Convention on Wetlands

Ramsar

Guidelines for inventories of tropical peatlands to facilitate their designation as Ramsar Sites

Background

Ramsar Resolution XII.11 on *Peatlands, climate change and wise use: Implications for the Ramsar Convention* asked the Convention's Scientific and Technical Review Panel (STRP) to develop "guidelines for inventories of peatlands for their designation as Wetlands of International Importance". The STRP recommended in its 2016 to 2018 work plan to focus on tropical peatlands, which face rising rates of degradation and loss, and the Standing Committee identified this task among the STRP's highest priorities. This Briefing Note provides scientific and technical guidance to assess the location, extent, peat depth and quality, and drainage status of tropical peatlands.

Purpose

This Briefing Note aims to support wetland managers in tropical countries by providing step-by-step guidance on how to identify, select and inventory tropical peatlands for their possible designation as Ramsar Sites, using Ramsar Sites designation Criterion 1 (if a peatland is "a representative, rare, or unique example of a natural or near-natural wetland type") including an argument about climate regulation and carbon storage capacity, and Criterion 2 (if a peatland "supports vulnerable, endangered, or critically endangered species or threatened ecological communities").

Peatlands trap and store carbon, help regulate water cycles, purify water and support a wealth of biodiversity. They cover an estimated 3 percent of the earth's land surface, yet they hold twice as much carbon as the world's forest biomass.

Despite their great ecological role, peatlands are being degraded and lost. Tropical peatlands in particular continue to be drained for the production of fuel, food and fibre, resulting in greenhouse gas emissions, fires, land subsidence, soil degradation and deteriorating surface water quality.

Knowing where tropical peatlands are located will facilitate their conservation, wise use and management. Tropical peatlands are believed to comprise between 10 percent and 12 percent of the total global peatland resource, but information about their extent and location is far from complete (Joosten, 2016).

This Briefing Note provides guidelines to wetland managers in tropical countries for conducting inventories of peatlands, which may also facilitate their designation as Wetlands of International Importance ("Ramsar Sites").

Key messages

- Avoid peatland drainage. The draining of tropical peatlands causes significant and continuous greenhouse gas emissions, destructive fires, soil degradation, subsidence, the loss of productive land and deterioration of surface water quality.
- Determine the location of tropical peatlands and map them. Tropical peatlands are widespread and diverse, and occur from sea level to high altitudes. Detailed and comprehensive information on their location and extent is scarce, but in most countries national and regional data enable a rapid initial identification of the main peatland areas.
- Detailed inventory and monitoring based on standard Ramsar guidance[1] should where possible be supplemented by field research to assess peatland extent and the thickness of peat. This will entail peat coring in the field and (if feasible) the application of earth observation technologies.

1 See Ramsar Handbook No. 13: *Inventory, assessment, and monitoring* and Ramsar Handbook No. 15: *Wetland inventory*, available at: https://www.ramsar.org/resources/ramsar-handbooks.

Relevant Ramsar documents

Resolution XIII.xx *Guidance on identifying peatlands as Wetlands of International Importance (Ramsar Sites) for global climate change regulation as an additional argument to existing Ramsar criteria*

Resolution XII.11: Peatlands, climate change and wise use: Implications for the Ramsar Convention

Resolution XI.14: *Climate change and wetlands: implications for the Ramsar Convention on Wetlands*

Resolution XI.8 Annex 2: Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance of the Convention on Wetlands (Ramsar, Iran, 1971) – 2012 revision

Resolution X.24: *Climate change and wetlands*

Resolution VIII.17: *Guidelines for Global Action on Peatlands*

Recommendation 7.1: *A global action plan for the wise use and management of peatlands*

Recommendation 6.1: *Conservation of peatlands*

Ramsar Fact Sheet No. 8: *Keep peatlands wet for a better future* (2015)

- Designate peatlands as Ramsar Sites. The designation of peatlands as Ramsar Sites can help increase understanding of their important ecosystem services, including global climate regulation, water purification and biodiversity conservation, thus fostering their more comprehensive conservation and restoration.
- Information on peatland type, peat type (botanical composition) and drainage impact strengthens Ramsar designation following Criteria 1 and 2, helps highlighting the biodiversity values of undrained peatlands, and facilitates the identification of site-specific restoration aims and activities.

Peat depth, carbon content and drainage impact are especially important if a peatland is to be designated as a Ramsar Site using the additional argument to Criterion 1 on climate regulation and carbon storage.

Introduction

Peatlands constitute approximately half of the world's wetlands (Tiner, 2009). Peat is dead, partly decomposed plant material stored long-term under waterlogged conditions. Intact peatlands provide many ecosystem services: they trap and store carbon; they help regulate water cycles; they purify water; and they support a wealth of biodiversity. They cover an estimated 3 percent of the earth's land surface, yet they hold twice as much carbon (around 500 gigatonnes) as the entire world's forest biomass (Crump, 2017). Information about their extent and location is far from complete (Joosten, 2016).

If peatlands are drained, the peat is exposed to the air, oxidized and released as carbon dioxide. The problem may be even worse, as drained peatlands are at risk from peat fires, which also emit large amounts of greenhouse gases. The emission of greenhouse gases is accompanied by subsidence, a lowering of the peatland surface, which increases the risk of floods and salt intrusion in coastal lowlands (Crump, 2017).

The rising demand for food, biofuels (including palm oil) and fibres (such as wood pulp) has led to the draining of tropical peatlands in Southeast Asia, Australasia, South America and Africa. Conversion of peatlands can lead to the loss of their valuable characteristics, including their particular biodiversity, their carbon storage capacity, and, if they are ultimately flooded, their "land" character. To avoid destructive use of these fragile ecosystems and assure their conservation and wise use, it is necessary to identify, locate and demarcate them.

This Briefing Note first provides general information on tropical peatlands and how to identify them with existing maps and data. It provides guidance on conducting inventories of tropical peatlands and possibly designating them as Ramsar Sites, taking into account their various characteristics. The accompanying *Guidelines for inventories of tropical peatlands to facilitate their designation as Ramsar Sites: Background notes* (see https://www.ramsar.org/bn9-background-notes-e) provides further details on:

- Key sources of information, including country-specific references;
- Tropical and subtropical terrestrial ecoregions with substantial peat and organic soil occurrences;
- The assessment of peatland degradation (from satellite imagery and by field work); and
- Practical peatland mapping.

Tropical peatlands and their characteristics

Recent estimates of the extent of tropical peatlands range between 30 to 45 million hectares (ha) (Sorensen, 1993; Solomon *et al.* 2007; and 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.

Tropical peatlands are found from the coast to high altitudes. While all peatlands need near-permanent wet conditions, their development, water supply and landscape setting differ (Figure 1). In the tropics, suitable conditions for peatland formation are found in areas:

- With frequent and excessive rainfall (humid tropics);
- With high rainfall and restricted evapotranspiration (montane and alpine environments);
- Where large catchments guarantee regular water inflow and retention (terrain depressions and floodplains); and
- Along coastlines.

The natural vegetation in tropical peatlands may include dicot trees, palms, mangroves, sedges, grasses, mosses and other flora. The diverse vegetation produces different types of peat, which can include wood, herbaceous rhizomes, roots and rootlets, and moss remains. In highly decomposed peat ("muck") plant remains are less recognizable, but these soils are very dark, due to the presence of abundant humus (decomposed plant materials) (USDA, NRCS, 2016).

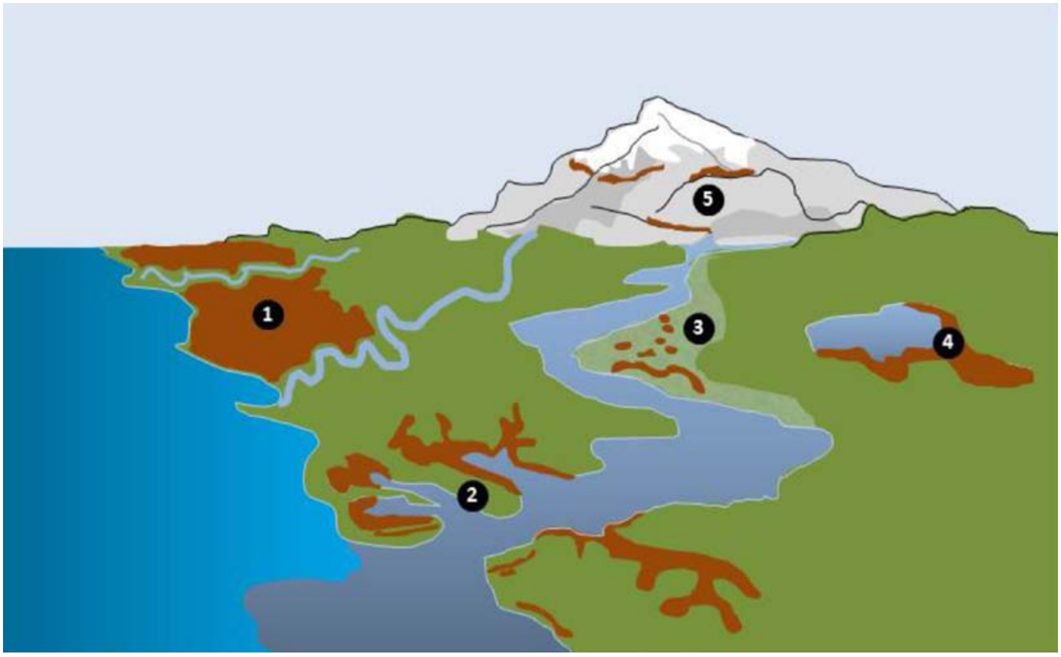


Figure 1
Tropical settings in which peatlands may occur
1. Coastal lowlands
2. Perimarine areas, including river deltas, lagoons, salt marshes and back-swamps
3. Floodplains, including oxbow lakes and pan depressions
4. Lake margins
5. Montane and alpine environments, including peat filled valleys or areas covered by "blankets" of peat
Source: Greifswald Mire Centre, 2017

Using existing maps to identify peatlands

The presence of peat is the defining characteristic of peatlands. Various maps from tropical regions indicate the presence of peatlands in some way or another, but many maps must be interpreted with critical awareness. English terms such as mire, marsh, swamp, fen and bog (Joosten *et al.* 2017) and local terms (Krasilnikov *et al.* 2009) may not differentiate between peatlands (having a peat soil) and wetlands with mineral soil. Varying with country and scientific discipline, peatlands have been defined as having a peat layer ranging from 20 to 100 centimetres (cm) thick, whereas also the minimum content of organic matter of the "peat" varies similarly across definitions (Joosten *et al.* 2017).

In soil science, peatland soils are grouped under the wider concept of "organic soil" ("sol organique" in French, "suelo orgánico" in Spanish) or "histosols". While all peatland soils are histosols, the histosol concept also includes soils with shallower organic layers and less organic matter than peatland soils and also comprises organic soils of sedimentary origin, such as lake sediments (IUSS Working Group WRB, 2015).

The Intergovernmental Panel on Climate Change (IPCC) considers "organic soil" to be soil with at least 12 to 18 percent of organic carbon, depending on the clay content (IPCC 2014). The IPCC definition encompasses all peatlands and other organic soils, but has no criterion for the minimum thickness of the organic layer to allow countries to use their country-specific definitions, often historically determined.

Since natural peatlands are wetlands, the distribution and extent of wetlands gives a first indication of the presence of peatlands. The best remote sensing tool for identifying waterlogged areas in tropical lowlands is currently the *Expert system model for mapping tropical wetlands and peatlands* (CIFOR, 2016; Gumbricht *et al.* 2017; see https://www.cifor.org/global-wetlands/), which includes a "peat" layer (see the *Background notes*, section I). However, this tool barely covers peatlands outside lowland areas, while in some regions the model overestimates peatland occurrence. Thus, field surveys are needed to get the information necessary for detailed land use planning.

If direct data on the distribution of peatlands and organic soils is lacking, other information, for example on specific vegetation, soils, topography or geology, may suggest the presence of wet conditions and possibly peat (see the *Background notes*, section I).

Conducting peatland inventories in the tropics

The process for conducting peatland inventories in the tropics is the same as for peatlands in other parts of the world and includes three steps:

I. A preparatory desk study;

II. Field work to assess peatland extent and depth, and other biotic and abiotic features; and

III. Analysis of the field data to prepare a peatland boundary map and other thematic maps (for example, on vegetation, soil and geology).

I. Preparatory desk study

The desk study should, if possible, be carried out in a Geographic Information System (GIS) environment using earth observation tools (see Fitoka & Keramitsoglou, 2008; MacKay *et al.* 2009). Information can be collected on the physical features of the catchment, such as relief (digital elevation models), geology and water supply. If access to GIS or satellite imagery is limited, hard copy topographic maps can be used.

Outputs of the preparatory desk study may include:

- A peatland typology;
- A coring plan;
- A drainage map; and
- A country peatland profile.

The data from existing maps on the distribution of peat, organic soil or their indirect indicators, including point data, should be integrated in a "peatland probability map" with the approximate location and extent of peatland, as a basis for the field survey.

Relief and peatland types

The identification of tropical peatlands may focus on ecoregions and landscape units where peatlands are expected to occur (see Figure 1 and the *Background notes*, section II). As different hydrological processes may lead to different peatland habitats with characteristic plant species and communities, it is relevant to consider the relief of the peatland and its surroundings. A major distinction is made between **bogs**, which rise above the surrounding landscape and are only fed by rainwater, and **fens**, which are found in depressions and are also fed by water that has been in contact with the mineral bedrock and soil. Whereas all bogs are acid and nutrient-poor, the water quality of a fen may be much more diverse as it depends on the climate and the extent, bedrock, soil, vegetation and land use of the catchment (Joosten & Clarke, 2002).

Developing a coring plan

Corings are created to identify the depth and nature of the peat. Corings should be made along transects to reduce their number without compromising quality (Agus *et al.* 2011). For roundish peatlands (such as domed peatlands), transects may run radially crossing the centre of the peatland with corings taken 200 to 500 meters (m) apart, depending on the size of the peatland and the intended detail (see Figure 2 A). Representative transects in elongated valleys may cross the valley every 500 to 1000 m (Figure 2 C) and should include the main tributary valleys. Additional coring might be carried out outside these transects for more complete coverage (see the red dots in Figure 2 C). In large peatlands the transects and coring sites may be further apart (see the *Background notes*, section IV). Closer distances between coring points across the presumed peatland boundary allow for more precise delineation.

The coordinates of each point should be recorded using a global positioning system (GPS) or plotted on a hard-copy topographic map.

Peatland surveys should include the collection of peat samples to determine the carbon content and possibly other physical and chemical properties.

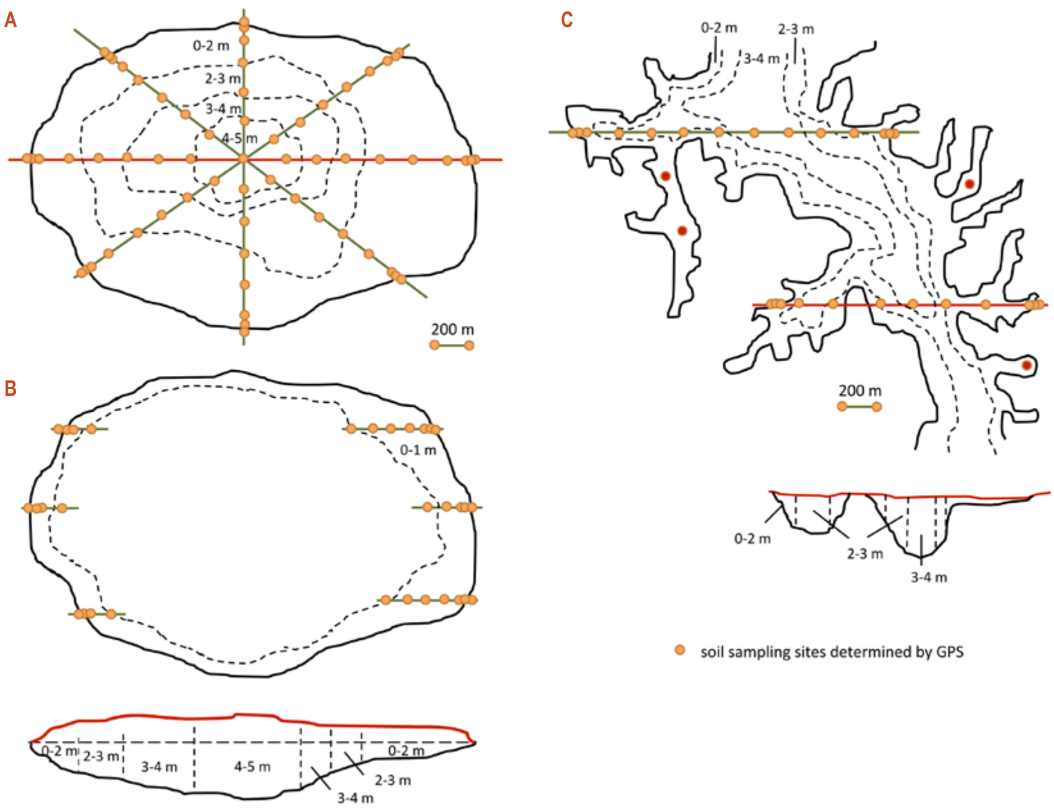


Figure 2
Peat coring designs. Coring plans for a domed peat swamp forest (A and B) and a peat-filled valley or depression (C) using the transect method (adapted from Agus *et al.* 2011). See the *Background notes*, section IV for a coring design for large and difficultly accessible areas.

Peatland drainage

Comprehensive mapping of drainage infrastructure is essential, because drainage of the peatland and its surroundings may have a significant impact on:

- The water supply from the catchment to the peatland;
- The water losses from the peatland;
- The peat-forming process;
- The habitats of particular fauna and flora; and
- The water regulation function.

Partial drainage of the peatland may also affect the groundwater and surface water hydrology of the "undrained" parts. The mapping of drainage infrastructure can be based on satellite or aerial imagery (see the *Background notes*, section III) and should record (in a GIS) the position and length of any visible drainage structure. The depth and condition of the structures may be determined by field work. In case of restricted access to GIS or satellite imagery, hard-copy topographic maps can be used to map the ditches during field surveys.

II. Field work

Outputs of the field work may include:

- The identification of peat soil;
- A description of textural and botanical peat types;
- An overview of peat extent, depth and stratigraphy;
- An assessment of peat carbon stocks; and
- An overview of peatland types and habitats.

Identifying peat soils

Peat soils differ from mineral soils and require different sampling methods and tools (see Table 1 below). The easiest way to identify an organic soil is by observing its colour, weight and texture:

- Soils rich in organic matter are dark (mostly black to reddish brown, or grey from ash when burned), while mineral soils are brighter in colour (mostly grey, yellowish or red).
- Since organic matter is two to three times less dense than mineral (clastic) particles, organic soils are notably lighter than mineral soil materials, even when wet.
- Organic soil feels greasy to the touch, while mineral soil may feel gritty if it contains sand, leave a powdery residue in the hands, if it contains silt, or feel sticky, if it contains clay (Vepraskas & Craft, 2016).

Working with an experienced soil scientist who is familiar with the soils in the region is recommended at least for the first days of field work.

Table 1. **Characteristics of peat/ organic soil and mineral wetland soils in the tropics**

Characteristics	Peat / organic soil	Mineral wetland soil
Content of organic carbon (*organic matter*)	Greater than 12-18% (20-30%) dry weight (depending on clay content)	Less than 12-18% (20-30%) dry weight (depending on clay content)
Distribution of organic matter	Organic matter homogeneously distributed from surface to the mineral soil at the peat bottom	Organic matter mostly concentrated close to the surface (in uppermost centimetre)
Ease of burning	Easily burnt when dry - can be used as fuel	Not easily burnt
Device used for soil examination and sampling	Peat corer	Spade or soil core sampler
Recognizable plant remains	Abundant wood, root and moss remains	Only a few small wood pieces or roots (often living)

Identifying the texture of organic soil (after Vepraskas & Craft, 2016)

Organic soil can be categorized as:

- **Muck**, the most decomposed form;
- **Mucky peat**, the intermediate form; or
- **Peat**, the least decomposed form of organic soil matter.

To determine the soil texture, take a golf ball-sized sample of the material and shape it into a ball by rubbing it between your fingers and thumb about eight to ten times. Break the ball open and examine the abundance of visible non-living plant fibres and roots. In muck, such fibres make up less than one sixth, in mucky peat between one sixth and three quarters and in peat more than three quarters of the sample.

The classification into **sapric**, **hemic** and **fibric** peat follows a similar approach. Sapric peat is the most highly decomposed form, hemic is intermediate and fibric is the least-decomposed form (Paramananthan, 2016). Guidance is provided below for estimating the carbon density of these peat types.

Peat and organic soil quality

Three main botanical peat types are found in tropical peatlands:

- Wood peat, produced by dicot, palm and mangrove trees;
- Herbaceous root peat, produced by roots, rootlets and rhizomes of grass-like plants like sedges; papyrus, reeds, bulrushes, or grasses; and
- Moss peat, deposited by peat- and brown mosses.

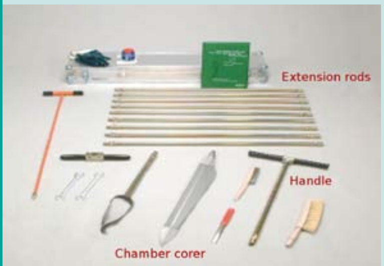
These peat types may occur in pure or mixed forms (reflecting a wide variety of former peat-forming conditions), may show different sequences within a peat core (reflecting the long-term succession of the peatland) and may differ between the coring sites within one peatland (reflecting former ecological gradients).

Undisturbed peats are reddish-brown to black in colour when waterlogged. When exposed to air, the colour generally darkens quickly by surficial oxidation. When drained, the proportion of visible plant remains and organic matter gradually decreases by aerobic decomposition and the mineral content of the peat increases proportionally. When completely dry, the peat is light brown in colour and very light in weight.

How to conduct peat coring, based on the coring plan

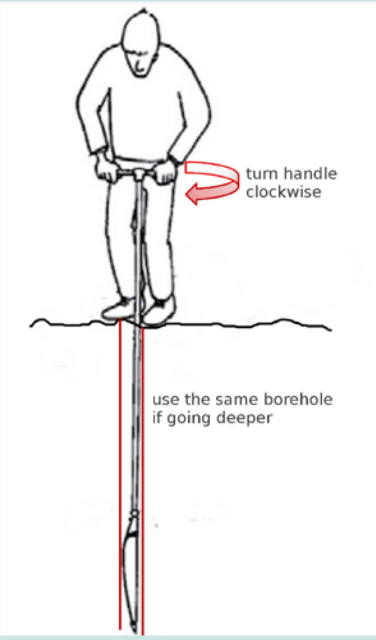
A peat corer, (i.e., a D-section chamber corer), is recommended for peat coring (see box and De Vleeschouwer *et al.* 2011). A chamber corer works well in water-saturated conditions and allows undisturbed peat samples to be taken for further laboratory analysis. Take sufficient extension rods if the maximum peat depth has to be assessed.

Tools and materials for conducting peat coring (Adapted from Agus *et al.* 2011)



The following tools are necessary for peat coring:

- A chamber corer, a handle, extension rods and a spanner or wrench to assemble and disassemble the extension rods;
- A tape (e.g., 50 m) for measuring the distance between the observation points on a transect;
- A knife to cut the vegetation and surficial roots at the coring site and to take volumetric peat samples from the corer;
- A brush and cloths for cleaning the corer;
- Plastic bags, labelling cards and markers for peat sampling; and
- A GPS device to determine the exact location of the coring site.



Step-by-step procedure for peat coring:

1. Connect the handle, the extension rods (according to the desired depth of sampling) and the corer to each other.
2. Turn the fin so that the chamber is covered (with Eijkelkamp corers, turn the fin in such a way that the convex side covers the corer chamber).
3. Drive the corer vertically into the peat without turning it. If a hard layer is encountered, do not use excessive force to drive the corer in, as this may damage the corer. The fin keeps the chamber closed so that no peat enters the chamber at this stage. The cone at the bottom of the corer pushes the peat aside.
4. When the corer has reached the desired depth, turn the handle clockwise 180 degrees. While the chamber rotates, the chamber is filled with peat, whereas the fin stays in position and eventually closes the chamber so that the sampled peat is protected while the corer is pulled up.
5. Pull the corer out slowly and lay it on a plain surface covered by a plastic sheet with the fin facing downward. Then, turn the handle, so that the chamber moves around and exposes the sample on the fin. Now the core can be inspected and peat samples taken.

Assessing peat depth and carbon stocks

When peatlands have to be identified for climate regulation protection (“no-go-areas”), it is sufficient to demonstrate the presence of a peat layer, as a 15 cm thick layer of peat contains already more carbon than a high carbon stock forest (Barthelmes *et al.* 2015). Therefore, surveys may initially concentrate on the uppermost soil layer.

If a peatland’s total carbon stock is to be estimated, the total peat depth has to be determined at each coring point. This allows the total peat volume and (when multiplying the total volume with the mass of carbon per unit volume) the total carbon content of the peatland to be calculated by interpolation (see the box below).

In coastal and fluvial environments peat layers may be intersected by mineral layers. Recording (thicker) mineral layers during the coring survey will enable a more exact calculation of the carbon stock.

Inventory of peatland types and habitats

A detailed field inventory (at mapping scales from 1:10,000 to 1:50,000) can also be conducted to assess plant and animal communities, land use, peatland drainage and management. Such an inventory can use the same transects as the peat coring and apply the Ramsar Convention's guidance for wetland inventories (Ramsar Convention Secretariat, 2010b). Care should be taken to cover the complete range of habitats.

III. Analysis of field data

The GPS coordinates of the coring points should be transferred to a GIS in which other data (for example, satellite images, digital elevation models and topographic soil wetness) or digital maps (for example, on vegetation or geology) may be integrated to facilitate delineation of the peatland borders. If access to GIS and satellite imagery is limited, a hard copy (topographic) map can be used to delineate the approximate peatland boundary.

Calculating peat bulk density and carbon stocks

Peat carbon stocks are calculated as peat volume (**V**) x carbon density (**CD**)

where **V** (in cubic metres (m^3)) = peatland area (in square metres (m^2)) x peat depth (in m);

CD = peat bulk density (BD, expressed in kilograms (kg)/m^3) x carbon fraction (percentage (%) of carbon (C)).

Peat bulk density **BD** (kg/m^3) is calculated as dry peat weight (kg) per wet peat sample volume (m^3).

To determine bulk density, one (or more) representative sample(s) between 5 cm and 10 cm thick are taken from each peat core in the field (see Chimner *et al.* 2014). If the peat fills the coring chamber of the corer completely, the wet volume of the peat slices can be calculated by multiplying the chamber section ($0.5 \pi r^2$) with the thickness of the slice. If the recovery of peat material in the coring chamber is incomplete, the slices can be frozen and their volume determined with water displacement in the laboratory. Afterwards the samples are dried at 105 degrees Celsius and their dry weight determined. The dried peat samples are then analysed for carbon (C) concentration using a carbon analyser.

There is a linear relationship between bulk density and carbon density for tropical peats with more than 40 percent organic carbon (Warren *et al.* 2012). When using their equation (CD (kg/m^3) = BD (kg/m^3) × 0.48+4.28), no carbon (C) analysis is required, only field sampling for bulk density.

When the percentage of organic matter in the soil is lower than that of pure peat, the carbon density is (counterintuitively) higher, because the amount of water (which is excluded when calculating bulk density) is decreasing and the amount of clastic material like sand, silt and clay (which are included but which are much heavier than organic matter) is increasing (Ruehlmann & Körschens, 2009). At the threshold of organic soils (with an organic matter content of 20 to 30 percent of the soil by weight) the carbon density might even double the value of pure peats.

Undisturbed, pure tropical peats have a typical carbon density of about 60 kg/m^3 (Dommain *et al.* 2011; Warren *et al.* 2012). For such peats, each hectare of peatland stores 60 tonnes of carbon for every 10 cm of peat depth.

Designating a tropical peatland as a Wetland of International Importance using the Ramsar designation criteria

The designation of tropical peatlands as Ramsar Sites will raise awareness about their importance for global climate regulation and their provision of other ecosystem services, such as water purification and biodiversity conservation.

The inclusion of a wetland in the Ramsar List embodies the government's commitment to take the steps necessary to ensure that its ecological character is maintained.

Peatland designation using Criterion 1

A site that contains a **"representative, rare, or unique example"** of a peatland within a specific biogeographic region may include pristine, active peatlands, human-modified and naturally degrading peatlands that are no longer forming peat, as well as restored peatlands. Selection must be based on a meta-analysis of information available for the peatlands of the specific biogeographic region (The Ramsar Convention, 2012).

Peatland designation with respect to carbon storage, as an additional argument under Criterion 1

Peatlands that are considered for designation as demonstration sites with respect to carbon storage and climate change would have (some of) the following attributes:

- Large size;
- Information on the area's history, land use, hydrology, and peat volume to enable assessment of the effects of restoration, as appropriate, on carbon storage capacity and greenhouse gas fluxes, to be used for communication and awareness raising; and
- Accessibility to provide site facilities that enable awareness raising and education activities to be carried out on-site.

Peatland designation using Criterion 2

A peatland should be considered internationally important if it "**supports vulnerable, endangered, or critically endangered species or threatened ecological communities**". This requires a detailed assessment of plant and animal species, habitats and habitat complexes in the peatland, taking into account the IUCN global red list or regional red lists (The Ramsar Convention, 2012).

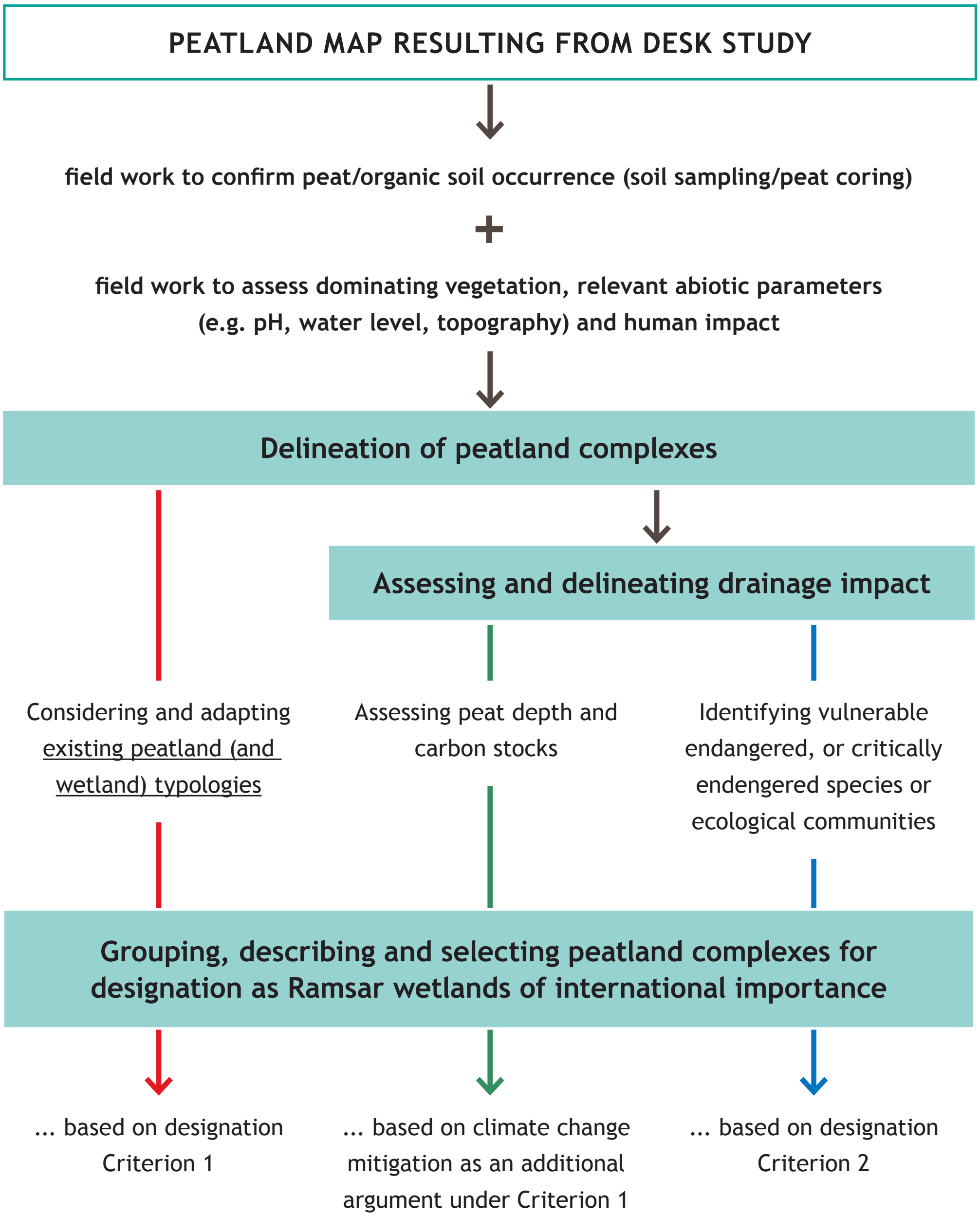
Preparing the designation

1. Determine the biogeographic region in which the peatland is located (see the *Background notes*, section II). Collate information about the peatland, including its distribution, landscape, abiotic features and biotic diversity (see *Background notes*, section I and also Ramsar Convention Secretariat, 2010 c). Determine whether the site contains a "representative, rare or unique example" of a peatland in the relevant biogeographic region, under Criterion 1 (see *The Ramsar Convention on Wetlands*, 2012).
2. Conduct field work to determine the peatland boundary. Assess dominant vegetation, relevant abiotic parameters (for example, pH, water level and topography) and human impact.
3. Delineate peatland complexes and habitats based on the results of the field work. The location and delineation of peatlands should be informed by knowledge of the climate, geology, relief, hydrology and ecology on a landscape level, and supplementary data.

Peat depth, carbon content and drainage impact are especially important if a peatland is to be designated as a Ramsar Site using the additional argument on climate regulation and carbon storage.

Information on the peatland type, the botanical composition of the peat and the impact of drainage all strengthen a Ramsar designation, help to highlight the biodiversity values of undrained peatlands and facilitate the identification of site-specific restoration aims and activities.

Figure 3
Applying the Ramsar Criteria for the designation of Wetlands of International Importance (Source: Greifswald Mire Centre).



Peatlands in the Ramsar Classification System

Since peatlands are characterized by the presence of peat, whereas the Ramsar Classification System is based on vegetation, peatlands may occur in various Ramsar Wetland Categories, including:

- Marine and coastal wetlands (mainly Ramsar categories H, I, J and K), such as intertidal marshes, intertidal forested wetlands, coastal brackish and saline lagoons, and coastal freshwater lagoons that stretch along tropical coastlines. The vegetation of these wetlands is often dominated by mangroves, reeds or grasslands.
- Inland floodplain wetlands and inland deltas, including Ramsar categories L (permanent inland deltas), O (permanent freshwater lakes – over 8 ha), P (seasonal/intermittent freshwater lakes – over 8 ha) and Xp (forested peatlands), which may contain peatlands with various types of vegetation, including peat-filled oxbow lakes and pan depressions dominated by flooded grasslands, as in the Pantanal (Brazil), the Barotse floodplain (Zambia), or the Okavango Delta (Botswana). Peat swamp forests, as in the Congo and Amazon Basins, can also be found within these categories.
- Permanent freshwater lakes (Ramsar category O) which are filled with peat. Peat deposition often starts at shallow margins or in tributary valleys; examples can be found at the Lakes Victoria and Kyoga (Uganda) and Lake Bangweulu (Zambia).
- Open peat bogs and fens (mainly Ramsar category U, non-forested peatlands) are widespread and reach from lowlands to montane and alpine altitudes with very diverse vegetation. Peatlands may be dominated by grassland, dwarf shrubs or mosses. At high altitude, adapted (often endemic) species occur, such as in the Afro-montane (East Africa) or high Andes paramos.
- Peat swamp forests (Ramsar category Xp), covering extensive coastal lowlands, often behind a mangrove belt. Large areas occur in Southeast Asia, the Congo Basin, Western Amazonia and on the northeastern coast of South America (Venezuela, Guyana, Suriname and French Guyana).
- Geothermal wetlands (Ramsar Category Zg), such as the spring mire complexes in Kruger National Park (South Africa).
- All other wetland categories, except Tp (permanent freshwater marshes/pools on inorganic soils), Ts (seasonal/intermittent freshwater marshes/pools – inorganic soils), W (shrub-dominated wetlands – inorganic soils), Xf (wooded swamps on inorganic soils) and Zk (b) (subterranean karst systems).

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Citation

Barthelmes, A. & Joosten, H. (2018). *Guidelines for inventories of tropical peatlands to facilitate their designation as Ramsar Sites.* Ramsar Briefing Note No. 9. Gland, Switzerland: Ramsar Convention Secretariat.

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Published by the Secretariat of the Ramsar Convention.

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