Inventory of peatlands in the Caribbean and first description of priority areas

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This report was prepared in the frame of “Strategic Environmental Dialogues for Coastal Peatlands in the Caribbean - Underlining the importance of peatlands for biodiversity, climate change mitigation, coastal protection, and human livelihoods”, a project implemented by Michael Succow Stiftung, Partner in the Greifswald Mire Centre with funding from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), facilitated by the Gesellschaft für Internationale Zusammenarbeit (GIZ).

The objectives of the project were 1) to map Caribbean peatlands using methods developed by the Global Peatlands Database at the Greifswald Mire Centre; 2) to initiate expert round table dialogues in key peatlands countries in the region (Costa Rica, Cuba, Honduras, Nicaragua, Panama); 3) to prioritise sites; and 4) to assess potentials and priorities for peatland conservation, restoration and alternative, wet use (paludiculture) of degraded areas for following steps. In this report, we briefly summarise the results of the mapping and dialogues before we present identified priority peatland sites in the assessed countries Costa Rica, Cuba, Honduras, Nicaragua, Panama.
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1. Introduction

Coastal peatlands in the Caribbean provide important ecological functions beyond declining habitats for endangered biodiversity and sequestration and long-term storage of carbon. Intact coastal ecosystems including coastal peatlands fulfil important roles in the protection against extreme weather events (e.g. hurricanes, which have become more frequent and strong in times of climate change). Coral reefs break the biggest waves in front of the shore, mangroves stabilize the coastline’s soils with their roots, and coastal peatlands finally act like buffer zones between salt and inland freshwaters. Peatlands store freshwater like huge sponges, blocks salt water intrusion in the aquifers and provide permanent water supply throughout the year for local communities, bridging periods of water shortage in the dry seasons. Therefore, they are key ecosystems in climate change adaptation.

Draining coastal peatlands implies emission of CO₂ to the atmosphere due to oxidation of peat layers and dissolving of underlying carbonates typical for Caribbean mires. This process is fast under tropic climate condition and imposes the risk of catastrophic fire events during droughts. Furthermore, decomposition of peat soils leads to subsidence, which implicates a risk of irreversible land loss as sea level is rising in contrast to dropping peatland surface. Last but not least, the beauty of mire landscapes is a significant asset for future development of eco-tourism in the region. However, little is known about the distribution, the ecosystem functioning and status of the peatlands in the Caribbean region (including Bahamas, Cuba, Dominican Republic, Haiti, Jamaica, Mexico (Yucatan), Panama, Puerto Rico). There are indications that some of them are in unfavourable conditions and under threat of degradation.

To start a dialogue with stakeholders in the Caribbean countries on coastal peatlands within this project, a comprehensive overview of the distribution in the Caribbean countries is needed. Existing data from the Global Peatland Database, hosted at the Greifswald Mire Centre, has been screened, existing gaps identified and filled as far as possible in consultation with regional partners by expert-guided literature and internet research for soil maps, scientific publications, official statistical datasets, expert interviews etc. Data newly available have been harmonized and included in the database. In this desk study, peatland probability maps for the region and selected countries (Cuba, Panama, Costa Rica, Honduras, Nicaragua, Mexico (Yucatan)) are presented indicating different levels of confidence of peatland locations. They are also necessary basis for further research e.g. on carbon stocks, biodiversity and conservation efforts in the countries and give primary information for the priority list of peatlands, which was drawn with acquired information of scoping missions and workshops.
2. Methodology

2.1. Identification and delineation of areas with high probability of peatland occurrence with available data from cartography and other sources

The method of the present desk study is derived from ‘identification and delineation of peatlands/organic soils with available data’ developed in the framework of the “High carbon stock (HSC) study of the sustainable palm oil manifesto” (Barthelmes et al., 2015). Peatlands are areas with a thick layer of peat (dead, locally produced plant material) at the surface. In the context of this study, we define peatlands as special form of organic soils according to IPCC (2014): Soil with (dependent on the clay content) at least 12-18% (by weight) of organic carbon. Only limited attention was paid on peatlands so far in the Caribbean region. To assess the extent and location of peatlands in the Caribbean region it is necessary to collate a vast variety of cartographic information and to extrapolate spatially restricted peatland/organic soil data to adjacent areas. In doing so, the search intensity and the number of appropriate key words determine the final amount of accessed meaningful data sets. Spatially explicit information indicating organic soil of various scales was collected under consideration of local terminology for e.g. organic soils and (peat forming) wetland vegetation. Because of the restricted direct peatland and organic soil information, a broad variability of indirect (proxy) data has been included which indicates potential peatland and organic soil occurrences. This contains data on e.g. specific (hydromorphic) soil conditions, landforms as e.g. depressions and valleys, wetland vegetation and habitat types, and land use restrictions through permanent high water levels or flooding. The internet search has been conducted using ‘Google’ engine.

We used the following online archives for this study:

ISRIC (World Soil Information; http://eusoils.jrc.ec.europa.eu/esdb_archive/eudasm/indexes/access.htm)
JRC (Joint Research Centre; http://eusoils.jrc.ec.europa.eu/esdb_archive/eudasm/indexes/access.htm)

We used the following keywords while searching for data:

histosoles, suelo organico, materia organica del suelo, mapa de suelos, manglares, vegetation, histosols, organic soil, mangroves

Datasets (GIS datasets as well as digital maps) of national, regional and global scale have been used. Digitalised printed maps produced decades ago were considered as well as recently produced raster or vector data, as they are mostly of very high precision. Results of geospatial data from the internet search with scales ranging from 1:50.000 to 1:5.000.000 were stored, if necessary georeferenced and imported into a Geodatabase (ESRI, 2013). All used data is listed in Annex 1.

In a further step, all sources of information that indicate probable occurrence of peat or organic soil were digitalised and depicted as overlaying features in ArcGIS2 and compared to available satellite images (World Imagery1, BING Maps, Google Earth) with a peatland expert judgement from Greifswald Mire Centre. Areas of high probability of peatland occurrence were derived and demarcated by the evaluation of the collected spatial information and the comparison of (partly legacy) cartographic and (recent) satellite image data. The more proxy data for peat occurrence was overlapping in certain areas, the higher the probability was rated; indicated in darker red signature in the maps. We produced probability maps for the whole region as an overview and

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1 Sources: Esri, DigitalGlobe, Earthstar Geographics, CNES/Airbus DS, GeoEye, USDA FSA, USGS, Aerogrid, IGN, IGP, and the GIS User Community
on higher resolution for each of the target countries Panama, Costa Rica, Nicaragua, Honduras and Cuba. By adding additional socio-geographical data like the boundaries of protected areas (WDPA) the protection and potential threats on peatland areas can be derived.

2.2. Dialogue with environmental specialist and stakeholders in region to cross-check probability maps and collate additional data

During missions to the selected key countries, the dialogue on existing knowledge of peatlands was initiated among relevant academic and practicing experts. 4 specialist’s round tables on the distribution and importance of coastal peatlands for the Caribbean key countries for biodiversity, climate change mitigation, coastal protection, and human livelihoods have been conducted with scientists and practitioners in the fields of ecology and conservation biology, geography, agriculture, and land use economics (Tab. 1). Additionally, individual meeting with specialists in these key countries (incl. Honduras) have been conducted to acquire additional information. A detailed list and description of all meetings conducted you find in Annexes 2-5.

2.3. Scoping mission to selected peatland sites to confirm peatland occurrence in the field

During field missions to the target countries (Panama, Costa Rica, Nicaragua, Honduras, Cuba) internationally renowned peatland experts of Greifswald Mire Centre visited some of the delineated areas in the probability map and conducted soil sampling with peat coring devices of max. 2.2 m length. They confirmed or falsified the occurrence of peat in some identified probable areas with this ground-truthing information. With the help of this acquired information more detailed maps of peatland occurrence of specific areas can be drawn in a further working step.

2.4. Identify priority for conservation and restoration action

We discussed the gathered information from literature (e.g. Bundschuh & Alvarado 2007) and probability maps with experts and stakeholders during the meetings to specify locations of peatlands and their status. Based on discussions, we prepared a preliminary list of priority peatlands in the Caribbean region. Either selected sites have high conservation values with need for management and research or they are under risk by anthropogenic threats (mainly land use change) with limited knowledge and protection. For each peatland site, we draw individual site maps based on available data and collated factsheets with site description, status and

Table 1: List of conducted round tables

<table>
<thead>
<tr>
<th>Date</th>
<th>Country</th>
<th>Venue</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th Sep. 2017</td>
<td>Costa Rica</td>
<td>Universidad Nacional de Costa Rica (UNA), Heredia</td>
</tr>
<tr>
<td>6th Sep. 2017</td>
<td>Panama</td>
<td>Smithsonian Tropical Research Institute, Panama City</td>
</tr>
<tr>
<td>31st Oct. 2017</td>
<td>Nicaragua</td>
<td>Puerto Cabezas</td>
</tr>
</tbody>
</table>
possible threats. Information on peatland areas are rare so these descriptions are only a first step for future, more in-depth investigations of each individual site.
3. Probability maps

Figure 2: Peatland probability map for the Caribbean region; darker red indicates higher probability; scope countries green-coloured.
Figure 3: Peatland probability map for Panama; darker red indicates higher probability; protected areas in green colours
Figure 4: Peatland probability map for Costa Rica; darker red indicates higher probability; protected areas in green colours
Figure 5: Peatland probability map for Nicaragua; darker red indicates higher probability; protected areas in green colours.
Figure 6: Peatland probability map for Honduras; darker red indicates higher probability; protected areas in green colours
Figure 7: Peatland probability map for Yucatan / Mexico; darker red indicates higher probability; protected areas in green colours.
Figure 8: Peatland probability map for Cuba; darker red indicates higher probability; protected areas in green colours
4. Priority peatland areas

In the following section, brief descriptions of preliminarily selected priority peatland areas are presented. The focus of selected sites lays on areas along the Caribbean Sea coast of the target countries, but experts also indicated other important peatland sites in their countries, which have been included in the list for the sake of higher completeness (Tab. 2). The factsheets encompass a site map indicating probable peatland area and borders of protected areas, description of the location, status, land use and other available information. For few sites, which the project team visited during scoping missions, more precise information on peat sampling and vegetation are given.

Table 2: List of priority potential peatland sites (confirmed peat occurrence marked red)

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Country</th>
<th>Site</th>
<th>Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Panama</td>
<td>Matusagaratí / Rio Tuira</td>
<td>8°14’ N 77°79’ W</td>
</tr>
<tr>
<td>2</td>
<td>Panama</td>
<td>Portobelo</td>
<td>9°57’ N 79°65’ W</td>
</tr>
<tr>
<td>3</td>
<td>Panama</td>
<td>Damani Guariviara</td>
<td>8°97’ N 81°74’ W</td>
</tr>
<tr>
<td>4</td>
<td>Panama</td>
<td>Changuinola</td>
<td>9°40’ N 82°42’ W</td>
</tr>
<tr>
<td></td>
<td>Panama</td>
<td>Punta Patiño / Golfo de San Miguel</td>
<td>8°23’ N 78°17’ W</td>
</tr>
<tr>
<td>5</td>
<td>Costa Rica</td>
<td>Gandoca-Manzanillo</td>
<td>9°61’ N 82°65’ W</td>
</tr>
<tr>
<td>6</td>
<td>Costa Rica</td>
<td>Aeropuerto Limón</td>
<td>9°96’ N 83°05’ W</td>
</tr>
<tr>
<td>7</td>
<td>Costa Rica</td>
<td>Moín (Cocal &amp; Finca Sandoval)</td>
<td>10°02’ N 83°14’ W</td>
</tr>
<tr>
<td>8</td>
<td>Costa Rica</td>
<td>Parque Nacional Tortuguero</td>
<td>10°43’ N 83°51’ W</td>
</tr>
<tr>
<td>9</td>
<td>Costa Rica</td>
<td>Barra de Colorado (Calero &amp; Brava Islands)</td>
<td>10°70’ N 83°66’ W</td>
</tr>
<tr>
<td>10</td>
<td>Costa Rica</td>
<td>Turberas de Talamanca</td>
<td>9°50’ N 83°70’ W</td>
</tr>
<tr>
<td>11</td>
<td>Costa Rica</td>
<td>Caño Negro</td>
<td>10°87’ N 84°75’ W</td>
</tr>
<tr>
<td>12</td>
<td>Costa Rica</td>
<td>Medio Queso</td>
<td>10°97’ N 84°63’ W</td>
</tr>
<tr>
<td>13</td>
<td>Nicaragua</td>
<td>Humedales Bluefields</td>
<td>11°99’ N 83°74’ W</td>
</tr>
<tr>
<td>14</td>
<td>Nicaragua</td>
<td>Wetlands South of Puerto Cabezas (Laguna</td>
<td>13°97’ N 83°48’ W</td>
</tr>
<tr>
<td></td>
<td>Nicaragua</td>
<td>Karata, Wounta</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Nicaragua</td>
<td>Wetlands North of Puerto Cabezas (Laguna</td>
<td>14°84’ N 83°35’ W</td>
</tr>
<tr>
<td></td>
<td>Nicaragua</td>
<td>Bismuna</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Honduras</td>
<td>Wetlands Puerto Lempira</td>
<td>15°22’ N 83°64’ W</td>
</tr>
<tr>
<td>17</td>
<td>Honduras</td>
<td>Laguna Lagunara</td>
<td>15°59’ N 84°12’ W</td>
</tr>
<tr>
<td>18</td>
<td>Cuba</td>
<td>Rio Cauto</td>
<td>20°49’ N 77°03’ W</td>
</tr>
<tr>
<td>19</td>
<td>Cuba</td>
<td>Laguna de la Leche</td>
<td>22°19’ N 78°50’ W</td>
</tr>
<tr>
<td>20</td>
<td>Cuba</td>
<td>Ciénaga de Majaguillar</td>
<td>23°02’ N 80°98’ W</td>
</tr>
<tr>
<td>21</td>
<td>Cuba</td>
<td>Ciénaga de Zapata (Laguna del Tesoro)</td>
<td>22°32’ N 81°74’ W</td>
</tr>
<tr>
<td>22</td>
<td>Cuba</td>
<td>Wetlands South of Havana</td>
<td>22°70’ N 82°46’ W</td>
</tr>
<tr>
<td>23</td>
<td>Cuba</td>
<td>Isla de la Juventud</td>
<td>21°50’ N 82°89’ W</td>
</tr>
</tbody>
</table>
Figure 9: Locations of the selected important peatland sites in the Caribbean region
4.1. Factsheets on priority peatland sites in Panama

4.1.1. Laguna de Matusagaratí

**Location:** South-eastern province of Darién along the river Rio Tuira, east of its tributary Rio Iglesia (Nr. 1 in Fig. 9) The area is sparsely inhabited; the community of Nuevo Progreso in the district of Yaviza is located in north-eastern direction of the site.

**Figure 10: Potential peatland site at Laguna de Matusagaratí**

**Geography:** Lowland wetland in the Wet Forests of Chocó-Darién ecoregion (Olson et al. 2001) under wet tropical climate (average temperatures of 25°C; precipitation ~ 2,000 mm/a) and with a constant water supply from the River Tuira and its tributaries. Permanent wetlands of the Rio Iglesia and Rio Aruza have the potential to form peat layers in depressions under water saturation. Potential peatland size: ~ 11,000 ha.

**Vegetation:** Inundated, wet tropical forest and open wetland vegetation with *Elocharis* sp. (which known as proxy plant for potential peat occurrence).

**Land use:** Core areas of the wetland show only little human disturbance, whereas more accessible parts used for forestry, subsistence farming and grazing lands from local communities. Recently, concessions for palm oil plantations have been issued for the area and large drainage channels affect approximately 2,000 ha so far (Fig. 11). Their expansion for palm oil and rice paddies and deforestation for timber are the main threats for this area.

**Conservation:** Predominantly no or weak protection status; small parts are included in the Canglón forest reserve; planned to enlarge the hydrological reserve of Serranía Filo del Tallo with major parts of Matusagaratí.
Figure 11: Satellite image of drainage system in the potential peatland area of Matusagarati


4.1.2. Portobelo

Location: At the Caribbean coast of the province of Colón at the estuary of the river Rio Cascaja, close to the town of Portobelo.

Geography: Coastal wetland. Due to wet tropical climate with average temperatures of 27°C and precipitation of around 4,000 mm/a and constant water supply by the River Cascaja and its tributaries, permanent wetlands are found with the potential for the development of peat layers in depressions under permanent water saturation. Potential peatland size in the floodplain of Rio Cascaja and tributaries: ~230 ha.

Vegetation: Partly inundated, wet tropical lowland forest, mangroves at the estuary of rivers.

Land use: Core parts in natural state with little interventions, more accessible parts of forest used for small-scale forestry and areas closer to habitations for subsistence farming and grazing lands. Tourism plays major role in the area, mostly at the coastline affecting beaches and mangroves. In recent years, development of tourist sector is increasing, so conservationists report risk of negative influence of tourism. Nevertheless, risk for the peatland sites, which are in the core of the wetland and hardly accessible, is relative low.

Conservation: Part of the Portobelo National park and therefore well protected by national legislation.
Figure 12: Potential peatland site at Portobelo

4.1.3. Damani-Guariviara

Location: North-west of Panama, province of Ño Kribo, indigenous reserve Ngöbe-Buglé. Part of the districts of Kankintú and Kusapín. The eastern parts are bordering to open Caribbean Sea, the western to Laguna de Chiriquí. Sparsely inhabited with only small villages within the area.

Geography: Coastal and inland features like beaches, marshes, salty and freshwater lagoons, rivers, wet tropical forest and mangroves, belonging to the Neotropical-Caribbean biogeographical region. Climate is wet tropical without dry season. Average temperature is 27°C with 3000 mm/a precipitation. Peat is mainly found in marshes, wet forest and possibly mangroves. Researchers from the Smithsonian Tropical Research Institute and of Nottingham University have confirmed peat layers at Cricamola and Damani sites at the shore of Laguna de Chiriquí (personal communication Jorge Hoyos Santillán, 2011). Potential peatland area: ~28,000 ha.

Vegetation: Dominated by mangroves, wet tropical lowland forest and open grasslands. Because of its various habitats, high biological value with ample diversity of flora and fauna.

Land use: Core parts of wetland are in natural state with little interventions; more accessible parts of forest are used for hunting, fishing and small-scale forestry and areas closer to habitations for subsistence farming and grazing lands of local, indigenous communities. Eco-tourism is carried out in more accessible parts. Major threats are deforestation for timber and
farmland development esp. rice cultivation and palm oil plantations, other inappropriate agricultural practices, subsistence hunting, mining, and pollution of its catchment.

**Figure 13: Potential peatland site at Damani-Guariviara**

**Conservation:** Designated a national protected area in 2004 under the category “Wetland of International Importance”; designated Ramsar site. Management plans are in place; nevertheless, land use pressure is large at the borders of the protected area.


**4.1.4. Changinola / San San-Pond Sak**

**Location:** Within the larger wetland complex of San San-Pond Sak in the north-west of Panama, province of Bocas del Toro. The peatland is part of the Changinola district, which is also the biggest town in the vicinity. Along the edges of the peatland, smaller villages called Las Millas are located.

**Geography:** Climate is wet tropical without dry season with average temperatures of 26°C and 3000 mm/a precipitation. Potential peatland area: ~10,000 ha; maximum peat layers 8 m thick (Cohen et al., 1995). One of the best-researched peatlands at Caribbean coast of Central America. The peatland is a so-called back-barrier peatland (Cohen et al., 1989) which form behind natural barriers like beach barriers along the shoreline, which prevents the water coming from the inland hills to run off quickly to the sea and therefore provides permanent water saturation and peat forming conditions. First studies on greenhouse gas (GHG) fluxes from the peat layers in Changinola indicate a net efflux of GHG, which might increase with
increased decomposition of peat due to drainage or drier climate conditions (Wright et al., 2011; Wright et al., 2013; Sjögersten et al., 2018). Vegetation composition affects GHG emission balances from peatlands, described in Hoyos-Santillan et al., 2016 for Raphia palm swamp.

Figure 14: Changinola peatland site in San San-Pond Sak wetland

**Vegetation:** Coastal and inland features like wet tropical forest, mangroves, and open marshes with sedges, sawgrass, ferns and shrubs, belonging to the Neotropical-Caribbean biogeographical region. Peat is found mostly in wet forest with the palm *Raphia taedigera* and *Campnosperma panamense*, a tree genus that is also abundant in the peat swamp forests in South-east Asia, in marshes and possibly in mangroves.

**Land use:** Core parts are in natural state with little interventions, the edges are used for hunting, fishing, subsistence farming and grazing lands of local communities. Eco-tourism is carried out in the more accessible edges of the area. In surrounding area large-scale intensive banana plantations are abundant. Major threats are deforestation of the edges for farmland and potential peat mining plans and concessions for energetic use close to Almirante.

**Conservation:** Part of the designated Ramsar site “San San-Pond Sak” since 1993 and nationally protected area. Management plans and zonation are in place; nevertheless, land use pressure is large at the borders of the protected area.

**References:**
4.2. **Factsheets on priority peatland sites in Costa Rica**

4.2.1. **Gandoca-Manzanillo**

**Location:** Southeast of Costa Rica, close to Panama border, part of Limón province, district of Talamanca. Small villages are at the edge of the reserve, the closed town is Puerto Viejo.

![Figure 15: Potential peatland site at Gandoca-Manzanillo](image)

**Geography:** Coastal and inland features like beaches, marshes, salty and freshwater lagoons, rivers, wet tropical forest and mangroves, belonging to the Neotropical-Caribbean biogeographical region. Climate is wet tropical without dry season. Average temperature is around 27°C with 3000 mm/a precipitation. Peat is mainly found in marshes, wet forest and possibly mangroves. Potential total area in which patches of peat could be found: ~3,800 ha. During the 1st scoping mission, wood peat was confirmed in a wet forest close to the village Gandoca at the riverside of Rio Gandoca (Fig. 16).

**Vegetation:** Dominated by *Raphia taedigera* and *Campnosperma panamensis* forest. Open grassland patches with sedges and sawgrass exist to a smaller extend. Gandoca estuary at the border to Panama characterized by mangroves (*Rhizophora mangle*).
Figure 16: Peat core in Gandoca-Manzanillo

**Land use:** Core parts in natural state with little interventions, more accessible parts of forest are used for hunting, fishing and small-scale forestry. Small patches are used for subsistence farming and grazing lands of local communities. Eco-tourism is carried out in the more accessible parts of the area. Major threats are deforestation at the edges of the forest.

**Conservation:** Designated as a national forest refuge (Refugio Nacional de Vida Silvestre) and as Ramsar site “Gandoca-Manzanillo”.

**References:** Ramsar Convention (2018): Ramsar Sites Information Service. Accessible online: rsis.ramsar.org

### 4.2.2. Aeropuerto Limón

**Location:** Called after his location Aeropuerto Limón, in the centre of Costa Rican Caribbean shoreline, south of the city of Puerto Limón, which is also the capital of Limón province and district. The villages of Cieneguita, Westfalia, Beverly and La Bomber are around the peatland.

**Geography &** Inland the international airport of Limón which is built on the mineral beach-barrier which prevents water run-off from the site. The peatland can be classified as a back-barrier peatland. Climate is wet tropical, average temperature is around 25°C with 3400 mm/a precipitation. The potential total area: ~800 ha, peat layers are in average 1 m thick (Obando et al., 1995). During the 1st scoping mission, peat was confirmed in the *Raphia* swamps accessed from the road along the road opposite of the airport.

**Vegetation:** Dominated by *Raphia taedigera*. Other parts are deforested and partly drained for grazing lands.

**Land use:** Densely overgrown with *Raphia taedigera* and unused. Edges close to bordering villages are partly drained for agriculture including large-scale banana plantations and cattle grazing. Major threats are deforestation at the edges of the swamp for agricultural extensions (plantations, grazing land). Due to the vicinity to the city of Puerto Limón, to infrastructure like roads and airport and to agricultural plantations, the hydrological regime could be disturbed so that water availability and quality could negatively affect the peatland site.
Figure 17: Potential peatland site at Aeropuerto Limón

Figure 18: Raphia taedigera peatland at Aeropuerto Limón

Conservation: Not designated as a protected area.

4.2.3. Moín

**Location:** In centre of Costa Rican Caribbean shoreline, north of the city of Puerto Limón, which is also the capital of the Limón province and district. The harbour and industrial complex of Moín and the villages of Cocal and Finca Sandoval are bordering the peatland.

![Map of Moín](image)

**Figure 19: Potential peatland site at Moín**

**Geography & Vegetation:** The peatland can be classified as a back-barrier peatland, separated from the sea by a sandy beach-barrier. Potential total peatland: ~780 ha, peat layers are in average 1.6 m thick (Obando et al. 1995). Climate is wet tropical, average temperature is around 25°C with 3400 mm/a precipitation. Vegetation dominated by *Raphia taedigera*.

**Land use:** Mostly overgrown with *Raphia taedigera* and inaccessible. Edges close to the bordering villages are partly drained for agriculture and for cattle grazing. There is a risk of further deforestation at the edges of the swamp for agricultural extensions (plantations, grazing land). Close to the site, a big petroleum refinery, a power plant and Moin port are operational, in recent years the port developed into one of the major Costa Rican ports for exports of goods at the Caribbean coast. This is followed by large-scale infrastructure developments like a new highway to the inland in close vicinity to the peatland. Major threats are the disturbance of the hydrological regime so that water availability and quality could negatively affect the peatland site. In addition, an exploitation of peat was considered for energetic use but no further investigation carried out in recent years.

**Conservation:** Not designated as a protected area.
4.2.4. Tortuguero

Location: Stretched 25 km along northern Costa Rican Caribbean shoreline, within Limón province and Pococi district. Only smaller villages like Boca de Las Lagunas del Tortuguero are located close to the wetland.

Geography & Vegetation: Back-barrier peatland, separated from the sea by a sandy beach-barrier. Potential total peatland area: ~20,000 ha. First peat investigations in only two boreholes by Obando et al., 1995 indicated peat layers of 1.2 m thickness in average. Climate is wet tropical, average temperature is around 26°C with 6000 mm/a precipitation. Wet tropical forest is widespread in the area, in the wetter parts vegetation dominated by Raphia taedigera, along the lagoons and channels mangroves could be found.

Land use: Not used, at edges small-scale gathering of forest products and fishing allowed for local communities. Around the wetland, large areas are under cattle ranching and agricultural farming, which could negatively affect water availability and quality in peatlands of Tortuguero.

Conservation: Designated as national park in 1975; part of the “Humedal Caribe Noreste”, declared as a Wetland of International Importance (Ramsar site) since 1996.

Figure 20: Potential peatland site at Tortuguero

4.2.5. Barra del Colorado

Location: Stretched 50 km along the northern Costa Rican Caribbean shoreline starting from Tortuguero up to Nicaragua border. Within Limón province and Pococi district. Only smaller villages like Barra del Colorado are located close to the wetland.

Geography & Vegetation: Classified as a back-barrier peatland, separated from the sea by a sandy beach-barrier, San Juan and Colorado rivers are supplying the wetland with inland waters. Potential total peatland area: ~42,000 ha. Sampling of Obando et al., 1995 indicate peat layers of 1.2 m thickness in average like in Tortuguero site. Climate is wet tropical, average temperature is around 26°C with 6000 mm/a precipitation. Wet tropical forest with *Campnosperma panamense* widespread in the area, in wetter parts the vegetation dominated by *Raphia taedigera*, along lagoons and channels mangroves.

Figure 21: Potential peatland site at Barra del Colorado

Land use: One of most remote places in Costa Rica; therefore mostly without any human interventions. Just at edges small-scale forestry, hunting and fishing by local communities. Around wetland, large areas are under cattle ranching and agriculture, which possibly have a light negatively effect on the peatlands in Barra del Colorado.
Conservation: Designated as Barra del Colorado Wildlife Refuge in 1985, part of the “Humedal Caribe Noreste”, declared as Ramsar site since 1996.


In sensu strictu, the following inland and mountain peatland sites are not part of the assessment of Caribbean coastal peatlands, but as many experts during the meetings and most of the literature on peatlands mentioned them, we will also provide a brief overview of non-coastal peatlands in Costa Rica.

4.2.6. Turberas de Talamanc

Location: Distributed over the central Costa Rican mountain range of Talamanca within provinces of San José and Cartago.

Figure 22: Potential peatland site at Talamancan Mountains

Geography & Vegetation: In an altitude between 700-3,821 m in small, mostly elongated basins, which hold the water for the initial peat forming processes. Due to high precipitation (2,000-3,000 mm/a depending on exposition and altitude) and moisture, blanket bogs, so called “Paramos” develop on the peat layers. Potential total peatland area: ~47,000 ha, but actual coverage by peat in this area will be much lower. Sampling of Obando et al., 1995
indicate nutrient poor peat layers of max. 1.3 m thickness. Paramo vegetation characterized by grasses, sedges, herbs, but also Sphagnum mosses, ferns, and shrubs.

**Land use:** Mostly in a natural state, some are used for sheep and goat grazing which can negatively affect the vegetation and soil structure through compaction. Peatlands are of vital importance in terms of hydroelectric power production and supply of a large portion of the drinking water for the country's largest cities.

**Conservation:** Partly within the National Parks of Los Quetzales, Tapanti and Chirripó. In 2003, declared as Ramsar site “Turberas de Talamanca”.


**4.2.7. Caño Negro**

**Location:** North of Costa Rica, close to Nicaragua border. 20 km north of district capital Los Chiles in Alajuela province.

**Geography & Vegetation:** Located in river and lake floodplain with permanent water saturation where peat has formed over centuries and filled up old meanders of Frío River or former bays of Lake Caño Negro. Potential peatland area: 5,700 ha. Tropical savannah climate
with average temperature of 27°C and precipitation of 1,700 mm/a. Covered with grasses, sedges and small shrubs, but no forest.

**Land use:** Mostly well protected and used only for eco-tourism, mainly bird watching. Edges are used for cattle grazing and other agriculture, which could negatively affect the water quality in the wetland, vegetation and soil structure through compaction.

**Conservation:** In 1984, Caño Negro Wildlife Refuge declared as national protected area, as the Ramsar site “Caño Negro” in 1991, mostly because of its importance for breeding and migrating water birds.

**References:** Ramsar Convention (2018): Ramsar Sites Information Service. Accessible online: rsis.ramsar.org

### 4.2.8 Medio Queso

**Location:** Transboundary area between Costa Rica in the south and Nicaragua in the north. Costa Rican part in district Los Chiles in Alajuela province. Part in Nicaragua situated in department of Río San Juan.

![Figure 24: Potential peatland site at Medio Queso](image)

**Geography & Vegetation:** Within depressions like old meander of floodplain of Río Medio Queso, a tributary to the Río San Juán and finally to the Nicaragua Lake, peat has formed. Potential peatland area: ~3,800 ha. Average peat depth is 1.6 m and total peat deposit reported as 1,024,264 Mt dry matter (Obando et al., 1995). Tropical savannah climate with average temperature of 27°C and precipitation of 1,700 mm/a. Covered with grasses, sedges and small shrubs. *Raphia* palm, which is predominant plant in described coastal areas, is absent.
**Land use:** Floodplain used for pastures and agriculture (protein plants like soy beans), for which small-scale drainage system was constructed by local farmers and frequent burning of fields takes place. Due to these practices, high oxidation and subsidence take place in the area. The use of peat for agriculture and horticulture as well as for energy was suggested in the 1980s (Obando et al., 1995; Cohan & Raymond, 1984), but nowadays there are no mining concessions. Small-scale eco-tourism is conducted in the area.

**Conservation:** Costa Rican part of the floodplain not protected; in Nicaragua, designated as a wildlife reserve and declared a Ramsar site “Los Guatuzos” in 1997.

**References:**
4.3. Factsheets on priority peatland sites in Nicaragua

4.3.1. Bluefields

**Location:** Southern part of Nicaraguan Caribbean coast in the South Caribbean Autonomous Region. Situated at the estuary of the Rio Escondido to the Bahia de Bluefields and at shoreline of the Smokey Lane Lagoon north of the town of Bluefields.

![Map of Bluefields area](image)

*Figure 25: Potential peatland site at Bluefields*

**Geography & Vegetation:** Coastal and continental wetland types like beaches, mangroves, permanently flooded marshes with graminoid and palm species like *Acoeloraphe wrightii* and *Raphia taedigera*, and wet inundated forest dominated by *Raphia* and *Pterocarpus officinalis*. Peatlands can be found along the river Escondido and at the lagoon in form of back-barrier peatlands. Potential peatland area: ~11,000 ha. No sampling or other further investigations of peat layers in the area are available. Tropical rainforest climate with average temperature of 26°C and precipitation of 4,300 mm/a.

**Land use:** Area around Bluefield is an important area of indigenous communities of Creoles and Rama who use the area for subsistence fishing and hunting. Eco-tourism takes place in more accessible parts of the wetland. The wetland plays a vital role as buffer ecosystem for coastal protection as it serves as a barrier for floods caused by hurricanes to protect habitations from destruction. Due to climate change, the frequency and magnitude of hurricanes is increasing and sea level is rising, therefore the wetlands are under pressure of being salinated and ultimately flooded. Another risk is the advancing of agricultural extension in the upstream areas of the Rio Escondido with increased rates of deforestation. In effect, sedimentation is increased in the estuary of the river and water are contaminated with chemicals and nutrients.
Conservation: Designated as a “Reserva Natural Cerro Silva” and declared as Ramsar site “Sistema de Humedales de la Bahía de Bluefields” in 2001. Monitoring and scientific assessment is carried out by the local universities Universidad de las Regiones Autónomas de la Costa Caribe Nicaragüense (URACCAN) and Bluefields Indian and Caribbean University (BICU).


4.3.2. Wetlands South of Puerto Cabezas (Laguna Karatá, Wouhhta)

Location: Northern part of the Nicaraguan Caribbean coast in the North Caribbean Autonomous Region. The peatlands spread in the backwater areas south of district capital
Puerto Cabezas, also known as Bilwi. Back-barrier peatlands are situated at the lagoon system of Laguna de Karatá and Laguna de Wouhnta and at the estuary of the Rio Wawa.

Figure 27: Potential peatland site at Laguna Karatá / Wouhnta

Geography & Vegetation: Coastal and continental wetland types like beaches, mangroves, permanently flooded marshes with mostly graminoid like Cladium jamaicense and Eleocharis and patches of the palm Acoeloraphe wrightii. Raphia taedigera is absent from these sites. Peatlands can be found along the river Wawa and at the lagoons in form of back-barrier peatlands. During the 2nd scoping mission, 11 corings have been conducted by project team and peat layers of more than 2.2 m thickness (max. coring depth) have been identified in different parts of the wetland (Fig. 28, Fig. 29). Peat was mostly undecomposed to slightly decomposed graminoid peat in upper layers and wood peat in deeper layers. A more detailed description of the findings of the scoping mission, you find in Annex 3. Potential peatland area: ~478,000 ha. Tropical monsoon climate with average temperature of 26°C and precipitation of 2,800 mm/a.

Land use: The area around Puerto Cabezas is an important area of indigenous communities of Miskitos who use the area for subsistence fishing and hunting. Eco-tourism takes place in more accessible parts of the wetland. A channel was cut through the peatland to connect Laguna Karatá and Laguna de Wouhnta. It is used by local people for transportation to avoid the inconvenient and dangerous passage over the open sea to get from Wouhnta to Puerto Cabezas. The channel has a possible drainage effect on the peatland along its bank and transports salty water from the lagoons into the sweet water environments. There are plans to extend the channel system which could increase negative impact, e.g. to dig a connection to Bluefields. The wetland plays a vital role as buffer ecosystem for coastal protection as it serves
as a barrier for floods caused by hurricanes to protect habitations from destruction. Due to climate change, the frequency and magnitude of hurricanes is increasing and sea level is rising, therefore the wetlands are under pressure of being salinated and ultimately flooded. Another risk is the advancing of agricultural extension in the upstream areas of the Rio Wawa with increased rates of deforestation. In effect, sedimentation is increased in the estuary of the river and lagoons and water are contaminated with chemicals and nutrients.

Figure 28: Site map Puerto Cabezas with coring points and peat occurrence during 2nd mission
Conservation: Designated as a “Reserva Biológica Cayos Miskitos y Franja Costera” and declared a Ramsar site “Cayos Miskitos y Franja Costera Immediata” in 2001. Monitoring and scientific assessment is carried out by the local universities Universidad de las Regiones Autónomas de la Costa Caribe Nicaragüense (URACCAN) and Bluefields Indian and Caribbean University (BICU).


4.3.3. Wetlands North of Puerto Cabezas (Laguna Bismuna)

Location: Northern part of the Nicaraguan Caribbean coast in the North Caribbean Autonomous Region up to the border to Honduras. The peatlands spread in the lagoon and backwater areas north of district capital Puerto Cabezas, also known as Bilwi. Back-barrier peatlands are situated at the lagoon system of Laguna de Bismuna and tributary rivers.

Geography & Vegetation: Coastal and continental wetland types like beaches, mangroves, permanently flooded marshes with mostly graminoids like Cladium jamaicense and Eleocharis and patches of the palm Acoeloraphe wrightii. Peatlands can be found along the rivers and at the lagoons in form of back-barrier peatlands. Potential peatland area: 81,000 ha, but there is no sampling data available. Tropical monsoon climate with average temperature of 26°C and precipitation of 2,800 mm/a.

Land use: The area around Puerto Cabezas and village of Bismuna are important for indigenous communities of Miskitos who use the area for subsistence fishing and hunting. The wetland plays a vital role as buffer ecosystem for coastal protection as it serves as a barrier for floods caused by hurricanes to protect habitations from destruction. Due to climate change, the frequency and magnitude of hurricanes is increasing and sea level is rising, therefore the wetlands are under pressure of being salinated and ultimately flooded.

Conservation: Designated as “Reserva Biológica Cayos Miskitos y Franja Costera” and declared a Ramsar site “Cayos Miskitos y Franja Costera Immediata” in 2001. Parts of wetland further inland are designated as “Reserva Natural Cabo Viejo Tela Sulamas”.

Figure 30: Potential peatland site at Laguna Bismuna
4.4. Factsheets on priority peatland sites in Honduras

4.4.1. Wetlands of Puerto Lempira

**Location:** Southern part of the Honduran Caribbean coast in Gracias a Dios province stretching towards the Rio Coco, the border to Nicaragua. The peatlands are situated at the shoreline of Laguna de Caratasca, Laguna Daiwras, Laguna Cojunta and Laguna de Liwa and along the little river Crique Lakamaya, a tributary of Rio Cruta, south of the city of Puerto Lempira. The village of Tuntuntara is located in the peatland area.

![Figure 31: Potential peatland site at Puerto Lempira](image)

**Geography & Vegetation:** Permanently and temporary flooded marshes with mostly graminoids like Cladium jamaicense and Eleocharis, patches of the palm Acoelorape wrightii and mangroves.

![Figure 32: a) Landscape impression of peatland site with Eleocharis, Cladium, Acoelorape wrightii, and Rhizophora mangle; b) Peat core sample from Crique Lakamaya.](image)
Peatlands can be found along the rivers and at the lagoons in form of back-barrier peatlands. During the 2nd scoping mission in the project, experts from Greifswald Mire Centre confirmed peat occurrence in the area by 8 corings of which 6 showed considerable peat layers with peat depth of around 1.5 m thickness at most places (Fig. 32). Peat was classified as slightly to highly decomposed root peat with wood inclusions. Potential peatland area: ~100,000 ha. Tropical rainforest climate with average temperature of 27°C and precipitation of 3,300 mm/a.

Figure 33: Site map Puerto Lempira with coring points and peat occurrence during 2nd mission
**Land use:** The area around Puerto Lempira and village of Tuntuntara are important for indigenous communities of Miskitos who use the area for subsistence farming, fishing and hunting. The wetland plays a vital role as buffer ecosystem for coastal protection as it serves as a barrier for floods caused by hurricanes to protect habitations from destruction. Due to climate change, the frequency and magnitude of hurricanes is increasing and sea level is rising, therefore the wetlands are under pressure of being salinated and ultimately flooded.

**Conservation:** The wetlands towards the border with Nicaragua are protected in the “Parque Nacional de Kruta”, other sites are no designated conservation areas.

### 4.4.2. Laguna Laguntara

**Location:** Southern part of the Honduran Caribbean coast in Gracias a Dios province, north of Puerto Lempira at north-western edge of Laguna de Caratasca. Peatlands are situated in lagoon complex of Laguna Laguntara, Laguna Siksa, Laguna Tilbalakan and Laguna Warunta.

**Geography & Vegetation:** Coastal and continental wetland types like beaches, mangroves, permanently flooded marshes. Peatlands probably can be found in the matrix between the lagoons in form of back-barrier peatlands. Potential peatland area: ~92,000 ha. No sampling or other further investigations of peat layers in the area are available. Tropical rainforest climate with average temperature of 26°C and precipitation of 4,300 mm/a.

**Land use:** The area is sparsely inhabited. It is an important area of indigenous communities of Miskitos who use the area for subsistence farming, fishing and hunting. The wetland plays
a vital role as buffer ecosystem for coastal protection as it serves as a barrier for floods caused by hurricanes to protect habitations from destruction. Due to climate change, the frequency and magnitude of hurricanes is increasing and sea level is rising, therefore the wetlands are under pressure of being salinated and ultimately flooded.

**Conservation:** Designated as a “Reserva de Vida Silvestre Caratasca”.
4.5. Factsheets on priority peatland sites in Cuba

4.5.1. Rio Cauto

Location: East of Cuba in Granma province at the southern coast. Closest towns are Rio Cauto and Manzanillo. It is the biggest river delta in Cuba. Peatlands have been described mainly for the northern part of the delta called Ciénaga de Birama.

![Map of Rio Cauto and surrounding areas](image)

*Figure 35: Potential peatland site at Delta of Rio Cauto*

Geography & Vegetation: The delta has formed by sedimentation of fluvial material transported from Rio Cauto. Most of the delta is covered with these mineral sediments with mangrove and marshland, only the northern part Ciénaga de Birama is reported to have peat layers of 60 – 70 cm. Potential peatland area: 500 ha (Perejrest, 1964). No sampling or other recent investigations of peat layers in the area are available. Vegetation of peatlands is dominated by graminoid species (e.g. *Eleocharis, Typha domingensis*) with groups of the palm *Sabal parviflora*. The climate has average temperatures of 26°C and precipitation of 1,200 mm/a.

Land use: The area has been intensively used in the last decades. First, tropical wet forest was chopped down to create pastures and agricultural land within the delta. Later, the hydrological regime has been changed to improve navigability for ship on Rio Cauto and dams were built to create artificial water basins for irrigation of adjacent rice paddies (Schaller, 2014). Due to climate change and sea level rise there is a risk of losing land of the delta to the sea. The abstraction of fresh water from the wetland to irrigate agricultural land creates a risk of water scarcity and degradation of the peat body. Activities of shrimp farming create a risk of pollution and destruction of mangroves.
**Conservation:** Designated as protected area “Refugios de Fauna Delta del Cauto y Monte Cabaniguan” and declared as Ramsar site “Humedal Delta del Cauto” in 2002.


**4.5.2. Laguna de la Leche**

**Location:** Laguna de la Leche with the adjacent Ciénaga de Morón is located in the centre of Cuba in the Villa Clara province at the northern coast. Closest town is Móron.

**Geography & Vegetation:** Formed on calcareous bedrocks and is surrounded by mangrove vegetation. The Ciénaga de Morón has bigger, mostly inundated grasslands (e.g. *Cladium jamaicense*, *Eleocharis rostellata*, *Typha domingensis* (Peros et al. 2007). In addition, wet forest with *Callophyllum antillanum*, *Annona glabra*, *Bucida sp.*, *Copernicia sp.*, *Sabal parviflora* exists in the area. Investigations by Schaller, 2014 showed that in the vegetated depression peat layers of average 1.5 m thickness formed. Mostly highly decomposed peat strongly intermixed with calcareous sediments were found. Potential peatland area: 43,000 ha. Tropical savannah climate with average temperature of 25°C and precipitation of 1,300 mm/a.

![Figure 36: Potential peatland site at Laguna de la Leche](image)

**Land use:** Parts used for forestry and fisheries (Schaller, 2014). Tourism is intense in other parts. Agriculture has developed further inland; therefore, Canal de Chicola was dig to transport sugar cane to the sea, which is draining the area and allows salt-water intrusion into
Laguna de la Leche. Deforestation and agriculture in the catchment increased sedimentation into the lagoon and led to covering of peat soils and stopped their natural capacity to grow up with the rising water levels. Wastewater from Morón town is contaminating the wetland.

**Conservation:** Parts designated as protected areas (in total 6 protected areas) which form the core zones of the 2002 declared Ramsar site “Gran Humedal del Norte de Ciego de Ávila”.


### 4.5.3. Ciénaga de Majaguillar

**Location:** Western Cuba at the northern coast, Matanzas province. The town of Cárdenas is situated closely to the area in western direction.

![Map of Ciénaga de Majaguillar](image)

**Figure 37:** Potential peatland site at Ciénaga de Majaguillar

**Geography & Vegetation:** Formed on calcareous bedrocks, surrounded by mangrove vegetation. Inner part characterized as inundated grasslands with shrubs dominated by *Cladium jamaicense* (Schaller, 2014). Corings by Schaller, 2014 confirmed peat layers of 1 m thickness in average at central parts. Mostly highly decomposed peat strongly intermixed with sediments. Potential peatland area: 20,000 ha (Perejrest, 1964). Tropical savannah climate with average temperature of 25°C and precipitation of 1,300 mm/a.

**Land use:** Eastern parts of Ciénaga de Majaguillar were planned to be converted into agricultural lands, channels and ditches dig into the area. Nowadays, agricultural activities
within the peatland have stopped but drainage system negatively affects the water regime and functioning of the peatland. In addition, roads were built to develop the area, which influence the water flow and peatlands functioning. Intense agricultural activities in the surrounding inland with irrigation systems also has negative effect. The area is recognized as an important area for climate change mitigation and adaptation to prevent flooding and salination of aquifers.

**Conservation:** Parts of the wetlands have been designated as ecological areas but in general, conservation status of the peatland is low.


### 4.5.4. Ciénaga de Zapata

**Location:** On peninsular at the southern coast of Cuba, in Matanzas province. Jagüey Grande is the closest city; within Ciénaga de Zapata several smaller villages and touristic infrastructure can be found. One of the largest and best preserved wetlands in the Caribbean Islands, with the largest peatland in Cuba.

**Geography:** Formed on calcareous bedrocks and closely connected with karstic system of the region. Precipitation in the inland catchment area is drained through the complex karst holes and discharged at northern edge, which leads to a permanent water supply throughout the year (Rodriguez Yi, 1991). Additionally, several rivers discharge water into the wetland. The central part of the wetland is a tectonic depression where peat has possibly formed over an
historic lake. Until today fresh water lakes like Laguna del Tesero can be found. Run-off to the sea is blocked in the eastern part, which is the part with biggest peatland distribution, by a limestone ridge, which is itself pervaded by a karst system with limited discharge rate. Peat could be mainly found in the northern part of the wetland dominated by wet grasslands. Pajón et al., 2004 indicate a peat depth of up to 7 m for this part, Perejrest, 1964 even a peat depth of up to 10 m in the area around Laguna del Tesero. Schaller, 2014 describes a peat depth of 5 m with changing intermixed layers of calcareous and gleyic sediments. The peat is composed by roots of graminoids and is mostly highly decomposed and rich in nutrients. Potential peatland area: 345,300 ha (Schaller, 2014). Tropical savannah climate with average temperature of 25°C and precipitation of 1,600 mm/a.

Vegetation: Typical peatlands in Ciénaga de Zapata are permanently or temporally inundated grasslands dominated by Cladium jamaicense, Typha domingensis and Eleocharis interstincta with palms (Sabal parviflora) and small forest islands. In addition, wet forest with Annona glabra, Bucida buceras, Hibiscus elatus, Sabal parviflora exists. Salt water influenced areas closer to the shoreline or along channels with connection to the sea have extensive mangrove vegetation, which partly form peat deposits as well.

Land use: 19 communities with a total population of approximately 10,000 persons live in the wetland. Main economic activities are forestry for timber and charcoal production, tourism and fishing. There were plans to drain parts of the peatland for sugar cane and rice agriculture already in pre-revolution times around 1900, but they have not been implemented due to high costs (Perejrest, 1964). In 1959, extensive drainage of the peatland was implemented. 400 km² area in the western part and 250 km² in the eastern part were planned to be converted into rice fields. Construction started with a 5.4 km² pilot area for which a canal was built to redirect the outflow of the Río Hanábana into the sea. For technical and financial reasons finally only a smaller area was drained (Perejrest, 1964), which is still well visible on satellite imagery today. In this and other drained areas, peat mineralization is going on for decades with high GHG emissions. Invasive species like Casuarina equisetifolia and Melaleuca quinquinervia can easily spread along the channels, increase evapotranspiration and suppress native species. Additional problems are the salinization of soils by the capillary rise of salt water from formerly agricultural sites. Also due to agriculture in adjacent inland areas, nutrient inputs into the peatland increased and large-scale irrigation of e.g. citrus plantations reduced...
fresh water discharge through the karst system. The still existing drainage system increased outflow of water and drying of peat, which leads to fire events during dry summer periods. Deforestation is prevalent, especially in the semi-deciduous forest at the edges of the peatlands for timber or grazing lands

**Conservation:** Declared as multi-use protected area by Cuban legislation and as UNESCO Biosphere Reserve in 2000. Its core is conserved as five strictly protected areas, including a national park. Declared as Ramsar site “Ciénaga de Zapata” in 2001.


### 4.5.5. Wetlands South of Havana (Gran Humedal del Sur de La Habana)

**Location:** Narrow band for 110 km along southern coast of Cuba, south of country’s capital Havana in provinces of Mayabeque and Pinar del Río.

![Figure 40: Potential peatland site at Wetlands South of Havana](image-url)
Geography & Vegetation: Formed by marine sedimentation along the coast and following establishment of mangrove vegetation (*Rhizophora mangle, Avicennia germinans*) which formed growing organic peat soils over centuries and stabilised the coastline (Ortega Sasatriques, 1980). Inland, fresh water conditions established, which harbour inundated grasslands with *Cladium jamaicense, Typha domingensis* and patches of *Sabal parviflora*. Peat deposits with thickness of 2.5 m can be found mainly in the eastern part of the wetland, composed mostly from highly decomposed peat strongly intermixed with calcareous sediments (Schaller, 2014). Potential peatland area: ~38,000 ha. Tropical savannah climate with average temperature of 25°C and precipitation of 1,300 mm/a.

Land use: Starting in the year 1942, peatland near Playa Guanímar was drained with channels to the sea for agricultural use but drainage failed. In 1962, plantations of bananas, peppers and corn started in drained areas close to Playa del Rosario and for forestry use close to Playa Cajío (Perejrest, 1964). The tree *Casuarina equisetifolia* was introduced as a neophyte and nowadays spreading along the channels in the peatland. In 1985, the construction of a dike along the south coast began on a length of about 100 km between Majina and Batabanó. The goal was to stop fresh water outflow to the sea, as it was needed for agriculture and drinking water supply for Havana and to prevent intrusion of salt water into aquifers. In effect, the mangrove belt suffer due to lacking of fresh water supply and are damaged or died-off in many places along the coast today, so that their protective function for the coast in storm events is reduced (Díaz-Briquets & Pérez Lopez 2000).

Conservation: No legal protection status.


4.5.6. Isla de la Juventud / Ciénaga de Lanier

Location: On Canareos Archipelago, specifically on southern part of Isla de la Juventud. Runs from the bay of Siguanea to eastern mouth of the San Juán River.

Geography & Vegetation: Ciénaga de Lanier has developed in depressions formed by San Juán River and connected lagoon, which forms a natural geographical barrier that divides the northern part of the island from the karst plain in the south including nearby marine areas. Water discharges from the karst system of the northern part of the island so that continuous water supply to allow peat growth in ensured throughout the year. Water flows through the peatland and recharges karst system at the southern part of the island, partly to the sea. Several habitats exist in the area especially mangroves and swamp grasslands with *Cladium jamaicense, Typha domingensis* with patches of *Sabal parviflora* and shrubs. Potential peatland area: 4,000 ha. Tropical savannah climate with average temperature of 25°C and precipitation of 1,000 mm/a.
Figure 41: Potential peatland site at Ciénaga de Lanier

**Land use:** Mostly in natural state and no utilisation. In northern part of Ciénaga de Lanier, extraction of peat for agricultural soil improvement takes place. Agricultural development especially rice paddies need water for irrigation which could reduce discharge to peatland area and negatively affect the hydrological regime. Small-scale Tourism developed at edges.

**Conservation:** Partly designated as Refugios de Fauna and as an Ecological reserve. In 2002, the Ramsar site “Ciénaga de Lanier y Sur de la Isla de la Juventud” was declared.

**References:** Ramsar Convention (2018): Ramsar Sites Information Service. Accessible online: rsis.ramsar.org
5. Conclusion

Given the large extend of coastal peatlands in the Caribbean region and their value for climate change mitigation and adaptation, local livelihoods and biodiversity, very little is known about their distribution, functioning and status. In this project, we could only focus on a limited set of countries (Panama, Costa Rica, Nicaragua, Honduras, Cuba) within the region with a first assessment of probable peatland distribution, dialogue with experts and decision makers and two scoping missions to selected peatland sites for ground-truthing. As a first step, we draw maps to show potential sites of future interest. Derived from these maps, we identified the list of priority sites for further investigations and actions, and we rose awareness among the target group. For the selected countries alone, approximately 1,500,000 ha of peatland have been estimated, the total extend in the whole region will be much bigger. Local stakeholders from practitioners, scientists to politicians showed big interest to learn more about the features and specialities of peatlands of their region. The list presented here shows that there are relatively well-protected areas in a near-natural state or used in a sustainable way, many of them in hardly accessible, remote areas along the Caribbean coast. On the other hand, there are sites under risk of direct human interventions like agriculture and development of infrastructure for transport and tourism, even more by indirect influence of degradation of lands in the catchment area of the peatlands further inland by deforestation and agricultural extension. Some of the areas might get under pressure by advancing agricultural belt e.g. concessions for palm oil plantations. Without further knowledge and understanding of the properties and functioning of their tropical peatlands as sensitive ecosystems important for the coastal zone in times of climate change, the countries of the region run the risk of taking the same pathway of peatland destruction as South-east Asian countries with devastating effects like fire, subsidence, salination, loss of land to flooding by the sea and high greenhouse gas emissions. In follow-up projects in research and conservation, more knowledge, awareness and capacity has to be gained to understand and value peatlands of the region as important coastal buffer zones, habitats and carbon sinks.

6. Acknowledgments

This report and the collection of information and data including two scoping missions with experts from Greifswald Mire Centre was made possible by the funding of the project “Strategic Environmental Dialogues on Caribbean Coastal Peatlands” by the German Federal Ministry of Environment and Nature Conservation (BMU), facilitated by the Gesellschaft für Internationale Zusammenarbeit (GIZ). We thank the experts Prof. Dr. Michael Succow and Prof. Dr. Dr. h.c. Hans Joosten from Greifswald Mire Centre for their time and effort to travel to the region within the scoping missions and their valuable input. We thank Rebeca Magaña and her team from the Centro Regional para la capacitación e investigación sobre humedales para el Hemisferio Occidental (CREHO) for valuable information on wetlands of the region and the constant support for organising the trips and meeting. Special thanks go to the Manfred-Hermsen-Stiftung, represented by Johannes Burmeister, who supported our efforts in the region constantly and made this project possible. In this regard, we also thank all colleagues, which supported and dedicated their time to this study in various important ways. Specially, we want to name Alexandra Barthemles, Laura Villegas Mejia (both Greifswald University), Dr. Lilliana Piedra Castro, Prof. Dr. Ludwig Ellenberg (both UNA Costa Rica), Hector Rodriguez Aburto (Nicaragua), and Dr. Elier Tabillo Valdivieso (Centro Neotropical de Entrenamiento en Humedales Chile).
7. References


Valdespino & Santamaría (1997): Evaluación ecológica rápida del Parque Nacional Marion Isla Bastimentos y áreas de influencia, Islas Solarte, Swan Cay, Mimitimbi (Isla Colón) y humedal San San-Pond Sak, provincial de Bocas del Toro. Tomo 1: Recursos terrestres. ANCON. Panama.


8. Annexes

Annex 1: Maps of probable peatland areas at the Caribbean coast of Panama, Cosa Rica, Nicaragua, and Cuba showing specific used geospatial data

Annex 2: List of geospatial data used for the mapping of probable peatland areas at the Caribbean coast of Panama, Cosa Rica, Nicaragua, Honduras, Yucatan / Mexico, and Cuba

The project “Strategic Dialogues for Coastal Peatlands in the Caribbean - Underlining the importance of peatlands for biodiversity, climate change mitigation, coastal protection, and human livelihoods” is funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, facilitated by the Gesellschaft für Internationale Zusammenarbeit (GIZ). The project is implemented by Michael Succow Foundation, partner in the Greifswald Mire Centre.
Annex 1: Maps of probable peatland areas at the Caribbean coast of Panama, Costa Rica, Nicaragua, and Cuba showing specific used geospatial data.
Nicaragua - Combined information indicating peatland/organic soil

Indication from GIS data
Source 2
- Formations of wet forests, swamps and marshes

Indication from digital maps
Source 1
- Organic soil

Source 22
- Manglar
- Pantano con vegetación herbácea
- Tierras sueltas a inmudación
- Palma (Yolillo)

Source 23
- Raphia taedigera

Source 24
- Histosol

Source 25
- Vegetación costera pantanosa
- Herbazal en depósitos orgánicos de crecida
- Pantano de ciperáceas
Annex 2: List of geospatial data used for the mapping of probable peatland areas at the Caribbean coast of Panama, Costa Rica, Nicaragua, Honduras, Yucatan / Mexico, and Cuba

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<p>| 26 | Panama | x | swamp s and seaso nally floode d areas | Panama_source26 | swamps and seasonally flooded areas digitalised from map | 2000 | La guia 2000 | <a href="http://geografia.laguia2000.com/climatologia/panama-clima-y-vegetacion">http://geografia.laguia2000.com/climatologia/panama-clima-y-vegetacion</a> |
| 27 | Panama | x | vegetation | Panama_source27 | digitalised from map: Mapa de vegetación de Panamá, vegetation form: Vegetacion de paramo (16), Pantanos de ciperáceas con abundante acumulación de material organico (17), Pantanos herbáceos salobres (18), Bosque de manglar (13), Bosque perennifoloi ombrofilo tropical pantanoso (9-11) | 1500,000 | ANAM / CCBMAP | ANAM / CCBMAP (2000) Mapa de vegetación de Panamá | <a href="http://www.gifex.com/fullsize/2011-10-14-14630/Mapa-de-vegetacion-de-Panama-2000.html">http://www.gifex.com/fullsize/2011-10-14-14630/Mapa-de-vegetacion-de-Panama-2000.html</a> |</p>
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