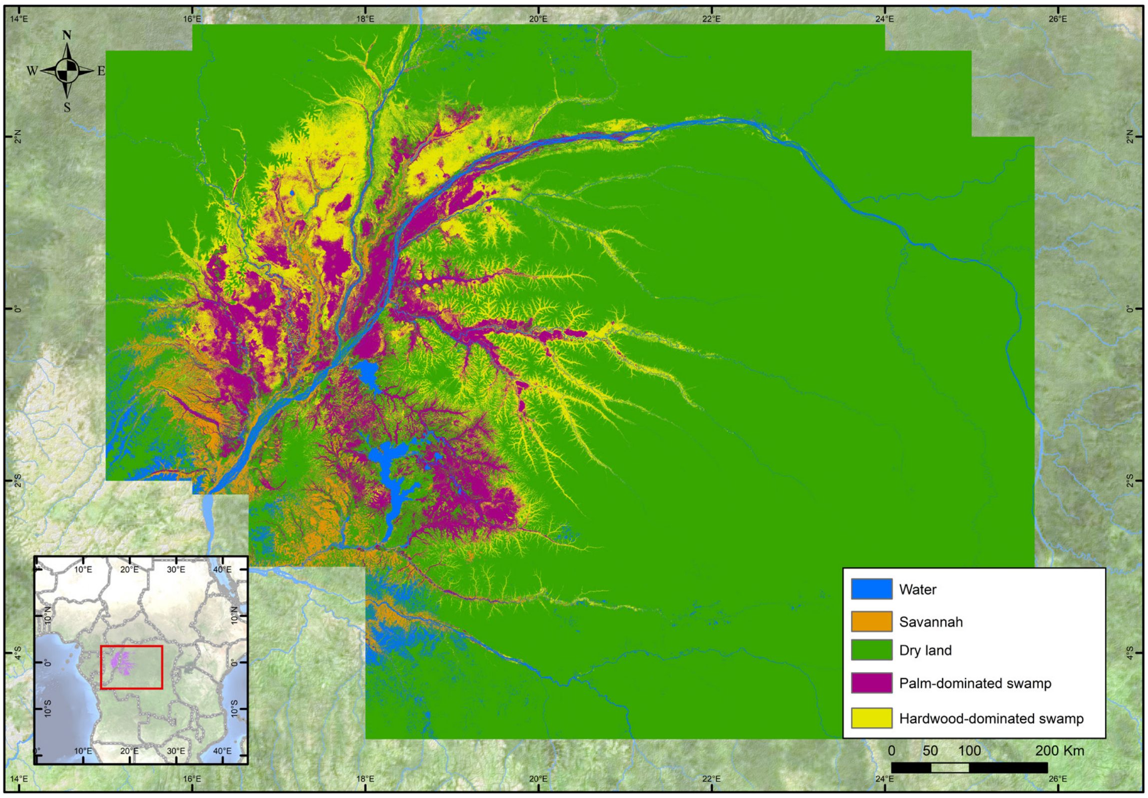

Figure 9.2 : Probability map of vegetation types derived from 1,000 runs of a maximum likelihood classification using eight remote sensing products (three ALOS PALSAR; two SRTM-derived variables; three Landsat ETM+ bands) and jack-knifed selections of training data. Peat is located under palm-dominated swamp and hardwood-dominated swamp, reproduced from Dargie et al. 2017.

Source: Dargie et al. 2017

many of which are endemic (Inogwabini and Lingopa 2013). Characins, Cyprinids, Cyprinodonts, Mormyrids and Catfishes, which are numerous in the forested Central Congo peatlands, require specific ecological conditions known only in large, stable and relatively undisturbed forests (Roberts 1975). Many fish found in these peatland forest ecosystems have developed specialized adaptations such as the emission of electric signals and organs that allow them to breathe air in hypoxic waters (Roberts 1972; Hopkins 1981).

The Central Congo peatlands are also important to crocodiles, turtles, amphibians, and birds though data are scarce due to insufficient inventory efforts, especially in the peatlands (Thieme et al. 2008; Hanssens 2016; Harrison et al. 2016; Diamond and Hamilton 1980; Chifundera 2019). Given the limited data further research is needed to properly characterize this rich biodiversity.

Instruments installed in the peatlands to monitor water table levels indicate that the interfluvial peatlands are predominantly rainfed, rather than receiving flood- or ground-water (Dargie et al. 2017). It is assumed that the DRC riverine peatlands will be impacted by river flooding as well (Lewis S.L., Dargie G.C., Ewango C., Crezee B., pers. obs.), but confirmation of this with instruments is needed. The role of the relatively low rainfall in peatland maintenance is reflected in the peat itself, as it is more decomposed and has a higher carbon density compared to tropical Asian and American peat (Dargie et al. 2017).

In the Likouala Region, in the RoC, the maximum depth found by coring peat is 5.9 m depth, with a median of 2.0 m depth and mean of 2.4 m depth (peat defined as soil containing ≥ 65 percent of organic matter) (Dargie et al. 2017). More recent field campaigns in the DRC, in the process of being published, have also discovered peat deposits with maximum depths > 5 m. Finding peat across the DRC portion of the Dargie et al. (2017) map gives increasing confidence that there is indeed a large area of peatland in the Cuvette Centrale (Lewis S.L., Dargie G.C., Ewango C., Crezee B., pers. obs.).

In the future, better high resolution maps of the peatlands, wider wetlands and surrounding non-wetland land areas will help to better manage the area through improved land use planning. Increased laboratory analyses on field-collected peat samples for peat depth, bulk density and carbon concentration will also help to refine estimates of carbon storage and potential greenhouse gas emissions if peat is drained or disturbed.

9.1.2 Carbon storage

By combining the areas of peatland area in the Central Congo with field measurements of peat depth, bulk density and carbon concentration, Dargie et al. (2017) made a first estimate of the median carbon storage in peat 30.6 gigatons of carbon (Gt C). Total below-ground carbon storage is greater than the peat-only estimates because a layer of organic-matter-rich (<65 percent of organic content) occurs beneath the peat (≥ 65 percent organic content). The carbon stored in the peat is much greater than that stored in the living vegetation overlying the peatland (median, 1.4 Gt C; Dargie et al. 2017), and is estimated to be similar to the above-ground carbon stocks of the entire Congo Basin tropical forests (Verhegghen et al. 2012; Saatchi et al. 2011a).

The Central Congo peatlands are estimated to harbour approximately 29 percent of the total tropical peat carbon stock, and approximately 5 percent of the estimated global peat carbon stock, although additional fieldwork is needed to refine both total tropical peat and Central Congo peat carbon stocks (Dargie et al. 2017). If all the carbon stored in the Central Congo peatlands were released to the atmosphere, this amount of carbon is equivalent to three years of the current annual global emissions of carbon from all fossil fuel use. This stored carbon is vulnerable to land-use change, including drainage for agriculture, roadbuilding, damming of rivers for hydropower, selective logging, plus the impacts of climate change, particularly any future reduction in precipitation (Dargie et al. 2019). See Section 4 on threats.

9.2 Improving the state of knowledge of the Central Congo peatlands

9.2.1 Advancing peatland mapping in Central Africa

Dargie et al. (2017) show that there is a clear relationship between vegetation type and peat presence in the Central Congo peatlands. For the production of peat, areas need to have sufficiently productive vegetation to provide carbon inputs to the soil surface, and condition to inhibit decomposition, typically being inundated most of the year (i.e., in which the water table does not fall far below the surface). To delineate these permanently flooded areas, studies generally use satellite Synthetic Aperture Radar (SAR) imagery (Betbeder et al. 2013; Dargie et al. 2019). SAR data sends microwaves from satellite sensors that penetrate through the canopy to interact with the tree stems and palm fronds, with the amount of radiation returning to the satellite depending strongly on how wet the ground is: wetter ground means more returns to the satellites. However, the use of SAR data has limitations, as some imagery covers only a part of the Cuvette Centrale, and/or a single time period, and its spatial resolution for long-term assessments can be coarse (1 km).

Additional efforts to delineate the Congo Basin peatlands have been provided by pantropical studies. For example, Gumbricht et al. (2017) used a combination of hydrological modelling and soil wetness to map wetland and, by extension through vegetation data, peatland extent across the tropics. While in many locations, particularly in South America, this study predicted peat covering much larger areas than other methods have predicted, over the Central Congo Basin area the Gumbricht's map total peatland area is similar to the total peatland area mapped by Dargie et al. (2017) , despite the different methods used by these two authors. While the total area is similar spatially, there are striking differences in the Gumbricht et al. (2017) map and the Dargie et al. (2017) map, they both together provide confidence that there is a large area of peatland in the Cuvette Centrale.

Efforts to improve the mapping of forest types and peatland areas are currently underway. CIRAD scientists' use of time series imagery acquired using SAR sensors (the Jason-2 Poseidon altimeter SAR sensor, jointly developed by NASA and CNES and the SAR PALSAR-2 sensor from the JAXA ALOS satellite) is allowing a new characterization of the different forest types according to their flooding over time (Betbeder et al. 2013; Frappart et al. 2021). Previous efforts to characterize peats using RADAR data include through detecting dome formation (Siegert and Jaenicke 2008). This approach only guarantees wetland presence and not peatland formation. Thus, peatland mapping requires field data to calibrate and validate remote sensing derived products. Fieldwork, which is the most expensive and logistically complex part of mapping and estimating carbon stocks, remains a necessity.

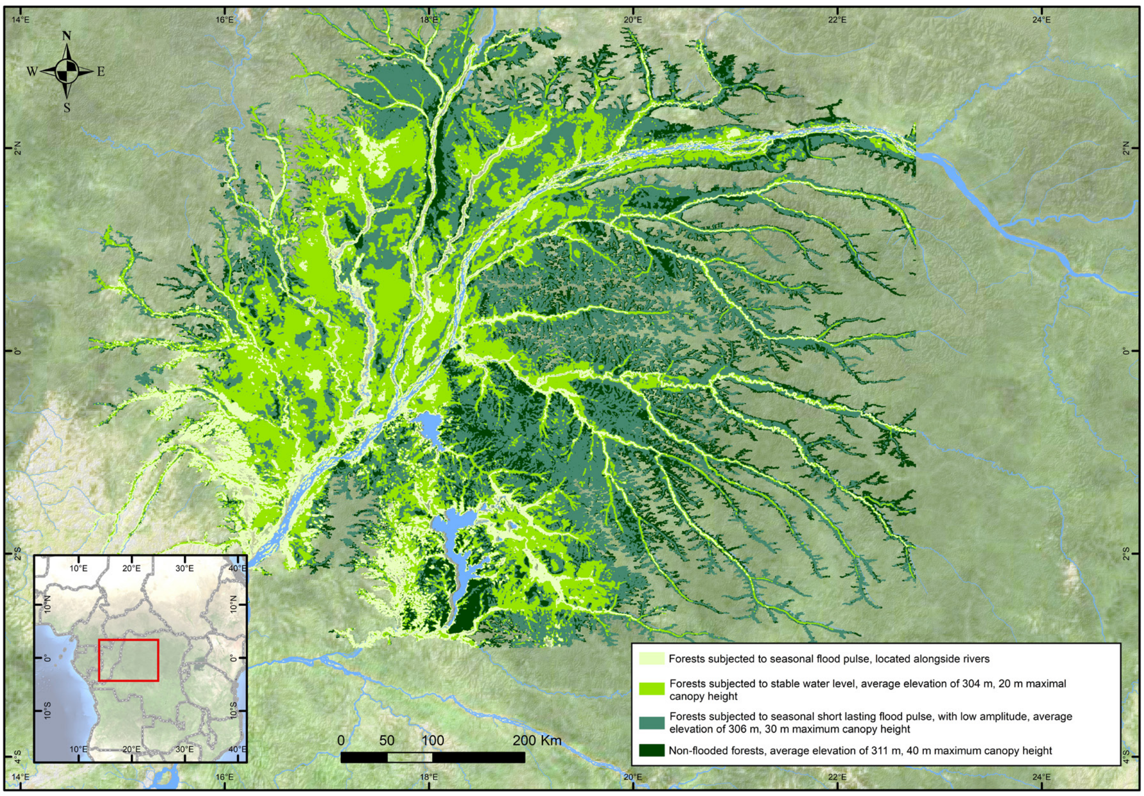

Figure 9.3: Mapping of swamp forest types in Central Africa based on MODIS, PALSAR satellite images and LiDAR data

Source: Betbeder et al. 2013

The CongoPeat project funded by the UK's Natural Environment Research Council, is collecting new field data from sites across RoC and the DRC, to reduce the key limitation on mapping the peatland by greatly expanding the field-based vegetation, peat depth and bulk density data reported in Dargie et al. (2017), which will significantly improve the maps of vegetation types that overlie peat and estimates of peat depth. Beyond this, the project is also using remote sensing data in three new ways to gain additional insights. Firstly, the project collected high-resolution LiDAR data from a drone to reveal peatland topography for the first time, showing that a large interfluvial peatland in this region has formed a dome (Davenport et al. 2020). The project is now expanding these findings across the Central Congo basin using satellite LiDAR data from ICESat-2. Secondly, the project is using JAXA's ALOS-2 PALSAR-2 satellite data to characterize the flooding regime over the basin, to provide improved maps of peat presence/absence and peat depth. This work will also assist in understanding how these dynamics influence peat formation and stability, assessed using field data. Finally, CongoPeat are using new satellite sensors combined with more extensive field data and high throughput cloud computing facilities, to provide a new reference map of the peatlands to supersede the (Dargie et al. 2017) map.

Minasny et al. (2019) have underlined that the proliferation of satellite data available in an open-access format, the availability of machine learning algorithms in an open-source computing environment and the high-performance of available computing facilities could enhance the way peatlands are mapped (see Greifeneder et al. (2019) for a recent Indonesian example). Furthermore, the Norwegian government has agreed with the PLANET/KSAT/AIRBUS consortium for publicly available monthly data high-resolution 3-metres optical data for the period 2020-2024. This dataset will be particularly useful for monitoring changes to the peatland area due to land-use change. Additionally, it may be possible to apply longer wavelength SAR datasets that penetrate the canopy such as ALOS 2, which may improve our capability to monitor soil moisture changes through time, on a very regular (weekly) and fine-scaled (10 m) basis. This has the potential to improve maps of peatland areas when combined with other remotely sensed data and field measurements.

In all of the approaches outlined above, one of the biggest limiting factors is collection of field data, which is costly especially in the difficult to access Central Congo peatlands. Such field data is essential for the calibration and validation of peatland maps to reduce uncertainty as well as providing additional information regarding vegetation typologies, carbon stock stored in the peat soil, biodiversity and local community presence in and use of these areas.

Beyond the Central Congo peatlands, findings in Gumbricht et al. (2017) and Xu et al. (2018) suggest there may be additional isolated peat patches throughout tropical Africa albeit on a much smaller scale than that found in the Central Congo. There is a need to also map and collect field data in these areas to estimate extent and characterize these ecosystems.

9.2.2 Field measurements

To understand the genesis, development, contemporary function and extent of the Central Congo peatlands requires field data. Field measurements to define the peatland area include peat cores to characterize the soil type and peat thickness, characterization of the vegetation (species composition and structure), topographic studies and hydrologic characterization to identify high water tables (Dargie et al. 2017; FAO 2020a). In the Central Congo peatlands, collection of data is costly and time consuming given the difficulty to access sites due to limited transportation infrastructure, the same dynamics which has, in part, resulted in low peatland degradation to date.

Estimating peat carbon stocks requires data on peat thickness, bulk density and carbon content (Dargie et al. 2017; Minasny et al. 2019). These have been obtained by Dargie et al. (2017) from the northern RoC and additionally now from across the DRC, as part of the CongoPeat project.

Some of these peat cores have been sampled and analysed to date the peat. The oldest published age of the base of a peat core is 11,000 years, suggesting the region began accumulating peat in the African Humid Period, when the region warmed and got wetter (Dargie et al. 2017). More dates from the base of peat cores from the region will help understand the genesis of the peatlands of the Central Congo basin.

Vegetation characteristics that have been collected in peatland and adjacent regions show long shallow gradients of changes in species composition within the interfluvial basin peatlands of the RoC (Bocko 2018; Bocko et al. 2017; Dargie 2015; Dargie et al. 2017). New field data on vegetation characteristics from the DRC is being conducted as part of the CongoPeat project to understand if the Congo River is a significant barrier to peat swamp tree species and if tree species composition differs in peatlands on either side of the River.

Understanding the contemporary function of the peatlands can be improved by field measurements of the water table, to show if inundation levels follow rainfall events, or if flood waves from rivers are observed overtopping their banks. Field data collecting water table data every 20 minutes for two years across several locations in an interfluvial peatland in the RoC show that there were no floodwaves and the water table depth both closely followed rainfall events, but also the water budget can be closed by only accounting for rainfall inputs. This suggests that for the interfluvial basin studied, it is a rainfed system, and hence sensitive to future climate change. Measurements under the CongoPeat project are investigating if other peatlands in the region are rain-fed.

Peatlands are important sinks for carbon dioxide and sources of the greenhouse gases methane and nitrous oxide. The CongoPeat project is also collecting *in situ* ground data from both the wet and dry seasons for these key greenhouse gases, in peatlands across the Central Congo region. In addition to investing in local expertise, investment in laboratory facilities in the RoC and DRC for processing peat samples to estimate carbon stocks, and analysing samples of greenhouse gases, could help to further assist in building local research capacity and infrastructure. Some local laboratories already are equipped to complete some of the soil analyses required, which can further be built upon.

Finally, social science data is necessary to understand local communities' relationship to and use of peatland areas as well as the impacts of different sectors' activities impacting ecological functioning and access to peatlands. This detailed on-the-ground research in the region has been limited to date.

9.2.3 Current key research gaps

Despite recent advancement of the knowledge of the Central Congo peatlands (Bocko 2018; Bocko et al. 2017; Dargie 2015; Dargie et al. 2017; Davenport et al. 2020), research still remains limited and many knowledge gaps exist. Maps of the Central Congo peatlands can be improved by collecting additional field data and creating maps at finer resolution. Further field data will allow for improved understanding of peatlands state, if they are drying, drained, or otherwise managed, if they have been disturbed or are pristine, as well as the relationship between vegetation types and peat location, depth and other characteristics.

Box 9.1: Ecosystems services of the Central Congo peatlands

Provisioning services: Peatlands are vital sources of food and income for local communities. Most local populations draw on peatlands resources to feed their families and gain a source of income. This includes harvesting medicinal plants, shrimp, crustaceans, fish, wildlife, firewood and timber and producing charcoal. More than two thirds of the peatland population living in wetland areas source 80 percent of animal protein consumed from fisheries for direct consumption or sold in local markets.

Some compounds derived from peatland ecosystems have antimalarial, antibiotic, antiviral, and antioxidation properties which can provide great value to the pharmaceutical sector. Furthermore, *Raphia sese* fruits pulp, roots of *Lasimorpha senegalensis* are edible and are still eaten by the peatland communities of Central Africa wetlands, and surrounding zones. Some peatland species have long leaves that can be used as raw material for handicrafts. In both Congos, palm species, particularly *Raphia lauretii* and *R. sese*, in addition of providing palm wine, have leaves, which are used for roofing and palm liana species for handicraft products such as handbags, baskets and building raw material. This could be one potential income generating activity that could be further developed with local communities (Quintela et al. 2004).

Regulating services: Peatlands regulate water flows, provide clean water, reduce sediment and erosion events, cycle nutrients and store carbon in the rich organic soils. Peatlands are very important stores of carbon sequestered often over thousands of years, which in the case of the Congo Basin peatlands, help to regulate climate at micro, regional and global scales. Furthermore, the Central Congo peatlands play key roles in water cycling and provision in the region, feeding into the Congo Basin River.

Supporting services: Peatlands accumulate matter and paleo-information within peat layers. Peatlands across the globe are refuge to a multitude of fauna and flora species, with a broad spectrum of morphological forms across various temporal and spatial zones.

Cultural services: Communities living around the Central Congo peatlands have traditional knowledge and cultural practices that should be learned from and protected alongside biodiversity conservation. Such cultural heritage and practices can be attributed, in part for the conservation and protection of these peatland areas. In some villages, peatland areas are declared sacred and constitute an important part of the identity of the people. These sacred spaces represent for the local populations “the cornerstone of the vision of the world, their cultures and philosophies”. Traditional rules, based on local knowledge passed down through the generations ensure their conservation. Some popular beliefs such as the existence of supernatural beings in the wetland forests have also played a key role in conservation of peatlands. It is believed that some mysterious creatures inhabit the peatlands (e.g., *Monama* in the DRC, *Mokelembembe* in the RoC) requiring respect for anyone venturing into the peatland forests.

-

continued on next page

Box 9.1 : Continued

Local customary tenure, culture and tradition must be respected and can provide invaluable in efforts to sustainably manage peatland forests. For example, fishermen can have substantial knowledge of the ecology of freshwater fishes and animals, their characteristics, habitats, breeding areas, etc. Thus, like the traditional practices of many indigenous peoples, these practices are an important means of securing and sustainably managing resources (Artaud 2014). Equally, efforts should be made to preserve cultural heritage and knowledge, i.e., oral traditions, traditional methods of landscape management and forestry, and related rural crafts activities.

In addition to advancing mapping and ground truthing efforts to improve understanding on the location and characterization of peatlands in the Congo Basin, better understanding peatland ecosystems' biological functioning can inform the assessment of potential future management decisions within these landscapes. Hydropedology and hydrological functioning need to be better understood alongside structure and floristic and fauna composition of the peatlands. More specifically, a working model of the gain and loss of organic material in the peatlands is needed to estimate change in soil carbon. This requires data on the productivity of the vegetation, how much carbon is transferred from the vegetation into the peat, the decomposition rates of organic matter in the peat, and the environmental drivers of these processes from weather station and hydrological monitoring data, particularly water table data. Modelling these processes can provide projections of different possible future scenarios and provide the basis for establishing both monitoring and early warning systems.

On the social science side, little is currently known about how local communities and indigenous peoples use and interact with these peatland ecosystems. It is essential this understanding is improved and that local communities are properly informed and consulted, in line with Free, Prior and Informed Consent, before any management decisions are made in respect to the land which would fall under customary land tenure. Any change to the contemporary broadly sustainable management of these ecosystems requires the full engagement and support of local populations. Therefore, studies on customary use as well as the development of sustainable livelihood options will be key to inform future approaches and programming in the region. Further understanding of the local populations that live adjacent to the peatlands, and the different types of existing land uses, will be a key prerequisite.

Finally, studies are needed on how to incentivize the protection of peatland landscapes from local to national levels. Given that peatlands are easily impacted by changes to the hydrology of the area where they are located, it is important to manage these areas through an integrated landscape approach (FAO 2020b). Incentives could include further exploration of results-based payments based on their carbon storage and sequestration and/or biodiversity. Policies that protect peatland landscapes should include incentives to ensure enforcement of laws and regulations will be essential. Development of strong cross-sectoral policies are still needed. An initial review of the legal framework for peatland management in the DRC outlines some recommendations for strengthening existing legislation and developing a national peatland policy (SWAMP 2021).

9.3 Threats to peatlands

Across the tropics, peatlands have been subjected to widespread degradation and destruction. Yet the Central Congo peatlands remain largely intact. But as witnessed in South East Asia, where 47 percent of peatlands were deforested in 25 years (Miettinen et al. 2016), the situation can change rapidly and a number of threats to the Central Congo peatlands have already been identified. Peatland drainage alters vegetation cover, threatens wetland biodiversity, decreases water quality, causes land subsidence (and subsequent heightened risk of floods and loss of riverine areas), increases fire frequency and other negative impacts on people, their livelihoods, and the environment. After peatland damage has occurred efforts to re-wet and restore peatlands can be very costly and may not succeed in restoring original levels of ecosystem services provisioning. Therefore, prevention is essential especially in the relatively intact Central Congo peatlands. Threats identified range from climate change to infrastructure development, industrial land conversion to compounding interlinked activities.

9.3.1 Climatic threats

Climate change is one threat which has the potential to destabilise the entire region. The continued accumulation and preservation of organic matter within a peatland is largely dependent on maintaining saturated, anoxic conditions. Any changes in the peatland's hydrological balance which results in a drop of the water table can increase decomposition of the organic matter, potentially transforming peatlands from a carbon sink to a carbon source, releasing carbon dioxide into the atmosphere.

Ombrotrophic (rain-fed) peatlands are particularly vulnerable to changes in climate, whereas minerotrophic peatlands, which receive additional inputs from fluvial or ground waters, are in part buffered against changes in precipitation. Whilst on-the-ground data is available for only a small proportion of peatland sites in the Central Congo, there is evidence that the large peat filled interfluvial basin between the Likouala-aux-herbes River and the Ubangui River are rain fed peatlands (Dargie et al. 2017) and has a shallow domed surface topography, which is a classic indication of ombrotrophic conditions (Davenport et al. 2020).

Even under the moderate Representative Concentration Pathway (RCP) 2.6 scenario of the CMIP6 exercise, mean annual temperatures within the Congo Basin are projected to rise by ~0.85°C by the end of 2050 relative to the period 1980-2010 (IPCC 2021). Increases in temperature can increase rates of evapotranspiration within the peatlands, which would negatively impact the hydrological balance. However, a more dramatic impact would be from a change in rainfall, such as an intensification of the dry season. Yet how climate change will affect rainfall, both in terms of amount and seasonality, is highly uncertain. Lack of meteorological data across the region and the peatlands especially, makes it hard to assess how well the different earth system models represent the present-day climate within the Basin, let alone future projections. However, a number of model ensembles show a slight wetting trend across the basin (Creese et al. 2019). Yet in other model ensembles, the wetting trend is accompanied by an intensification of seasons, with an increase in rainfall extremes and an increase in the intensity and frequency of dry events (Dosio et al. 2019). Meanwhile, analyses at the scale of the whole Congo Basin rainforest show over the past two decades a recent increase in the length of the boreal summer dry season to the northeast, i.e., upstream of the peatlands, hence it is unclear if dry season intensity is increasing or not over the peatland region (Jiang et al. 2019). Over the past four decades, the Congo Basin peatlands have recorded an approximate mean annual temperature of 25.5°C which is slightly warmer than temperatures recorded over open-water areas, but similar to savannah areas (Figure 9.4). According to the most pessimistic scenario (RCP 8.5) of the CMIP5 exercise, temperatures in the Congo Basin peatland area could reach 27°C by the middle of the century, i.e., an increase of about 1.5°C compared to 1980-2010. Such temperatures may reduce the productivity and carbon stocks of the swamp forests (Sullivan et al. 2020), reducing carbon inputs and increasing decomposition which may decrease peat carbon stocks.

Mean annual rainfall amounts (Figure 9.5) as estimated by CHIRPS data (Funk et al. 2015) for the period 1981-2019 are around 1758 mm for peatland. The bimodal annual cycle pictures the SON (September-October-November) rainy season as the wettest one which is concordant with observations at the scale of the Central Africa region. The rainfall annual cycle evolution over the last four decades (Figure 9.5, difference 2011-2019 minus 1981-1990) is characterized by significant decreases in rainfall during the dry seasons especially in July and December (-16 and -24 mm respectively) as well as in September (-33 mm) suggesting a shortening of the wettest rainy season. The RCP6.0 and 8.5 scenarios of the CMIP5 exercise predict much larger rainfall amounts (+300 mm) over the Congo Basin for the three coming decades than what has been observed since the 80's. This is especially marked during the two rainy seasons, with for example ~65 mm gained by the middle of the century in April and ~40 mm in October. These significant potential changes in the regional hydroclimatic cycle could have major consequences on the ecological functioning of peatlands, although there is great uncertainty in this. If dry season trends continue, then a loss of peat may be expected, but if rainfall increases, then continued or even increased peat accumulation could occur. Such changes would also likely change the species composition of the trees of the peatland as they track the changing environmental conditions. Furthermore, policy decisions could exacerbate changes if parts of the Ubangi and other Congo river tributaries are diverted into Lake Chad as has been under discussion, it could result in significant negative impacts in the Central Congo peatlands, particularly those connected to these rivers, due to changes in the water table (Dargie et al. 2019; Inogwabini and Lingopa 2013; Lemoalle and Magrin 2014).

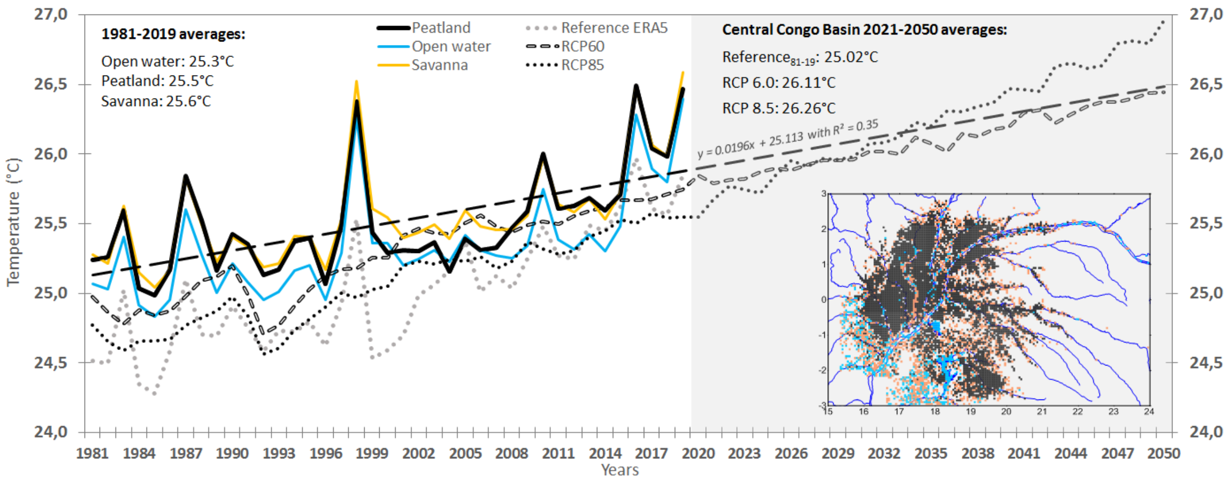

Figure 9.4: Temperature's recent evolution (1981-2019, TerraClimate data at 2 m and ERA5) measured for three land cover types (peatland, open water and savannah, located on the map at bottom right; calculated from ecological data of Dargie et al., 2017) in the Central Congo Basin: the linear trend for peatland is shown as long-dashed line; projections for 2050 according to scenarios RCP 6.0 and 8.5 of the CMIP5 exercise are shown as short-dashed and dotted lines.

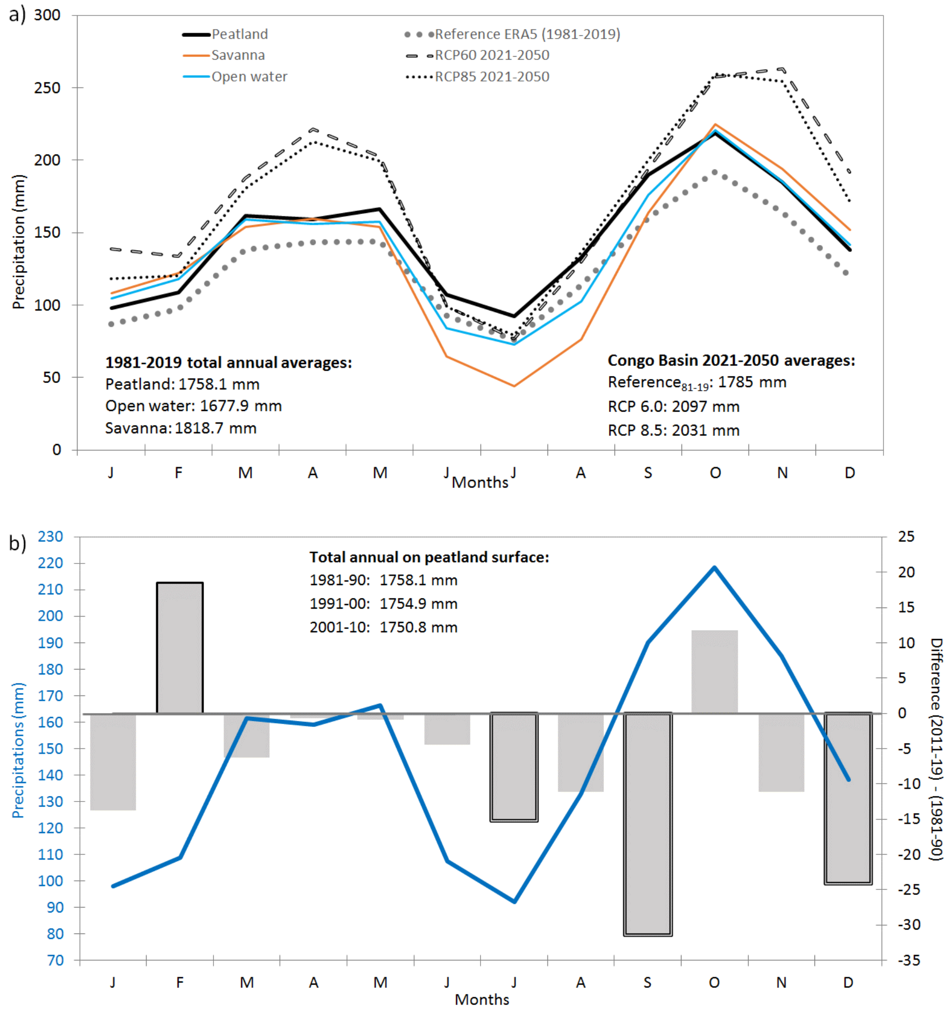

Figure 9.5: a) Comparison of mean annual rainfall regimes (in mm) for the Congo Basin's three land cover types and the period 1981-2019 (monthly totals are calculated using CHIRPS data; the 1981-2019 reference average for the entire Congo Basin, as well as those for Representative Concentration Pathway (RCP) projections 6.0 and 8.5, are also provided); b) mean annual rainfall cycle (1981-2019) of the Congo Basin (line) and differences between decades 2011-2019 minus 1981-1990 (bars); significant differences according to a Student's t-test are indicated by a bold box (90 percent) or a double box (95 percent).

9.3.2 Threats of conversion

There are also more direct anthropogenic threats from socioeconomic activities. Much of the Central Congo peatlands coincide with logging and hydrocarbon concessions (Dargie et al. 2019). These activities themselves pose potential threats, such as deforestation, and, in the case of oil extraction, pollution. But they also require infrastructure such as roads, and a work force, which often requires people to migrate into the region. The roads, if built directly across the peatlands, can impact and interrupt the hydrology of the peatlands, while also permitting access to areas of forest which were previously relatively inaccessible. This in turn could facilitate defaunation and deforestation, especially when combined with an increase in population from migratory workers (Finer et al. 2008; Laurance et al. 2017). That being said, current threat of conversion is relatively low given the challenges in operation and access, but this context can always rapidly change.

Roads

Forestry concessions cover a much larger area of peatlands in the DRC than in the RoC (Gourlet-Fleury et al. 2017; Dargie et al. 2019). In RoC, a limited number of concessions (7) are located on the edge of the Central Congo peatlands, whereas in the DRC about 30 concessions entirely or partially cover around 4.5 million hectares, i.e., 26 percent of the peatlands in the country (Gourlet-Fleury et al. 2017), though not all are operational at the time of writing. In both countries, the law authorizes the inclusion of peatlands in forest concessions, but officially no logging is allowed in permanently waterlogged areas, and peatlands must be incorporated into a "protection series". However, logging can occur in inundated forest, which is periodically waterlogged, during the dry season, though these areas are generally not preferred for extraction and have not been exploited to date. This provides a critical loophole, as in the dry season the water table in the peatlands is below the surface, so could be argued to be inundated forest. The potential risk of logging, whether legal or illegal, in these forests is opening access to the peatland area, possibly disrupting the natural water drainage network. Furthermore, there are potential risks that are yet to be studied, including how the removal of the trees will result in opening the understorey to sunlight, more evaporation, and potentially slowing or reversing carbon accumulation. See Interlinked challenges below.

Hydrocarbon concessions

Both the governments of the DRC and the RoC have opened hydrocarbon (oil and gas) concessions within the Cuvette Centrale for bidding (Goodrich 2019; Ministère Des Hydrocarbures 2019). Oil deposits have long been known and researched for extraction in the Cuvette Centrale (Cornet 2012). First commercial oil explorations were conducted between 1970 and 1984 by SHELL, TEXACO and the Japan National Oil Company (Kadima et al. 2011). In 2019 the RoC (re)announced that oil had been found beneath one of the peatland hydrocarbon concessions (Le Monde/AFP 2019). One controversial industry calculation suggested that this oil field has the potential to quadruple national production (Noiraud et al. 2017; Tchoumba et al. 2021). Exploiting this resource has high risks of disrupting the peatland hydrology, polluting the sensitive ecosystem, increasing greenhouse gas emissions and having negative socio-economic impacts, such as the displacement of communities. Examples of hydrocarbon pollution in tropical peats can be found in the wetlands and peatlands of Tabasco in Southern Mexico (Cram et al. 2004), as well as in tropical forests in Peru, where 474 oil spills occurred between 2000 and 2019 (Oxfam Peru 2021). Linked to this is the challenge of the national energy policy, ensuring that the country's energy needs can be met through more renewable or low carbon sources, and whether there will be a large market for oil in the future. It is unclear at this time if and when either government will advance with further exploration and extraction.

Agriculture

Currently across the Congo Basin, present day forestry and agricultural activities, whether industrial or subsistence scale, occur mainly on land that does not flood, known as *terra firme*. Slash-and-burn farming or shifting agriculture is the main technique used on *terra firme* but more intensive raised-field agriculture has been practiced in various open floodplains. While some raised-fields have been abandoned, others are still active. They are more labour intensive than *terra firme* slash-and-burn agriculture or flood recession agriculture, but they produce high yields and decrease flooding risks (Comptour et al. 2020). Currently, communities' activities within the peatland areas consist mainly of hunting, fishing and harvesting of forest products such as palm fronds for roof construction.

Based on the available information, current impact of local inhabitants on or around the peatland ecosystems is minor and relatively sustainable in present form (Dargie et al. 2019), as seen in the very low deforestation rates within the peatlands. That said, population densities have been increasing in and around the Central Congo peatlands, which may result in future degradation. At the moment, a lot of food production for cities such as Mossaka or Mbandaka are coming from outside areas implying: 1) deforestation pressure around more urban areas is transferred elsewhere, and; 2) there is a need for local population to generate income through various activities in order to buy these products. Therefore, efforts to promote sustainable agriculture outside the peatland areas as well as develop alternative livelihood income sources are both important for the protection of the peatlands. Applying landscape approaches for peatland management and preservation can help to address such complex dynamics and linkages.

Palm oil

Another cause for concern is the rise of palm oil production across Africa (Ordway et al. 2017). Globally Indonesia and Malaysia are the two biggest palm oil producers (FAO 2020a) and it is this industry that is responsible for the majority of peatland destruction in South East Asia (Miettinen et al. 2016). It is feared that with increasingly strict regulations and less available land to expand into, the companies will look to expand into central Africa (Ordway et al. 2017).

In order to successfully grow palm oil in peatland areas it is necessary to lower the peatland water table (although palm oil also grows well on *terra firme* land). It is this drainage of the peatlands, which results in peat decomposition through oxidation and an increased vulnerability to fire as the peatland dries out. Whilst the carbon dioxide emissions from oxidation are considerable, with 2.5 Gt C being released over the period of 1990 to 2015 across South East Asia (Miettinen et al. 2017a), peatland fires in some years have released up to 0.9 Gt C in a matter of months.

In the context of the National REDD+ strategy in the DRC, the Letter of Intent on the establishment of a long-term partnership with the Central African Forest Initiative (CAFI) (see Table 9.1), promotes the protection and sustainable management of peatlands, and prevents their drainage and drying out. These provisions will be included in the upcoming investment program, which will encourage industrial agricultural expansion to occur in open and degraded ecosystems on *terra firme* land to prevent destruction of intact forest ecosystems including the peatlands forests.

9.3.3 Interlinked challenges

The above-mentioned threats are unlikely to occur in an isolated context. The extent to which these threats are realised will depend on numerous political and socioeconomic factors, both at a national and international level and synergies between threats can exacerbate the negative impacts on the peatlands. A South-East Asian example of this is the vast peatlands fires in El Niño years. Increased temperatures and reduced rainfall led to fires which are more severe than the average year (Miettinen et al. 2017b; Page et al. 2002). These fires, which were often started as a way to clear an area of land, spread particularly easily through the peatlands which have been deforested and drained (Page et al. 2009), leading to millions of hectares of peatland being burned (Vetrita and Cochrane 2020). Without proper investment to ensure the preservation of the Central Congo peatlands, a scenario where hydrocarbon exploration or industrial agriculture are allowed to expand into the region, against the backdrop of climate change, leading to widespread peatland degradation, is not implausible.

9.4 Institutional arrangements and governance of the Congo Basin peatlands

Several international and regional agreements and conventions exist with implications for the management and service provision of wetlands and peatlands, see Table 9.1. Both Congos are signatories of several international agreements, notably the Ramsar Convention whose mission is "the conservation and wise use of wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world" (Ramsar Convention 2021). Additionally, despite the signature of several regional agreements and commitments from 2016 to present related to the protection and sustainable management of peatlands, concrete action and implementation has, generally, been slow to materialize. There

Table 9.1: Select international agreements, conventions and resolutions with implications for Congo Basin peatland ecosystems.

Agreements / Initiative / Meeting	Document / Detailed plans	Inclusion of peatlands
International		
2030 Agenda for Sustainable Development	Sustainable Development Goals (SDGs)	Relevance of peatlands to address following SDGs: SDG 2 Zero Hunger SDG 6 Clean Water and Sanitation SDG 13 Climate Action SDG 15 Life on Land
IUCN World Conservation Congress, 2016	Resolution 043- Securing a future for global peatlands	Calls for better protection and restoration of the world's peatlands.
Ramsar Convention	COP 6 1996	Recommendation 6.1: Conservation of peatlands
	COP 7 1999	Recommendation 7.1: A global action plan for the wise use and management of peatlands
	COP 8 2002	Resolution VIII.17: Guidelines for global action on peatlands Resolution VIII.11: Additional guidance for identifying and designating underrepresented wetland types as Wetlands of International Importance
	COP 12 2015	Resolution XII.11: Peatlands, climate change and wise use: Implications for the Ramsar Convention
	COP 13 2018	Resolution XIII.13: Restoration of degraded peatlands to mitigate and adapt to climate change and enhance biodiversity and disaster risk education. Resolution XIII.12: Guidance on identifying peatlands as Wetlands of International Importance (Ramsar Sites) for global climate change regulation as an additional argument to existing Ramsar sites.
UN Framework Convention on Climate Change (UNFCCC)	Paris Climate Change Agreement	Two articles are of relevance to peatlands: Article 4 (1): New long-term goal to achieve "a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century." Article 5: (1) Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1(d), of the Convention, including forests.

-

continued on next page

Table 9.1 : Continued

Agreements / Initiative / Meeting	Document / Detailed plans	Inclusion of peatlands
Convention on Biological Diversity (CBD)	Post-2020 Global Biodiversity Framework	Concrete goals under negotiation at the time of publishing; https://www.cbd.int/conferences/post2020
UN Decade on Ecosystem Restoration	Strategy	Highlighting importance of wetland restoration
The Sendai Framework for Disaster Risk Reduction		30 (g) To promote the mainstreaming of disaster risk assessment, mapping and management into rural development planning and management of, inter alia, mountains, rivers, coastal flood plain areas, drylands, wetlands and all other areas prone to droughts and flooding, including through the identification of areas that are safe for human settlement, and at the same time preserving ecosystem functions that help to reduce risks.
United Nations Environment Assembly (UNEA) 4	UNEP/EA.4/RES.16: Resolution for the Conservation and Sustainable Management of Peatlands	The resolution urges Member States and other stakeholders to give greater emphasis to the conservation, sustainable management and restoration of peatlands worldwide. It further acknowledges the contributions of the Global Peatlands Initiative and further requests UN Environment "to coordinate efforts to create a comprehensive and accurate global peatlands inventory."
Regional		
Global Peatlands Initiative 3rd Partners Meeting, 2018	Brazzaville Declaration	The Democratic Republic of the Congo, the Republic of the Congo and Indonesia jointly signed the Brazzaville Declaration on Peatlands to work together to protect the Central Congo peatlands in the Congo Basin from unregulated land use, and prevent its drainage and degradation.
Central Africa Forest Initiative (CAFI)	Letter of Intent: France and Republic of the Congo	Signed by heads of State from France and Republic of the Congo on September 3, 2019, the LOI constitutes a strong commitment to protection and sustainable management of RoC's peatlands by prohibiting all drainage and drying.
	Letter of Intent: CAFI and Democratic Republic of the Congo	The LOI in the Democratic Republic of the Congo was signed in April 2016 establishing a cooperative partnership for the implementation of the DRC's National REDD+ Framework Strategy and REDD+ Investment Plan. Increased awareness about peatlands resulted in the inclusion of peatlands in the Country's Investment Plan.
Lake Tele Lake Tumba Memorandum of Understanding (MOU)	MOU and Plan of Action	In July 2017, an MOU and Plan of Action on the sustainable transboundary management of Lake Tele and Lake Tumba, was signed between the Republic of the Congo and the Democratic Republic of the Congo in Kinshasa.
Ramsar Convention	Transboundary declaration	In 2017, three existing Ramsar sites located in the two Congos were joined together to make the Complexe Transfrontalier Lac Télé - Grands Affluents - Lac Tumba, the largest transboundary Ramsar site comprising 45 percent of peatland area in the Cuvette Centrale.
MOU between RoC and Indonesia	South-South collaboration MOU between Republic of the Congo and Indonesia on peatlands	In October 2018, the Republic of the Congo and Indonesia signed the first MOU of collaboration on peatlands between an African and an Asian country. Both countries committed to develop sound management systems for peatlands and cooperate in promoting best practices in sustainable peatland management in this five-year MOU.

are several ongoing regional initiatives (Table 9.2), which ideally will advance knowledge and programming on peatlands in the near future. To-date, there is still much more that is needed to realize stated commitments such as under the Brazzaville Declaration signed in 2018 by the DRC, the RoC and Indonesia, which pledges to protect the Central Congo peatlands from unregulated land use, and prevent its drainage and degradation.

Ideally, the work of various actors and programs should be anchored in national guidelines aligned with clear national agendas on peatlands. Additionally, studies and programs should also be used to inform the development of national policies. Currently both Congos lack an official peatland definition and national policy on peatland management, though both are currently working on putting peatland-specific policies in place. At the same time, given the current status of monitoring, reporting and verification (MRV) in the two Congos, peatlands have yet to be included in most policy frameworks. RoC mentions peatland progress in the enhanced Nationally Determined Contribution (NDC) of 2021, but does not include targets to avoid emissions from peatlands. The DRC is undertaking the NDC enhancement at the time of writing. Other key policy documents to be expected are the long-term strategies (LTSs), which will outline the long-term greenhouse gas emission plans.

As reflected by the range of related agreements outlined in Table 9.1, peatland management is a cross-sectoral issue, which requires inter-ministerial engagement at the national level to effectively design and implement policies for long-term protection and sustainable management of peatland ecosystems. This includes ministries presiding over management of water, biodiversity, wildlife, fish, forest, agriculture, energy and hydrocarbon resources as well as ministries engaged in land use planning, land tenure, rural development and protection of indigenous peoples. At the same time, peatland management has direct implications for local communities across several provinces/departments as well as for the broader Congo Basin. Therefore, it is essential that the framework for peatland governance includes participation, consultation and inclusion of local communities, clearly linking multiple stakeholders and government bodies at local, provincial and national institutions.

In the DRC, a Peatland Management Unit under the Ministry of Environment and Sustainable Development was established in July 2017 to oversee national processes related to peatlands management, including the development of a national peatlands policy and agenda. The DRC has already defined its national vision for peatlands: “to protect peatlands for people and nature.” Currently the country wants to define a national peatland strategy. The Peatland Management Unit is establishing national thematic groups, made up of focal points from different ministries, civil society groups, private sector actors, international institutions and researchers. The thematic groups are the framework for the participation of stakeholders and experts in discussions and decision-making processes related to peatlands.

Both the DRC and the RoC are facilitating technical dialogues within and across technical groups and sectors to advance national processes related to peatlands including capitalizing on ongoing sectoral reforms underway in each country. For example, the DRC has an ongoing land use planning reform process and the forestry code is also being reviewed with an accompanying REDD+ investment plan being drafted. In the RoC, the National Environmental Action Plan is being reviewed. Following the 3rd meeting of the Global Peatlands Initiative partners in Brazzaville in 2018, the President of the RoC held an inter-ministerial dialogue resulting in the proposed decree to establish a “*Comité National pour la Gestion des Tourbières*”, however the committee is not yet established at the time of writing.

Table 9.2: Initiatives related to the sustainable management of the Congo Basin peatlands

Initiatives / Programs	Description
Global Peatlands Initiative (GPI)	The GPI is an international partnership coordinated by the United Nations Environment Programme (UNEP) to save peatlands as the world's largest terrestrial organic carbon stock. Supported by the German International Climate Initiative, forty-four international partner organizations and four key tropical peatland countries of Indonesia, Peru, the RoC and the DRC have come together to improve the conservation, restoration and sustainable management of peatlands globally. GPI works to assess, measure, monitor and preserve peatlands' carbon and biodiversity, sharing knowledge and experience through a South–South and triangular cooperation approach. The GPI brings the best science and practice to inform decisions with notable achievements like the Brazzaville Declaration on Peatlands, the UNEA4 Resolution on Peatlands, the International Tropical Peatlands Center, the GPI Research Working Group, and more. The GPI promotes healthy peatlands through restoration and conservation action as one of the best Nature-Based Solutions to tackle the climate crisis while delivering multiple benefits for water security, biodiversity, people and their health.
International Tropical Peatlands Center (ITPC)	Launched in October 2018, with the support of CIFOR, UNEP and the GPI partners, the ITPC is a hub, which aims to connect different tropical peatlands researchers, practitioners and stakeholders to support international collaboration and exchanges on research. This also includes the collection and sharing of best practices for tropical peatlands management with a strong link to South–South Cooperation and implementation of the Brazzaville Declaration on Peatlands.
CongoPeat	In 2017, the Congo Basin's Cuvette Centrale gained prominence as an important peatlands system, when an international team of scientists estimated, for the first time, its extent making it the world's largest intact, contiguous tropical peatland complex (Dargie et al. 2017). This original research formed the scientific basis of the Brazzaville Declaration was followed by the CongoPeat project, a scientific program also funded by the UK government's National Environment Research Council, which is gaining a comprehensive understanding of the Congo Basin peatlands by combining field measurements, laboratory analysis, big data and modelling techniques to better map the carbon-rich ecosystem, understand how the peatland formed, assess how it functions today, and model its response to human pressures in the future. CongoPeat is a network of over 50 scientists from 15 institutions. CongoPeat works closely with the RoC and DRC governments to provide the latest scientific understanding of the peatlands and is a member of the GPI.
The Congo Basin Sustainable Landscapes Impact Program (CBSL IP)	Supported by the Global Environment Facility (GEF), the UNEP led CBSL IP aims to catalyse transformational change in conservation and sustainable management of key transboundary landscapes in the Congo Basin through landscape approaches that empower local communities. CBSL IP includes projects aiming to support the sustainable management of the peatlands in the DRC and RoC.
International Commission of the Congo-Oubangui-Sangha Basin (CICOS)	CICOS was set up in 1999 as a collaboration framework established amongst the six countries of the Congo Basin, responsible for integrated water resources management and river transport issues of the Congo-Ubangui-Sangha Basin.
Congo Basin Forest Partnership (CBFP/ PFBC)	A response to Resolution 54/214 of the United Nations General Assembly urging the international community to support efforts towards conservation and sustainable management of Congo Basin forests, the CBFP has 117 members including 10 Central African countries. CBFP supports "the shared vision of the Central African Heads of State, notably by improving efficiency of measures-including technical and financial assistance to promote biodiversity conservation and sustainable management of forest ecosystems, combat climate change and reduce poverty in Central African countries in line with the COMIFAC Convergence Plan".
Central African Regional Program for the Environment (CARPE)	Funded by the U.S. Agency for International Development (USAID), CARPE provides significant financial and technical resources to support efforts to conserve the planet's second largest tropical rainforest and its threatened biodiversity.
Sustainable Wetlands Adaptation and Mitigation Program (SWAMP)	SWAMP is a technical assistance program of USAID jointly implemented by the Center for International Forestry Research (CIFOR) and the U.S. Forest Service (USFS) which facilitates research to estimate greenhouse gas emissions and carbon stocks of tropical wetlands, builds local research capacity and informs national policy discussions to support development of climate change adaptation and mitigation strategies based on credible scientific information. SWAMP provides technical assistance to both Congos on strengthening capacity for better management, measuring and monitoring of peatland forests.

Both countries, as part of the Global Peatlands Initiative, which brings the best available science and knowledge of peatlands to decision makers and facilitates south-south exchange of lessons with tropical peatland countries, have elevated the importance of peatlands at the national, regional and international levels. Furthermore, each country is taking action to mobilize investment and technical support for both countries to put in place policies, plans and institutions to address threats to peatlands and build the essential enabling environment to improve livelihoods and ensure the sustainable management of peatlands landscapes in the Congo Basin.

9.5 Advancing programming on peatlands in the Congo Basin

There are several programs and initiatives in the Congo Basin region focusing on biodiversity conservation and sustainable management of the second largest region of tropical forest in the world. Peatland-specific programs are more recent whereas other more longstanding programs have recently elevated the importance of peatlands (Table 9.2). Given the recent focus on peatlands, programs and initiatives should be leveraged to improve knowledge of these ecosystems, build technical capacity within the region and implement programming which facilitates both sustainable management and sustainable livelihoods within peatland areas. In parallel, there is a need to strengthen governance from local to national to regional levels as well as understand effective incentives and policy frameworks for the sustainable management of peatlands. Action and implementation will require resources, and while current programming is encouraging, further investment can help to address many existing gaps.

9.5.1 Key implementation challenges

Several key challenges must be considered when implementing programs which aim to protect and/or facilitate the sustainable management of peatlands. Communities are key stakeholders whose customary rights must be respected. Any management decisions at the national level and implementation at the local level should account for communities' rights and interests and a process adhering to Free, Prior and Informed Consent should be facilitated before any implementation or land management decisions are enacted in their lands. Similarly, environmental and social impact assessments (ESIA) should be conducted when undertaking land use planning or designing programs and considering land management and development options. While there are laws requiring ESIAs in Central Africa including guidelines published by COMIFAC on conducting ESIAs in forest environments (COMIFAC 2017), generally such assessments are rarely undertaken or not completed appropriately when undertaken. ESIAs should be integrated into implementation of programming in the Central Congo peatlands, as well as more broadly into land use planning and decision-making toward the sustainable development goals.

Creating incentives at the local level alongside low-emission livelihood development will be key to reduce local-based threats of peatland degradation. Payment for ecosystem services schemes may be part of this process but further development of sustainable livelihood activities should be further explored. Currently the Central Congo peatlands is a source of non-timber forest products, bushmeat, fish, and fuelwood and some timber extraction (See Box on Ecosystem Services). Fishing is a main subsistence and income generating activity including sending smoked fish to markets as far as capital cities, Brazzaville and Kinshasa. While fish provides an excellent source of protein and is the main source of cash for most households (Comptour et al. 2018), and is family-based in the region, the development of intensive commercial fishing could degrade the resource (Inogwabini 2014). Further studies are needed on sustainable livelihood options and other incentives and criteria for investments to prevent peatland degradation and protect these vital carbon stores.

9.5.2 Peatland protection and governance

Currently there are conflicting and overlapping land use zones in the central Congo peatland areas in both Congos (Dargie et al. 2019). Facilitating national multi-sectoral processes will be essential to resolve these potential conflicts and ideally further strengthen protection of peatlands by preventing damaging activities from affecting these intact ecosystems (See Section on Threats).

Development of inter-sectoral and multi-stakeholder consulted land use plans at provincial and local levels are critically also important, land use planning being a key element specifically outlined in the Brazzaville Declaration and the CAFI LOI in the Republic of the Congo (see Table 9.1) to promote the protection and sustainable management of peatlands, and prevent their drainage and drying out.

Protected areas provide the strongest form of conservation and protection from damaging land use change. Establishing protected areas within the Central Congo peatlands area was first proposed 30 years ago, during the preparation of the first phase of the ECOFAC project (Doumenge 1990; Hecketsweiler 1990). Since then, some important reserves have been established: Lake Télé Community Reserve (2001) and Ntokou-Pikounda National Park (2013) in the RoC; and Ngiri Triangle Nature Reserve (2011) in the DRC (Dargie et al. 2019; OFAC 2020). Several sites have also been included in the international list of Ramsar sites: Lac Télé/Likouala aux Herbes (1998), Grands affluents (2007), Sangha-Nouabalé-Ndoki (2009) and Ntokou-Pikounda (2012) in Congo, Tumba-Ngiri-Maï-Ndombe (2008) and Tumba-Ledima Nature Reserve (2006) in the DRC. The transboundary site established in 2017, Complexe Transfrontalier Lac Télé - Grands Affluents - Lac Tumba, is the largest transboundary Ramsar site in the world. However, these protections were to safeguard the wetlands rather than being specifically designed to protect the peatlands.

One option to further strengthen protection of the central Congo peatlands is to create new protected areas by extending the existing network of reserves to specifically protect areas of peatland, especially in the most remote areas and between river basins, for example North-East of Ngiri, on the bank of the Congo River, North of Ruki River and between Lake Tumba and North-East of Lake Maï Ndombe in the DRC, and between the Ubangi and Likouala-aux-herbes rivers in the RoC. While this is one approach, it should not be the only option considered in supporting peatland management programming. For example, Community Reserves, such as the Lac Télé Community Reserve that explicitly include local people as equal co-managers can protect peatlands and help communities increase incomes and develop sustainably. Furthermore, allocation of community forestry concessions may be another way to ensure both protection and community access and sustainable use of these peatland areas. Creation of any kind of protected area should take into account local populations, specifically including them in the process as a key stakeholder, respecting their customary rights.

Both governments have highlighted the need to support local communities with improved, sustainable livelihoods that are compatible with maintaining the peatland ecosystem integrity. Provision of basic needs such as improved access to clean water, healthcare, schooling and better transport while offering equal opportunities to indigenous peoples and other vulnerable groups, is essential to avoid potential negative pressures on peatlands to meet these needs in the future.

Conclusions and recommendations

The central Congo peatlands of the Congo Basin play an important role locally, regionally and globally. Spanning 145,000 Km^2, they store approximately the equivalent of what is found in the above ground biomass of the trees of the entire Congo Basin forest (Dargie et al. 2017; Verhegghen et al. 2012). Despite this, much is still unknown about this important ecosystem. Further research is needed on: mapping peatland extent and depth; identification and characterization of peatland forest types; the biodiversity of the peatlands; potential threats and ecological, hydrological and climate impacts of disturbance/degradation; monitoring systems that can detect change and disturbance in near real-time; local community use and value of these areas; and incentive mechanisms/approaches for their protection (Table 9.3). To advance this research a cadre of experts within both the universities and government is needed in the RoC and the DRC to monitor and sustainably manage the peatlands.

At present, limited disturbance or degradation of the peatlands have occurred largely due to local sustainable use and limited access into these remote areas which has avoided large-scale land-use change. But these ecosystems are especially sensitive to disturbances and can be irreversibly changed resulting in large emissions of greenhouse gases as has occurred in other drained and degraded peatlands, such as in Southeast Asia. Several potential threats exist, including hydrocarbon prospection, road building, logging, agricultural expansion, palm oil plantations, and climate change, but their relative likelihoods are not currently understood. Therefore, more research to inform policies and new inter-sectoral sustainable management plans and actions for urgent conservation of the Central Congo peatlands are paramount to ensure continuing provision of the ecosystem services and stability they provide.

As partners of the Global Peatlands Initiative, the governments of the DRC and the RoC are taking action, through national leadership and support from partners to develop consultative, inter-sectoral and scientifically informed peatlands management policies, strategies and plans. Any peatland policies, plans or investments need to be linked to both countries' commitments to regional and international global environmental agreements reinforced by targets of the Sustainable Development Goals (SDGs) and be drainage-free and deforestation free livelihood sources. Most critical is that the inter-sectoral, inter-disciplinary and multi-stakeholder participatory processes of developing policies, plans and programmes to conserve, restore and sustainably manage these peatlands need adequate financing, innovation, institutional strengthening, and access to knowledge.

Table 9.3 presents a list of specific policy, research and peatland management recommendations for investing in peatland protection by strengthening institutional frameworks, improving knowledge of these ecosystems and implementing programs which facilitate sustainable management of peatland landscapes. While some programs and investments exist (see Table 9.2), significant additional sustainable funding will be required, which should not be underestimated.

Given the very limited disturbance and degradation of the peatlands to date, the Congo Basin presents a unique and important opportunity to take preventative measures versus reactive approaches for conservation and sustainable management of the central Congo peatlands. Conversely, if action is not taken today to protect and sustainably manage these irrecoverable carbon stores (Goldstein et al. 2020) at all scales, from international, national to regional, it may be too late tomorrow.

Table 9.3: Recommendations for policy, research and management actions across all actors to strengthen peatland protection and facilitate sustainable management of peatland landscapes.

Policies, laws and regulations
- Develop national peatland definition agreed between different stakeholder groups to harmonize maps - Create national peatland agendas/strategies/policies and land use plans - Include peatlands in national monitoring and reporting systems, including the climate transparency frameworks and their greenhouse monitoring and reporting, the Nationally Determined Contributions (NDCs), and the Long-term low greenhouse gas emission development strategies (LTSs) - Promote good governance and transparent information sharing, e.g., through accessible and up-to-date information platforms - Strengthen existing legislation for peatland protection - Provide a system of incentives to land managers developing sustainable livelihood sources (that do not cause logging nor drainage), e.g., through small- and medium-sized enterprises - Prohibit logging, hydrocarbon and agriculture concessions within the peatland areas and ensure monitoring and law enforcement - Extend the protected area zone to include the peatlands - Seek to mitigate climate risks
Research and monitoring
- Continue to develop and build national research expertise and capacity in fields related to peatland forest ecosystems and peatland management - Further map peatland extent and depth including identification and characterization of peatland forest types - Build a model of peatland development and function to assess the ecological, hydrological and climate impacts of disturbance/degradation from the major potential threats to the peatlands - Create a hydro-climatic observatory collecting long-term in-situ and remote sensed data allowing the simultaneous monitoring of the vegetation cover and productivity, peat accumulation, as well as the water balance (rain, infiltration, aquifer recharge, surface runoff, evapotranspiration) to understand the remotely forced intra-seasonal to inter-annual climate fluctuations potentially impacting the peatlands and conversely those locally forced that is induced by peatland conversion - Develop early-warning, early-action monitoring tools and approaches in collaboration with national and private entities that can detect change and disturbance in near real-time - Understand, document and quantify local community use and value of these areas - Analyze incentive mechanisms/approaches for peatland protection - Monitor and understand the emerging threats and trends in regional climate
Peatland management/program implementation
- Protect community rights and respect principles of Free, Prior and Informed Consent in peatland management decisions - Leverage community reserves and community forestry concessions as mechanisms to facilitate peatland protection and community access and management - Further explore incentive mechanisms for local, regional and national levels for peatland protection, including deforestation-free and drainage free sustainable land use investments and ecosystem results-based payments - Empower civil society to take action to maintain the socio-economic systems and environmental services - Facilitate inter-sectoral and multi-stakeholder land use planning at local, regional and national levels that ensure peatland protection through sustainable landscape management reconciling current conflicting zoning - Pilot initiatives to promote sustainable management that provide income for local communities - Ensure personnel and financial resources are available to meet Multilateral Environmental Agreements including the Ramsar Convention requirements and recommendations and implement robust and sustainable peatland programs - Strengthen institutional capacity for effective application of environmental and social impact assessments (ESIA) in land use planning and management processes, including monitoring - Support local communities in identifying and further developing sustainable livelihood means that do not threaten the peat integrity and ecosystem services - Document and share best practices and lessons learned and invite other French-speaking and other peatland countries to exchange knowledge