GLOBAL SYMPOSIUM ON SOIL ORGANIC CARBON, Rome, Italy, 21-23 March 2017

Distribution of tropical peatland types, their locating and current degradation status

Alexandra Barthelmes[1]& Cosima Tegetmeyer[1]*

[1] Greifswald Mire Centre, c/o Greifswald University, Germany (contact: alex.barthelmes@greifswaldmoor.de)

Abstract

Peatlands of the Tropics are highly diverse and occur from the coast to alpine altitudes. Natural tropical peatlands are covered by peat swamp forests, wet grasslands, *Papyrus* reeds, mangroves, salt-marshes, and specific high altitude afro-alpine or páramo vegetation. The total area of tropical peatland is estimated to be 30-45 million ha (10-12% of the total global peatland resource). It constitutes one of the largest near-surface pools of terrestrial organic carbon (Sorensen 1993).

Although the exact extent of peatlands in large and partially remote areas is unclear (e.g. western Amazon Basin, Pantanal, Congo Basin, Sudd, Okavango Delta, Ganges Delta), a wealth of information is available to locate the majority of peatlands across the Tropics (cf. Barthelmes et al. 2015). We present an overview of tropical peatland types and their distribution based on ecoregions and geospatial data collated in the Global Peatland Database.

The current degradation status of tropical peatlands is addressed in case studies from East Africa, the Ganges Delta and the Guyana shield. Furthermore, we highlight regions where vast areas of undisturbed tropical peatlands (may) occur, and that need protection against land reclamation that involves drainage (e.g. Congo Basin, Zambia floodplains, western Amazon Basin, coastal lowlands of Papua New Guinea).

Keywords: Tropics, peatland types and distribution, peatland mapping, organic soil, utilization pressure, drainage

Introduction, scope and main objectives

Peatlands have become increasingly recognized as a vital part of the world's wetland resources. Peatlands are wetlands where permanently waterlogged conditions prevent the complete decomposition of dead plant material. In peatlands thick layers of carbon rich peat has accumulated over thousands of years which make them to the most space-effective stocks of organic carbon on the planet.

Deforestation and drainage of peatlands stop their ability to sequester carbon and lead to the emission of huge amounts of greenhouse gases (e.g. Hooijer et al. 2012). Especially in the tropics, the rising global demand for food, biofuels (e.g. palm oil) and raw materials triggers the development and drainage of peatlands. Overall, an urgent need exists to identify the location of peatlands, to protect them against drainage for decrease greenhouse gas emissions and to prevent peat fires.

Until now, there is no satisfactory pantropical or continental geospatial data on peatland types, their location or distribution available. Therefore, the pantropical inventory of peatlands still depends on the aggregation of existing and new elaborated local, regional and national data.

During the last decades a tremendous amount of regionally or punctual research studies, expedition reports, governmental and NGO information and datasets on peatlands have been elaborated and are increasingly available electronically. A first global overview on peatland extent has been presented by Joosten et al. (2009[1]). We now provide a rough geospatial overview of peatland types, their distribution and drainage status across the tropics.

[1] https://www.wetlands.org/publications/the-global-peatland-co2-picture/

Methods

We compiled this geospatial overview of tropical peatland types, their distribution and drainage status based on comprehensive information on peatland and landscape ecology, and integrated very different datasets. We mainly used:

1) the global map of 'terrestrial ecoregions'[2],
2) the 'worldwide bioclimatic classification system - Ombrotypes' (1996-2017),
3) the 'tropical and subtropical histosol distribution'[3] (SWAMP 2016),
4) 'a new map of standardized terrestrial ecosystems for Africa' (Sayre et al. 2013), and
5) various geospatial data on distribution of peatlands, histosols and organic soils collated in the Global Peatland Database[4].

Moreover, we integrated own geospatial data elaborated in framework of the Global Peatland Database. Recognizing the vast diversity of definitions and terms for peatlands, we considered all available data that fit into the broad IPCC concept of 'organic soils' with 12 percent or more organic soil carbon without a depth criterion (cf. IPCC 2014). This automatically includes all peatlands, histosols, and most other organic soils, and moreover allows the integration of historically grown national or regional datasets.

To roughly estimate the drainage and degradation status of peatland areas we used the 'global 1-km consensus land cover' (Tuanmu & Jetz 2014) and the map on the 'world land stress – anthropic' from the 'Plant and soil sciences eLibrary of the university Nebraska[5]. Since the major threat to peatlands is drainage, we furthermore visually assessed the drainage system using available aerial and satellite imagery.

Results

We found that, as everywhere in the World, peat is deposited in the tropics under long-term water saturation of the soil in areas with frequent and excessive rainfall (e.g. in humid tropics) or areas where large amounts of water is available (e.g. in coastal environments), where water is flowing together (e.g. depressions, floodplains), or under cold and humid climates that inhibit the decay of organic matter (e.g. in montane and alpine environments). Natural tropical peatlands are covered by peat swamp forests, palms, wet grasslands, *Papyrus* reeds, mangroves, and specific high altitude afro-alpine or páramo vegetation (Fig. 1).

Peat swamp forests of South East Asia prevailed in the public and scientific perception of tropical peatlands during the last two decades. But forested peatlands also cover large areas in the western Amazonas basin, and the Congo Basin, and occur at the West African coast (e.g. in Ghana and Ivory Coast; Asante & Jengre 2012, cf. Barthelmes et al. 2015) and in South Africa. Whereas many African peat swamp forests are undrained and not heavily logged so far, the peat rich 'Sundarbans freshwater swamp forest' ecoregion in the Ganges delta seem to be completely extinct. Recently increased logging activities in Papua New Guinea may endanger the peatlands of the 'Southern New Guinea freshwater forest' ecoregion in next years too.

[2] http://maps.tnc.org/files/metadata/TerrEcos.xml
[3] https://data.cifor.org/dataset.xhtml?persistentId=doi:10.17528/CIFOR/DATA.00029
[4] http://www.greifswaldmoor.de/global-peatland-database-en.html
[5] https://passel.unl.edu/pages/

Fig. # Natural vegetation on tropical organic soils: 1-*Papyrus* dominated (Okavango Basin, Botswana); 2-grassy vegetation (Kenya); 3-Peat Swamp Forest (Malaysia); 4, 5-grassy vegetation (Uganda and Kenya); 6 - high altitude afro-alpine vegetation (Uganda); 6 - high altitude grassy vegetation (Peru).
(photos: Hans Joosten & Alexandra Barthelmes)

Peatlands in flooded grasslands are widely spread are across the tropics. For example the ‘Zambezian flooded grassland’ ecoregion that includes e.g. large peatland areas as the Okavango delta (Botswana), and in the Barotse floodplain, the Lukanga and Bangweulu swamps in Zambia. Most of these areas are still undrained or seem to be used only for subsistence agriculture without deep and intensive drainage. Comparable flooded grassland peatlands occur in the ‘Sahara flooded grassland’ ecoregion (incl. vast *Papyrus* dominated peatlands in the Nile floodplain – the Sudd, in the ‘Pantanal’ ecoregion (Brazil, Bolivia, Paraguay), and in the ‘Humid Chaco region’ (Argentina, Paraguay, Brazil). The overall human impact (drainage and agriculture) seem to be higher in South America than in the African flooded grasslands.

Another distribution center of tropical peatlands are high altitude peatlands that prevail e.g. in the ‘Paramos’ and ‘Wet Puna’ ecoregion in South America, on several East African mountains (e.g. Mount Kilimanjaro, Mount Meru, Mount Ruwenzori, Mount Kenya, the Bale Mountains = ‘alto-tropical moorlands’, cf. Bussmann 2006), and in the ‘New Guinea central mountains’ ecoregion in Papua New Guinea. Degradation hotspot of peat filled mountain valleys on the uplifted flanks of the East African Rift (Lake Victoria region) are Burundi (91% of all peatlands drained), Kenya (45%), and Rwanda (46%), respectively.

Peatlands and organic soils are widespread along the coasts of the humid tropics, e.g. in South America (Guiana shield, Orinoco delta, southern Brazil), in Africa (West Africa, Mozambique, East coast of Madagascar), and Asia (Indonesia, Malaysia, Papua New Guinea, Bangladesh, Sri Lanka). They basically can be divided in peat swamp forests (see above), inter-dune valley bottom peatlands, delta and lagoon peatlands and mangroves of organic soil. Especially in SE Asia, East Africa and southern Brazil these coastal peatlands are widely under drained land use.

Discussion

It is often emphasized that the knowledge especially on tropical peatlands outside SE Asia is rare, and comprehensive, accurate and up-to-date GIS data and remote sensing models are not available.

However, if considering different scientific disciplines, different languages, and different kinds of data, as well as indicative proxy and legacy data, there is a tremendous amount of information available. We used them to roughly deduce the location and distribution of tropical peatlands. The disadvantage of this method is, that this diverse data cannot be easily harmonized and processed automatically, and partly remain expert judgement.

This compilation aims to introduce wide spread tropical peatland types and the range of datasets that can be used to locate and describe them, e.g. for awareness rising, nature protection, or as starting point for high resolution mapping. We focused on geospatial data on ecoregions, bio- geographical or freshwater regions that are nowadays increasingly at available global and continental scale. Unfortunately, their zonation is often based on forest distribution pattern or huge freshwater basins, which makes them not fully operational considering often small and azonal distributed peatlands. Available national and regional datasets on ecoregions, landscapes, bio-geographical regions or vegetation might be used to derive higher resolution coverage on peatland types, and to determine their characteristics, variability and vulnerability to human or climate change disturbance.

We would like to point out, that although the exact extent of peatlands in large and partially remote areas is unclear (e.g. western Amazon Basin, Pantanal, Congo Basin, Sudd, Okavango Delta, Ganges Delta), a wealth of information is available to locate the majority of peatlands across the tropics with reasonable effort and sufficient results e.g. for biodiversity assessments, for developing sustainable land use options or nature protection strategies.

Conclusions

Considering the tropics as a whole, the current knowledge level is sufficient to identify important countries or regions is terms of peatland occurrence, typology, biodiversity and degradation as starting points for comprehensive peatland inventories for different purposes.

On a national level, for various countries large uncertainties on peatland locations exist. However, for hardly any country lacking knowledge is the bottleneck for starting inventory, assessment and setting monitoring baselines, certainly when the vast range of suitable and already available data is adequately located, provided and integrated.

References

Asante W & Jengre N 2012. Carbon Stocks and Soil Nutrient Dynamics in the Peat Swamp Forests of the Amanzule Wetlands and Ankobra River Basin. USAID Integrated Coastal and Fisheries Governance Program for the Western Region of Ghana. Accra: Nature Conservation and Research Centre, 45 p.

Barthelmes A, Ballhorn U & J Couwenberg 2015. Consulting Study 5: Practical guidance on locating and delineating peatlands and other organic soils in the tropics. The High Carbon Stock Study, available at: http://www.simedarby.com/sustainability/minimising-environmental-harm/high-carbon-stock/high-carbon-stock

Bussmann RW 2006. Vegetation zonation and nomenclature of African Mountains - An overview. Lyonia, Volume 11: 41-66. Download at: http://www.lyonia.org/downloadPDF.php?pdfID=2.476.1

Hooijer A, Page SE, Jauhiainen J, Lee WA, Lu XX, Idris A & Anshari G 2012. Subsidence and carbon loss in drained tropical peatlands. Biogeosciences 9: 1053-1071.

IPCC 2014. 2014 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi T, Krug T, Tanabe K, Srivastava N, Baasansuren J, Fukuda M & Troxler TG (eds), Published by IPCC, Switzerland.

Joosten H. 2009. The global CO_2 picture, Wetlands International, Ede, 2009,

Sayre RP, Comer J, Hak C, Josse J, Bow H, Warner M, Larwanou E, Kelbessa T, Bekele H, Kehl R, Amena R, Andriamasimanana T, Ba L, Benson T, Boucher M, Brown J, Cress O, Dassering B, Friesen F, Gachathi S, Houcine M, Keita E, Khamala D, Marangu F, Mokua B, Morou L, Mucina S, Mugisha E, Mwavu M, Rutherford P, Sanou S, Syampungani B, Tomor A, Vall J, Vande Weghe E, Wangui & L. Waruingi 2013. A New Map of Standardized Terrestrial Ecosystems of Africa. Washington, DC: Association of American Geographers, 24 p.

SWAMP 2016. ‘Tropical and Subtropical Histosol Distribution’, doi:10.17528/CIFOR/DATA.00029, Center for International Forestry Research (CIFOR) Dataverse, V3.

Tuanmu M-N & W Jetz 2014. A global 1-km consensus land-cover product for biodiversity and ecosystem modeling. Global Ecology and Biogeography 23: 1031-1045. Data available online at http://www.earthenv.org/.

Worldwide Bioclimatic Classification System 1996-2017, Rivas-Martinez S & S Rivas-Saenz, Phytosociological Research Center, Spain. http://www.globalbioclimatics.org.