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Socio-ecological Difficulties and Problems in Congo Basin Peatland Management: A Review of the Literature and Prospects.

[Difficultés et problèmes socio-écologiques liés à la gestion des tourbières du bassin du Congo: Revue de la littérature et Perspectives]

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Abstract

One of the world's largest tropical forest complexes, the peatlands of the Congo Basin are vital to the world's biogeochemical cycles. They carry out important ecological tasks such as maintaining biodiversity, regulating hydrology, and sequestering carbon. In order to analyze the floristic makeup of these ecosystems as well as the local and scientific attitudes connected with them, this study provides a thorough analysis of the literature. A rigorous evaluation of institutional and scientific literature served as the foundation for the analysis. The findings indicate that specialized flora suited to hydromorphic and anoxic conditions can be found in the peatlands of the Congo Basin. Additionally, they emphasize a divergence between local perceptions—which are often utilitarian—and scientific approaches focused on conservation. This study highlights the need for an integrated approach that combines local knowledge with scientific expertise to ensure the sustainable management of these strategic ecosystems. It underscores the importance of strengthening institutional frameworks and environmental governance to improve the effectiveness of conservation policies. Furthermore, it emphasizes the central role of local community participation in the development and implementation of management strategies. Finally, it recommends the development of in-depth interdisciplinary research to better understand the ecological and socio-economic dynamics of the Congo Basin's peatlands and to guide decisions based on robust integrated scientific data.

Keywords : Tropical peatlands, Congo Basin, biodiversity, local perceptions, ecology, vegetation.

Résumé

Comptant parmi les plus vastes complexes de forêts tropicales au monde, les tourbières du bassin du Congo jouent un rôle essentiel dans les cycles biogéochimiques mondiaux. Elles remplissent des fonctions écologiques cruciales, telles que la préservation de la biodiversité, la régulation du régime hydrologique et la séquestration du carbone. Afin d'étudier la composition floristique de ces écosystèmes ainsi que les perceptions locales et scientifiques qui s'y rapportent, cette étude propose une analyse approfondie de la literature. Une analyse approfondie de la littérature institutionnelle et scientifique a servi de base à cette étude. Les résultats indiquent que l'on trouve dans les tourbières du bassin du Congo une flore spécialisée, adaptée aux conditions hydromorphiques et anoxiques. Ils mettent en outre en évidence un décalage entre les perceptions locales — souvent utilitaires — et les approches scientifiques axées sur la conservation. Cette étude met en évidence la nécessité d'une approche intégrée alliant les savoirs locaux à l'expertise scientifique afin d'assurer la gestion durable de ces écosystèmes stratégiques. Elle souligne l'importance de renforcer les cadres institutionnels et la gouvernance environnementale pour améliorer l'efficacité des politiques de conservation. En outre, elle insiste sur le rôle central de la participation des communautés locales dans l'élaboration et la mise en œuvre des stratégies de gestion. Enfin, elle recommande la mise en place de recherches interdisciplinaires approfondies afin de mieux comprendre les dynamiques écologiques et socio-économiques des tourbières du bassin du Congo et d'orienter les décisions sur la base de données scientifiques intégrées et fiables.

Mots clés: Tourbières tropicales, Bassin du Congo, Biodiversité, Perceptions locales, Ecologie, Végétation

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1. Introduction

Tropical peatlands are unique wetland ecosystems characterized by the accumulation of partially decomposed organic matter under conditions of permanent waterlogging. This process results from an imbalance between primary production and decomposition, leading to massive carbon storage over timescales of thousands of years. These environments play a vital role in regulating global biogeochemical cycles and in mitigating climate change (Mitsch & Gosselink, 2015; FAO, 2020; Lewis et al., 2018).

Globally, peatlands cover a relatively small area but store a significant proportion of soil carbon, estimated at over 30%. This exceptional capacity is due to anoxic conditions that slow down decomposition processes. In tropical regions, their contribution to the carbon cycle has long been underestimated, but recent research has shed light on their strategic importance (Dargie et al., 2017; Page et al., 2011; Joosten et al., 2012).

The Congo Basin is among the key areas for the study of tropical peatlands. The discovery of the Central Basin peat complex revealed the existence of one of the world's largest peatland systems, covering approximately 145,000 km². This discovery has profoundly changed scientific understanding of peatland distribution and Africa's role in climate regulation (Dargie et al., 2017; Lewis et al., 2018; CIFOR, 2020).

The peatlands of the Congo Basin are characterised by distinctive vegetation, dominated by species adapted to hydromorphic and anoxic conditions. These species exhibit specific morphological adaptations, such as aerial roots and specialised tissues, which enable them to survive in anoxic and hydromorphic environments (Mitsch & Gosselink, 2015; Rydin & Jeglum, 2013; Keddy, 2010).

Ecologically, these ecosystems play a fundamental role in hydrological regulation by storing water and controlling water flows. They also contribute to maintaining rich and unique biodiversity (FAO, 2020; WWF, 2021; CIFOR, 2020). However, these ecosystems are subject to increasing anthropogenic pressures, including agricultural expansion, logging, and infrastructure development. These activities lead to the gradual degradation of peatlands and a loss of their ecological functions (Lewis et al., 2018; FAO, 2020; WWF, 2021; CRREBaC, 2022; CongoPeat Consortium, 2023).

Furthermore, peatlands are closely linked to local socio-economic systems. Local communities use them for a variety of activities, which strongly influences their perceptions and practices (Tshimanga et al., 2020; CIFOR, 2020; FAO, 2020).

In this context, the present study aims to analyze the floristic composition of peatlands in the Congo Basin as well as associated perceptions in order to contribute to a better understanding of these ecosystems and the development of sustainable management strategies.

2. Literature review

2.1. Location of the peatlands in the Congo basin

The peatlands of the Congo Basin are mainly located in the Central Basin, a vast marshy depression covering a significant part of the Democratic Republic of the Congo and the Republic of the Congo. Recent studies estimate that this peatland complex covers approximately 145,000 km², of which nearly 85% is in the Democratic Republic of the Congo and around 15% in the Republic of the Congo. They extend from southern Cameroon and the Central African Republic to the north of the Republic of the Congo, crossing the vast wet plains of the DRC. This distribution is favoured by a humid equatorial climate, abundant rainfall and soils saturated with water for much of the year (Dargie et al., 2017; Lewis et al., 2018; Garcin et al., 2022).

These peatlands are mainly found in floodplains, low-lying areas, alluvial valleys and swamp forests characterised by low altitude and a high accumulation of organic matter. The main peatland areas identified include the regions of Tshuapa, Équateur, Mongala, Sangha and Likouala, as well as the Lake Télé–Lake Tumba complex. Thanks to their significant water retention capacity, these ecosystems play a vital role in regional hydrological regulation, carbon storage and the maintenance of tropical biodiversity. The peatlands of the Congo Basin thus constitute one of the world's largest tropical carbon reservoirs and represent a major challenge in the fight against climate change (FAO, 2020; UNEP, 2021; CIFOR, 2020).

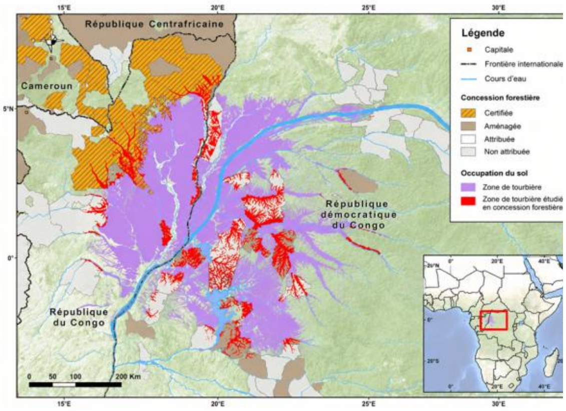

Figure 1. Location of peatlands in the Congo Basin (Sonwa et al., 2022)

2.2. General Approach to the Study

This study is based on a narrative and critical literature review aimed at analyzing the current state of knowledge regarding peatlands in the Congo Basin. This approach allows for the mobilization, comparison, and synthesis of research from multiple disciplinary fields to produce an integrated understanding of these ecosystems. It appears particularly well-suited in the contexts where field data remain fragmentary, spatially dispersed, and difficult to access, as is the case with African tropical peatlands. The narrative review also allows the structured identification, selection, and interpretation of studies according to explicit criteria, thereby ensuring the transparency and reproducibility of the analysis (Zedler & Kercher, 2005; Page et al., 2011; Joosten et al., 2012; Mitsch & Gosselink, 2015).

The study adopts an interdisciplinary perspective that combines ecology, hydrology, biogeography, and the social sciences to better understand the interactions between natural processes and human activities. This approach allows for the integration of dimensions that are often analyzed separately, including vegetation structure, hydrological dynamics, ecosystem services, and the local perceptions of local communities. The integration of these different levels of analysis is essential for understanding the functioning of the Congo Basin peatlands, whose stability depends on water regimes, floristic composition, and human practices (Parish et al., 2008; Maltby & Barker, 2009; Keddy, 2010; Turetsky et al., 2015).

A critical analysis of the identified studies was prioritized in order to identify biases, methodological limitations, and key research gaps. Particular attention was paid to the spatial representativeness of the studies, differences in observation scales, the sampling methods used, and the uncertainties associated with ecological and hydrological estimates. This critical approach avoids a simple juxtaposition of results and instead promotes a reasoned interpretation of the convergences, divergences, and contradictions present in the scientific literature. It also helps highlight areas that remain insufficiently documented, particularly knowledge regarding local uses, degradation trajectories, and peatland responses to climate change (Arksey & O'Malley, 2005; Whittemore & Knafl, 2005; Petticrew & Roberts, 2006; Borenstein et al., 2009).

Finally, the methodology is based on a triangulation approach that combines information from scientific articles, institutional reports, geospatial data, and documents produced by international organizations. Cross-referencing these different sources enhances the robustness of the results, reduces the risk of bias associated with relying on a single data category, and ensures overall analytical consistency across ecological, hydrological, and socioeconomic dimensions. This approach also facilitates the development of scientifically grounded recommendations for the conservation and sustainable management of peatlands in the Congo Basin, while highlighting priorities for future research (Creswell, 2014; Fink, 2014; Haddaway et al., 2015; Ramsar Convention Secretariat, 2016).

2.3. Literature Review

The literature review was conducted using international scientific databases such as Scopus, Web of Science, and Google Scholar. These platforms provide access to peer-reviewed, multidisciplinary scientific literature that is widely recognized in review studies. The combined use of multiple databases helps limit coverage bias and improves the comprehensiveness of the identified references, as each platform has specific characteristics regarding indexing, journal visibility, and temporal depth. This strategy is particularly recommended in narrative reviews addressing interdisciplinary topics such as tropical peatlands (Falagas et al., 2008; Haddaway et al., 2015; Harzing & Alakangas, 2016; Mongeon & Paul-Hus, 2016).

The keywords used include "peatlands," "tropical wetlands," "Congo Basin," "floristic composition," and "local perceptions." Boolean operators, lexical variants, and thematic combinations were used to broaden the scope of the search while maintaining the relevance of the results. The terms were combined in various ways, such as "peatlands and Congo Basin," "tropical wetlands and floristic composition," and "local perceptions and peatland conservation." This approach allows for the identification of studies from multiple disciplines and reduces the risk of omitting important work related to the ecological, hydrological, and social dimensions of peatlands (Webster & Watson, 2002; Kitchenham, 2004; Cooper, 2010; Okoli & Schabram, 2010).

The publication period from 2000 to 2025 was chosen to ensure that the information remains up-to-date by incorporating recent scientific advances, while the quality of the selected data guarantees the reliability and scientific validity of the analyses included. Studies that came out before this time were still included if they were important for understanding how to do reviews or what tropical peatlands are like.

This choice allows for a balance between up-to-date results and theoretical depth. The time frame also facilitates better comparability of studies by taking into account recent advances in remote sensing, peatland mapping, and interdisciplinary analysis (Arksey & O'Malley, 2005; Levac et al., 2010; Peters et al., 2015; Tricco et al., 2018).

2.4. Criteria for Selecting Sources

The sources were selected based on their thematic relevance, scientific quality, and contribution to the understanding of the peatlands of the Congo Basin. Priority was given to articles published in peer-reviewed journals, academic reference works, and reports from recognized international organizations. The assessment of the study's quality was based on several criteria, including clarity of objectives, methodological rigor, data transparency, and consistency of results. This approach helps strengthen the credibility of the selected information and limits the inclusion of studies that are insufficiently substantiated or scientifically weak (Liberati et al., 2009; Higgins & Green, 2011; Gough et al., 2012; Shea et al., 2017).

Geographic location was a key selection criterion, with priority given to studies conducted in the Congo Basin and, generally, in the wetlands of Central Africa. This choice reflects the need to take into account the ecological, climatic, and socioeconomic characteristics of this region. Studies conducted in other tropical regions, notably the Amazon and Southeast Asia, were also drawn upon to broaden the scope for comparison and to identify common or contrasting dynamics regarding the degradation, conservation, and uses of peatlands. This comparative approach facilitates a better interpretation of the processes observed in the Congo Basin (Geist & Lambin, 2002; Foley et al., 2005; Turner et al., 2007; Lambin & Meyfroidt, 2011).

Studies with major methodological flaws, opaque data, or results that were not properly documented were not included in the analysis. Particular attention was paid to risks of bias related to sample selection, data collection methods, analysis procedures, and proposed interpretations. This rigorous selection helps improve the reliability of the analysis and limit the risks of overinterpretation or overgeneralization. It also ensures that the conclusions drawn from this literature are based on scientifically robust and methodologically explicit work (Begg & Berlin, 1988; Ioannidis, 2005; Rothstein et al., 2005; Song et al., 2010).

A wide range of source types was sought to cover all the ecological, hydrological, economic, and social dimensions associated with the peatlands of the Congo Basin. Scientific publications were supplemented by institutional reports, public policy documents, geospatial data, and qualitative studies on local perceptions and practices. This diversity of sources allows for cross-referencing across analysis, improves the validity of interpretations, and captures the complexity of interactions between human societies and peatland ecosystems (Patton, 2002; Maxwell, 2012; Creswell, 2014; Flick, 2018; Yin, 2018; IPBES, 2019; UNEP, 2022).

2.5. Data Analysis and Processing

Data were analyzed using a qualitative thematic approach, which allows information to be grouped into coherent analytical categories and helps identify the main recurring themes in the literature. This method is particularly well-suited to interdisciplinary reviews involving heterogeneous data, as it facilitates the identification of cross-cutting themes from a variety of sources. The thematic analysis was conducted in several successive stages, including familiarization with the data, coding, theme construction, theme review, and theme interpretation. This approach is widely recognized for its ability to rigorously structure the results of qualitative syntheses (Braun & Clarke, 2006; Guest et al., 2012; Vaismoradi et al., 2013; Nowell et al., 2017).

The main analytical categories selected include plant community composition, ecological functions, resource use, local perceptions, and conservation issues. This framework allows data to be organized according to comparable dimensions while highlighting the relationships between the various themes. Grouping information into clearly defined categories also facilitates the identification of commonalities and specificities among the studies. This approach promotes an integrated interpretation of the results and strengthens the coherence of the interdisciplinary analysis of the Congo Basin's peatlands (Denzin & Lincoln, 2011; Maxwell, 2012; Silverman, 2013; Miles et al., 2014).

A comparative analysis was conducted to identify general trends, methodological differences, and contrasts observed across the studies. This comparative approach examines variations based on geographic contexts, scales of analysis, and the types of data used. It contributes to a better understanding of the ecological and social dynamics of peatlands by revealing the factors likely to explain the differences observed between studies. Analyzing the convergences and contradictions among the studies also serves as a means of highlighting areas of uncertainty and gaps that still present in the scientific literature (Glaser & Strauss, 1967; Charmaz, 2006; Bowen, 2009; Corbin & Strauss, 2015).

A critical review of the selected studies was also conducted to assess their methodological quality, the robustness of the data used, and the validity of the proposed interpretations. This step focused particularly on the consistency between objectives and methods, the precision of sampling procedures, the transparency of the analyses, and the consideration of the limitations of each study. Such an evaluation is essential for identifying the most reliable results and for minimizing the risk of bias in the final synthesis. It thus helps to strengthen the scientific rigor of the research as a whole (Lincoln & Guba, 1985; Sandelowski, 1993; Mays & Pope, 2000; Whittemore et al., 2001).

2.6. Methodological Limitations

Certain limitations remain, notably the still limited availability of scientific data on the peatlands of the Congo Basin. This lack of documentation applies equally to floristic inventories as well as to hydrological, socioeconomic, and cartographic data, which reduces the depth of analysis and limits the scope for generalization. The scarcity of field studies, difficult access to sites, and the lack of continuity in scientific monitoring constitute significant constraints in this region. This situation is regularly highlighted in studies on African tropical peatlands and the forest ecosystems of the Congo Basin (Turner et al., 2001; Turetsky et al., 2015; Dargie et al., 2017; Gumbricht et al., 2017).

The concentration of research in a few relatively accessible geographic areas can also introduce spatial bias. Studies are often conducted in the best-documented areas or those closest to transportation infrastructure, while vast portions of the peatlands remain understudied. This uneven distribution of research risks producing an incomplete picture of ecological and social dynamics across the entire Congo Basin. Such spatial biases are frequently observed in environmental research on land-use changes and tropical ecosystems (Ellis et al., 2010; Verburg et al., 2011; Veldkamp et al., 2011; Meyfroidt et al., 2013).

Methodological differences among the studies represent another significant limitation. The studies included in this review employ a variety of protocols regarding sampling, spatial scale, floristic analysis methods, and ecological indicators, which complicates direct comparisons of results. The heterogeneity of approaches can lead to differences in interpretation and reduce the comparability of data from different contexts. This limitation is common in interdisciplinary literature reviews and in environmental syntheses based on heterogeneous studies (Glass, 1976; Borenstein et al., 2009; Gurevitch et al., 2018; Cooper et al., 2019).

Finally, publication bias can influence the availability and representativeness of the results used. Studies presenting significant or positive results are generally published more frequently than those reporting null or contradictory results. This situation can lead to an overestimation of certain phenomena and an underrepresentation of information that is nonetheless relevant. Limitations related to the language of publication, access to journals, and the visibility of local research also exacerbate this risk in the case of research on the Congo Basin. These biases are well documented in the methodological literature on scientific syntheses (Rosenthal, 1979; Rothstein et al., 2005; Song et al., 2010; Fanelli, 2012).

2.7. Floristic composition of the peatlands in the Congo basin

2.7.1. Plant Diversity

The plant diversity of the Congo Basin's peatlands is characterized by marked ecological specialization, directly linked to hydromorphic conditions, permanent soil waterlogging, and low oxygen availability. Species capable of surviving in these environments exhibit high tolerance to anoxic conditions, acidity, and nutrient poverty. These conditions generally limit species richness compared to well-drained tropical forests but favor the dominance of highly specialized taxa. This floristic organization constitutes a major characteristic of tropical peatlands and forest wetlands in Central Africa (Wheeler & Proctor, 2000; Keddy, 2010; Page et al., 2011; Joosten et al., 2012).

The vegetation is dominated primarily by a few iconic tree and palm species, including Raphia laurentii, Guibourtia demeusei, Uapaca spp., Symphonia globulifera, and Alstonia congensis. These species exhibit various morphological and physiological adaptations that enable them to survive in waterlogged substrates, such as the development of stilt roots, pneumatophores, aeriferous tissues, or a shallow root system. The strong dominance of Raphia laurentii in certain parts of the peatlands of the central Congo Basin is, in fact, one of the most distinctive floristic features of these ecosystems. This plant structure has been highlighted by several fundamental studies on Congolese peatlands and tropical swamp forests (Richards, 1952; Letouzey, 1985; Parish et al., 2008; Dargie et al., 2017).

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The spatial distribution of species is strongly influenced by microenvironmental conditions, including pH, peat depth, duration of flooding, local topography, and nutrient availability. The most flooded and acidic areas tend to be dominated by a few highly specialized species, while slightly better-drained areas exhibit greater diversity. Floristic composition also varies according to distance from watercourses, the degree of organic matter accumulation, and seasonal fluctuations in water table levels. These environmental gradients explain the spatial heterogeneity observed even within the peatlands of the Congo Basin (Wheeler & Proctor, 2000; Limpens et al., 2008; Rydin & Jeglum, 2013; Brady & Weil, 2016).

Despite recent advances in research, the plant diversity of the Congo Basin's peatlands remains poorly documented. Current knowledge is based on a limited number of localized inventories, concentrated mainly in the most accessible areas of the Republic of the Congo and the Democratic Republic of the Congo. Vast areas remain understudied, limiting our understanding of regional floristic variability and species' responses to environmental changes. This gap underscores the need to develop more systematic botanical inventories, long-term monitoring, and approaches combining remote sensing, plant ecology, and local knowledge (Dargie et al., 2017; Lewis et al., 2018; CIFOR, 2020; FAO, 2020; Crezee et al., 2022; WWF, 2021; Bocko et al., 2024).

2.7.2. Structure and Organization of Vegetation

The vegetation structure of the Congo Basin's peatlands is strongly influenced by water gradients, peat depth, and the duration of flooding. These factors determine oxygen availability, nutrient dynamics, and species establishment capacity, thereby creating a mosaic of habitats ranging from permanently flooded areas to periodically drained sectors (Wheeler & Proctor, 2000; Keddy, 2010; Rydin & Jeglum, 2013; Mitsch & Gosselink, 2015; Corlett, 2016).

The central areas of peatlands are generally dominated by monospecific or sparsely diversified stands of palms of the genus Raphia, notably Raphia laurentii, while the higher, better-drained margins exhibit greater diversity of woody species such as Guibourtia demeusei, Uapaca spp., and Symphonia globulifera. This spatial organization reflects local variations in water level, peat depth, and soil fertility (Parish et al., 2008; Dargie et al., 2017; Gumbricht et al., 2017; Lewis et al., 2018; Bocko et al., 2024).

Vertical stratification is also a fundamental component of the floristic structure. Peat forests typically feature a discontinuous canopy dominated by a few tree species, a relatively dense shrubby subcanopy, and a herbaceous layer composed of ferns, Araceae, and young palms. This structural model, already described in seminal works on tropical rainforests, facilitates the coexistence of species occupying different ecological niches (Richards, 1952; Richards, 1996; Whitmore, 1998; Corlett, 2016; Etuge et al., 2023).

The relationships between vegetation and hydrology play a central role in the functioning of these ecosystems. Plant communities partially control water retention, the rate of organic matter decomposition, and peat accumulation, while hydrological conditions in turn determine floristic composition. These interactions produce positive ecological feedbacks that contribute to the long-term maintenance of peatlands (Limpens et al., 2008; Page et al., 2011; Joosten et al., 2012; Rydin & Jeglum, 2013; Lawson et al., 2022).

However, vegetation structure remains dynamic and sensitive to natural and human-induced disturbances. Climate variations, fires, logging, drainage, or land conversion can rapidly alter the composition and spatial organization of vegetation, reducing the ecological resilience of peatlands. Fundamental research on land-use changes shows that these disturbances often lead to biological homogenization and a loss of ecological functions (Turner et al., 2001; Foley et al., 2005; Ellis et al., 2010; Lambin & Meyfroidt, 2011; Dargie et al., 2019).

2.7.3. The ecological role of flora

The main cause of carbon storage in these ecosystems is the flora of peatlands. The breakdown of organic materials is considerably slowed by the high production of plant communities, ongoing waterlogging, and oxygen scarcity. Tropical peatlands are among the most significant terrestrial carbon repositories because of the slow buildup of plant detritus that results in the creation of peat over several millennia (Page et al., 2011; Joosten et al., 2012; Turetsky et al., 2015). According to the groundbreaking work by Dargie et al. (2017), the Central Basin peatlands in the Congo Basin contain over 30.6 Gt of carbon in the form of peat, which accounts for about 28% of the global carbon stock of tropical peatlands. This finding significantly changed our perception of the Congo Basin's role in the global carbon cycle and established these peatlands as the largest known tropical peatland complex. Subsequent studies have confirmed the magnitude of this stock and clarified its spatial distribution as well as its vulnerability to climate change and anthropogenic disturbances (Crezee et al., 2022; Garcin et al., 2022).

In addition to their role as carbon sinks, peatland vegetation plays a central role in hydrological regulation. The vegetation and peat matrix act as a natural sponge capable of retaining large volumes of water, slowing surface runoff, and maintaining soil moisture during dry periods. This buffering capacity contributes to the stability of regional hydrological regimes, limits flooding events, and supports the functioning of adjacent wetlands (Maltby & Barker, 2009; Mitsch & Gosselink, 2015). At the Congo Basin scale, the wetland mapping conducted by Gumbricht et al. (2017) highlights that the vast swamp formations of the Central Basin play a major role in regional water dynamics.

Peatlands are also habitats of great biological importance. Their flora provides food resources, shelter, and ecological niches for a wide variety of plant and animal species, many of which are endemic to tropical swamps. Peatland plant communities in Central Africa are characterized by the presence of species adapted to conditions of permanent flooding, acidity, and low nutrient availability, which promotes the development of unique and sometimes endemic plant communities (Keddy, 2010; Corlett, 2016). Recent studies conducted in the peatlands of the Congo Basin have confirmed the existence of a specific flora associated with peat swamp forests and have highlighted its role in maintaining regional biodiversity (Etuge et al., 2023).

Ultimately, the ecological functioning of these habitats depends on close interactions between plant species and their environment. In peatlands, constraints related to low oxygen levels, acidity, and nutrient poverty often promote facilitative interactions between species, in addition to competitive processes. These positive interactions contribute to the stability and resilience of plant communities in the face of environmental disturbances by maintaining the functional diversity necessary for ecological regulation (Bertness & Callaway, 1994; Grime, 2001).

The degradation of peatland vegetation therefore poses a major threat. Drainage, fires, logging, infrastructure development, and agricultural expansion cause peat to dry out and accelerate its mineralization, leading to massive emissions of carbon dioxide and methane. Dargie et al. (2019) identify these pressures as the main factors likely to compromise the stability of carbon stocks in the Central Basin. The findings of Garcin et al. (2022) further show that these peatlands are highly sensitive to hydroclimatic variations, reinforcing the need for their conservation. Thus, the protection of the Congo Basin's peatlands now stands as a major scientific and political priority for climate change mitigation and the preservation of tropical biodiversity.

Table I. List of plant species found in the peatlands of the Congo Basin (Keddy, 2010; Joosten et al., 2012; FAO, 2015; Mitsch & Gosselink, 2015)

Flora species	Family
Raphia laurentii De Wild.	Arecaceae
Guibourtia demeusei Harms	Fabaceae /Caesalpinioideae
Uapaca guineensis Müll.Arg.	Phyllanthaceae
Symphonia globulifera L.f.	Clusiaceae
Alstonia congensis Engl.	Apocynaceae
Pandanus candelabrum P.Beauv.	Pandanaceae
Cyperus papyrus L.	Cyperaceae
Anthocleista vogelii Planch.	Gentianaceae
Ficus congensis Engl.	Moraceae
Mitragyna stipulosa (DC.) Kuntze	Rubiaceae
Nauclea diderrichii Merr.	Rubiaceae
Pycnanthus marchalianus Ghesq.	Myristicaceae
Lasiodiscus mannii Benth. & Hook.f.	Rhamnaceae
Hallea stipulosa (DC.) J.-F.Leroy	Rubiaceae
Moisture-loving ferns	Various families
Tropical vines	Various families
Araceae spp.	Araceae
Palisota ambigua C.B.Clarke	Commelinaceae
Leersia hexandra Sw.	Poaceae
Eremospatha haullevilleana De Wild.	Arecaceae

2.8. Perceptions of peatlands

2.8.1. Local perceptions

The living conditions of riparian communities and the economic roles these habitats play in their everyday lives are closely associated with local conceptions of peatlands in the Congo Basin. Peatlands are largely seen by the local populace as productive areas that offer necessary resources for survival. They are utilized for hunting, fishing, gathering non-timber forest products, building materials, and subsistence farming, especially the production of cassava, maize, and lowland vegetables. In situations characterized by poverty and restricted access to infrastructure, this utilitarian view is based on a logic of food security and economic resilience (Angelsen & Kaimowitz, 1999; Lambin et al., 2001; Geist & Lambin, 2002; Megevand et al., 2013).

At the same time, traditional knowledge plays a significant role in how communities interpret and manage peatlands. In several regions of the Congo Basin, local people recognize through experience the ability of these ecosystems to retain water, mitigate the effects of seasonal droughts, and maintain soil fertility. Some communities also distinguish between different types of wetlands based on their flood levels, productivity, or suitability for specific uses. This knowledge, passed down from generation to generation, constitutes a form of local ecological management grounded in experience and observation of the environment (Leach & Fairhead, 2000; Stringer et al., 2006; Berkes, 2012). However, despite its potential to increase the societal acceptability of protective measures, recent research shows that this knowledge is still widely ignored in conservation programs and peatland management strategies. (CIFOR, 2020; Sonwa et al., 2022).

Local perceptions are nevertheless changing as a result of demographic, economic, and territorial shifts. Population growth, the opening of markets, improved transportation routes, and increased demand for agricultural land are leading to more intensive use of peatlands. In this context, these environments are increasingly viewed as land reserves available for agriculture, timber harvesting, or infrastructure development. This shift in perceptions is often accompanied by a decline in traditional management practices and increased pressure on peatland ecosystems (Geist & Lambin, 2002; Rudel, 2007; DeFries et al., 2010; Ordway et al., 2019). Several studies conducted in the Central Basin thus show that local populations rarely associate peatlands with global climate issues or carbon storage, due to a lack of information and awareness (Dargie et al., 2019; CIFOR, 2020).

This discrepancy between local perceptions and international conservation approaches is now a major challenge. While international stakeholders view peatlands as strategic carbon sinks and reservoirs of biodiversity, local communities primarily view them in terms of their immediate utility. Therefore, a number of authors stress that conservation programs can only be successful if they incorporate local knowledge, socioeconomic requirements, and the active involvement of the impacted community. Governance based on consultation, the promotion of sustainable uses, and the recognition of local rights appears essential to ensure the long-term protection of the Congo Basin's peatlands (Ostrom, 1990; Berkes, 2012; Dargie et al., 2019; Sonwa et al., 2022).

2.8.2. Scientific Perspectives

Because of their crucial role in regulating the climate, the peatlands of the Congo Basin are now regarded by scientists as ecosystems of worldwide significance. Early reviews of tropical peatlands showed that these environments accumulate large amounts of organic matter over long periods and thus serve as particularly effective carbon sinks (Parish et al., 2008; Page et al., 2011; Joosten et al., 2012). This viewpoint has been supported by more recent studies, which show that protecting peatlands is one of the best ways to reduce greenhouse gas emissions associated with changes in land use (Leifeld & Menichetti, 2018). In the Congo Basin, the discovery of the vast peat complex of the Central Basin marked a major milestone.

Scientists also highlight the exceptional ecological value of these ecosystems. Tropical peatlands are home to specialized flora and fauna that have adapted to conditions of waterlogging, acidity, and low nutrient availability. Early research on wetland ecology showed that these environmental constraints promote the emergence of unique biological communities, often characterized by a high degree of specialization and sometimes endemism (Zedler & Kercher, 2005; Keddy, 2010). More recent reviews on peatlands highlight the complexity of interactions between plant species, microorganisms, and hydrological conditions, which contribute to the maintenance of biodiversity and the biogeochemical functioning of these environments (Limpens et al., 2008; Rydin & Jeglum, 2013). In the Congo Basin, several recent floristic studies have confirmed the existence of plant communities specific to peat swamp forests and highlight their importance for understanding the mechanisms of ecological resilience in the face of environmental disturbances (Etuge et al., 2023).

Researchers also highlight how susceptible peatlands are to disruptions caused by humans. Wildfires, logging, deforestation, and drainage quickly change the hydrological conditions required to sustain peat. The stored organic matter in peat soils quickly oxidizes as they dry up, producing large emissions of methane and carbon dioxide. (Parish et al., 2008; Turetsky et al., 2015). Several studies also show that fires in peatlands can cause irreversible carbon losses and permanently alter vegetation structure (Limpens et al., 2008; Leifeld & Menichetti, 2018). In the Congo Basin, Lewis et al. (2018), Dargie et al. (2019), and CRREBaC (2022) consider that agricultural expansion, road infrastructure, and oil extraction projects constitute the main threats to the Central Basin. Recent analyses by Garcin et al. (2022) further show that these peatlands are sensitive to hydroclimatic variations, which could increase their vulnerability in the context of climate change. Thus, the body of scientific research points to the urgent need to conserve these ecosystems, not only to preserve their biodiversity but also to maintain their essential role in regulating the global climate.

2.8.3. Problems with Perception

One of the biggest challenges to the sustainable management of the peatlands in the Congo Basin today is the disparity between local and scientific perspectives. Local communities generally view these ecosystems as essential to their livelihoods, while scientists and international institutions perceive them primarily as carbon sinks and habitats to be protected. The traditional conflict between local communities' urgent demands and long-term conservation objectives is reflected in this divergent perspective. Early analyses of this issue have shown that environmental policies developed without taking social realities into account can exacerbate inequalities and provoke local resistance (Agrawal & Gibson, 1999; Adams et al., 2004; Brockington et al., 2006).

Local populations' limited participation in decision-making processes frequently makes these conflicts worse. In many conservation projects, rules governing access to resources are established centrally, without meaningful consultation with the affected communities. However, several studies show that top-down policies are frequently perceived as unfair, ill-suited to local practices, and likely to threaten livelihoods. This situation reduces public support for conservation programs and can lead to open conflict or strategies to circumvent regulations (Pretty, 1995; Berkes, 2004; Reed, 2008; Ostrom, 2009). Recent research in the Congo Basin shows that these misconceptions are exacerbated by the denial of customary land rights and the ignorance of the problems peatlands face due to climate change. (Dargie et al., 2019; Sonwa et al., 2022).

Several authors have also shown that discrepancies between scientific knowledge and local knowledge often stem from a lack of dialogue between different knowledge systems. Researchers generally prioritize global indicators, such as carbon storage or biodiversity, while communities assess peatlands based on their everyday utility, accessibility, or ability to provide resources. This difference in scale and time frame partly explains why certain protective measures are met with resistance at the local level (Cash et al., 2003; Folke et al., 2005). Research on environmental governance, nevertheless, shows that conflicts can be reduced when scientific knowledge is translated into terms that are understandable and relevant to the affected populations and when local knowledge is recognized as legitimate in decision-making processes (Armitage et al., 2009; Tengö et al., 2014).

From this perspective, an integrated approach that combines local knowledge and scientific expertise appears to be the most promising path for managing the peatlands of the Congo Basin. Participatory approaches, based on consultation, the joint development of rules, and community-based resource management, make it possible to reconcile conservation objectives with the socioeconomic needs of local populations. They also promote greater ownership of environmental policies and enhance their long-term effectiveness (Stringer et al., 2006; Reed, 2008; Armitage et al., 2009). Recent experiences in several regions of the Congo Basin show that governance involving local communities, researchers, and public institutions improves both peatland protection and the social acceptability of conservation measures (CIFOR, 2020; Sonwa et al., 2022).

2.9. Local peatland conservation practices in the Congo basin

In the Congo Basin, local peatland conservation practices play a significant role in preserving wetland ecosystems and the carbon they store. Long before the advent of modern conservation policies, local communities and indigenous peoples were already applying traditional methods of sustainable natural resource management. These practices are based primarily on indigenous knowledge, local customs, and the close cultural ties between communities and their natural environment. Peatlands are thus viewed not only as areas for subsistence, but also as environments of significant spiritual, social and ecological value (Dargie et al., 2017; CIFOR, 2022).

One of the main local conservation practices is the traditional protection of swamp forests, which are regarded as sacred. In several regions of the central Congo Basin, certain wetlands are off-limits or subject to traditional restrictions imposed by traditional leaders and community elders. These prohibitions often relate to overhunting, excessive logging, or the exploitation of resources during certain periods of the year. Thanks to these traditional rules, several peatland areas have been able to maintain their ecological integrity despite increasing human pressures (Oyono, 2005; Nguimalet & Ndjendolé, 2021).

Local communities also engage in moderate, seasonal use of the natural resources found in peatlands. Small-scale fishing, the collection of non-timber forest products, the gathering of medicinal plants, and the domestic use of wood are generally carried out on a small scale. This traditional management approach limits the overexploitation of resources and promotes the natural regeneration of ecosystems. Unlike industrial operations, which often lead to the drainage and degradation of peatlands, local activities remain relatively in tune with the natural environment’s capacity for renewal (FAO, 2023; CIFOR, 2022).

Traditional ecological knowledge is also a key element in the conservation of peatlands. Local communities have a sound understanding of the hydrological, biological, and ecological characteristics of wetlands. They know the best times for fishing, which plant species are useful for medicine, which vulnerable areas need protecting, and which harvesting techniques minimise environmental impacts. This knowledge, passed down from generation to generation, enables a more balanced management of natural resources and contributes to maintaining the biodiversity of peatlands (Assembe-Mvondo, 2013; CIFOR, 2022).

Furthermore, community-based land management plays an important role in the conservation of peatlands in the Congo Basin. In many localities, natural resources are managed collectively through traditional governance systems. Communities establish rules governing access to areas for fishing, hunting, or the collection of forest products in order to prevent conflicts and overexploitation. This community-led monitoring also reduces illegal activities such as unregulated logging or the uncontrolled occupation of wetlands (Oyono, 2005; Assembe-Mvondo et al., 2015).

Traditional farming practices observed around peatlands also contribute to their conservation. Local communities often practice low-intensity farming, confined to the peripheral areas of wetlands, without extensive drainage of peat soils, which maintain the natural moisture levels of peatlands. As these ecosystems play a major role in carbon storage and climate regulation, when peatlands are drained, they release significant quantities of greenhouse gases, which exacerbates climate change (Dargie et al., 2017; Parish et al., 2015).

However, despite the importance of these local practices, the peatlands of the Congo Basin currently face a number of threats, including industrial logging, oil projects, extensive agriculture and increasing urbanisation. These activities undermine traditional conservation mechanisms and increase the risk of degradation of peatland ecosystems. Against this backdrop, several researchers and environmental organisations recommend integrating local knowledge into modern policies for the sustainable management of peatlands (Turetsky et al., 2015; FAO, 2023).

Thus, the sustainable conservation of the Congo Basin's peatlands requires a participatory approach that fully involves local communities and indigenous peoples. Valuing traditional knowledge, strengthening community governance, and supporting sustainable local practices appear to be essential strategies for protecting these unique ecosystems whilst improving the living conditions of local communities (CIFOR, 2022; Assembe-Mvondo et al., 2015).

2.10. Legal and regulatory framework

2.10.1. International Legal Framework

The management of peatlands in the Congo Basin is part of a broader framework of international legal and policy instruments aimed at protecting wetlands and strengthening efforts to combat climate change. The first major instrument is the Ramsar Convention on Wetlands, adopted in 1971, which recognizes the ecological, hydrological, economic, and cultural value of wetlands. This convention encourages states to ensure the conservation and wise use of peatlands through national policies, the establishment of protected sites, and international cooperation. Over time, Ramsar has progressively placed greater emphasis on peatlands, notably by identifying them as strategic ecosystems for water and climate regulation (Davidson, 2014; Ramsar Convention Secretariat, 2016; Finlayson et al., 2018).

This strategy was extended in the 1990s by the Convention on Biological Diversity (CBD, 1992), which acknowledged peatlands as crucial ecosystems for biodiversity conservation. The CBD emphasizes in situ conservation, the sustainable management of natural resources, and the involvement of local communities. The Aichi Targets adopted in 2010, followed by discussions on the post-2020 global biodiversity framework, place particular emphasis on the protection of vulnerable ecosystems, including tropical peatlands. These peatlands are recognized not only for their biological richness but also for the ecosystem services they provide to local communities and on a global scale (Secretariat of the Convention on Biological Diversity, 2014; Díaz et al., 2019; CBD, 2020).

Since the Paris Agreement was adopted in 2015, the importance of peatlands in regulating climate change has become more widely acknowledged. The Agreement urges nations to include ecosystems in their national climate strategies and emphasizes the value of natural carbon sinks in reducing climate change. Therefore, Nationally Determined Contributions (NDCs) offer a framework that allows Congo Basin nations to incorporate peatland protection into their objectives for reducing emissions. Protecting carbon-rich ecosystems, like peatlands, is one of the best natural ways to slow down global warming, according to a number of scientific studies. (Griscom et al., 2017; Leifeld & Menichetti, 2018). This approach has been reinforced by recent reports from the Intergovernmental Panel on Climate Change, which consider peatlands to be essential components of global climate stability (IPCC, 2019; IPCC, 2021).

Other international frameworks complement these instruments. The Sustainable Development Goals adopted in 2015 establish a direct link between ecosystem protection, poverty reduction, and climate resilience. SDG 13 on climate action and SDG 15 on life on land explicitly promote the sustainable management of wetlands and forests. In the same vein, several recent international initiatives, such as the United Nations Decade on Ecosystem Restoration 2021–2030 and the Brazzaville Declaration on the Peatlands of the Congo Basin, emphasize the need to restore, protect, and sustainably manage tropical peatlands. These tools aid in incorporating the peatlands of the Congo Basin into a framework for global environmental governance where local involvement, development, and conservation must be balanced. (UN, 2015; Costanza et al., 2016; Sachs et al., 2019; Brazzaville Declaration, 2018; UNEP, 2021).

2.10.2. Regional Regulatory Framework (Congo Basin)

At the regional level, peatland management is guided by several initiatives led by institutions in the Congo Basin. The Central African Forest Commission (COMIFAC) is a key player in coordinating forestry and environmental policies. COMIFAC's Convergence Plan incorporates the conservation of forest and wetland ecosystems, indirectly including peatlands (COMIFAC, 2015; Megevand et al., 2013; de Wasseige et al., 2015; CIFOR, 2020).

Additionally, the UN-backed Congo Basin Peatlands Initiative seeks to advance the sustainable management of these ecosystems. It encourages regional collaboration, institutional capacity building, and scientific research. (UNEP, 2018; CIFOR, 2020; FAO, 2020; WWF, 2021).

Regional mechanisms such as REDD+ also play an important role in protecting peatlands by addressing emissions from deforestation and forest degradation. These mechanisms include financial incentives to encourage the conservation of carbon-rich ecosystems (Angelsen et al., 2018; FCPF, 2019; FAO, 2018; World Bank, 2020).

Regional coordination still faces institutional and political obstacles, nonetheless, in spite of these efforts. The successful execution of programs can occasionally be hampered by institutional limitations and disparities in national priorities. (Megevand et al., 2013; de Wasseige et al., 2015; CIFOR, 2020; WWF, 2021).

2.10.3. National Regulatory Framework (DRC)

In the Democratic Republic of the Congo, the legal protection of peatlands is based on a set of laws relating to the environment, forests, land use planning, and natural resources. The initial foundations of this framework were laid by the Forest Code adopted in 2002, which serves as the primary instrument for managing forest ecosystems. This law aims to ensure the conservation, sustainable use, and restoration of national forests. Although it does not explicitly refer to peatlands, they are indirectly covered when located within swamp forests or forest concessions. The Code notably provides for the classification of certain areas of high ecological value and imposes harvesting rules designed to limit damage to wetlands (Debroux et al., 2007; MEDD, 2002).

This strategy was strengthened in the years that followed by a number of sectoral programs. The significance of wetland habitats for biodiversity conservation and climate control has gradually been acknowledged in national plans on biodiversity and sustainable forest management. National forestry initiatives and the Growth and Poverty Reduction Strategy Paper already highlight the importance of better incorporating wetlands into land-use planning and rural development strategies. (Megevand et al., 2013; de Wasseige et al., 2014).

A significant milestone was reached with the adoption of Law No. 11/009 of July 9, 2011, on fundamental principles relating to environmental protection. This law establishes the general framework for environmental governance in the Democratic Republic of the Congo. In particular, it requires the conduct of environmental and social impact assessments for all projects likely to affect ecosystems, including wetlands and peatlands. It also introduces the principles of precaution, prevention, and "polluter pays," which can serve as a foundation for better protection of peatlands in the face of infrastructure, agricultural, or mining projects (MEDD, 2011; FAO, 2020).

Starting in the mid-2010s, national climate policies began to incorporate peatlands more directly through REDD+ mechanisms. The National REDD+ Framework Strategy and the creation of the National REDD+ Fund have facilitated the financing of forest conservation and carbon emission reduction projects. Following the discovery of the vast peatlands of the Central Basin, these ecosystems have gradually come to be regarded as strategic carbon sinks in climate planning documents. Programs supported by the National REDD+ Fund, the Central African Forest Initiative, and the World Bank thus aim to promote sustainable agricultural practices, community-based resource management, and the mitigation of deforestation in peatland areas (Angelsen et al., 2018; Dargie et al., 2017; FONAREDD, 2020; World Bank, 2020).

Despite these advances, the Congolese legal framework still has several gaps. There is currently no specific law that defines peatlands as a distinct ecological category or sets out specific rules governing their protection, use, or restoration. Their status remains scattered across various sector-specific laws relating to forests, the environment, mining, and agriculture, which creates institutional overlaps and weak regulatory consistency. This lack of explicit legal recognition limits the authorities' ability to regulate the use of peatlands and prevent their degradation, particularly in regions subject to oil, forestry, or agro-industrial development projects (Lewis et al., 2018; CIFOR, 2020; FAO, 2020; WWF, 2021).

Table II. Summarising the legal framework: Level, Instrument and Scope (MEDD, 2002; Debroux et al., 2007; COMIFAC, 2015; UN, 2015).

Level	Instrument	Scope
International	Ramsar Convention (1971)	Protection and sustainable use of wetlands; recognition of peatlands as ecosystems that are essential for water and the climate
International	Convention on Biological Diversity (CBD, 1992)	Biodiversity conservation, sustainable ecosystem management, protection of critical habitats
International	Paris Agreement (2015)	Reducing GHG emissions through natural carbon sinks, integrating ecosystems into climate policies (NDCs)
International	Sustainable Development Goals (SDGs, 2015)	SDGs 13 and 15: climate action and the protection of terrestrial ecosystems and wetlands
International	UN Decade on Ecosystem Restoration (2021–2030)	Restoration of degraded ecosystems, including peatlands
International	Brazzaville Declaration (2018)	Regional commitment to the conservation and sustainable management of peatlands in the Congo Basin
Regional (Congo Basin)	COMIFAC – Convergence Plan	Coordination of forestry policies and conservation of forest and wetland ecosystems
Regional	Congo Basin Peatlands Initiative	Scientific research, regional cooperation, sustainable management and capacity building
Regional	REDD+	Reducing emissions from deforestation and financing the conservation of forests and peatlands
National (RDC)	Forest Code (2002)	Sustainable forest management, indirect protection of wetlands and peatlands
National (RDC)	Law No. 11/009 of 9 July 2011 (Environment)	Environmental impact assessments, the principles of prevention, precaution and 'the polluter pays'
National (RDC)	REDD+ Strategy and FONAREDD	Funding for forest conservation and the integration of peatlands as carbon sinks
National (RDC)	Sectoral policies (biodiversity, spatial planning)	The gradual integration of wetlands into development and conservation strategies

2.10.4. Limitations and Challenges of the Regulatory Framework

From the earliest attempts at integrated environmental management, it became clear how difficult it would be to implement rules to protect peatlands in the Congo Basin. As early as the 1990s, several authors demonstrated that conservation efforts suffered from a lack of financial resources, weak institutions, and poor coordination among government agencies, international donors, and local communities. The limited technical capacities of Central African states reduce the scope of the numerous legal texts at the national and international levels (Agrawal & Gibson, 1999; Kaimowitz & Angelsen, 1998; Adams et al., 2004; Brockington et al., 2006). This situation is exacerbated by weak governance systems, corruption, and dependence on external funding, which make it difficult to ensure the continuity of environmental programs (Ostrom, 2009; Megevand et al., 2013; World Bank, 2019; CIFOR, 2020).

Another major obstacle is the absence of scientific information. The Congo Basin's peatlands were mainly disregarded in national climate initiatives, land-use plans, and public policies until recently. Several authors have pointed out that tropical wetlands are often under-mapped and insufficiently addressed in land-management policies. The recent discovery of vast peatland complexes in the Central Basin has highlighted the extent of this scientific and institutional gap (Frazier, 1999; Joosten & Clarke, 2002; Dargie et al., 2017; Lewis et al., 2018). Despite these advances, peatlands remain poorly integrated into national planning documents and legal frameworks related to forests, agriculture, or infrastructure (FAO, 2020; WWF, 2021).

Human pressures also continue to undermine the effectiveness of conservation measures. For several decades, agricultural expansion, logging, infrastructure development, and the opening up of new areas for exploitation have contributed to the gradual conversion of peatlands. Research on land-use dynamics shows that population pressure and the growing integration of rural economies into markets are accelerating the transformation of natural environments. In many regions of the Congo Basin, law enforcement remains limited due to the remoteness of the affected areas, a lack of administrative oversight, and weak penalties (Geist & Lambin, 2002; Foley et al., 2005; Ellis et al., 2010; Lambin & Meyfroidt, 2011). Recent projects related to roads, agribusiness, oil, and mining thus pose additional threats to peatlands, particularly when environmental impact assessments remain inadequate or poorly implemented (Edwards et al., 2014; Dargie et al., 2019; FAO, 2020).

Lastly, development needs and environmental imperatives often clash with conservation measures. Local communities rely heavily on peatlands for agriculture, fishing, hunting, and the collection of forest products. In this context, restrictive measures may be perceived as incompatible with subsistence needs and economic security. Several studies have shown that conservation approaches imposed without local participation often lead to tensions, or even forms of resistance. The challenge therefore lies in the ability to reconcile conservation objectives with the social and economic realities of the affected areas (Pretty, 1995; Agrawal & Gibson, 1999; Adams et al., 2004; Brockington et al., 2006; Ostrom, 2009). Recent approaches therefore emphasize the need to strengthen participatory governance, the recognition of local rights, and compensation mechanisms in order to reconcile peatland protection with sustainable development.

2.10.5. Prospects for Improvement

Strengthening the legal framework governing peatlands in the Congo Basin requires, above all, explicit recognition of these ecosystems in national legislation. Since the 1990s, numerous studies have shown that environmental policies remain largely ineffective when they fail to take into account the ecological specificities of wetlands. Peatlands thus require specific legal frameworks due to their role in major ecological functions. Recent recommendations emphasize the adoption of specific laws that clearly define their status, permitted uses, monitoring mechanisms, and restoration obligations in the event of degradation (Joosten & Clarke, 2002; Parish et al., 2008; Joosten et al., 2012; FAO, 2020). Such a development would also allow for the more systematic integration of peatlands into the forestry, agricultural, mining, and climate policies of the Congo Basin countries (CIFOR, 2020; WWF, 2021).

Improving governance also requires strengthening institutional capacity. Several analyses highlight that environmental and forestry agencies often lack the financial, technical, and human resources needed to effectively monitor activities in peatland areas. Consequently, developing specialized training programs, equipping monitoring services, and strengthening environmental monitoring systems are key priorities. The use of technologies such as remote sensing, participatory mapping, and geographic information systems could contribute to better identification of peatlands and more effective management of pressures on these ecosystems (World Bank, 2013; FAO, 2018; UNEP, 2018; World Bank, 2020).

Furthermore, several authors emphasize the need to incorporate local knowledge and community practices into public policy. Local communities often possess a detailed understanding of the ecological dynamics of peatlands, acquired over generations. Participatory management approaches developed since the 1990s show that incorporating this knowledge improves the social acceptability and effectiveness of conservation measures. Governance based on collaboration between public institutions, researchers, and local communities helps reduce conflicts over land use and better reconcile conservation with economic development (Pretty, 1995; Berkes, 2004; Folke et al., 2005; Reed, 2008; Berkes, 2012).

Finally, the sustainable protection of peatlands requires closer regional and international cooperation. The Congo Basin's peatlands are spread across multiple nations, and their degradation may have an impact on the world's climate. Since the discovery of their importance as carbon sinks, several regional and international initiatives have highlighted the need to harmonize policies, share scientific data, and coordinate funding. Cooperation programs between the states of the Congo Basin, United Nations agencies, international donors, and research organizations must therefore be strengthened to ensure the coherent management of these transboundary ecosystems (UNEP, 2018; FAO, 2020; World Bank, 2020; CIFOR, 2020).

2.11. Challenges and outlook

2.11.1. Environmental Issues

The peatlands of the Congo Basin are facing increasing environmental pressures resulting from a combination of human activities and global changes. Initial analyses of tropical land degradation dynamics have shown that agricultural expansion is one of the main drivers of change in wetland ecosystems. Shifting cultivation, widely practiced in several regions of the Congo Basin, leads to the clearing of vegetation and the disturbance of hydromorphic soils. This practice causes the gradual drying out of peatlands, a decrease in organic matter, and an acceleration of decomposition processes. The ability of these ecosystems to store carbon sustainably is thus significantly reduced (Houghton et al., 1991; Geist & Lambin, 2002; Foley et al., 2005; Gibbs et al., 2010; Curtis et al., 2018).

Drainage poses a particularly serious threat to peatlands. As early as the beginning of the 2000s, several studies showed that lowering the water table profoundly alters the functioning of peat soils. By exposing peat to oxygen, drainage accelerates its oxidation and leads to the release of large quantities of carbon dioxide and other greenhouse gases. Studies conducted in various tropical regions demonstrate that drained peatlands can rapidly shift from being carbon sinks to net sources of emissions. This transformation not only reduces their role in the climate but also promotes wildfires, which are often difficult to control in peat soils (Joosten & Clarke, 2002; Hooijer et al., 2010; Page et al., 2011; Turetsky et al., 2015).

Deforestation and unsustainable logging exacerbate these disturbances. The loss of forest cover alters microclimates, increases soil exposure to solar radiation, and disrupts hydrological cycles. Early studies on the ecological effects of forest fragmentation have shown that vegetation loss leads to decreased humidity, increased local temperatures, and reduced ecosystem resilience. In the peatlands of the Congo Basin, these changes weaken specialized plant species and disrupt the ecological interactions that ensure the stability of the environment. They can also lead to a rapid decline in biodiversity and a lasting alteration of plant community composition (Laurance et al., 1997;

Barlow et al., 2016; Dargie et al., 2017; Lewis et al., 2018).

An additional step in the degradation of peatlands is their transformation into plantations or agricultural land. When converted for cultivation or the establishment of monocultures, peatlands gradually lose the organic matter essential for peat formation. This conversion leads to a decline in natural biological productivity, a simplification of vegetation structure, and an acceleration of mineralization processes. Recent observations in the Congo Basin show that this transformation can rapidly lead to a reduction in peat thickness and a loss of its essential ecological functions (Miettinen et al., 2012; Wijedasa et al., 2017; Mutonkole, 2023).

Finally, climate change acts as an aggravating factor for all of these pressures. Rising temperatures and changes in precipitation patterns directly influence the hydrological functioning of peatlands. Prolonged droughts, which are more frequent in certain climate scenarios, contribute to lowering the water table, drying out the peat, and increasing the risk of fire. Since the 2000s, several authors have shown that the interactions between climate change and anthropogenic pressures significantly increase the vulnerability of tropical peatlands. These ecosystems could thus gradually lose their ability to sequester carbon if the hydrological conditions necessary for their functioning are no longer maintained (Davidson & Janssens, 2006; Dise, 2009; Turetsky et al., 2015; Loisel et al., 2021; IPCC, 2021).

Table III. Threats, Impacts and Risk Levels (Laurance et al., 1997; Houghton et al., 1991; Geist & Lambin, 2002; Joosten & Clarke, 2002).

Threat	Description	Impacts on peatlands	Risk level
Shifting cultivation	Clearing and temporary cultivation using fire	Deterioration of vegetation, disruption of hydromorphic soils, gradual drying out, loss of soil carbon	High
Drainage of peaty soilsDrainage of peaty soils	Artificial lowering of the water table	Peat oxidation, massive CO_2 emissions, transformation into a carbon source, increase in wildfires	Very high
Deforestation and unsustainable logging	Deforestation or degradation of forest cover	Changes to the microclimate, lower humidity, rising temperatures, loss of biodiversity and resilience	High
Conversion to agricultural land or plantations	Conversion of peatlands into agricultural systems or monocultures	Loss of peat formation, reduced biodiversity, soil mineralisation, and a decrease in peat thickness	Very high
Climate change	Rising temperatures and changes in rainfall patterns	Droughts, falling groundwater levels, an increase in wildfires, and a loss of carbon storage capacity	Very high

2.11.2. Sustainable Management of Peatlands

The sustainable management of peatlands in the Congo Basin requires integrated strategies capable of reconciling ecological conservation imperatives with the development needs of local communities. As early as the 1990s, several authors demonstrated that sector-specific approaches are insufficient for managing complex ecosystems such as peatlands, whose functioning depends on interactions between vegetation, hydrology, human uses, and climate dynamics. Ecosystem-based approaches thus appear particularly well-suited, as they simultaneously consider the ecological, social, and economic dimensions of management. They aim to preserve hydrological functions, biodiversity, and carbon storage capacities while maintaining the livelihoods of riparian communities (Holling, 1973; Costanza et al., 1997; Millennium Ecosystem Assessment, 2005; Folke et al., 2005).

From this perspective, sustainable management also involves restoring the ecological functions of already degraded peatlands. Reestablishing vegetation cover, preserving a high water table, and hydrological restoration are all necessary for reestablishing peat production processes, according to research on wetlands. These measures not only reduce carbon emissions but also strengthen the resilience of ecosystems to climate change. Recent strategies therefore recommend prioritizing the prevention of degradation, combined with ecological restoration programs in areas already affected by drainage, agriculture, or deforestation (Mitsch & Gosselink, 2000; Joosten & Clarke, 2002; Parish et al., 2008; FAO, 2020).

International climate mechanisms also offer significant opportunities to support these efforts. Since the 2000s, REDD+ initiatives and climate finance programs have sought to create economic incentives that promote the conservation of carbon-rich ecosystems. The peatlands of the Congo Basin, due to their major role in carbon storage, occupy a strategic position within these mechanisms. However, several studies highlight that their effectiveness depends heavily on the quality of governance, transparency in the management of funds, and the equitable distribution of benefits. Programs that do not take local realities into account risk exacerbating inequalities or sparking conflicts over land use (Phelps et al., 2010; Corbera & Schroeder, 2011; Sunderlin et al., 2015; Angelsen et al., 2018).

The integration of local knowledge is another fundamental pillar of sustainable management. For several decades, research on community-based natural resource governance has shown that local communities possess valuable knowledge about hydrological dynamics, vegetation, and traditional uses of peatlands. When this knowledge is combined with scientific expertise through participatory processes, management strategies become better suited to local contexts and more readily accepted. Participatory approaches also help strengthen the legitimacy of environmental policies, limit conflicts, and promote sustainable ownership of conservation measures (Pretty, 1995; Cash et al., 2003; Berkes, 2004; Reed, 2008; Berkes, 2012).

Building stronger institutional and legal frameworks is essential to the sustainability of management. The implementation of environmental legislation is severely hampered by poor institutions, a lack of coordination among government agencies, and a lack of enforcement resources, according to several evaluations carried out in the Congo Basin countries. Effective governance therefore requires the development of technical capacity, the establishment of monitoring and surveillance systems, and better coordination among national, regional, and international stakeholders. Remote sensing technologies, peatland mapping, and environmental monitoring systems can help improve the monitoring of anthropogenic pressures and guide management decisions (Ostrom, 2009; World Bank, 2013; World Bank, 2019; UNEP, 2018; FAO, 2020; CIFOR, 2020).

2.11.3. Research Prospects

There are still many research opportunities regarding the peatlands of the Congo Basin, and these represent a major challenge for improving their conservation and management. One of the priorities involves detailed mapping and the spatial delineation of these ecosystems. Despite recent progress, knowledge of the actual extent of the peatlands remains incomplete, particularly in areas that are difficult to access. Early mapping approaches relied on field surveys and aerial photographs, but advances in remote sensing, geographic information systems (GIS), and radar sensors now make it possible to produce more accurate maps and track the dynamics of deforestation, flooding, and drainage. The integration of multi-temporal satellite data appears particularly important for detecting long-term changes and identifying the most vulnerable areas (Malingreau, Tucker, & Laporte, 1989; Bwangoy et al., 2010; Hansen et al., 2013; Asner, 2009).

Improvements in mapping methods must also include a better hydrological characterization of peatlands. Future research should analyze more precisely seasonal variations in water levels, the connections between peatlands and river systems, and the effects of hydrological changes caused by human activities. These parameters are critical, as maintaining a stable water regime directly determines the ability of peatlands to store carbon and preserve their biodiversity. Studies on tropical wetlands thus show that hydrological disturbances are often the primary factor in peatland degradation (Mitsch & Gosselink, 2000; Joosten & Clarke, 2002; Rydin & Jeglum, 2013).

The study of the floristic composition and biodiversity of peatlands represents a second priority area. Current knowledge of the plant communities in the Congo Basin's peatlands remains fragmentary, even though species diversity plays a crucial role in the ecological functioning of these habitats. Future research should focus on species inventories, the structure of plant communities, and the interactions between plants, soils, and hydrology. A better understanding of these relationships would allow for a more accurate assessment of peatlands' resilience to disturbances, particularly deforestation, fires, or climate change. Studies on wetlands have shown that biological diversity directly contributes to ecosystem stability and adaptive capacity (Tilman, 1997; Zedler & Kercher, 2005; Maltby & Barker, 2009; Keddy, 2010; Rydin & Jeglum, 2013).

Research should also focus more on indicator species and endemic species associated with peatlands. These species can serve as tools for ecological monitoring and provide valuable information on the conservation status of ecosystems. Furthermore, paleoecological analyses, based on the study of pollen, plant macroremains, and sediments, would make it possible to reconstruct the historical evolution of peatlands and better understand their response to past climate variations (Charman, 2002; Birks & Birks, 2006; Swindles et al., 2018).

Carbon dynamics and greenhouse gas fluxes are another important field of study. The peatlands of the Congo Basin represent one of the world's largest tropical carbon reservoirs, but the mechanisms governing carbon storage and release remain poorly understood. Future research should more accurately quantify emissions of carbon dioxide, methane, and nitrous oxide according to different peatland types and land uses. It should also analyze the impact of climate change, drainage, and deforestation on carbon budgets. This work is essential for properly integrating peatlands into global climate models and emissions reduction policies (Gorham, 1991; Page et al., 2011; Turetsky et al., 2015; Leifeld & Menichetti, 2018).

Future research must adopt interdisciplinary approaches that integrate social, economic, institutional, and political dimensions. The pressures on the peatlands of the Congo Basin are closely linked to demographic trends, agricultural practices, land policies, and development strategies. Understanding the interactions between local stakeholders, institutions, and ecosystems is therefore essential for designing sustainable solutions. Studies on natural resource governance show that management frameworks are more effective when they involve local communities, public authorities, and international organizations. Interdisciplinary research can thus help identify forms of governance adapted to local realities and capable of reconciling conservation and development (Agrawal, 2001; Cash et al., 2003; Folke et al., 2005; Ostrom, 2009; Berkes, 2012).

2.12. Discussion

2.12.1. Floristic composition and ecological structure of tropical peatlands

The peatlands of the Congo Basin are home to flora adapted to hydromorphic conditions, acidic soils and low oxygen levels. They are dominated by species such as Raphia laurentii, Guibourtia demeusei, Symphonia globulifera and Uapaca guineensis. According to Dargie et al. (2017), Lewis et al. (2018), Etuge et al. (2023) and Sonké et al. (2024), this vegetation promotes the accumulation of organic matter and the formation of peat due to the permanent waterlogging of the soils. The work of Keddy (2010), Corlett (2016) and Joosten et al. (2012) also shows that these ecological conditions favour specialised and sometimes endemic plant communities. Compared to other tropical peatlands, those of the Congo Basin remain relatively intact.

2.12.2. Carbon sequestration and its significance for the climate

The peatlands of the Congo Basin constitute one of the world's largest tropical carbon reservoirs. Dargie et al. (2017) estimate that those in the Central Basin store approximately 30.6 gigatonnes of carbon in the form of peat. According to Lewis et al. (2018), Crezee et al. (2022) and Garcin et al. (2022), this stock plays a major role in climate regulation. Conditions of permanent waterlogging slow down the decomposition of organic matter and promote the gradual accumulation of carbon over several millennia (Page et al., 2011; Joosten et al., 2012; Turetsky et al., 2015). In Indonesia, peatlands also represent significant carbon reservoirs, but they are severely degraded by drainage, fires and industrial oil palm plantations (Page et al., 2011; Miettinen et al., 2016).

2.12.3. REDD+ mechanisms and peatland conservation

REDD+ mechanisms were developed to reduce emissions from deforestation and promote the conservation of carbon-rich ecosystems. In the Congo Basin, peatlands are gradually being incorporated into national climate strategies. According to FONAREDD (2020), COMIFAC (2015), CIFOR (2020) and Sonwa et al. (2022), several initiatives support their conservation through carbon markets and international funding. However, the implementation of REDD+ remains limited by institutional weakness, a lack of funding and governance challenges. Indonesia is one of the leading examples of REDD+ implementation in tropical peatlands. Following the 2015 fires, several international programmes were launched to restore degraded peatlands and reduce carbon emissions (Murdiyarso et al., 2015). However, results remain limited due to land conflicts, corruption and interests linked to oil palm (Angelsen, 2009; Phelps et al., 2010; Goldstein, 2020). In the Amazon, the most effective projects are those that involve indigenous communities and respect local land rights (Nepstad et al., 2014; Börner et al., 2017), whilst in Papua, REDD+ remains hampered by land disputes and governance issues (Filer, 2011).

2.12.4. Payments for ecosystem services (PES)

Payments for ecosystem services (PES) aim to compensate local communities for the conservation of environmental services such as carbon sequestration, biodiversity and water regulation. In the Congo Basin, PES remain underdeveloped despite initiatives supported by FONAREDD, the World Bank and UNEP. According to CIFOR (2020), the World Bank (2020) and Sonwa et al. (2022), their effectiveness remains limited by land tenure insecurity, weak administrative capacity and a lack of transparency in the redistribution of benefits. In the Amazon, several PES programmes have helped to partially reduce deforestation and support local communities engaged in forest conservation (Wunder, 2005; Börner et al., 2017). In Indonesia, these mechanisms remain heavily reliant on international funding and sometimes benefit large corporations more than local communities, which fuels land disputes (Miettinen et al., 2016; Goldstein, 2020). In Papua, several carbon projects have also sparked controversy over land rights and revenue sharing (Filer, 2011).

2.12.5. Conflicts between conservation and development

Conflicts between environmental conservation and economic development pose a major challenge in the management of tropical peatlands. In the Congo Basin, local communities rely heavily on these ecosystems for agriculture, fishing, hunting and the collection of non-timber forest products. According to Angelsen and Kaimowitz (1999), Geist and Lambin (2002), Dargie et al. (2019) and Sonwa et al. (2022), conservation policies are sometimes perceived as restrictions that limit the livelihoods of local communities, whilst oil, mining, road and agro-industrial projects exacerbate conflicts over the use of peatlands. This tension is also observed elsewhere in the world. In Indonesia, the expansion of oil palm plantations conflicts with climate and environmental objectives (Page et al., 2011; Miettinen et al., 2016). In the Amazon, conflicts are linked to cattle ranching, mining and road infrastructure (Fearnside, 2005; Nepstad et al., 2014). In Papua, they mainly concern mining and forestry concessions, as well as the recognition of customary rights (Filer, 2011). Overall, the lack of participatory governance and land tenure recognition exacerbates these tensions in tropical peatland areas.

2.12.6. Outlook and comparative insights

A comparison of the peatlands of the Congo Basin, the Amazon, Indonesia and Papua highlights key lessons for their conservation. The Congo Basin is one of the last major tropical peatland complexes that remains relatively intact, in contrast to Indonesia, where peatlands have been severely degraded by drainage and fires. This situation offers the Congo an opportunity for preventive conservation before irreversible disturbances occur (Dargie et al., 2017; Lewis et al., 2018; Garcin et al., 2022), highlighting the urgency of integrating these ecosystems into development and land-use policies. International experience also shows that conservation success depends on the participation of local communities, the recognition of land rights, and the equitable sharing of benefits from REDD+ mechanisms and payments for ecosystem services. According to Ostrom (1990), Berkes (2012), Reed (2008) and Armitage et al. (2009), participatory governance improves the acceptability of environmental policies. In the Congo Basin, the integration of traditional ecological knowledge, alongside the strengthening of scientific research, climate finance and regional cooperation, appears essential to ensure the sustainable protection of peatlands in the face of growing pressures.

3. Conclusion

This study highlights the major ecological importance of peatlands, particularly those in the Congo Basin, as exceptional reservoirs of biodiversity and essential carbon sinks in the regulation of the global climate. Despite their crucial role, these ecosystems remain poorly documented and insufficiently integrated into conservation and development policies. The findings therefore underscore the need to strengthen scientific knowledge and better guide sustainable management strategies.

From a scientific perspective, future priorities must focus on the implementation of high-resolution mapping of peatlands, in order to improve their delineation and monitoring. It is also essential to develop research in functional ecology to better understand the internal functioning of these ecosystems, particularly the interactions between soil, vegetation and hydrology. The study of carbon fluxes, combined with the advanced use of remote sensing, is a key area for better quantifying their role in the global carbon cycle and anticipating their response to climate change.

From a political and institutional perspective, there is an urgent need to draft specific legislation on the protection and sustainable management of peatlands, in order to fill the current legal vacuum. Governance must also be strengthened through a participatory approach involving local communities, researchers and public decision-makers. Furthermore, strengthening national capacity in research, environmental monitoring and ecosystem management is essential to ensure effective and sustainable decision-making.

Finally, from an economic perspective, it is essential to promote a green economy based on the sustainable management of the ecosystem services provided by peatlands, particularly carbon sequestration and water regulation. The development of climate finance mechanisms, such as carbon funds and payments for environmental services, could support their conservation whilst improving the living conditions of local communities. Thus, an integrated approach linking science, policy and economics appears to be the most effective way to ensure the sustainable preservation of peatlands.

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Conflict of interest

There are no conflicts of interest relating to this study.

Ethical considerations

It is worth noting that this research was conducted in strict accordance with the fundamental principles of scientific ethics.

Authors' Contribution

J.M., R.M.T., P.-C.B.B. : Conceptualisation
J.M., G.B.B., P.-C.B.B. : Methodology
J.M., J.O.A., O.M. : Analysis of data from the peatland map
J.M., J.B.M. : Search for articles
J.M., G.B.B. : Data analysis
J.M. : Draft – initial version
J.B.M., D.M.M., A.A.O., C.K., P.-C.B.B. : Manuscript revision and editing
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Références bibliographiques

Adams, W. M., Aveling, R., Brockington, D., Dickson, B., Elliott, J., Hutton, J., Roe, D., Vira, B., & Wolmer, W. (2004). Biodiversity conservation and the eradication of poverty. *Science, 306*(5699), 1146–1149. https://doi.org/10.1126/science.1097920

Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World Development, 29*(10), 1649–1672. https://doi.org/10.1016/S0305-750X(01)00063-8

Agrawal, A., & Gibson, C. C. (1999). Enchantment and disenchantment: The role of community in natural resource conservation. *World Development, 27*(4), 629–649. https://doi.org/10.1016/S0305-750X(98)00161-2

Angelsen, A., & Kaimowitz, D. (1999). Rethinking the causes of deforestation: Lessons from economic models. *The World Bank Research Observer, 14*(1), 73–98. https://doi.org/10.1093/wbro/14.1.73

Angelsen, A., Martius, C., De Sy, V., Duchelle, A. E., Larson, A. M., & Pham, T. T. (Eds.). (2018). *Transforming REDD+: Lessons and new directions*. Center for International Forestry Research. https://doi.org/10.17528/cifor/007045

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology, 8*(1), 19–32. https://doi.org/10.1080/1364557032000119616

Armitage, D., Plummer, R., Berkes, F., Arthur, R., Charles, A., Davidson-Hunt, I., Diduck, A., Doubleday, N., Johnson, D., Marschke, M., McConney, P., Pinkerton, E., & Wollenberg, E. (2009). Adaptive co-management for social–ecological complexity. *Frontiers in Ecology and the Environment, 7*(2), 95–102. https://doi.org/10.1890/070089

Aromataris, E., & Munn, Z. (2020). *JBI manual for evidence synthesis*. Joanna Briggs Institute. https://doi.org/10.46658/JBIMES-24-01

Asner, G. P. (2009). Tropical forest carbon assessment: Integrating satellite and airborne mapping approaches. *Environmental Research Letters, 4*(3), 034009. https://doi.org/10.1088/1748-9326/4/3/034009

Assembe-Mvondo, S. (2013). *Local communities and forest governance in Central Africa*. CIFOR.

Assembe-Mvondo, S., Brockhaus, M., & Lescuyer, G. (2015). Assessment of the effectiveness, efficiency and equity of benefit-sharing schemes under large-scale agriculture: Lessons from land fees in Cameroon. *European Journal of Development Research, 27*(4), 641–656.

Barlow, J., Lennox, G. D., Ferreira, J., Berenguer, E., Lees, A. C., Nally, R. M., Thomson, J. R., Ferraz, S. F. B., Louzada, J., Oliveira, V. H. F., Parry, L., Ribeiro de Castro Solar, R., Vieira, I. C. G., Aragão, L. E. O. C., Begotti, R. A., Braga, R. F., Cardoso, T. M., de Oliveira Jr., R. C., Souza Jr., C. M., & Gardner, T. A. (2016). Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation. *Nature, 535*(7610), 144–147. https://doi.org/10.1038/nature18326

Begg, C. B., & Berlin, J. A. (1988). Publication bias: A problem in interpreting medical data. *Journal of the Royal Statistical Society: Series A, 151*(3), 419–463. https://doi.org/10.2307/2982993

Berkes, F. (2004). Rethinking community-based conservation. *Conservation Biology, 18*(3), 621–630. https://doi.org/10.1111/j.1523-1739.2004.00077.x

Berkes, F. (2012). *Sacred ecology* (3rd ed.). Routledge. https://doi.org/10.4324/9780203123843

Bertness, M. D., & Callaway, R. (1994). Positive interactions in communities. *Trends in Ecology & Evolution, 9*(5), 191–193. https://doi.org/10.1016/0169-5347(94)90088-4

Birks, H. H., & Birks, H. J. B. (2006). Multi-proxy studies in palaeolimnology. *Vegetation History and Archaeobotany, 15*(4), 235–251. https://doi.org/10.1007/s00334-006-0066-6

Bocko, Y. E., Ifo, S. A., Ndzié, J. P., & Lawson, I. T. (2024). Floristic variability and environmental gradients in the peat swamp forests of the central Congo Basin. *Wetlands Ecology and Management, 32*(1), 45–63. https://doi.org/10.1007/s11273-023-09954-8

Booth, A., Sutton, A., & Papaioannou, D. (2016). *Systematic approaches to a successful literature review* (2nd ed.). Sage.

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. Wiley. https://doi.org/10.1002/9780470743386

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9*(2), 27–40. https://doi.org/10.3316/QRJ0902027

Brady, N. C., & Weil, R. R. (2016). *The nature and properties of soils* (15th ed.). Pearson.

Bramer, W. M., de Jonge, G. B., Rethlefsen, M. L., Mast, F., & Kleijnen, J. (2017). A systematic approach to searching: An efficient and complete method to develop literature searches. *Journal of the Medical Library Association, 105*(1), 84–87. https://doi.org/10.5195/jmla.2017.225

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brazzaville Declaration. (2018). *Brazzaville Declaration*. United Nations Environment Programme.

Brockington, D., Igoe, J., & Schmidt-Soltau, K. (2006). Conservation, human rights, and poverty reduction. *Conservation Biology, 20*(1), 250–252.

https://doi.org/10.1111/j.1523-1739.2006.00335.x

Bwangoy, J.-R. B., Hansen, M. C., Roy, D. P., De Grandi, G., & Justice, C. O. (2010). Wetland mapping in the Congo Basin using optical and radar remotely sensed data and derived topographical indices. *Remote Sensing of Environment*, *114*(1), 73–86. https://doi.org/10.1016/j.rse.2009.08.004

Bwangoy, J.-R. B., Oszwald, J., & Doumenge, C. (2022). Vegetation structure and biodiversity patterns in Congo Basin swamp forests. *African Journal of Ecology*, *60*(4), 921–934. https://doi.org/10.1111/aje.12987

Byrne, D. (2022). A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity*, *56*(3), 1391–1412. https://doi.org/10.1007/s11135-021-01182-y

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., Jäger, J., & Mitchell, R. B. (2003). Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences*, *100*(14), 8086–8091. https://doi.org/10.1073/pnas.1231332100

Castleberry, A., & Nolen, A. (2018). Thematic analysis of qualitative research data: Is it as easy as it sounds? *Currents in Pharmacy Teaching and Learning*, *10*(6), 807–815. https://doi.org/10.1016/j.cptl.2018.03.019

Charman, D. J. (2002). *Peatlands and environmental change*. John Wiley & Sons.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Sage.

CIFOR. (2020). *Peatlands of the Central Congo Basin: Current realities and perspectives*. Center for International Forestry Research. https://doi.org/10.17528/cifor/008700

Convention on Biological Diversity. (2020). *Global biodiversity framework: First draft of the post-2020 global biodiversity framework*.

Convention on Wetlands Secretariat. (2016). *An introduction to the Convention on Wetlands* (7th ed.). Ramsar Convention Secretariat.

Cooper, H. (2010). *Research synthesis and meta-analysis: A step-by-step approach* (4th ed.). Sage.

Cooper, H., Hedges, L. V., & Valentine, J. C. (2019). *The handbook of research synthesis and meta-analysis* (3rd ed.). Russell Sage Foundation. https://doi.org/10.7758/9781610448864

Corbera, E., & Schroeder, H. (2011). Governing and implementing REDD+. *Environmental Science & Policy*, *14*(2), 89–99. https://doi.org/10.1016/j.envsci.2010.11.002

Corbin, J., & Strauss, A. (2015). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (4th ed.). Sage.

Corlett, R. T. (2016). *The ecology of tropical East Asia* (2nd ed.). Oxford University Press.

Costanza, R., Daly, L., Fioramonti, L., Giovannini, E., Kubiszewski, I., Mortensen, L. F., Pickett, K. E., Ragnarsdóttir, K. V., De Vogli, R., & Wilkinson, R. (2016). Modeling and measuring sustainable well-being in connection with the UN Sustainable Development Goals. *Ecological Economics*, *130*, 350–355. https://doi.org/10.1016/j.ecolecon.2016.07.009

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Sage.

Crezee, B., Dargie, G. C., Ewango, C. E. N., Lawson, I. T., Bocko, Y. E., Ifo, S. A., Mitchard, E. T. A., Lewis, S. L., & Page, S. E. (2022). Mapping peat thickness and carbon stocks of the central Congo Basin using field data. *Environmental Research Letters*, *17*(3), 034039. https://doi.org/10.1088/1748-9326/ac4f30

Crezee, B., Dargie, G. C., Mitchard, E. T. A., Lawson, I. T., Bocko, Y. E., Ifo, S. A., & Lewis, S. L. (2022). Mapping the distribution and characteristics of peatlands in the central Congo Basin. *Environmental Research Letters*, *17*(9), 094018. https://doi.org/10.1088/1748-9326/ac8d68

Curtis, P. G., Slay, C. M., Harris, N. L., Tyukavina, A., & Hansen, M. C. (2018). Classifying drivers of global forest loss. *Science*, *361*(6407), 1108–1111. https://doi.org/10.1126/science.aau3445

Dargie, G. C., Lawson, I. T., Rayden, T. J., Miles, L., Mitchard, E. T. A., Page, S. E., Bocko, Y. E., Ifo, S. A., & Lewis, S. L. (2019). Congo Basin peatlands: Threats and conservation priorities. *Mitigation and Adaptation Strategies for Global Change*, *24*(4), 669–686. https://doi.org/10.1007/s11027-017-9774-8

Dargie, G. C., Lewis, S. L., Lawson, I. T., Mitchard, E. T. A., Page, S. E., Bocko, Y. E., & Ifo, S. A. (2017). Age, extent, and carbon storage of the central Congo Basin peatland complex. *Nature*, *542*(7639), 86–90. https://doi.org/10.1038/nature21048

Davidson, E. A., & Janssens, I. A. (2006). Temperature sensitivity of soil carbon decomposition and feedbacks to climate change. *Nature, 440*(7081), 165–173. https://doi.org/10.1038/nature04514

Davidson, N. C. (2014). How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research, 65*(10), 934–941. https://doi.org/10.1071/MF14173

de Wasseige, C., Flynn, J., Louppe, D., Hiol Hiol, F., & Mayaux, P. (Eds.). (2014). *The forests of the Congo Basin: State of the forest 2013*. Publications Office of the European Union. https://doi.org/10.2788/12182

de Wasseige, C., Tadoum, M., Eba'a Atyi, R., & Doumenge, C. (Eds.). (2021). *The forests of the Congo Basin—State of the forest 2021*. Congo Basin Forest Partnership. https://doi.org/10.17528/cifor/008700

Debroux, L., Hart, T., Kaimowitz, D., Karsenty, A., & Topa, G. (2007). *Forests in post-conflict Democratic Republic of Congo: Analysis of a priority agenda*. Center for International Forestry Research. https://doi.org/10.17528/cifor/002186

DeFries, R., Rudel, T., Uriarte, M., & Hansen, M. (2010). Deforestation driven by urban population growth and agricultural trade in the twenty-first century. *Nature Geoscience, 3*(3), 178–181. https://doi.org/10.1038/ngeo756

Denzin, N. K., & Lincoln, Y. S. (2011). *The Sage handbook of qualitative research* (4th ed.). Sage.

Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Agard, J., Arneth, A., Balvanera, P., Brauman, K. A., Butchart, S. H. M., Chan, K. M. A., Garibaldi, L. A., Ichii, K., Liu, J., Subramanian, S. M., Midgley, G. F., Miloslavich, P., Molnár, Z., Obura, D., Pfaff, A., & Zayas, C. N. (2019). Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science, 366*(6471), eaax3100. https://doi.org/10.1126/science.aax3100

Dise, N. B. (2009). Peatland response to global change. *Science, 326*(5954), 810–811. https://doi.org/10.1126/science.1174268

Egger, M., Zellweger-Zähner, T., Schneider, M., Junker, C., Lengeler, C., & Antes, G. (1997). Language bias in randomised controlled trials published in English and German. *The Lancet, 350*(9074), 326–329.

Ellis, E. C., Goldewijk, K. K., Siebert, S., Lightman, D., & Ramankutty, N. (2010). Anthropogenic transformation of the biomes, 1700 to 2000. *Global Ecology and Biogeography, 19*(5), 589–606. https://doi.org/10.1111/j.1466-8238.2010.00540.x

Etuge, M., Sonké, B., & Couvreur, T. L. P. (2023). Plant diversity and ecological functions in Central African swamp forests. *Plant Ecology and Evolution, 156*(2), 181–197. https://doi.org/10.5091/plecevo.2023.2145

Etuge, M., Sonké, B., Couvreur, T. L. P., & Droissart, V. (2023). Floristic diversity and ecological characteristics of peat swamp forests in the Congo Basin. *Plant Ecology and Evolution, 156*(2), 245–260. https://doi.org/10.5091/plecevo.100112

Falagas, M. E., Pitsouni, E. I., Malietzis, G. A., & Pappas, G. (2008). Comparison of PubMed, Scopus, Web of Science, and Google Scholar: Strengths and weaknesses. *FASEB Journal, 22*(2), 338–342. https://doi.org/10.1096/fj.07-9492LSF

Fanelli, D. (2012). Negative results are disappearing from most disciplines and countries. *Scientometrics, 90*(3), 891–904. https://doi.org/10.1007/s11192-011-0494-7

Food and Agriculture Organization of the United Nations. (2015). *Towards climate-responsible peatland management*.

Food and Agriculture Organization of the United Nations. (2017). *The future of food and agriculture: Trends and challenges*. https://doi.org/10.18356/6f320f8f-en

Food and Agriculture Organization of the United Nations. (2018). *REDD+ and forest governance: Lessons learned from Latin America and Africa*.

Food and Agriculture Organization of the United Nations. (2020). *Global forest resources assessment 2020: Main report*.

Food and Agriculture Organization of the United Nations. (2020). *Peatlands and climate change mitigation in agriculture*.

Filer, C. (2011). *Forest governance and development*.

Fink, A. (2014). *Conducting research literature reviews: From the Internet to paper* (4th ed.). Sage.

Finlayson, C. M., Milton, G. R., Prentice, R. C., & Davidson, N. C. (Eds.). (2018). *The wetland book*

II: Distribution, description, and conservation. Springer. https://doi.org/10.1007/978-94-007-6173-5

Flick, U. (2018). *An introduction to qualitative research* (6th ed.). Sage.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, F. S., Coe, M. T., Daily, G. C., Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Prentice, I. C., Ramankutty, N., & Snyder, P. K. (2005). Global consequences of land use. *Science, 309*(5734), 570–574. https://doi.org/10.1126/science.1111772

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources, 30*, 441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

FONAREDD. (2020). *Rapport annuel 2020*. Fonds National REDD+ de la République Démocratique du Congo.

Franco, A., Malhotra, N., & Simonovits, G. (2014). Publication bias in the social sciences: Unlocking the file drawer. *Science, 345*(6203), 1502–1505. https://doi.org/10.1126/science.1255484

Frazier, P. S. (1999). Wetland mapping and monitoring. *Remote Sensing of Environment, 68*, 252–263.

Garcin, Y., Deschamps, P., Bocko, Y. E., Moukandi, G., Toirambe, B., Mampouya, H., Mazoukou, J. M., Nguembous, Z., Sifeddine, A., & Schefuß, E. (2022). Hydroclimatic sensitivity of Congo Basin peatlands since the last deglaciation. *Nature, 612*(7939), 107–112. https://doi.org/10.1038/s41586-022-05389-3

Geist, H. J., & Lambin, E. F. (2002). Proximate causes and underlying driving forces of tropical deforestation. *BioScience*, *52*(2), 143–150. https://doi.org/10.1641/0006-3568(2002)052[0143:PCAUDF]2.0.CO;2

Gibbs, H. K., Ruesch, A. S., Achard, F., Clayton, M. K., Holmgren, P., Ramankutty, N., & Foley, J. A. (2010). Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s. *Proceedings of the National Academy of Sciences, 107*(38), 16732–16737. https://doi.org/10.1073/pnas.0910275107

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine.

Glass, G. V. (1976). Primary, secondary, and meta-analysis of research. *Educational Researcher, 5*(10), 3–8. https://doi.org/10.3102/0013189X005010003

Gorham, E. (1991). Northern peatlands: Role in the carbon cycle and probable responses to climatic warming. *Ecological Applications, 1*(2), 182–195. https://doi.org/10.2307/1941811

Gough, D., Oliver, S., & Thomas, J. (2012). *An introduction to systematic reviews*. Sage.

Gough, D., Oliver, S., & Thomas, J. (2017). *An introduction to systematic reviews* (2nd ed.). Sage.

Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information and Libraries Journal*, *26*(2), 91–108. https://doi.org/10.1111/j.1471-1842.2009.00848.x

Grime, J. P. (2001). *Plant strategies, vegetation processes, and ecosystem properties* (2nd ed.). John Wiley & Sons.

Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., Schlesinger, W. H., Shoch, D., Siikamäki, J. V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R. T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M. R., & Fargione, J. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences, 114*(44), 11645–11650. https://doi.org/10.1073/pnas.1710465114

Guest, G., MacQueen, K. M., & Namey, E. E. (2012). *Applied thematic analysis*. Sage.

Gumbricht, T., Roman-Cuesta, R. M., Verchot, L., Herold, M., Wittmann, F., Householder, E., Herold, N., & Murdiyarso, D. (2017). An expert system model for mapping tropical wetlands and peatlands reveals South America as the largest contributor. *Global Change Biology*, *23*(9), 3581–3599. https://doi.org/10.1111/gcb.13689

Gurevitch, J., Koricheva, J., Nakagawa, S., & Stewart, G. (2018). Meta-analysis and the science of research synthesis. *Nature, 555*(7695), 175–182. https://doi.org/10.1038/nature25753

Gusenbauer, M., & Haddaway, N. R. (2020). Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. *Research Synthesis Methods,* *11*(2), 181–217. https://doi.org/10.1002/jrsm.1378

Haddaway, N. R., & Macura, B. (2018). The role of reporting standards in producing robust literature reviews. *Nature Climate Change, 8*(6), 444–447. https://doi.org/10.1038/s41558-018-0180-3

Haddaway, N. R., Collins, A. M., Coughlin, D., & Kirk, S. (2015). The role of Google Scholar in evidence reviews and its applicability to grey literature searching. *PLoS ONE, 10*(9), e0138237. https://doi.org/10.1371/journal.pone.0138237

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S. V., Goetz, S. J., Loveland, T. R., Kommareddy, A., Egorov, A., Chini, L., Justice, C. O., & Townshend, J. R. G. (2013). High-resolution global maps of 21st-century forest cover change. *Science, 342*(6160), 850–853. https://doi.org/10.1126/science.1244693

Harzing, A.-W., & Alakangas, S. (2016). Google Scholar, Scopus, and the Web of Science: A longitudinal and cross-disciplinary comparison. *Scientometrics, 106*(2), 787–804. https://doi.org/10.1007/s11192-015-1798-9

Higgins, J. P. T., & Green, S. (Eds.). (2011). *Cochrane handbook for systematic reviews of interventions* (Version 5.1.0).

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2019). *Cochrane handbook for systematic reviews of interventions* (2nd ed.). Wiley. https://doi.org/10.1002/9781119536604

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (2020). *Cochrane handbook for systematic reviews of interventions* (2nd ed.). Wiley. https://doi.org/10.1002/9781119536604

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2022). *Cochrane handbook for systematic reviews of interventions* (Version 6.3). Wiley.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics, 4*, 1–23. https://doi.org/10.1146/annurev.es.04.110173.000245

Hooijer, A., Page, S., Canadell, J. G., Silvius, M., Kwadijk, J., Wösten, H., & Jauhiainen, J. (2010). Current and future CO_2 emissions from drained peatlands in Southeast Asia. *Biogeosciences, 7*(5), 1505–1514. https://doi.org/10.5194/bg-7-1505-2010

Houghton, R. A., Lefkowitz, D. S., & Skole, D. L. (1991). Changes in the landscape of Latin America between 1850 and 1985: I. Progressive loss of forests. *Forest Ecology and Management, 38*(3–4), 143–172. https://doi.org/10.1016/0378-1127(91)90140-T

Ingram, V., Schure, J., Tieguhong, J. C., Ndoye, O., Awono, A., & Iponga, D. M. (2014). Gender implications of forest product value chains in the Congo Basin. *Forests, Trees and Livelihoods, 23*(1–2), 67–86. https://doi.org/10.1080/14728028.2014.887610

Intergovernmental Panel on Climate Change. (2019). *Climate change and land: An IPCC special report*.

Intergovernmental Panel on Climate Change. (2021). *Climate change 2021: The physical science basis*. Cambridge University Press. https://doi.org/10.1017/9781009157896

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019). *Global assessment report on biodiversity and ecosystem services*. https://doi.org/10.5281/zenodo.3831673

Ioannidis, J. P. A. (2005). Why most published research findings are false. *PLoS Medicine, 2*(8), e124. https://doi.org/10.1371/journal.pmed.0020124

Joosten, H., & Clarke, D. (2002). *Wise use of mires and peatlands*. International Mire Conservation Group and International Peat Society.

Joosten, H., Tapio-Biström, M.-L., & Tol, S. (Eds.). (2012). *Peatlands: Guidance for climate change mitigation through conservation, rehabilitation, and sustainable use* (2nd ed.). Food and Agriculture Organization of the United Nations and Wetlands International.

Keddy, P. A. (2010). *Wetland ecology: Principles and conservation* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511778179

Kitchenham, B. (2004). *Procedures for performing systematic reviews* (Technical Report TR/SE-0401). Keele University.

Kuemmerle, T., Altrichter, M., Baldi, G., Cabido, M., Camino, M., Cuellar, E., Cuellar, R. L., Decarre, J., Díaz, S., Gasparri, I., Gavier-Pizarro, G., Ginzburg, R., Grau, R., Jobbágy, E., Leynaud, G., Macchi, L., Martinuzzi, S., Noss, A., Paruelo, J.,

& Zak, M. (2016). Forest conservation: Remember Gran Chaco. *Science, 355*(6324), 465. https://doi.org/10.1126/science.aal3020

Lambin, E. F., Geist, H. J., & Lepers, E. (2001). The causes of land-use and land-cover change: Moving beyond the myths. *Global Environmental Change, 11*(4), 261–269. https://doi.org/10.1016/S0959-3780(01)00007-3

Lambin, E. F., & Meyfroidt, P. (2011). Global land use change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences, 108*(9), 3465–3472. https://doi.org/10.1073/pnas.1100480108

Laurance, W. F., Laurance, S. G., Ferreira, L. V., Rankin-de Merona, J. M., Gascon, C., & Lovejoy, T. E. (1997). Biomass collapse in Amazonian forest fragments. *Science, 278*(5340), 1117–1118. https://doi.org/10.1126/science.278.5340.1117

Lawson, I. T., Bocko, Y. E., Dargie, G. C., Ifo, S. A., & Lewis, S. L. (2022). Environmental controls on peat swamp forest composition in the Congo Basin. *Journal of Tropical Ecology, 38*(5), 257–271. https://doi.org/10.1017/S0266467422000215

Leach, M., & Fairhead, J. (2000). Challenging neo-Malthusian deforestation analyses in West Africa's dynamic forest landscapes. *Population and Development Review, 26*(1), 17–43. https://doi.org/10.1111/j.1728-4457.2000.00017.x

Leifeld, J., & Menichetti, L. (2018). The underappreciated potential of peatlands in global climate change mitigation strategies. *Nature Communications, 9*, 1071. https://doi.org/10.1038/s41467-018-03406-6

Letouzey, R. (1985). *Notice de la carte phytogéographique du Cameroun au 1:500,000*. Institut de la Carte Internationale de la Végétation.

Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: Advancing the methodology. *Implementation Science, 5*, Article 69. https://doi.org/10.1186/1748-5908-5-69

Lewis, S. L., Dargie, G. C., Mitchard, E. T. A., Koch, A., Bocko, Y. E., Ifo, S. A., & Lawson, I. T. (2018). Congo Basin peatlands store large amounts of carbon but remain poorly known. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1760), 20170364. https://doi.org/10.1098/rstb.2017.0364

Lewis, S. L., Wheeler, C. E., Mitchard, E. T. A., & Koch, A. (2019). Restoring natural forests is the best way to remove atmospheric carbon. *Nature, 568*(7750), 25–28. https://doi.org/10.1038/d41586-019-01026-8

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., Clarke, M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *PLoS Medicine, 6*(7), e1000100. https://doi.org/10.1371/journal.pmed.1000100

Limpens, J., Berendse, F., Blodau, C., Canadell, J. G., Freeman, C., Holden, J., Roulet, N., Rydin, H., & Schaepman-Strub, G. (2008). Peatlands and the carbon cycle: From local processes to global implications—A synthesis. *Biogeosciences, 5*(5), 1475–1491. https://doi.org/10.5194/bg-5-1475-2008

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage.

Loisel, J., Gallego-Sala, A. V., Amesbury, M. J., Magnan, G., Anshari, G., Beilman, D. W., Benavides, J. C., Blewett, J., Camill, P., Charman, D. J., Christensen, T. R., Davies, L. J., De Vleeschouwer, F., Finkelstein, S. A., Garneau, M., Hribljan, J. A., Holmquist, J. R., Hughes, P. D. M., Jones, M. C., & Yu, Z. (2021). Expert assessment of future vulnerability of the global peatland carbon sink. *Nature Climate Change, 11*(1), 70–77. https://doi.org/10.1038/s41558-020-00944-0

Magliocca, N. R., Ellis, E. C., Allington, G. R. H., de Bremond, A., Dell'Angelo, J., Mertz, O., Messerli, P., Meyfroidt, P., Seppelt, R., & Verburg, P. H. (2018). Closing global knowledge gaps: Producing generalized knowledge from case studies of social-ecological systems. *Global Environmental Change, 50*, 1–14. https://doi.org/10.1016/j.gloenvcha.2018.03.003

Malingreau, J.-P., Tucker, C. J., & Laporte, N. (1989). AVHRR for monitoring global tropical deforestation. *International Journal of Remote Sensing, 10*(4–5), 855–867. https://doi.org/10.1080/01431168908903995

Maltby, E., & Barker, T. (2009). *The wetlands handbook*. Wiley-Blackwell.

Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & Delgado López-Cózar, E. (2018). Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *Journal of Informetrics, 12*(4), 1160–1177. https://doi.org/10.1016/j.joi.2018.09.002

Maxwell, J. A. (2012). *A realist approach for qualitative research*. Sage.

Mays, N., & Pope, C. (2000). Qualitative research in health care: Assessing quality in qualitative research. *BMJ, 320*(7226), 50–52. https://doi.org/10.1136/bmj.320.7226.50

Megevand, C. (Ed.). (2013). *Deforestation trends in the Congo Basin: Reconciling economic growth and forest protection*. World Bank. https://doi.org/10.1596/978-0-8213-9742-8

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Meyfroidt, P., Lambin, E. F., Erb, K. H., & Hertel, T. W. (2013). Globalization of land use: Distant drivers of land change and geographic displacement of land use. *Current Opinion in Environmental Sustainability, 5*(5), 438–444.

Miettinen, J., Shi, C., & Liew, S. C. (2012). Two decades of destruction in Southeast Asia's peat swamp forests. *Frontiers in Ecology and the Environment, 10*(3), 124–128. https://doi.org/10.1890/100236

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Sage.

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Wetlands and water synthesis*. World Resources Institute.

Mitsch, W. J., & Gosselink, J. G. (2000). *Wetlands* (3rd ed.). John Wiley & Sons.

Mitsch, W. J., & Gosselink, J. G. (2015). *Wetlands* (5th ed.). John Wiley & Sons.

Mlinarić, A., Horvat, M., & Šupak Smolčić, V. (2017). Dealing with the positive publication bias: Why you should really publish your negative results. *Biochemia Medica, 27*(3), 447–452. https://doi.org/10.11613/BM.2017.030201

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine, 6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: A comparative analysis. *Scientometrics, 106*(1), 213–228. https://doi.org/10.1007/s11192-015-1765-5

Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Medical Research Methodology, 18*, Article 143. https://doi.org/10.1186/s12874-018-0611-x

Musée Royal de l'Afrique Centrale. (2017). *Les tourbières du Bassin du Congo : Diversité écologique et importance environnementale*.

Mutonkole, J. B. (2023). Effets de la conversion agricole sur les tourbières du Bassin du Congo. *Revue Congolaise des Sciences de l'Environnement, 12*(2), 45–58.

Nakagawa, S., Samarasinghe, G., Haddaway, N. R., Westgate, M. J., O'Dea, R. E., Noble, D. W. A., & Lagisz, M. (2021). Research weaving: Visualizing the future of research synthesis. *Trends in Ecology & Evolution, 36*(9), 776–788. https://doi.org/10.1016/j.tree.2018.11.007

Nguimalet, C. R., & Ndjendolé, S. (2021). Dynamiques socio-environnementales et conservation des zones humides en Afrique centrale. *Revue de Géographie Tropicale et d'Environnement, 2*(35), 45–59.

Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *Evidence-Based Nursing, 18*(2), 34–35. https://doi.org/10.1136/eb-2015-102054

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods, 16*(1), 1–13. https://doi.org/10.1177/1609406917733847

Okoli, C., & Schabram, K. (2010). A guide to conducting a systematic literature review of information systems research. *Sprouts: Working Papers on Information Systems, 10*(26), 1–51. https://doi.org/10.2139/ssrn.1954824

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press. https://doi.org/10.1017/CBO9780511807763

Ostrom, E. (2009). A general framework for analyzing the sustainability of social-ecological systems. *Science, 325*(5939), 419–422. https://doi.org/10.1126/science.1172133

Oyono, P. R. (2005). Profiling local-level outcomes of environmental decentralizations: The case of

Cameroon's forests in the Congo Basin. *The Journal of Environment & Development, 14*(3), 317–337.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71.

Page, S. E., Rieley, J. O., & Banks, C. J. (2011). Global and regional importance of the tropical peatland carbon pool. *Global Change Biology, 17*(2), 798–818. https://doi.org/10.1111/j.1365-2486.2010.02279.x

Parish, F., Sirin, A., Charman, D., Joosten, H., Minayeva, T., Silvius, M., & Stringer, L. (Eds.). (2008). *Assessment on peatlands, biodiversity, and climate change*. Global Environment Centre and Wetlands International.

Paris Agreement. (2015). *Adoption of the Paris Agreement* (FCCC/CP/2015/L.9/Rev.1). United Nations Framework Convention on Climate Change.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Sage.

Patton, M. Q. (2015). *Qualitative research & evaluation methods* (4th ed.). Sage.

Peters, M. D. J., Godfrey, C. M., Khalil, H., McInerney, P., Parker, D., & Soares, C. B. (2015). Guidance for conducting systematic scoping reviews. *International Journal of Evidence-Based Healthcare, 13*(3), 141–146.

Petticrew, M., & Roberts, H. (2006). *Systematic reviews in the social sciences: A practical guide*. Blackwell.

Phelps, J., Webb, E. L., & Agrawal, A. (2010). Does REDD+ threaten to recentralize forest governance? *Science, 328*(5976), 312–313. https://doi.org/10.1126/science.1187774

Pretty, J. N. (1995). Participatory learning for sustainable agriculture. *World Development, 23*(8), 1247–1263. https://doi.org/10.1016/0305-750X(95)00046-F

Ramsar Convention Secretariat. (2016). *An introduction to the Ramsar Convention on Wetlands* (7th ed.).

Randolph, J. J. (2009). A guide to writing the dissertation literature review. *Practical Assessment, Research and Evaluation, 14*(13), 1–13.

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation, 141*(10), 2417–2431. https://doi.org/10.1016/j.biocon.2008.07.014

République Démocratique du Congo. (2002). *Loi n° 011/2002 du 29 août 2002 portant Code forestier*. Journal officiel de la République Démocratique du Congo.

République Démocratique du Congo. (2011). *Loi n° 11/009 du 9 juillet 2011 portant principes fondamentaux relatifs à la protection de l'environnement*. Journal officiel de la République Démocratique du Congo.

Richards, P. W. (1952). *The tropical rain forest: An ecological study*. Cambridge University Press.

Rosenthal, R. (1979). The file drawer problem and tolerance for null results. *Psychological Bulletin, 86*(3), 638–641.

Rothstein, H. R., Sutton, A. J., & Borenstein, M. (2005). *Publication bias in meta-analysis: Prevention, assessment, and adjustments*. Wiley.

Rudel, T. K. (2007). Changing agents of deforestation: From state-initiated to enterprise-driven processes, 1970–2000. *Land Use Policy, 24*(1), 35–41. https://doi.org/10.1016/j.landusepol.2005.11.004

Rydin, H., & Jeglum, J. K. (2013). *The biology of peatlands* (2nd ed.). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199602995.001.0001

Sachs, J. D., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G., & Woelm, F. (2019). *Sustainable development report 2019*. Bertelsmann Stiftung and Sustainable Development Solutions Network. https://doi.org/10.25546/61766

Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Sage.

Sandelowski, M. (1993). Rigor or rigor mortis: The problem of rigor in qualitative research revisited. *Advances in Nursing Science, 16*(2), 1–8.

Secretariat of the Convention on Biological Diversity. (2014). *Global biodiversity outlook 4*. Convention on Biological Diversity.

Shea, B. J., Reeves, B. C., Wells, G., Thuku, M., Hamel, C., Moran, J., Moher, D., Tugwell, P., Welch, V., Kristjansson, E., & Henry, D. A. (2017). AMSTAR 2: A critical appraisal tool for systematic reviews that include randomized or non-randomized studies of healthcare interventions, or both. *BMJ, 358*, j4008.

Silverman, D. (2013). *Doing qualitative research* (4th ed.). Sage.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research, 104*, 333–339.

Song, F., Parekh, S., Hooper, L., Loke, Y. K., Ryder, J., Sutton, A. J., Hing, C., Kwok, C. S., Pang, C., & Harvey, I. (2010). Dissemination and publication of research findings: An updated review of related biases. *Health Technology Assessment, 14*(8), 1–193. https://doi.org/10.3310/hta14080

Sonwa, D. J., Bambuta, J. J., Siewe, R., & Pongui, B. (2022). *Framing the peatlands' governance in the Congo Basin* (Infobrief No. 368). CIFOR-ICRAF. https://doi.org/10.17528/cifor/008645

Sterne, J. A. C., Egger, M., & Moher, D. (2016). Addressing reporting biases. In J. P. T. Higgins & S. Green (Eds.), *Cochrane handbook for systematic reviews of interventions* (pp. 297–333). Wiley.

Stringer, L. C., Dougill, A. J., Fraser, E. D. G., Hubacek, K., Prell, C., & Reed, M. S. (2006). Unpacking "participation" in the adaptive management of social-ecological systems: A critical review. *Ecology and Society, 11*(2), 39. https://doi.org/10.5751/ES-01896-110239

Sunderlin, W. D., Ekaputri, A. D., Sills, E. O., Duchelle, A. E., Kweka, D., Diprose, R., Doggart, N., Ball, S., Lima, R., Enright, A., Torres, J., Hartanto, H., & Toniolo, A. (2015). *The challenge of establishing REDD+ on the ground: Insights from 23 subnational initiatives in six countries*. Center for International Forestry Research. https://doi.org/10.17528/cifor/005418

Swindles, G. T., Morris, P. J., Baird, A. J., Blaauw, M., Plunkett, G., & Turner, T. E. (2018). Widespread drying of European peatlands in recent centuries. *Nature Geoscience, 12*(11), 922–928. https://doi.org/10.1038/s41561-019-0462-z

Tengö, M., Brondizio, E. S., Elmqvist, T., Malmer, P., & Spierenburg, M. (2014). Connecting diverse knowledge systems for enhanced ecosystem governance: The multiple evidence base approach. *Ambio, 43*(5), 579–591. https://doi.org/10.1007/s13280-014-0501-3

Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic analysis. In C. Willig & W. Stainton Rogers (Eds.), *The Sage handbook of qualitative research in psychology* (2nd ed., pp. 17–37). Sage.

Tilman, D. (1997). Biodiversity and ecosystem functioning. In G. C. Daily (Ed.), *Nature's services: Societal dependence on natural ecosystems* (pp. 93–112). Island Press.

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care, 19*(6), 349–357. https://doi.org/10.1093/intqhc/mzm042

Torraco, R. J. (2016). Writing integrative literature reviews: Using the past and present to explore the future. *Human Resource Development Review, 15*(4), 404–428. https://doi.org/10.1177/1534484316671606

Tracy, S. J. (2010). Qualitative quality: Eight "big-tent" criteria for excellent qualitative research. *Qualitative Inquiry, 16*(10), 837–851. https://doi.org/10.1177/1077800410383121

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., … Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine, 169*(7), 467–473. https://doi.org/10.7326/M18-0850

Tshimanga, R. M., Hughes, D. A., Trigg, M. A., & Kabuya, P. M. (2020). Understanding factors influencing wetland parameters of a monthly rainfall-runoff model in the Upper Congo River Basin. *EGU General Assembly 2020*. https://doi.org/10.5194/egusphere-egu2020-642

Turetsky, M. R., Benscoter, B., Page, S., Rein, G., van der Werf, G. R., & Watts, A. (2015). Global vulnerability of peatlands to fire and carbon loss. *Nature Geoscience, 8*(1), 11–14. https://doi.org/10.1038/ngeo2325

Turner, B. L., II, Skole, D., Sanderson, S., Fischer, G., Fresco, L., & Leemans, R. (2001). *Land-use and land-cover change: Science/research plan*. International Geosphere-Biosphere Programme.

Turner, B. L., Lambin, E. F., & Reenberg, A. (2007). The emergence of land change science for global environmental change and sustainability.

Proceedings of the National Academy of Sciences, 104(52), 20666–20671.

United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*.

United Nations Environment Programme. (2018). *Congo Basin Peatlands Initiative: Brazzaville Declaration*.

United Nations Environment Programme. (2021). *The UN Decade on Ecosystem Restoration 2021–2030: Scaling up restoration of degraded and destroyed ecosystems*.

United Nations Environment Programme. (2022). *Global peatlands assessment: The state of the world's peatlands*.

Václavík, T., Lautenbach, S., Kuemmerle, T., & Seppelt, R. (2019). Mapping global land system archetypes. *Global Environmental Change, 59*, 101979.

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences, 15*(3), 398–405.

Veldkamp, A., Polman, N. B. P., Reinhard, S., & Slingerland, M. (2011). From scaling to governance of the land system: Bridging ecological and economic perspectives. *Ecology and Society, 16*(1), 1.

Verburg, P. H., Neumann, K., & Nol, L. (2011). Challenges in using land use and land cover data for global change studies. *Global Change Biology, 17*(2), 974–989.

Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly, 26*(2), xiii–xxiii.

Wheeler, B. D., & Proctor, M. C. F. (2000). Ecological gradients, subdivisions, and terminology of northwest European mires. *Journal of Ecology, 88*(2), 187–203. https://doi.org/10.1046/j.1365-2745.2000.00459.x

Whittemore, R., Chase, S. K., & Mandle, C. L. (2001). Validity in qualitative research. *Qualitative Health Research, 11*(4), 522–537.

Whittemore, R., & Knafl, K. (2005). The integrative review: Updated methodology. *Journal of Advanced Nursing, 52*(5), 546–553.

World Bank. (2013). *Republic of Congo: Forest and economic diversification*.

World Bank. (2019). *Forest-smart mining: Identifying factors associated with the impacts of large-scale mining on forests*.

World Bank. (2020). *Democratic Republic of Congo: Country forest notes*.

World Wide Fund for Nature. (2021). *Congo Basin peatlands: A global carbon store under threat*.

Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research, 39*(1), 93–112.

Xu, J., Morris, P. J., Liu, J., & Holden, J. (2018). PEATMAP: Refining estimates of global peatland distribution based on a meta-analysis. *Catena, 160*, 134–140.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage.

Zedler, J. B., & Kercher, S. (2005). Wetland resources: Status, trends, ecosystem services, and restorability. *Annual Review of Environment and Resources, 30*, 39–74. https://doi.org/10.1146/annurev.energy.30.050504.144248