International importance of peatlands for climate change mitigation and adaptation

Hans Joosten

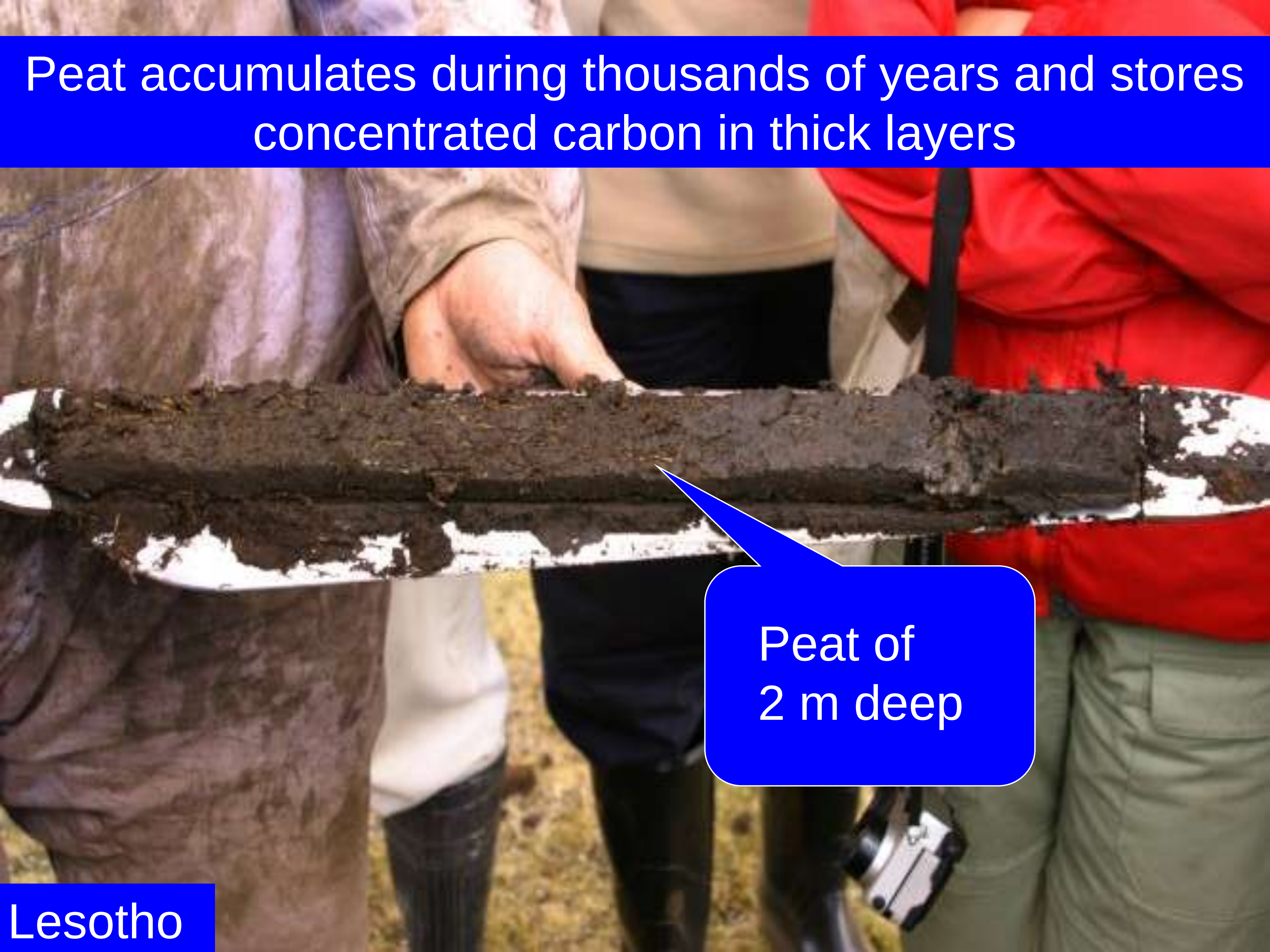
Greifswald University
International Mire Conservation Group

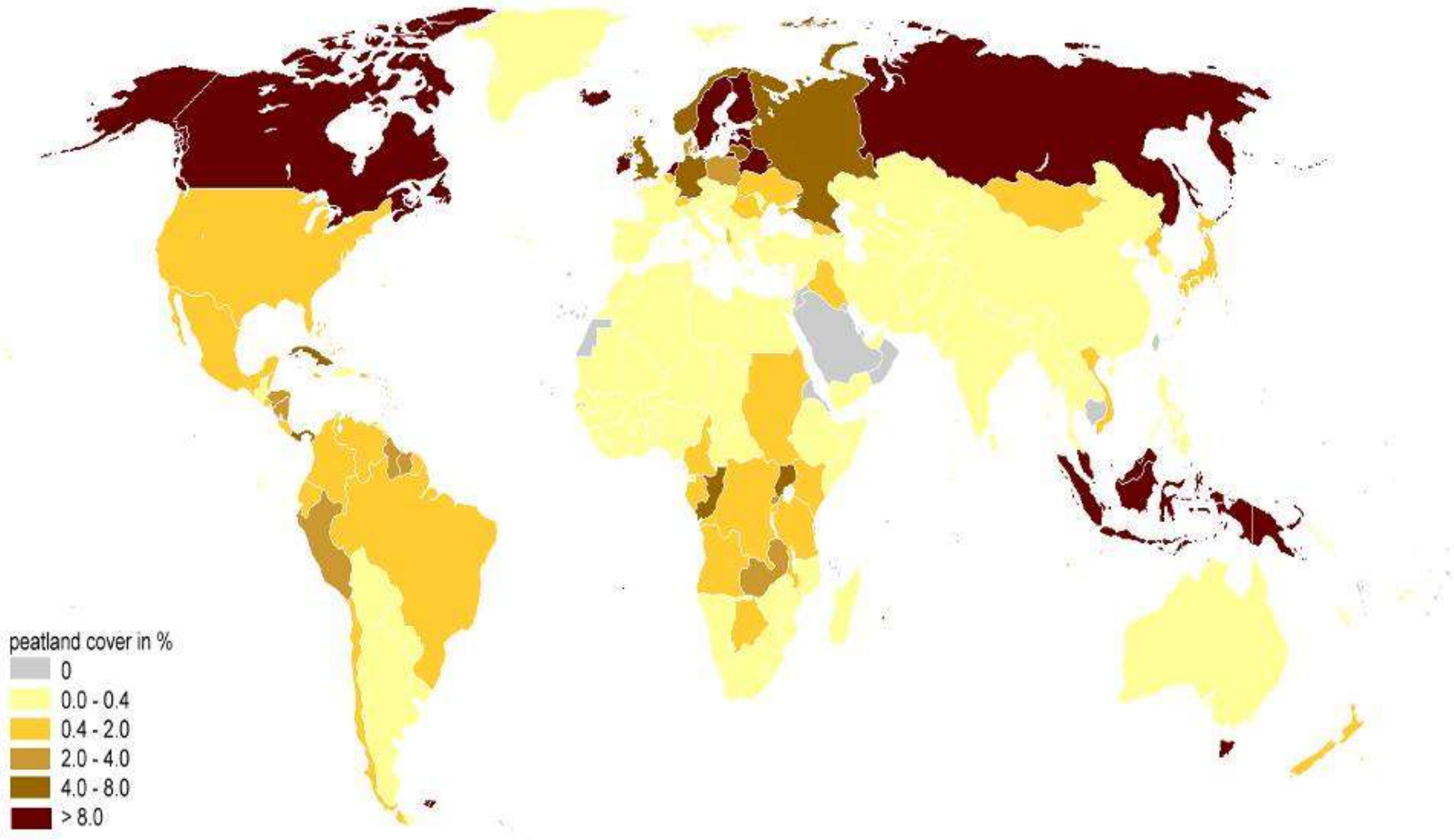
In living peatlands (mires):

- Production > decay
- Peat accumulates
- Positive C-balance

Kolkheti,Georgia

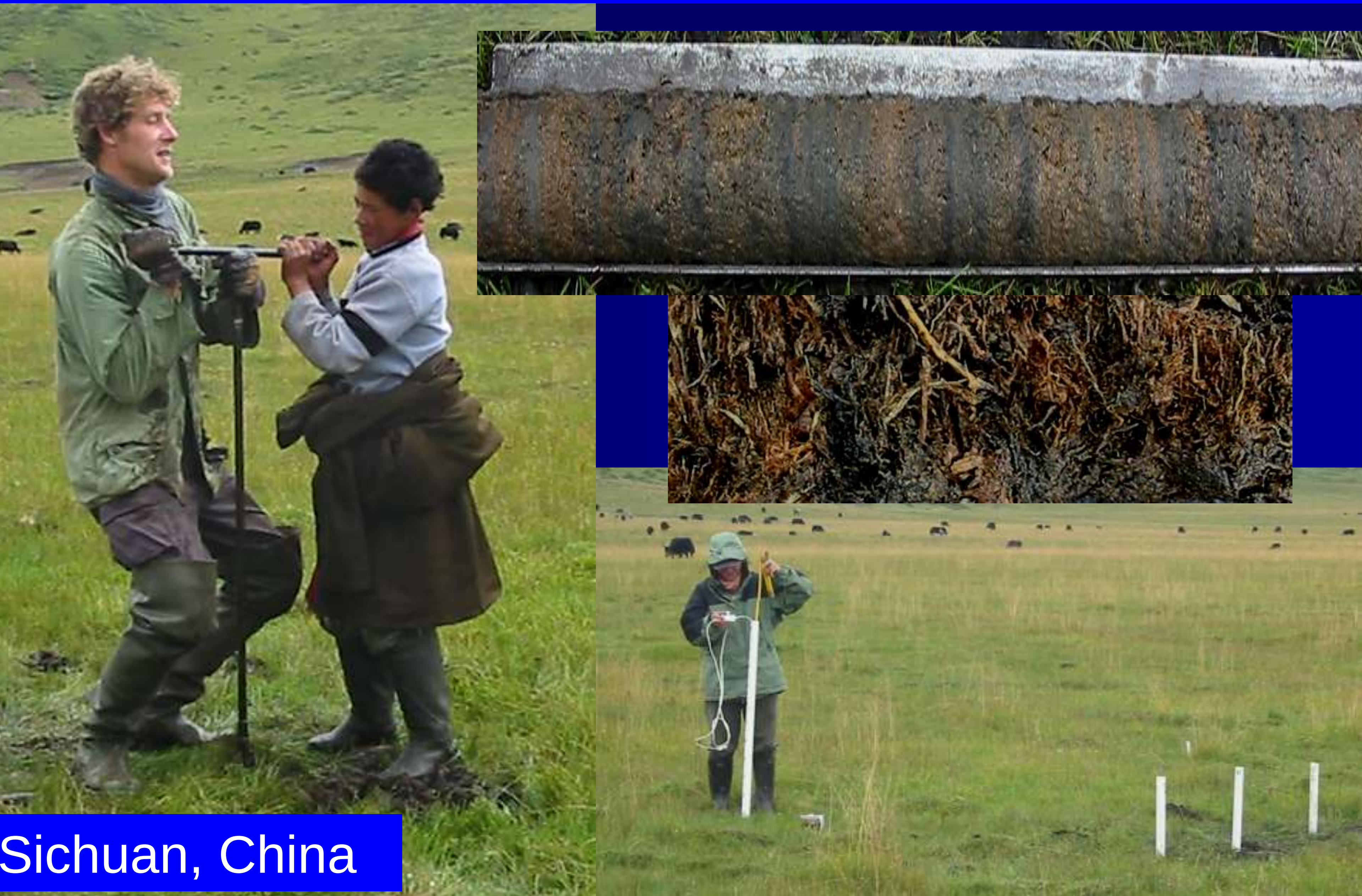
Peat accumulates during thousands of years and stores concentrated carbon in thick layers





Peatlands are found in almost every country.
Worldwide: 4 million km^2

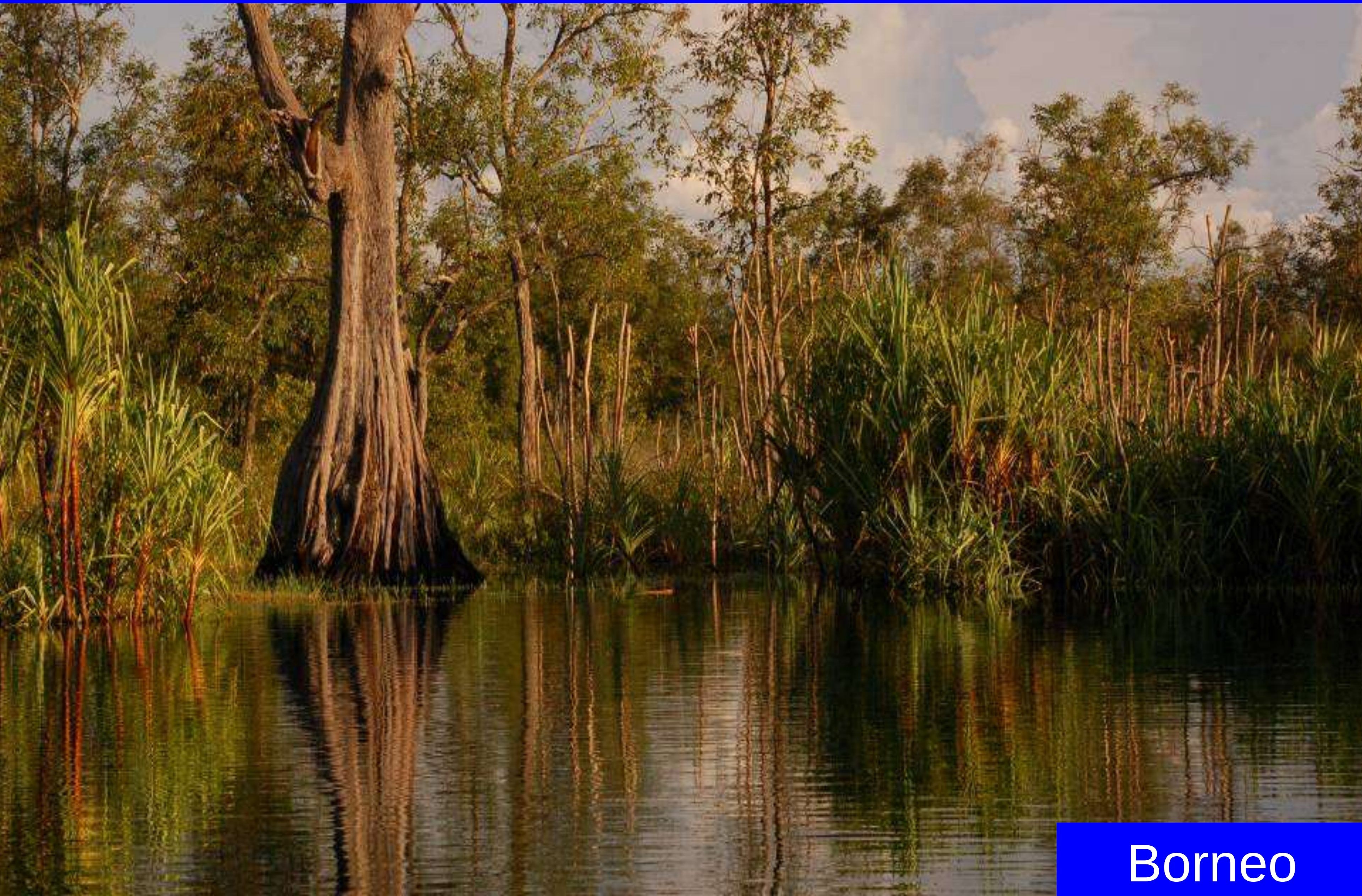
Peatlands are everywhere



Sichuan, China

… from the tundra …

… to the tropics and …



…to the uttermost part of the World…

Tierra del Fuego
Argentina

…from the mountains …

… to the sea …

Peatlands have long been overlooked in UNFCCC…

The Cinderella Syndrom

Ruoergai, Tibet

Pristine peatlands hardly have relevance for the climate

C-*sequestration* (sink): globally only 1% of the emissions from burning fossil fuels

Greenhouse gas sink (CO_2): 150-250 Mio t CO_2 J^{-1}

Greenhouse gas source (CH_4): 200 Mio t CO_2-eq J^{-1}

But in the long run so much is sequestered that peatlands cool the climate: already 11,000 years.

Netherlands

Much more important is their function as carbon *store:* peatland is *peat*-land

Peatlands are the most space-effective carbon (C) stocks of all terrestrial ecosystems.

In the boreal zone peatlands contain 7 x more carbon per ha than other ecosystems, in the tropics 10 x.

Ireland

While covering only 3% of the World’s land area, peatlands contain 500 Gt of carbon in their peat.

This is equal to all terrestrial biomass, and 2 times the carbon stock in the total forest biomass of the world.

They hold *in average* per ha even twice the carbon content of the mammoth forest in California

Kalimantan, Indonesia

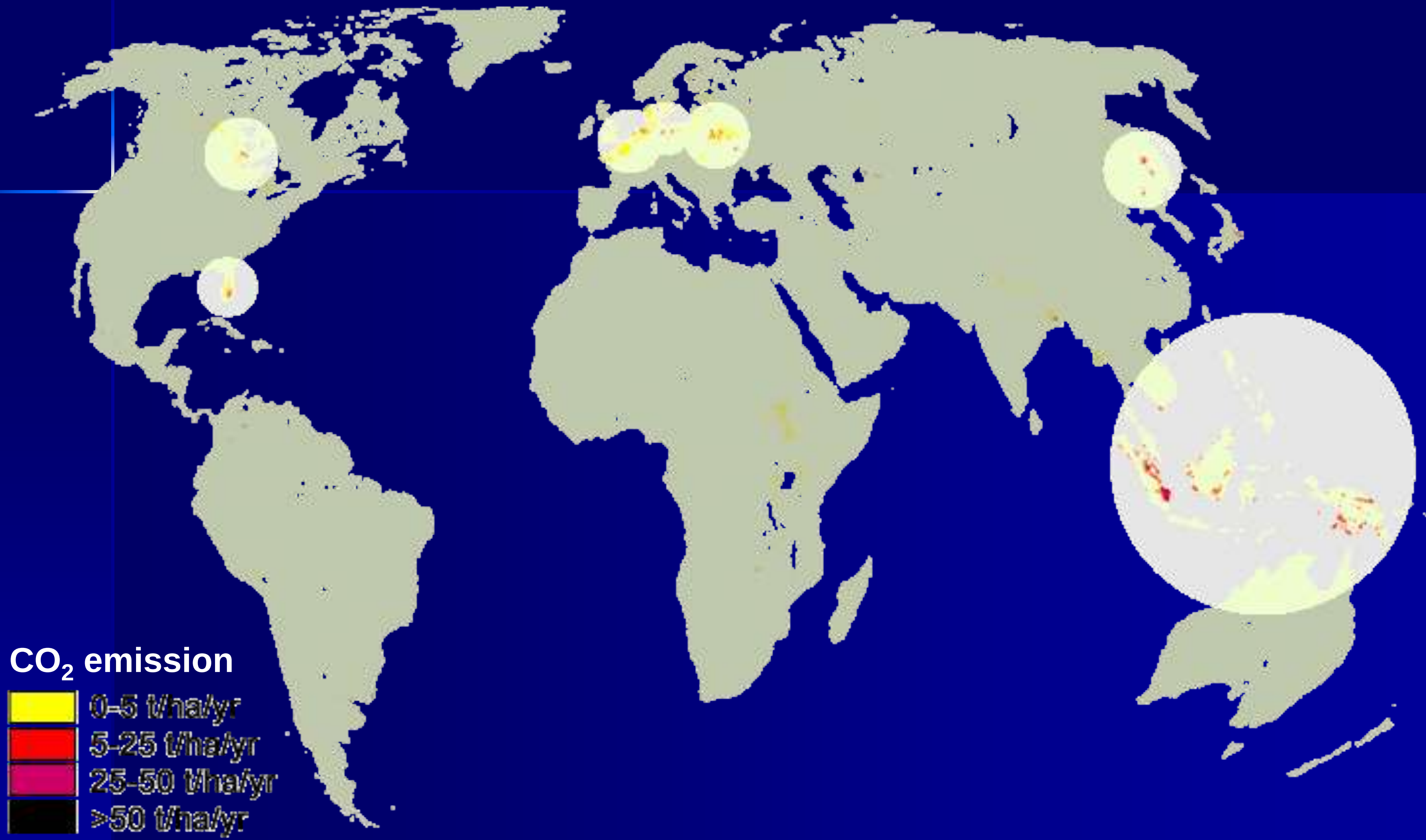
When drained, peatlands become vigorous sources of carbon dioxide (and nitrous oxide)

Agriculture on drained peatland is the most effective way to oxidize peat and to emit CO_2 (and N_2O)…

Globally peatlands have turned from a C-sink to a C-source (although 80% is still “pristine”…).

Globally, degraded peatlands emit 2 Gtons CO_2 yr^{-1}

0.3 % of the land surface is responsible for 6 % of the total global anthropogenic CO_2 emissions…



Drained peatlands: emission hot spots

Temperate Europe second largest hot spot…

World picture

- Global CO_2 emissions from drained peatland: 1.3 Gton / yr

  (excl. extracted peat and 0.5 Gton from fires, also excl. N_2O).

- emissions have strongly increased since 1990 (+25%).

Top emittors 2008

- The top (excl. extraction and fires) includes

Indonesia	500	Poland	24
Russia Eur. part	139	Russia Asian part	22
China	77	Uganda	20
USA (lower 48)	67	Pap. New Guinea	20
Finland	50	Iceland	18
Malaysia	48	Sweden	15
Mongolia	45	Brazil	12
Belarus	41	United Kingdom	10
Germany	32	Estonia	10

The growers

- Since 1990 peatland emissions have increased in 50 countries
- These include > 40 developing countries
- > 50% growth: **Papua New Guinea**, Burundi, **Malaysia**, **Indonesia**, Kenya, Colombia, Gabon, Togo, Dominican Republic, Trinidad and Tobago, Rwanda, **China**, Brunei, Ethiopia, Guatemala.

Rewetting to reduce emissions

Rewetting to reduce emissions

Peatland rewetting

Emission reduction potential:

- Gross 2 Gtons on 500,000 km^2
- Nett: much less
- Half of the CO_2 reduction annihilated by CH_4 emissions after rewetting

→ realistic several 100s Mton CO_2-eq./yr

→ à € 10 per ton: several billion €/yr

How to include peatlands in climate policies?

Can emission reductions ('carbon credits') from rewetting be sold?

Kyoto Protocol

- Countries can already account for peatland rewetting on forest-, crop-, and grazing land
- But only when *all* forest, crop- and grazing land, also on mineral soil, are accounted
- The monitoring is, however, considered too much work
- And therefore countries don‘t do it.

Kyoto Protocol

→ Proposal for special peatland rewetting:

- “Wetland management”: Account all rewetting and drainage since 1990
- Will work out positively for all industrial states
- Widely supported, but still doubt on MRV-ability (G-77 + China)
- Depends also on ‘larger politics’
- Will probably be decided on in Mexico, Dec. 2010

→ Put pressure on politics to go for it !


Altai, China

Other option: voluntary market. Voluntary Carbon Standard (VCS) for peatland rewetting in Oct. ready

In Belarus we currently prepare the sales of 750,000 carbon credits (tons of CO_2) from peatland rewetting

Voluntary markets

- For the good name: “corporate social responsibility”, promotion, market opportunities
- Market requires excellent standards (what, how much, how…), because good name is easily damaged
- “I may say once that your daugther is a whore, you may see 100 times that she is not” (Jewish proverb)

Criteria

- Reference (reduction compared to what?)
- Crediting period (20 – 100 yrs)
- Additionality (no reduction without project)
- Measurability (can you measure it?)
- Verifiability (can others check this?)
- Conservatism (deliver more than you say)
- Reliability (do not sell the same twice…)
- Permanence (reductions must be for ever…)
- Leakage (no emission increase elsewhere)
- Community/biodiversity impact (not negative)

Measuring directly is too expensive (€ 10,000 /ha/yr)

Proxies / indicators

- Easy
- Cheap
- Cover large areas
- Continuously over long time (20-100 yr)

Proxies

Three types of proxies currently emerge:

- Water level, incl. modelling
- Subsidence: in the tropics
- Vegetation

Vegetation as a GHG proxy

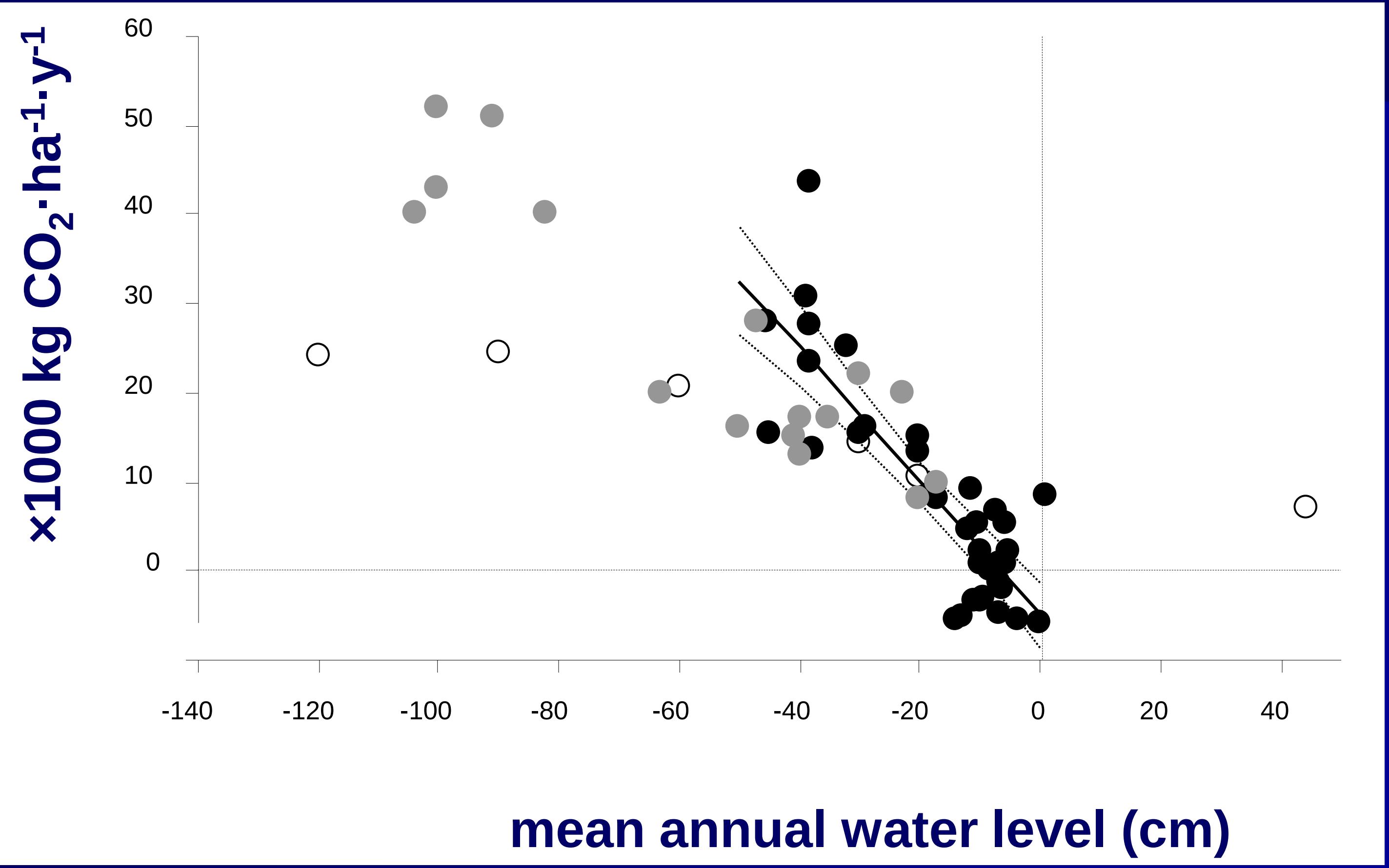
- good indicator of water level
- controlled by various other site factors that determine GHG emissions (nutrients, soil reaction, land use)
- directly responsible for emissions by supplying organic matter, reducing peat moisture, and providing bypasses for CH_4 via aerenchyma
- integrates over longer time
- can be monitored by remote sensing

→ **GEST-concept** (GHG Emission Site Types)

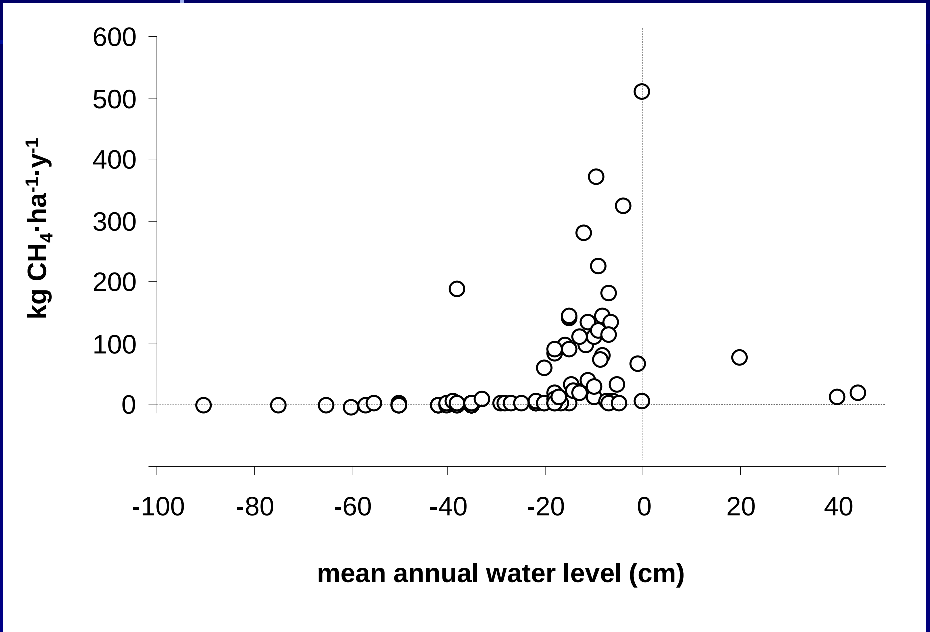
Comparison with literature

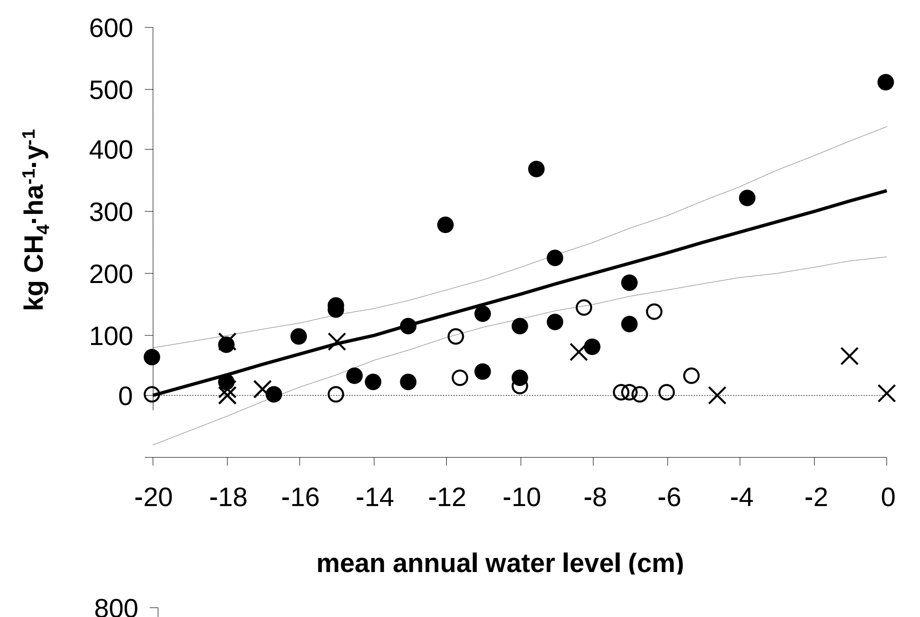
Vegetation type	CO_2 emissions (CO_2-eq. ha^{-1} a^{-1})	CH_4 emissions (CO_2-eq. ha^{-1} a^{-1})	GWP estimate (CO_2-eq. ha^{-1} a^{-1})	Remarks
Bare peat	7.0 (±2.6) for active extraction sites (*n*=12) / 7.4 (±0.9) for abandoned extraction sites (*n*=3) (Maljanen et al. 2009)	0.4 (±0.6) for active extraction sites (*n*=13) / 0.06 (±0.0) for abandoned extraction sites (*n*=2) (Maljanen et al. 2009)	7.5	
Calluna	as 'moist bog heath'		12.5	Drier than 'bare peat'
Eriophorum	3.3 (±2.1) (n=8) (Tuittila et al. 1999, Maljanen et al. 2009)	0.3 (±0.1) (n=8) (Tuittila et al. 2000, Maljanen et al. 2009)	3.5	Direct GHG flux measurements from S Finland. Litter accumulation of Eriophorum vaginatum counteracts carbon losses from degrading peat
Polytrichum	as 'bare peat'		7.5	As mosses do not produce any root exudates
Dry grassland	as 'moderately moist forb meadows'		20	As measurements from dry bogs are lacking and water level fluctuations are expected to be similar
Moist bog heath	12.6 (±4.0) (*n*=3) (Drösler 2005)	negligible (Drösler 2005)	12.5	With the same water levels higher than emissions from bare peat because of the 'priming effect' of labile organic compounds from recently died roots and root exudates that stimulate the decomposition of the more recalcitrant peat components (Kuzyakov, 2006).
Very moist bog heath	9 (Drösler 2005)	0.7 (Drösler 2005)	10	
Moderately wet *Sphagnum* hummocks*	neglected	0.7 (±0.2) (*n*=4) (Bortoluzzi et al. 2006)	0.5	Reflecting increasing methane emissions with higher water levels. Whereas net emissions of CO2 have been reported from some rewetted bog sites (Drösler, 2005), in general published measurements show uptake of CO2 (Bortoluzzi et al., 2006; Maljanen et al., 2009) due to a decrease in peat decomposition rate (Tuittila et al., 1999; Maljanen et al., 2009), an increased gross photosynthesis of Sphagnum mosses (Tuittila et al., 2004; Bortoluzzi et al. 2006), and an expansion of Eriophorum vaginatum tussocks on the formerly bare peat which results in considerable net sequestration (Tuittila et al., 1999) that may continue for decades (Kuntze & Eggelmann, 1981). With respect to wet sites, flux measurements overestimate actual carbon sequestration rates when water-borne losses of dissolved organic carbon (DOC) are not taken into account (Roulet et al., 2007; Nilsson et al., 2008). However, available data indicate that DOC export is general larger before rewetting (Holden et al., 2004) and we have thus conservatively neglected this flux: As a conservative approach, we have furthermore opted for discarding any potential
Wet *Sphagnum* lawn*	neglected	5.2 (±3.2) (*n*=5) (Drösler 2005)	5	
Very wet *Sphagnum* hollows*	neglected	12.8 (Drösler 2005)	12.5	

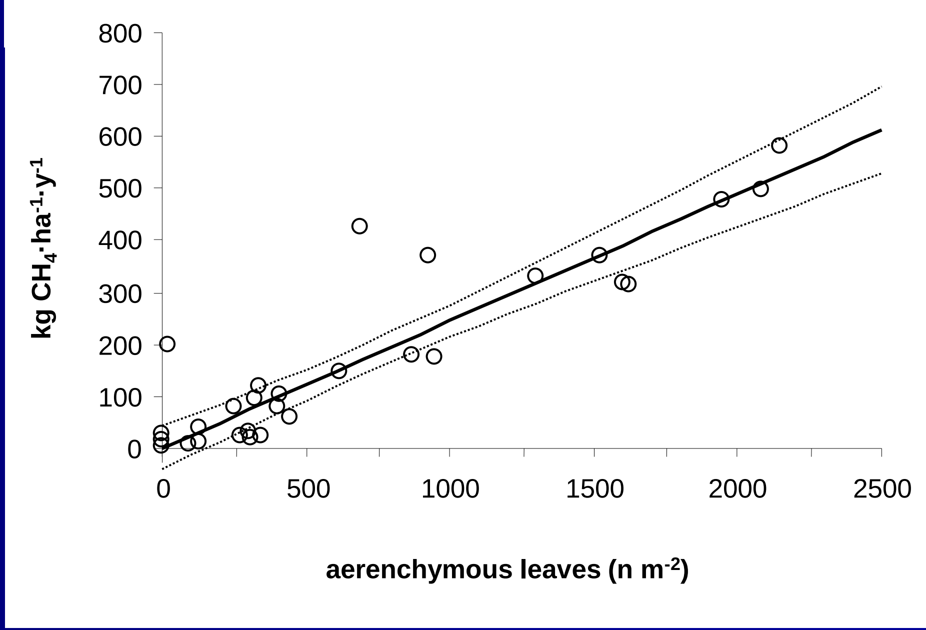
Comparison with models



Annual CO_2 emissions correlate well with mean annual water level in peatlands







CH_4 emissions in relation to mean annual water level (l.) and presence/density of aerenchymous leaves (r.)

Expert matrix analysis

2-, 2+, 2~	(3+/2+) 3+	4+/3+	4+	5+/4+	5+	6+
CULTIVATED PEATLAND	**CULTIVATED PEATLAND**	**CULTIVATED PEATLAND**	**CULTIVATED PEATLAND**		**REWETTED CULTIVATED PEATLAND (NO SHUNTS)**	**DROWNED CROPS**
EU	EU	EU	EU		EU	EU
N-AC	N-AC	N-AC	N-AC		N-AC	N-AC
GRZ, MWN, PLW	GRZ, MWN, PLW	GRZ, MWN, PLW	GRZ, MWN, PLW		GRZ, MWN, FLW	MWN, PLW
0 (-0.03 – 0.04)	0 (-0.05 – 0.04)	0	0.5		1	up to 85
24 (20.5 – 25.5)	15 (14.5 – 15.5)	13 (8.5 – 16.5)	8		0	0
24	15	13	8.5		1	HIGH!
MOD. MOIST FORBS & MEADOWS	**MOIST FORBS & MEADOWS**	**VERY MOIST MEADOWS**	**VERY MOIST MEADOWS, FORBS & TALL REEDS**	**VERY MOIST TALL SEDGE MARSHES**	**WET TALL SEDGE MARSHES**	**FLOODED TALL AND SHORT REEDS**
EU	ME/EU	ME	EU	EU	EU	ME/EU
AC/SU	AC/N-AC	AC	N-AC	N-AC	N-AC	AC/N-AC
GRZ, MWN, PLW	MWN/FLW	MWN				
0	1.5 (1.3 – 2)	3.5 (2.5 – 6)	3	2.5 (2.4 – 2.6)	7 (5.0 – 9.5)	1 (0.3 – 1.7)
24	15	13 (8.5 – 16.5)	8	2.5	0	0
24	16.5	16.5	11	5	7	1

GESTs with indicator species groups

Vegetation type	Typical/differentiating species	WL class	CH_4	CO_2	GWP
Sphagnum-Carex limosa-marsh	Sphagnum recurvum agg., Carex limosa, Scheuchzeria	5+	**12.5**	<0 (±0)	12.5
Sphagnum-Carex-Eriophorum-marsh	Sph. recurvum agg., Carex nigra, C. curta, Eriophorum angustifolium				
Drepanocladus-Carex-marsh	Drepanocladus div. spec., Carex diandra, Carex rostr., Carex limosa - Carex dominated				
Scorpidium-Eleocharis-marsh	Scorpidium, Eleocharis quinqueflora - Carex (shunt) dominated				
Sphagnum-Juncus effusus-marsh	Juncus effusus, Sphagnum recurvum agg.				
Equisetum-reeds	Equisetum fluviatile				
Scorpidium-Cladium-reeds	Cladium, Scorpidium				
Sphagnum-Phragmites-reeds	Phragmites, Solanum dulcamara	5+	**10**	<0 / ±0	10
Solano-Phragmitetum	Scorpidium, Eleocharis quinqueflora - Phragmites + Solanum without Urtica-gr.				
Rorippa-Typha-Phragmites-reeds	Typha latifolia, Phragmites, Rorippa aquatica, Lemna minor				
Bidens-Glyceria-reeds	Glyceria maxima, Berula erecta, Bidens tripartita, B. cernua				
Red or green Sphagnum lawn (optimal)	Sph. magellanicum, Sph. rubellum, Sph. fuscum, Sph. recurvum agg.	5+	**5**	**-2**	3
Green Sphagnum hollow	Sph. cuspidatum, Scheuchzeria	5+	**10**	**-2**	8
Polytrichum-lawn	Polytrichum commune	5+	2	<0	2

Perspectives

- Macro- ↔ microeconomics

- Market possible but still very expensive
- Costs for
  - Project and methodology development
  - Opportunity costs
  - Investments, management, monitoring
  - Validation, verification, certification
  - Marketing

Perspectives

- Lowers costs with
  - Lower opportunity costs (perverse subventions)
  - More experience (pioneers always pay…)
  - Lower quality demands (“Moorfutures”)
- Higher revenues with
  - Higher C-prices
  - Synergies (biomass, water, biodiversity)
  - Special markets

Moor Futures

Ihre Investitionen in Klimaschutz.

Exciting initiatives, worldwide…

Rewet drained peatlands!

Rouergai, China