SUDD PEATLANDS AND CLIMATE CHANGE
STATUS, POLICY AND FINANCE

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Summary

This report is the third and last deliverable of the project 'Climate Change mitigation and adaptation potential and Peatland wise-use options in the Sudd Wetlands (in short: the Sudd Peatland Dialogue). This project is part of the baseline studies on the Nile wetlands and their ecosystem services, particularly in relation to climate change mitigation, and their integration in river basin planning. The report presents the results of a- Sudd peatlands ground survey and b- Sudd peatlands dialogue and the evaluation of relevant policy and financing instruments.

Background

Peatlands play an important role in climate change mitigation and adaptation (IPCC, 2021). Despite covering only 0.3 % of the land, peatlands contribute annually 2 GtC, which is about 5 % of the annual global CO_2 emissions (Joosten, 2009). These emissions are driven mainly by land use conversion and drainage of peatlands for agriculture, infrastructure, peat extraction, etc (IPCC, 2014). Tropical peatlands also contribute to climate change, despite their limited extension in comparison to peatlands in the northern hemisphere (Joosten, 2009; Page et al., 2011). Peatlands generally, and tropical peatlands particularly, also provide other ecosystem services relevant for climate change adaptation, e.g. water and flood regulation and biodiversity (Joosten, 2016).

A tropical peatland's carbon stock per hectare is about 10-15 times higher than a tropical rain forest on mineral soil (Figure 1; Parish et al., 2008). Carbon stocks in tropical peatlands have received more attention over the last decade (e.g. Joosten, 2009; Yu et al., 2010; Page et al., 2011). Recent estimates of the extent of tropical peatlands range between 30 - 45 million hectares (ha) (Sorensen, 1993; Solomon et al., 2007; Page et al., 2011) and 170 million ha (Gumbricht et al., 2017). These figures are based on best available science, but their range indicates the uncertainties involved.

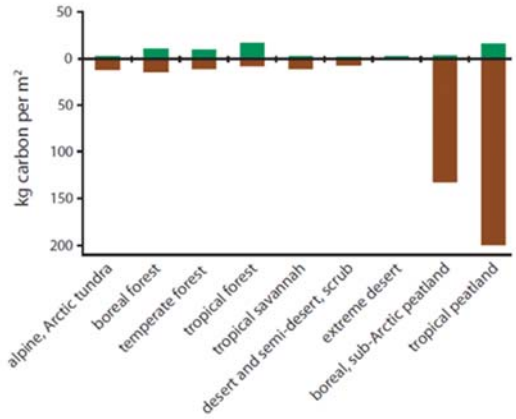

Figure 1. Carbon stocks for different terrestrial ecosystems (adapted from Victoria et al., 2012).

Peatlands cover about 3 Mha (million hectares) in the Nile Basin (Elshehawi et al., 2019a). The most important concentration of peatlands in the Nile Basin lies possibly in the Sudd wetlands, where it is estimated that the area of peatlands (organic soils) to be about 1.6 Mha (Figure 2). Such an area represents about 50 % of the total peatland area and 37 % of the total peatlands' carbon stock in the entire Nile Basin (Elshehawi et al. 2019a). The Sudd is also important to in regulating the rainfall patterns East Africa through evapotranspiration (Mohamed et al., 2005). The Sudd also acts as a barrier to the southward encroachment of the Sahara desert and its preservation (South Sudan NDC, 2021).

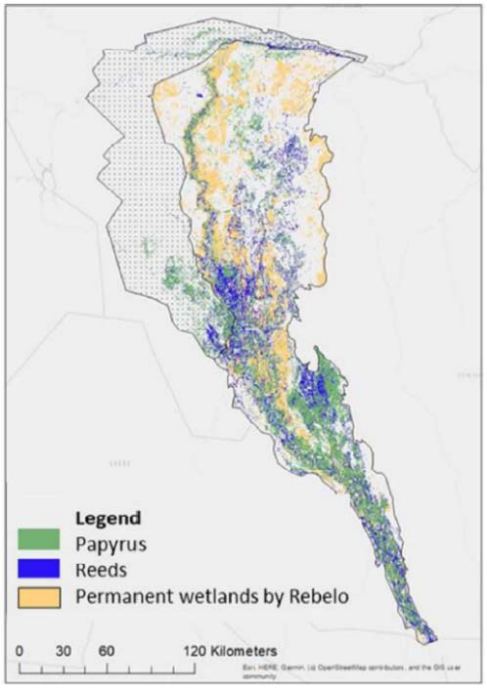

Figure 2. Extent of permanent wetland vegetation (Papyrus and Reeds) i.e. potential peatland areas (Source: Elshehawi et al., 2019a).

In this report, we aim to i) further our understanding of the peatlands distribution and carbon stocks of the Sudd peatlands, ii) identify potential climate change mitigation and adaptation scenario and priority actions and iii) recognise financing options suitable for priority actions.

Distribution and carbon stocks

In August 2021, we carried out a survey to ground-truth the mapping in 2019 (See Elshehawi et al. 2019a). The survey took place around the town of Bor (Figure 3) from 27-30th of August. Three local guides and assistants were hired to assist. This was also used as an opportunity to interview them on the developments around the visited sites and to raise awareness and capacity building.

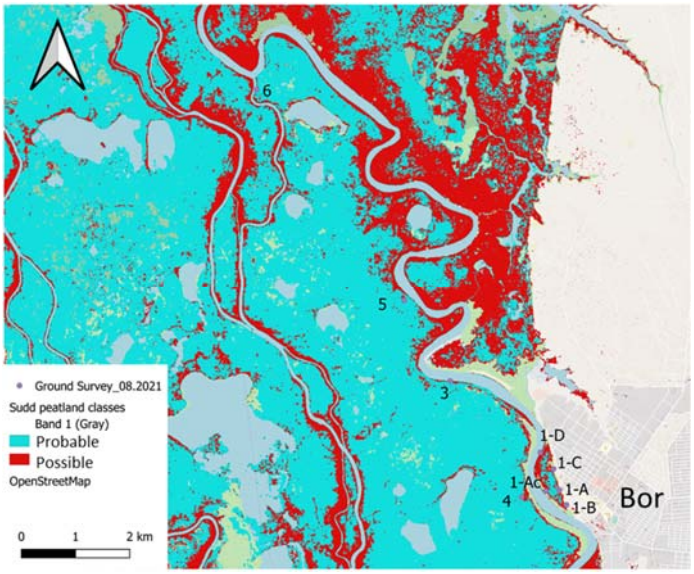

Figure 3. The map shows and the peatlands distribution and the points visited during the ground survey activity in August 2021 near Bor, South Sudan.

A total of six sites were visited using a speed boat except sites 1-A, 1-B and 1-C, which were accessible on foot. The sites visited had high water levels, due to the wet season, which lasts between June to October. Future ground surveys should take into account visiting in favourable conditions for accessibility, i.e. the end of the dry season between March to April. Many areas can be accessed then either on foot or with boat and shallow water access. In this ground survey, most of the access was limited to the riverine ones at the White Nile river banks. The lacustrine plains might be easier to access in the dry season, but also with small canoes.

It should be noted that this visit comes after extreme floods occurred in 2020, where the town of Bor was completely flooded. According to personal communications, the water levels at the moment are still higher than usual. The field assistants indicated that several sites (e.g. site 4) have been used prior to the flood as grazing land for cows, which were transported there, after burning the Papyrus

stands (Figure 4). After the flood these lands are now reclaimed by open water and Lilly, also some grasses are re-establishing (Figure 4).

In general it was noted that the conditions favouring peat accumulation are present, however, they are rather limited in places close to the river bank. At the river bank, the energy of the water flow does not allow peat precipitation from the floating mat (30 cm peat) to the soil (Figure 5). In stagnating areas behind the banks (e.g. Site 1), the floating mats are thicker and think peat layers with high mineral content (clay and sand) could be observed. It is expected that the swamp areas behind the White Nile river banks to be favourable for thicker peat accumulations.

Five samples were taken from the sites to analyse their carbon content using an Eijkelkamp peat corer. Each sample's wet volume and depth was recorded in the field. The sites description is available in

Annex 1.

Figure 4. Areas reclaimed by stakeholders in Bor for cattle grazing prior to 2020 flood events (Left). The floating mat peat appeared to be burnt (Right).

Figure 5. Peat in the papyrus mat after pressing (Right). The core at 350-400 cm depth with a gradient of clayey peat to clay from top to bottom (Left).

The peatlands in the Sudd appear to be of two main types riverine and lacustrine floodplains. Figure 6 shows a schematic of the peat accumulation in a profile on the basis of the field observation. Peat accumulation in papyrus stands takes place mainly in the mat where the peat is least humified and the thickness would range between 20-30 cm, the decomposing peat may then with time trickle down the water column to deposit at the bottom, where it is finer and more humified (Figure 5). The ground survey so far confirms that peat deposits in the Sudd are likely to be thinner, particularly in the riverine peat accumulations, than those seen in the Nile Equatorial Lakes region, where peat deposits may reach up to 20 meters (Elshehawi et al., 2019a).

Reeds and other tall grasses do not appear to be associated with peat accumulations. Future ground surveys should try to account for micro-relief to check if thick deposits can be found, particularly in areas with low energy water flow. This is likely to take place in the west of the White Nile river bank.

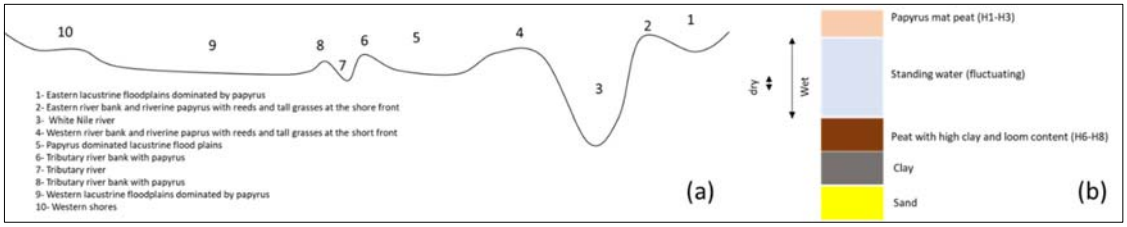

Figure 6. (a) A schematic of the peatland types distribution in a profile across the White Nile river and its banks and floodplains from the east to the west, and (b) A vertical schematic of the peat in the papyrus stand.

Climate change mitigation and adaptation

The Sudd peatlands are projected to have a carbon stock of about 1.5 to 3.6 GtC. This range is dependent on several factors: peatland area estimates, peat depth and carbon content. All of these factors need further ground surveys and research to quantify the carbon stocks in the Sudd peatlands. Furthermore, carbon sequestration of papyrus is rather high (Jones, 1997; Muthuri & Jones, 1997), which may lead to apparent high accumulation rates. But the real accumulation rates are still unknown. Accumulation rates may factor in potential climate change mitigation.

At the moment land use, fire and drainage, and associated greenhouse gas emissions, are expected to be extremely low. The observed changes around Bor remain minor and are limited to the river banks. This does not mean that threats to the carbon stocks, i.e. business-as-usual scenarios, are absent. For instance, two thirds of Jonglei Canal has been completed. While the project remains incomplete, the unstable hydro-politics in the region may stimulate re-activating the project. The risks of such a scenario are immense and may lead to large parts of the Sudd becoming a net source of greenhouse gases. If only 20 % of the peatland area in the Sudd are drained by such a project, this would lead to annual emissions of about 5.8 Mt CO_2-eq. This is closely connected with the intention also mentioned in South Sudan's first NDC to further develop hydro-power infrastructure to increase green energy supply. It should be safeguarded that by these installations no peatlands are drained e.g. by extra channels and emissions initiated from peat degradation.

Other threats that are currently present in development plans include conversion to grazing land, rice paddy, oil exploration and infrastructure, e.g. roads. Climate change is also an unquantified risk, thus far. South Sudan is vulnerable to climate change and fire occurrence is increasing in the dry periods, which may amplify the slash and burn practices of local fishermen and farmers looking for grazing land (South Sudan NDC, 2021).

The Sudd peatlands may play also important roles in the face of climate change. In particular water regulation in the essence of withstanding extended periods of drought and flooding may be important for the local communities subsisting in the Sudd wetlands. This is owing to the peat acting as a sponge property (Price et al., 2016). They also contribute to regulation of micro temperature zones providing

cool air (Pacini et al., 2018), while also contributing to regional rainfall patterns in the highlands through evapotranspiration (Mohamed et al., 2006). Papyrus wetlands in general also provide other adaptation services by acting as habitat for the reproduction of insects, fishes and birds, including a small number of endemic species (Pacini et al., 2018).

International commitments and local considerations

South Sudan is a party to the United Nations Framework Convention on Climate Change (UNFCCC). The ultimate objective of the Convention is

- to achieve stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system
- within a time-frame sufficient to allow ecosystems to adapt naturally to climate change,
- to ensure that food production is not threatened and
- to enable economic development to proceed in a sustainable manner.

To achieve the objective of the Convention, all Parties are obliged to communicate reliable, transparent and comprehensive information on GHG emissions, climate actions and support.

South Sudan is a non-annex I party to UNFCCC and has ratified the Paris Agreement on 22 April 2016. The Paris Agreement (2015) is an agreement within the UNFCCC with the goal to keep the increase in global average temperature to well below 2 °C above pre-industrial levels; and to pursue efforts to limit the increase to 1.5 °C. The Nationally determined contributions (NDCs) are the heart of the Paris Agreement. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement requires each Party to prepare, communicate and maintain successive NDCs. NDCs are submitted every five years and in order to enhance the ambition over time the Paris Agreement provides that successive NDCs will represent a progression compared to the previous NDC and reflect its highest possible ambition.

South Sudan submitted its first NDCs on 23/02/2021. It included the LULUCF sector in which peatlands feature as one of the major fields for mitigation and an uttermost importance of Sudd Wetland for climate change adaptation and biodiversity, but not mentioned peatlands specifically. It clearly says that GHG emissions are mainly from the land use, land-use change and forestry (LULUCF) and agriculture sectors, but detailed numbers on actual emissions are largely missing. South Sudan commits to conduct a national GHG inventory, which should include LULUCF emissions as well.

Emissions from peatlands are reported under the LULUCF sector (Land Use, Land Use Change and Forestry, Article 3.4 of the Kyoto Protocol), but almost exclusive attention has been given to REDD+ rather than to peatlands, which can be seen in South Sudan's NDCs as well. This said, in South Sudan forests and peatlands go hand in hand, and follow a similar fate of deforestation, drainage and

degradation. Emission reducing activities on peatlands, such as rewetting, restoration and low carbon management, may contribute substantially to climate change mitigation. Developing a methodology for Monitoring, Reporting and Verification ('MRV') of GHG emissions and carbon stock changes of peatlands for South Sudan is necessary for the implementation of and reporting on international commitments. Moreover, such methodological scheme is needed to substantiate and evaluate carbon credit projects, e.g. for the voluntary carbon market.

South Sudan's first NDC mentions

Whereas the term 'peatlands' is widely known, the IPCC guidance uses the term 'organic soils' (cf. IPCC 2014), because no IPCC definitions for peat or peatland exist. Peatland and organic soils overlap widely, but organic soils also include some lower carbon containing soils that under most (national) approaches would not serve as peatland.

Reporting emissions and removals from peatlands under LULUCF requires

a) information on peatland/organic soil occurrences

b) "activity data", i.e. areal data with respect to land-use categories on these organic soils

c) "emissions factors", i.e. area-related values of annual emissions and removals for the respective land-use categories.

The required national peatland/organic soil base maps are for most of the Nile Basin countries available from the Greifswald Mire Centre (Elshehawi, 2019a[1]), but additional ground surveys are recommended to further substantiate these mainly remotely elaborated maps.

The first step to assess anthropogenic emissions from peatlands is to determine whether the peatland is drained (step 1 in Figure 7), as drained peatlands have substantially more (and different) emissions compared to undrained. The peatland water level may have been lowered directly by larger channels or smaller ditches, or indirectly by groundwater abstraction or upstream damming. If the peatland is drained, the overall default IPCC emission factor of 14 t C ha-1 yr-1 for managed tropical peatlands can be applied to roughly estimate the annual emissions (step 2 in Figure 7).

Land-use maps that comply with the IPCC land-use categories and that have sufficient resolution to assess land-use on peatlands are currently largely unavailable. Once a land-use map is available, the appropriate Tier 1 emission factor (IPCC 2014) for each respective land-use category should be applied (Tier 1; step 3 in figure 7).

[1] https://nilebasin.org/information-hub/technical-documents/83-assessment-of-carbon-CO_2-emissionsavoidance-potential-from-the-nile-basin-peatlands/file

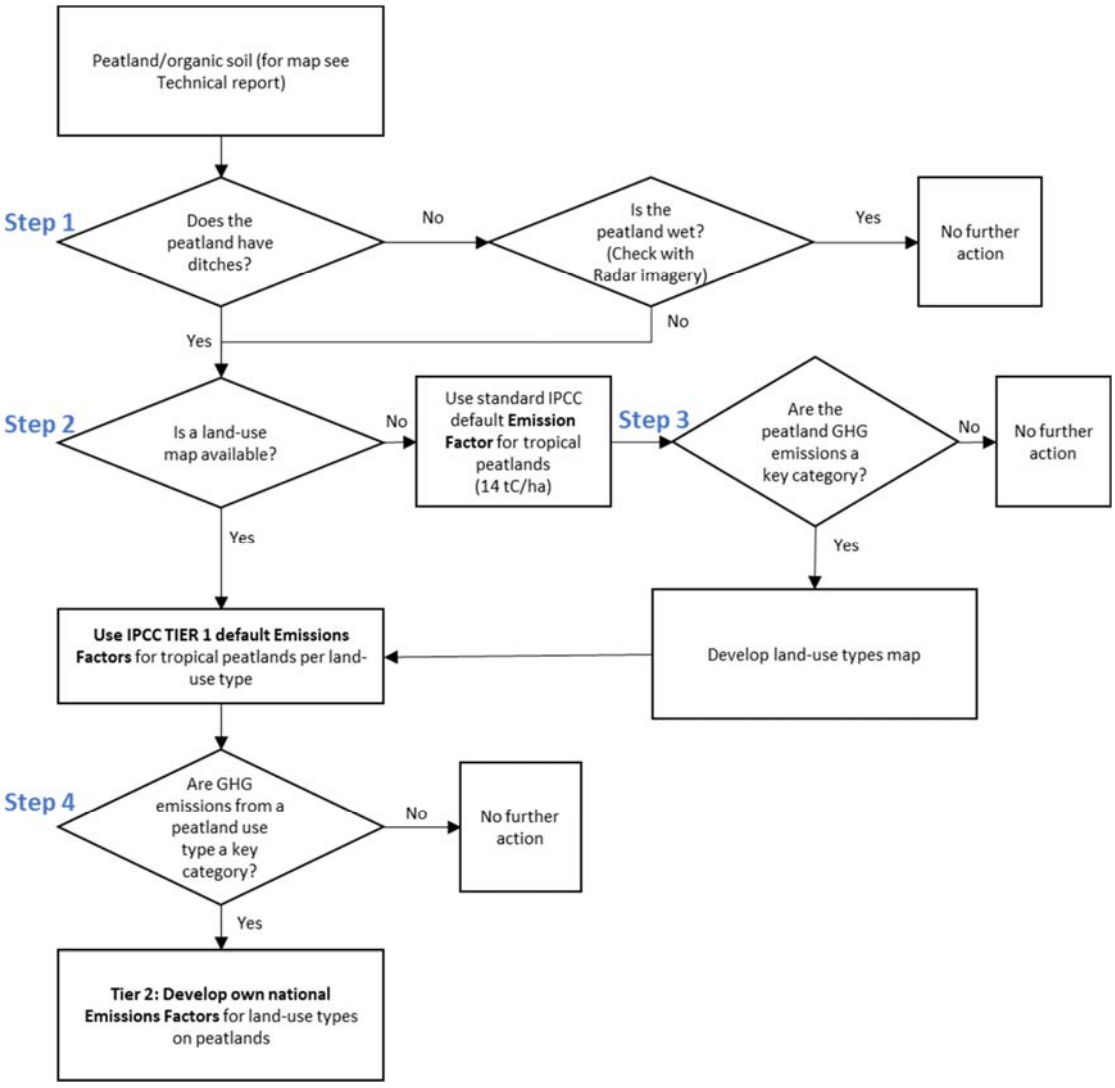

Figure 7. Monitoring, reporting and verification decision-making tree for emissions from peatlands.

The thus calculated peatland emissions may constitute for most NBI countries a considerable proportion of their total national emissions (cf. Technical report WP 1). Countries where peatland-use is "key category" cannot limit their reporting to using the Tier 1 default emission factors, but should develop own country specific Tier 2 emission factors (Tier 2; *step 4 in* Figure *7)*.

Developing own national emission factors requires measuring GHG emissions from different land-use categories over longer time to account for (largely weather induced) annual variability. For measuring two different approaches are available: 1) direct GHG measurements, and 2) indirect estimating CO_2 emissions by using 'proxy' data, e.g. peat subsidence in drained areas (IPCC, 2014).

Financing instruments and opportunities

There are three major funding frameworks for project-based peatland rewetting for climate change mitigation:

1. Bi- or multilateral international donor schemes
2. Commitment carbon market under the framework of the UNFCCC mechanism
3. Private voluntary carbon credit schemes

New, innovative frameworks are currently under development but have not reached the magnitude of the three main frameworks yet. They will be described in more detail below.

For developing and least developed countries such as South Sudan, pure carbon finance should not be applied to avoid negative side effects and eventually risking the sustainability and long-term consistency of any such project. Additional benefits should be incorporated, especially social, economic and environmental beside climate change considerations. They should be taken into account at the first stages of project development and site selection. For site selection, peatland distribution and status have to be well known. Peatlands can be classified into three major categories with different objectives and suitability for climate action projects:

1. **Pristine, undrained peatlands**: Focus on conservation to keep carbon in the ground, conserve habitat of biodiversity and secure other ecosystem services with the involvement of local people
2. **Drained, used peatlands**, not urgently needed for drainage-based subsistence food production: Focus on rewetting, involvement and possibly alternative wet agricultural use (paludiculture) by local people
3. **Drained peatlands required for subsistence food production** or for other reasons not easily rewet(able): Focus on climate-smart water management to slow down peat loss.

For climate action projects, site selection should prioritise on category 2, as the mitigation potential is the highest and local people can be involved in the project for mutual benefit. For detailed site selection an on-ground assessment of the following items should be performed:

- **Supportive social structure**: Rewetting projects only work with support or at least acceptance of local communities and their respective decision-making bodies (municipalities, village heads, self-governing structures etc.). Awareness can be raised by capacity building campaigns.
- **Clear land rights and ownership**: Lands within the project area must be clearly assigned to land owners and users. Traditional, unwritten customs of land-use without official titles have to be taken into account to avoid land grabbing in the name of climate action.

- **Current land-use and connected income from site**: In case of rewetting, opportunity costs for the ceasing of current, drainage- based land-use have to be calculated and compensated by the project to avoid impairing current land-users and their economic situation.
- **Potential alternative wet land-use**: To provide continuous income to sustain the livelihoods of current land-users, alternative (wet) land-use options have to be explored and support schemes (such as extension services, consultation, technology transfer, market accessibility etc.) integrated in the project design.

After site selection, a more comprehensive cost-benefit analysis (CBA) on the impact of the project on socio-economic factors, especially sustainable livelihood for local communities, is strongly advisable. This analysis should also include environmental co-benefits (ecosystem services) like water purification, local cooling effect, biodiversity etc., which is also relevant for reporting the adaptation part of the NDC. To incentivise change in local communities, a project should only be realised if the benefits in the project scenario exceed those in the business-as-usual scenario. Criteria to be incorporated in a CBA are listed in table 1.

Table 1: Selected benefits and costs of peatland rewetting projects.

Benefits	Costs
GHG reduction (avoided t CO_2/ year)	Investment Costs
New products (e.g. from paludiculture)	Opportunity costs
Traditional practices are further developed	Transaction costs
Other Ecosystem services	Negative side effects like water-borne diseases

Livelihood option from wet peatlands like in the Sudd wetlands can include traditional practices but potentially also modern applications. Main crop for this kind of wetland utilisation, which is also called paludiculture, is papyrus, which is currently under investigation for different value chains. These include use as sustainable bio-energy to reduce use of fuel wood resources and therefore counteract deforestation (Figure 8). Other options are use as material for handicrafts, furniture, construction materials as boards, roofing or insulation, packaging materials and many others

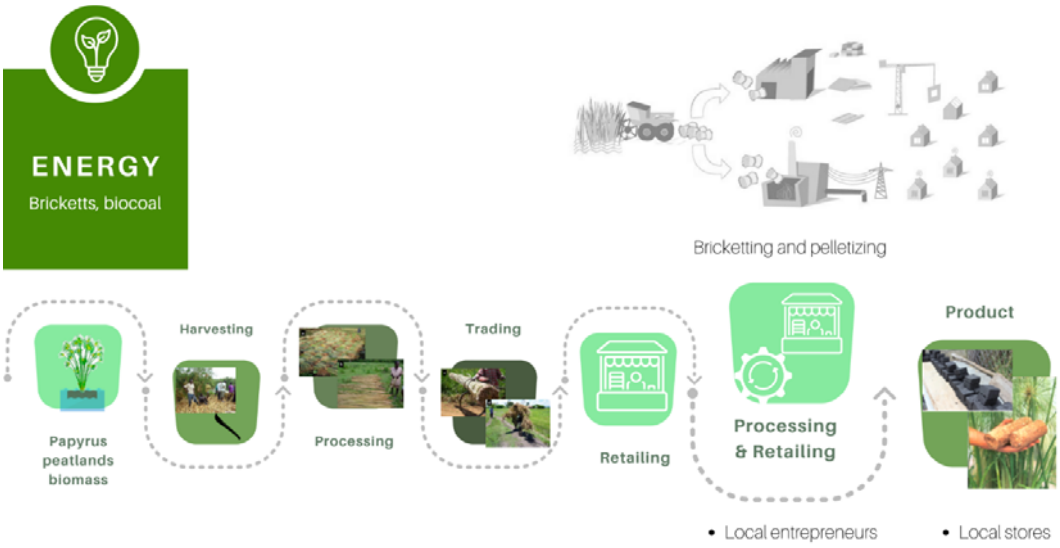

Figure 8. Potential value chain for use of papyrus biomass harvested in paludiculture from wet peatlands as bio-energy fuel in form of briquettes or pellets.

3.1. Bi- or multilateral international donor schemes

Bi-or multilateral donor schemes are public funded programmes financed through international donors. The legal basis under Paris Agreement is its Article 6 describing International cooperation. Article 6.2. of the Agreement offers Parties the opportunity to cooperate with one another. The main objective of the cooperation mechanisms is to support parties in their NDC implementation. According to the Paris Agreement, the mechanisms should be designed in a way that they not only assist the process of achieving existing reduction targets, but also raise ambition in future efforts. How the mechanism will work exactly is under negotiation and remains vague so far. Main steps are expected to be negotiated on the UNFCCC COP26 in Glasgow in November 2021. With respect to climate change adaptation and the issue of Loss and Damage, it is advised to emphasize in the NDCs LULUCF-related interventions, including for national planning purposes that on the one hand mitigate the risk of global warming and on the other hand build up resilience in the countries and of local communities.

No NBI country treats peatland GHG sources and sinks appropriately in their current LULUCF budgets nor includes peatland, wetland or soil carbon targets in their NDCs (if they recognise LULUCF at all…). To receive international support via Paris Agreement's Article 6 mechanisms, peatlands and their GHG balances should be incorporated in the relevant NDCs in the next updating cycle. Possible fear that inclusion might negatively affect the options for market-based climate change mitigation (New Market Mechanism, NMM) and voluntary carbon market schemes should consider that including these emissions also includes a revision of the baseline, leading to more and more realistic mitigation

options. Furthermore, it is foreseen that public international financial support will be much larger than private funded initiatives.

Besides in NDCs, the inclusion of wetlands and peatlands as key ecosystems for climate change adaptation in National Adaptation Programmes of Action (NAPAs) is essential for climate finance. NAPAs enable LDCs to identify priority activities that respond to their urgent and immediate needs with regard to climate change adaptation. Peatlands are important for adaptation by providing water during droughts, by mitigating floods and retaining peak water, by improving landscape hydrology by rising groundwater tables in connected watersheds and therewith combating desertification, and by providing evapotranspiration cooling. South Sudan mentions water as one of the key issues for adaptation in its NDC and specifically mentions wetland management, which also includes peatland management as one of the measures. Also it highlights the overarching importance of the Ramsar site of international importance, the Sudd Wetlands, as the most important ecosystem to buffer adverse effects of climate change on South Sundanese communities.

Peatland actions should be prioritised for funding and implementation as they provide - in most cases - a double win for climate change mitigation and adaptation. Relevant frames under which activities on wetlands/peatlands management could be funded South Sudan include:

1. The **Green Climate Fund (GCF)**: Set up in 2010, GCF aims to promote low-emission and climate-resilient development pathways by providing support to developing countries to limit or reduce their GHG emissions and to adapt to the impacts of climate change. GCF is an operating entity of the Financial Mechanism of the UNFCCC and the Paris Agreement. www.greenclimate.fund. A good example of a GCF funded peatland-related plan is the project “Building the Resilience of Wetlands in the Province of Datem del Marañón, Peru”, implemented by the Peruvian Trust Fund for National Parks and Protected Areas (Profonanpe) https://www.greenclimate.fund/projects/fp001
2. The **Project Preparation Facility (PPF)**: Within the GCF, funding is available for project preparation activities and climate finance “readiness”. For project preparation support, the Project Preparation Facility (PPF) supports Accredited Entities (AEs) in project and programme preparation. AEs are listed here: https://www.greenclimate.fund/how-we-work/tools/entity-directory
3. The **NDC Supporting Facility**: This facility is a multi-donor trust fund created and designed to facilitate the implementation of the Nationally Determined Contributions in the frame of the NDC partnership. It is operated by the World Bank (https://ndcpartnership.org/) and more information is available under https://www.worldbank.org/en/programs/ndc-support-facility
4. The **NDC Partnership** (https://ndcpartnership.org/) also offers a Climate Finance Explorer, which can help to identify suitable additional funding schemes:

https://ndcpartnership.org/climate-finance-explorer#navi

5. The **International Climate Initiative (IKI)**: IKI, launched in 2008 by the German Ministry for Environment (BMU), supports measures in developing and emerging countries. In addition to climate protection, it also covers measures to adapt to climate change and measures to protect biodiversity of relevance to climate change. Peatlands are well represented in the portfolio and one of the targeted nature-based solutions. IKI has country and regional specific calls, but also thematic calls including wetlands and peatlands. www.international-climate-initiative.com

6. The **Global Environmental Facility (GEF)**: GEF is supporting environmental projects including climate action and biodiversity conservation with various targeted programmes (www.thegef.org). Soon GEF will operationalise the new Least Developed Countries Fund (LDCF) designed to address the special needs of the Least Developed Countries under the UNFCCC, focusing on adaptation measures. https://www.thegef.org/topics/least-developed-countries-fund-ldcf

7. The **2050 Pathways Platform** with the objective to build climate resilience for communities, farmers and workers along value chains, funded by the Europe Climate Foundation, the Ikea Foundation, and the Hewlett Foundation. http://www.2050pathways.org

8. The **Blue Growth Initiative**, aimed to reduce CO_2 emissions by 10% in 5 years and 25% in 10 years and reduce overfishing by 20% in 5 years and 50% in 10 years in 10 developing countries (FAO)

9. The **Bonn Challenge**, a global effort to restore 150 million hectares of the world's deforested and degraded lands by 2020 and 350 million hectares by 2030.

http://www.bonnchallenge.org/

10. The **Climate Ambition Alliance (CAA)**. The CAA was announced at the UN Secretary-General's Climate Summit in September 2019 and brings together nations upscaling action by 2020, as well as those working towards achieving net zero CO2 emissions by 2050. The CAA currently includes 65 countries and the EU, 10 regions, 102 cities, 93 businesses and 12 investors. https://unfccc.int/news/call-by-high-level-climate-champion-to-join-the-climate-ambition-alliance-at-cop25

11. The **Great Green Wall for Sahara and the Sahel Initiative (GGWSSI)** with the goal to restore 50 million hectares of land, sequester 250 million tons of carbon and support 300 million people across the Sahel by 2030. https://www.greatgreenwall.org/

An option for the NBI to tap into these large international funding schemes would be to set up a climate financing facility to attract and facilitate funds. This facility could consider becoming a regional executing agency to the GEF to be able to receive funds and facilitate peatland related climate projects.

South Sudan is so far only poorly represented in al these multilateral initiatives and platforms and cannot receive substantial funding from these sources for climate action, which should be changed in the future. In addition, cooperation with the other NBI countries could help in this regard.

Experiences from peatland projects from other parts of the world show, that on the one hand larger scale projects with a volume of several million US-dollars are preferred by funding agencies to limit administrative burdens, but that on the other peatland projects are more successful if they are grounded and implemented in local set-ups like communities or municipalities. The latter facilitates careful site selection, integration of needs of local people and therewith their awareness and ownership. To channel large scale funding down to the local level, NBI (with help of a finance facility) could set-up a small grant programme for community peatlands projects, to which communities can apply in a competition following clear guidelines. Winning projects can be supported with technical and administrative capacity building, technology transfer, MRV training etc.

3.2. Financing options under the UNFCCC

Under the Kyoto Protocol's flexible instruments, the Clean Development Mechanism (CDM) is the most important mechanism to credit emission overshoot demands from Annex I countries by project-based emission reductions in Non-Annex I countries. The CDM has been successful in leveraging project-based climate finance interventions but has important limitations in the LULUCF sector, especially with respect to the non-eligibility of peatland rewetting as a project activity. The Marrakesh Accords permit within the LULUCF sector only afforestation and reforestation (A/R) for CDM actions, because of assumed permanence and MRV-ability constraints of other land-use related action. Indeed, land-use based carbon sequestration can easily be reversed by land-use change, fires, and other disturbances. Non-permanence, however, does not apply to emission avoidance as CDM acknowledges for avoidance projects in the energy and industry sectors. Land-use based avoidance activities, such as REDD+ and peatland rewetting, are, however, still wrongly treated like land-use based sequestration projects, not like industry-based avoidance projects (Joosten et al. 2016).

The new rules for market-based mechanisms, as mentioned in Article 6.4. of the Paris Agreement, are still under negotiation and no clear trend is visible. It is likely that some elements of the previous CDM will be adopted and modified with new elements. One way could be broadening CDM by including forest and peatland-related measures. This option finds support from a range of developing countries, and proposals have been presented to address the problem of permanence through buffer and/or insurance schemes. All future mechanism should incorporate a high level of environmental and social integrity, to be achieved by broad transparency and should guarantee that climate-related funds are spent for actions contributing to climate action.

A specific UNFCCC mechanism for the LULUCF sector with a clear focus on forest and forest management is "Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries" (REDD+). So far most REDD+ strategies focus on forest biomass and largely neglect soil carbon stocks although UNFCCC has decided that significant pools should not be omitted from forest reference emission levels or forest reference levels, and in many tropical countries emissions from drained peatland indeed cause the majority of emissions in the land-use category 'forest land'. Therefore, REDD+ programmes should always include soil carbon stocks. In negotiations, it is discussed to expand the REDD+ mechanism with a dedicated peatlands window. This window would treat peat forest conservation and restoration as REDD+ eligible activities, include continued land-use in the calculation of reference levels, build a robust peat spatial mapping and peat drainage and restoration MRV framework, and exclude all activities from the REDD+ scope that cause the drainage or degradation of peat soils. South Sudan should be aware of their peatland forest carbon stocks and value them in respective programmes.

3.3. Voluntary carbon markets

Leveraging private funds for climate action mostly happens through voluntary carbon market schemes. Across standards, most credit demand is corporate, led by socially and environmentally responsible corporate decision-making (Goldstein, 2016). Standards follow the concept of results-based finance, a robust framework of transparency – specifically the procedural guarantee of a transparent and independent review – as well as the principles of additionally, permanence and avoidance of leakage. Host countries have to create a legal framework for voluntary carbon credits, which fulfil and guarantee the high standard of principles (cf. Joosten et al., 2016; Umweltbundesamt, 2018).

The Paris Agreement intends to lead to a regulated world in which each country accounts for all its GHG emissions across sectors under the umbrella of the NDCs and sets own reduction targets ("caps"). This means that any voluntary initiative will ultimately show at the national accounting level: An emission reduction achieved through voluntary action would allow the relevant country to either claim the relevant emission reduction as a compliance effort under the national target or to monetize it (e.g. in line with the emissions trading mechanisms of the Paris Agreement, in particular Article 6.2). Here lies the inherent risk of double counting of emission reduction allowances with voluntary carbon schemes, when the allowance is first sold to a private entity to compensate for emissions and secondly used for the national reporting of the host country. As long as the host country does not account for

LULUCF and the included peatland emissions - as will be the case for the foreseeable future in the NBI countries -, there will not be a problem. Voluntary carbon schemes can thus in the NBI countries top-up national ambitions (Umweltbundesamt 2018).

But ultimately, to avoid double counting, voluntary crediting will only be effective under the condition that the host country makes a "corresponding adjustment" (cf. Article 6 of the Paris Agreement), so that the voluntary mitigation benefit adds to the country's overall target. Every five years, the revision of the country's NDC targets should thus account for such voluntary achievements.

Another concept for climate finance intervention in general, and carbon project development in particular, is the principle of additionally. Additionality in the context of project development means that the emission reduction/carbon sequestration would not have occurred in the absence of carbon market incentives, i.e. that it was not the most likely or profitable option and that there were barriers for its implementation. In most cases, this criterion will be uncomplicated, as project-based peatland rewetting interventions in South Sudan context would only happen with private funding from the voluntary carbon scheme.

Permanence could be a higher practical risk in South Sudan. Peatland rewetting can easily be reversed as experiences from projects show. Lack of involvement of local communities, lacking alternative income sources to compensate for lost income from drained peatlands, missing awareness and capacity and, last but not least, poor maintenance of installations after project's implementation and finalization can lead to re-drainage and the stopping of emission reduction effects. Whereas reversal in avoidance projects does not jeopardize the already achieved emission reductions (see above), the prevailing opinion will require state-guarantees and substantial buffers (of unsold emission allowances) to cover possible "reversals".

The combination of voluntary carbon projects with the development of further alternative wet utilisation options, e.g. papyrus paludiculture for biomass for bio-energy or construction material, can minimise the presumed risk of non-permanence as local communities will be provided a long-term, sustainable source of income and will therefore be incentivised to accept and maintain the rewetting structures for water management in their own interest. Such approach has not been implemented yet but it is worthwhile pursuing such system in South Sudanese context. More research and development (R&D) will be needed to examine various paludiculture utilisation schemes, including the processing and marketing of biomass and products.

Such approach would also reduce another high risk in South Sudan: leakage. Leakage is the increase of GHG emissions or decrease of removals outside the project area because of the carbon project's interventions. In areas with high land-use pressure on peatlands like in South Sudan, rewetting and

abandonment of previously drainage-based used lands in the frame of a carbon project could easily result in drainage of new lands and therefore clear leakage. The concrete determination of this and other forms of leakage is, however, arduous and various standards have established rather different and complex leakage accounting modules. An appropriate leakage mitigation approach could be the development of paludiculture systems to provide local communities with alternative livelihood options on rewetted peatlands.

3.4. Innovative Finance Instruments

New, innovative finance instruments have been developed in the last years to leverage sufficient funds for large-scale peatland rewetting. Frontrunner is Indonesia due to the high urgency to counteract peat fires and land degradation. South Sudan's NDC mentions the development of "payment for Ecosystem Services" schemes, which can not only reduce emissions from deforestation and forest degradation, but also be applied to peatlands of the Sudd.

The Peatland Partnership Fund (Dana Mitra Gambut Indonesia) is a small grant fund for community-based peatland conservation, restoration and sustainable development in Indonesia, which was endorsed by the Indonesian Peatland Restoration Agency (BRG) under the facilitation of Wetlands International. It operates through calls for proposals with clear objectives, procedures and progress monitoring. Each grant will be maximum of Rp. 300 million (~$20.000) for a maximum duration of 24 months project implementation (Wetlands International 2017).

The Indonesian Government set up Indonesia's Green Bond & Sukuk Initiative in 2018 to attract funding from private investors and to align with Indonesia's aim to achieve SDGs goals. The scheme was developed with support of the UN Development Programme in 2014. It involves a detailed assessment of the climate benefits of projects undertaken by the six-line ministries related to the climate change mitigation action plan (RAN GRK) including Ministry of Agriculture, Ministry of Environment and Forestry, Ministry of Industry, Ministry of Transportation, Ministry of Energy and Mineral Resources, and Ministry of Public Work and Housing. The bonds are sold on the official bond market with a total value of $1.25 billion and a profit rate of 3.75 % with five-year state insurance. The investors distributed around the globe (32% Islamic market, 25% Asia, 15% EU, 18% USA and 10% Indonesia). The raised funds are spent for 'eligible green projects' based on the Green Bond and Green Sukuk Framework which includes peatland restoration.

Policy recommendations

From this assessment and the interaction at the workshop on peatlands in South Sudan on 26/08/2021 in Juba, we draw the following concrete recommendation for future policy development on peatlands and climate change in South Sudan:

- Mitigation in NDC: LULUCF emissions are recognised as one of the main sector in South Sudan. Other stocks and emissions than forest should be identified more transperaently, including emissions and reductions from peatlands/organic soils.
- A better inventory of peatlands/organic soils, esp. the soils of the Ramsar site of Sudd Wetlands should be performed to get a better estimate of carbon potential for South Sudan.
- All infrastructure project including hydro-power should take peatlands and potential threats and CO_2 emissions into account.
- Adaptation in NDC: Actions to reduce vulnerability of the population to climate induced hazards by ecosystem-based adaptation measures are high on the agenda, water resources and security play crucial roles for South Sudan. To enhance access to water in light of growing climate threats through sustainable wetland management should include specific properties of peatland ecosystems and options for sustainable wet use in paludiculture.
- Recognising Ramsar site of international importance Sudd Wetlands specifically in the NDC is a very good starting point to also address peatlands in the Sudd as they play key role in carbon storage, water buffering and purification and biomass grows for sustainable value chains. A more in-depth inventory of the peat distribution in the area is important to get a better idea of appropriate type and scale of interventions.
- As South Sudan's NDC mentions the development of "Payment for Ecosystem Services" schemes and other nature-based solutions connected to peatlands, these systems should be developed. Key aspects is a good inventory of distribution and MRV of specific services. Such R&D work should be pursued with international donors as it lays the basis for future financial options to support ecosystem conservation and rehabilitation benefiting communities and ecosystem-based adaptation in South Sudan
- In South Sudan, pure carbon finance will not work. To avoid negative side effects for communities and ecosystems, cost-benefit assessments should be performed at first stages of project development and site selection. They should incorporate additional social, economic and environmental benefits other than carbon (Ecosystem services) to ensure sustainability and long-term consistency.

- Livelihood options from peatlands biomass like papyrus are promising avenues to improve acceptance and support by local communities for peatland measures and safeguards long term sustainability and continuance.
- As international financial support will focus on fields and targets mentioned in NDCs and other internationally recognised policy documents, peatlands should be mentioned and prioritised for actions for funding and implementation. They provide multiple win for climate change mitigation and adaptation. Mentioning peatlands in South Sudanese NDC Implementation Plan, environmental policies like for water and biodiversity would create good backup.
- Becoming member of regional and thematic partnerships like Global Peatlands Initiative (GPI) (https://www.globalpeatlands.org/) would facilitate attention by international donors and networking to learn from best practice examples from other countries globally.

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Annex 1

Description of the sites visited during the ground survey near the town of Bor, South Sudan in August 2021.

Name	description	Sample	Sample depth	Volume
Bor 1-A	Water to grass and then papyrus. Bubbles of gas are released upon walking over, with sulfur smell released. Sand then clay then organic floating area. Under the papyrus: mat (30 cm), water (157 cm) and peaty clay then clay at 168	yes (Label: Bor Ac-1 and Ac-2)	158-161 & 165-168	3.5325
Bor 1-B	Gas bubbles and sulfur smell at the papyrus. Mat up to 30 cm and water up to 138 cm then clay. plant remnants can be felt in the water (hard to capture)	no		
Bor 1-C1	Papyrus edge (no smell or gas). The site was excavated to build a dyke to protect against flooding and used now for fishing and cleaning. Sand only at the bottom.	no		
Bor 1-A2	Papyrus bank on the main White Nile. Mat thickness about 30 cm. Water column is 350 cm and core taken from 350-400 cm. 350-365 clayey peat, then clay (very soft and dark becoming grey at the bottom).	yes (Label: Bor Ac-c)	355-360	5.8875
Bor 1-D (2)	Papyrus mat, core to 190. 30-177 water. 177-190 sand with organic matter. Disturbed site by clearing for grazing (in the dry seasons), after 2020 floods covered with water again.	no		
Bor 3	Papyrus mat (30 cm), 30-350 water, 350-400 Peaty clay. plant remnants can be felt in the water (hard to capture)	no		
Bor 4	Papyrus mat (30 cm) H1-H3 peat. plant remnants can be felt in the water (hard to capture)	yes	20-30	157
Bor 5	Mat (30 cm), 136 water, 136-141 Peat with large plant remnants- dark grey, 141-147 peaty clay-small plant remnants- dark grey, 147-149 clay (lighter grey). plant remnants can be felt in the water (hard to capture)	yes	136-141	5.8875
Bor 6	Floating mat, clay at 350, sulfur smell strong and plant remnants can be felt in the water (hard to capture)	no		