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GLOBAL POTENTIAL OF PALUDICULTURE AS LAND USE ALTERNATIVE FOR REWETTED PEATLANDS

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SUMMARY

Peatlands cover only 3 % of the global land surface, but contain one third (550 Gton) of the global soil carbon. About 10% of all peatlands are drained for different purposes and emit ~2.0 Gton CO_2 per year, making drained and degraded peatlands a global emission hotspot. Drainage and degradation are strongly linked to economic utilization of peatlands. Intended global mitigation of GHG emissions must focus on providing alternatives to current non sustainable land use practices. A promising alternative is paludiculture (Latin 'palus' = swamp): the cultivation of biomass on wet and rewetted peatlands.
Based on exhaustive analysis of available sources, this paper presents a first worldwide overview on degraded peatlands as potential sites for different types of paludiculture. The highest potential of implementation of paludiculture have Europe and East Asia with degrading peatland areas of about 220 000 km² (mainly Russia, Belarus, Finland, Germany, Sweden, Poland) and 200 000 km² (mainly Indonesia, China, Malaysia; Mongolia), respectively.

KEYWORDS: degrading peatlands, rewetting, GHG mitigation, biomass production, global

INTRODUCTION

Peatlands cover only 3 % of the global land surface, but contain one third of the global soil carbon (550 Gton). About 10% are drained for different purposes and emit ~2.0 Gton CO_2 per year (Joosten, 2009). The major driver of peatland degradation is conventional agriculture, which requires a lowering of the water table. Inherent degradation of drained peatland soils continuously lowers their productive value (e.g. Succow and Joosten, 2001; Holden et al., 2004). Loss of soil fertility together with increasing costs of drainage and political and economic changes led to the abandonment of vast peatland areas (e.g. in East and Central Europe) and caused rural unemployment and social disintegration. Meanwhile, large-scale rewetting re-established ecosystem services of wet peatlands (Kimmel and Mander, 2010; Wichtmann, this volume), but the challenge of improving rural livelihoods persists. New production techniques that address both these environmental and socio-economic challenges are 'paludicultures', which produce biomass under wet conditions (cf. Schröder, this volume) while maintaining the peat body and the natural peatland ecosystem services (Wichtmann and Joosten, 2007). The implementation of paludicultures in the temperate zone is in progress and under investigation (e.g. Abel, Gaudig, Schröder, this volume). Their huge potential deserves consideration for implementation on degraded peatlands worldwide.

Although many inventories of peatland resources exist (e.g. Goodwillie, 1980; Kivinen and Pakarinen, 1980, 1981; Gore, 1983; Lappalainen, 1996) precise, comprehensive and comparable data on the location, extent and especially on the status of peatlands are lacking (Joosten and Clarke, 2002). This paper provides a guesstimate on the area of degrading peatlands for all countries of the world and thereby identifies regions with a high potential for paludicultures.

MATERIAL AND METHODS

Data are based on exhaustive analysis of available sources and taken from the Global Peatland Database, (GPD; Joosten, 2004-2012, Joosten, 2009). Establishing this database was recommended by the Guidelines for Global Action on Peatlands (8th Ramsar Conference Valencia 2002). The GPD presents an overview on the extent and situation of peatlands and mires for all countries of the world. This overview focues on, but not restricts itself to, freshwater peatlands. To provide a uniform standard, peatlands were defined as having a minimum peat depth of 30 cm; available data were recalculated if necessary. The data try to weigh up conflicting information from a variety of sources and to make an informed guess as to the situation in 2008. All countries with degrading peatlands are covered, countries without peatlands (e.g. at the Arab Peninsula) were excluded from the analysis. For more information see www.imcg.net/gpd/gpd.htm.

RESULTS

Degrading peatland areas occur in 183 countries and regions of the world (Table 1), but more than half of the countries/regions have less than hundred km^2. This is basically caused by unsuitable climatic and geographic conditions for peat formation (several North African states), predominant undisturbed peatlands (e.g. Argentina), but certainly also due to restricted information on peatland extent and utilisation (e.g. Gabon, Tanzania).

In 37 countries the degrading peatland area is estimated to be at least 1000 km², with the largest areas located in Europe (e.g. Russia, Belarus, Finland, Germany, Sweden, Poland) and Asia (e.g. Indonesia, China, Malaysia; Mongolia).

Table 1. (next page): Degrading peatland area (km²), degrading peatland as percentage of total peatland area and main causes of degradation: [(1)] agriculture; [(2)] forestry; [(3)] peat extraction; [(4)] other.

Country / Area	Degrading peatland area		Country / Area	Degrading peatland area		Country / Area	Degrading peatland area	
	km²	% of total		km²	% of total		km²	% of total

		peatland area
AFRICA	**14215**	**11**
Algeria	2[1]	20
Angola	1010**[1]**	10
Benin	50[1]	52
Botswana	100[1]	3
Burkina Faso	50[1]	34
Burundi	63[1]	42
Cameroon	100[1]	3
Central African Rep.	10[1]	10
Chad	5[1]	52
Congo	10[1]	0,1
Dem. Rep. of Congo	600[1]	5
Djibouti	18[1]	34
Egypt	5[1]	52
Equatorial Guinea	2[1]	26
Ethiopia	150[1]	7
Gabon	20[1]	1
Ghana	20[1]	20
Guinea	500[1]	52
Guinea-Bissau	5[1]	34
Ivory Coast	300[1]	44
Kenya	1000[1]	20
Lesotho	16[1]	85
Liberia	41[1]	42
Libya	10[1]	10
Madagascar	610[1]	33
Malawi	300[1]	45
Mali	50[1]	13
Mauritania	31[1]	54
Mauritius	0,02[1]	41
Morocco	5[1]	52
Mozambique	800[1]	41
Namibia	10[1]	10
Niger	10[1]	13
Nigeria	300[1]	28
Réunion	20[1]	17
Rwanda	205[1]	26
São Tomé & Príncipe	1[1]	52
Senegal	8[1]	15
Sierra Leone	41[1]	42
Somalia	50[1]	26
South Africa	71[1]	24
Sudan	1000[1]	3
Swaziland	35[1]	74
Tanzania	90[1]	2
The Gambia	20[1]	41
Togo	20[1]	69
Tunisia	1[1]	52
Uganda	**5000**[1]	37
Zambia	1200[1]	8
Zimbabwe	250[1]	75
AMERICA	**21936**	**1**
Argentina	23[1, 3]	1
Bahamas	30[1]	34
Belize	10[1]	4
Bermudas	0,9[1]	99
Bolivia	15[1]	15
Brazil	**3003**[1]	5
Canada	820[1]	0,1
Cayman Islands	1 [1]	34
Chile	50[, 2]	0,5
Colombia	30[1, 2]	0,3
Costa Rica	10[1]	3
Cuba	710[2]	11
Dominica	0,9[1]	99
Dominican Rep.	2[1]	20
Ecuador	100[1]	2
El Salvador	20[1]	23
French Guiana	10[1]	1
Guadeloupe (Fr.)	1[1]	10
Guatemala	15[1]	8
Guyana	1000[1]	13
Haiti	0,9[1]	99
Honduras	375[1]	13
Jamaica	25[1]	25
Martinique	0,9[1]	99
Mexico	1000[1]	10
Nicaragua	100[1]	3
Panama	100[1]	3
Paraguay	20[1]	20
Peru	100[1]	0,2
Puerto Rico	20[1]	20
Suriname	100[1]	2
Trinid. & Tobago	2[1]	20
USA (Alaska)	110[1]	0,1
USA (lower 48)	**13130**[1]	14
Uruguay	100[1]	17
Venezuela	901[1, 2]	11
ASIA	**197450**	**13**
Afghanistan	40[1, 4]	34
Armenia	50[1, 3, 4]	97
Azerbaijan	25[1]	84
Bangladesh	380[1]	67
Brunei	10[1, 2]	1
China	**27120**[1]	81
Georgia	65[1]	15
India	500[1]	52
Indonesia	***90400**[1]	43
Iran	60[1]	20
Iraq	1100[4]	55
Israel	40[1]	88
Jammu & Kashmir	70[1]	62
Japan	1842[1]	80
Kazakhstan	10[1]	20
Kyrgyzstan	135[1]	96
Laos	100[1]	52
Lebanon	0,9[1]	99
Malaysia	**12000**[1]	45
Maldives	0,9[1]	99
Mongolia	**15100**[1]	57
Myanmar	1000[1]	52
Nepal	5[1]	52
North Korea	1010[1]	84
Pakistan	11[1]	7
Philippines	80[1]	78
Russia (Asian)	**9000**[1]	1
Singapore	136[4]	99
South Korea	4[1]	
Sri Lanka	21[1]	92
Syria	2,7[1]	99
Thailand	540[1, 2]	86
Turkey	105[1]	87
Turkmenistan	90[1]	99
Un. Arab Emirates	0,9[1]	99
Uzbekistan	355[1]	97
Vietnam	1310[1]	55
Yemen	0,9[1]	99
AUSTRALIA & PACIFIC ISL.	**8261**	**11**
**Australia	860 [1]	94
Cook Islands	3 [1]	80
Fiji	20 [1]	52
French Polynesia	0,9[1]	99
Guam (U.S.A.)	1[1]	110
Hawaii (U.S.A.)	5[1]	14
Kiribati	1[1]	52
Micronesia (Federate States)	5[1]	14
New Zealand	1350**[1]**	69
Papua New Guinea	**5000**[1]	8
Samoa	1[1]	52
Solomon Islands	3[1]	31
Tasmania	1010[1]	10
Tonga	0,9[1]	99
EUROPE	**219495**	**44**
Albania	160[1]	98
Andorra	1[1]	20
Austria	120[1]	63
Belarus	**18050**[1]	81
Belgium	143[1]	98
Bosnia & Herz.	127[1]	92
Bulgaria	70[1]	63
Channel Island	9[1]	99
Croatia	0,9[1]	47
Czech Republic	220[1, 2]	88
Denmark	1250[1, 2]	98
Estonia	**4900**[1, 2]	52
Faroe Islands	6[1, 3]	20
Finland	**63250**[2]	80
France	1120[1]	80
FYRO Macedonia	20[1]	72
Germany	**13000**[1]	78
Greece	54[1]	82
Hungary	290[1]	96
Iceland	**7040**[1]	53
Ireland	3740[1]	34
Italy	100[1]	52
Latvia	1980[1, 2]	31
Liechtenstein	1[1]	110
Lithuania	2740[1, 2]	84
Luxembourg	2[1]	73
Moldova	8[1]	87
Netherlands	2300[1]	67
Norway	**5300**[2]	18
Poland	**10200**[1]	88
Portugal	15[1]	81
Romania	420[1]	44
Russia (Europe)	**62600**[1,2]	31
Montenegro	230[1]	82
Slovakia	110[1, 2]	93
Slovenia	67[1]	91
Spain	37[1]	65
Sweden	**13080**[2]	20
Switzerland	130[1]	45
Ukraine	2300[2]	30
United Kingdom	**4304**[1, 2]	25
(SUB) ANTARC. ISLANDS	**1032**	**7**
Auckland Islands	1[4]	0,3
Campbell Isl. group	5[4]	6
Falkland Islas & Islas Malvinas	1025[4]	9
Kerguelen Islands	1[4]	5

DISCUSSION

Degraded peatlands are primarily located in the temperate zone and in East Asia, i.e. in those areas that are densely populated and climatically favourable for agriculture (Fig. 1, cf. Joosten and Clarke, 2002). Degrading peatland areas of more than 1000 km² in 17 countries reveal that Europe is the region with the highest potential of paludiculture worldwide (Table 1). Another region with high potential is East Asia with more than 27 000 km² of degrading peatlands solely in China, where almost all peatlands have been disturbed to some degree by human activities (Yang, 2000). More than 90 400 km² of degrading peatland occur in Indonesia and about 12 000 km² in Malaysia, respectively. Especially in SE Asia, peatland rewetting and paludiculture may offer solutions for several problems associated with peat swamp degradation, including peat fires and enormous GHG emissions (cf. van der Werf et al., 2004).

On the African continent Uganda has by far the highest potential of paludiculture (5000 km² degrading peatlands; Table 1), which illustrates the high pressure on accessible and fertile peatlands under conditions of rapid population growth (Tindamanyire, 2003).
On the American continent the USA (lower 48) has with 13 130 km² the highest potential for paludicultures, in Australasia ít is Papua New Guinea with 5000 km² (Table 1).

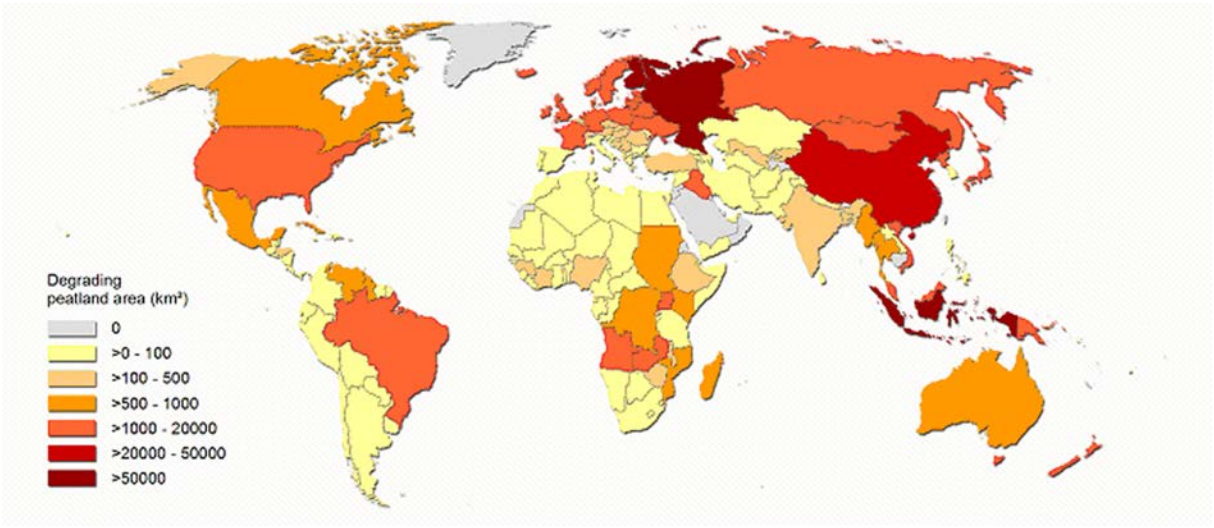

Fig. 1. Degrading peatland area per country or region (km²).

Our data are based on best professional judgment, but uncertainty is high for the bulk of the area-estimates, with 95% of the countries in uncertainty classes 1 and 2 (Figure 3). Only for 5 % of the countries/regions uncertainty is lower (classes 3 and 4), including Albania, Austria, Belarus, Belgium, Canada, Czech Republic, Finland and some countries without any peatland.

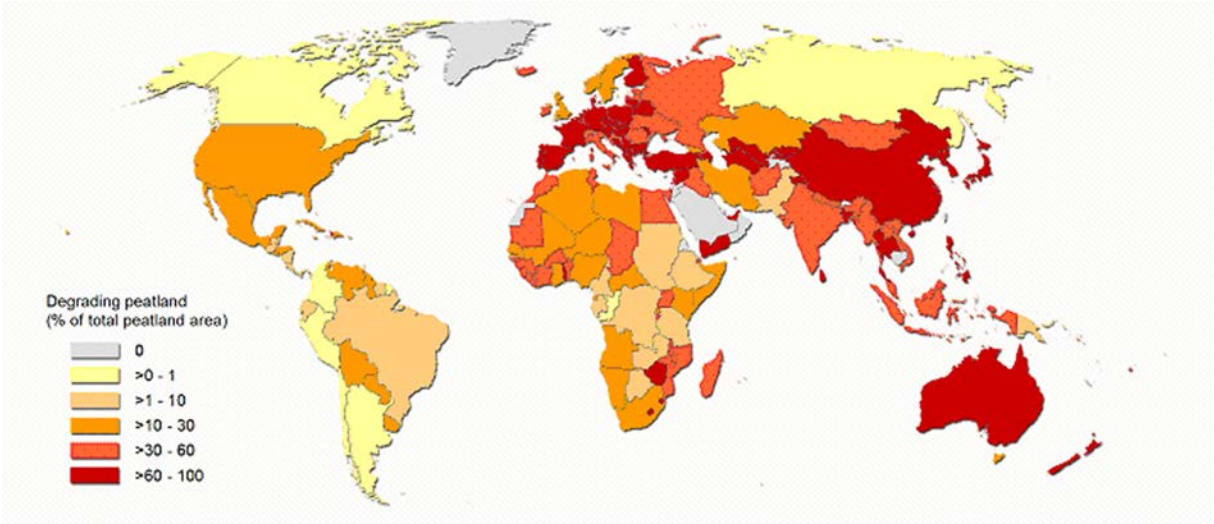

Fig. 2. Degrading peatland as percentage of total peatland area per country or region.

Fig. 3. Uncertainty of data. Uncertainty categories: 4 = 95% certain that the actual value is within 25% of the estimate reported; 3 = 95% certain that the actual value is within 50% of the estimate reported; 2 = 95% certain that the actual value is within 100% of the estimate reported; 1 = uncertainty > 100%. Includes the complete dataset of 269 countries or regions.

CONCLUSIONS

Based on a comprehensive analysis of available sources, our study estimates the area of degrading peatlands for 183 countries. The highest potential for implementing paludicultures have Europe and East Asia with degrading peatland areas of 220 000 km² (in Russia, Belarus, Finland, Germany, Sweden, and Poland) and of 200 000 km² (mainly in Indonesia, China, Malaysia; Mongolia), respectively.
More reliable, comprehensive and comparable data are urgently needed to improve our information on area and status of peatlands for almost all countries of the world.

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