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Paludiculture

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Succow Stiftung

Greifswald, Federal State Mecklenburg Western Pomerania, Germany

Partners in the Greifswald Mire Centre (GMC)

GREIFSWALD MIRE CENTRE

- Ernst-Moritz-Arndt-University Greifswald
  → **Research**

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- Michael Succow Foundation
  → **Implementation, Nature protection**

Succow Stiftung

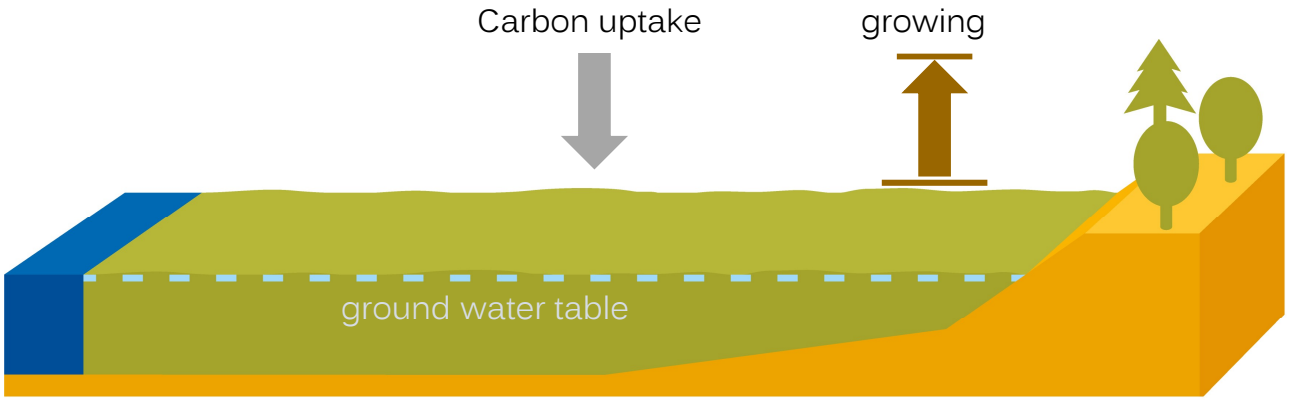
- DUENE e.V.
  → **Consultancy, Implemementation**

DUENE

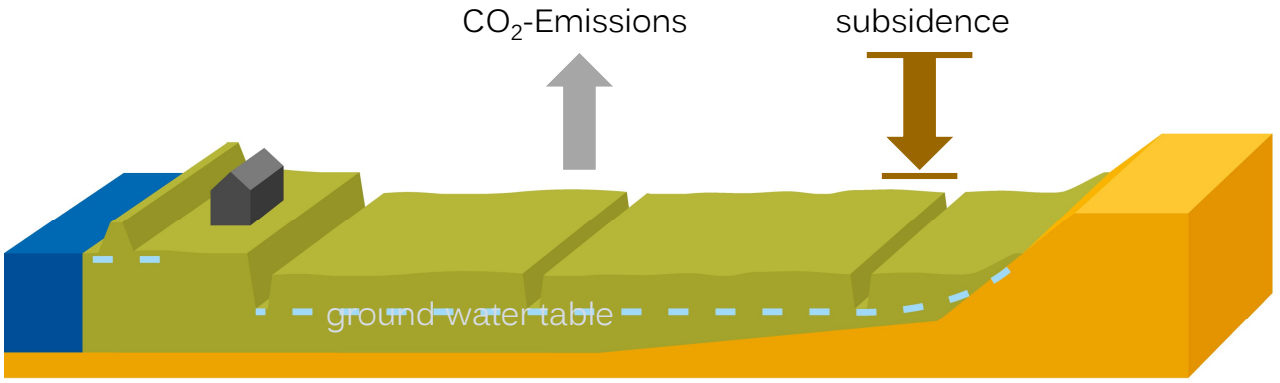
Interface between Science and Politics refering to mires and peatlands

Peatlands and drainage

Wet peatland = peat acumulation

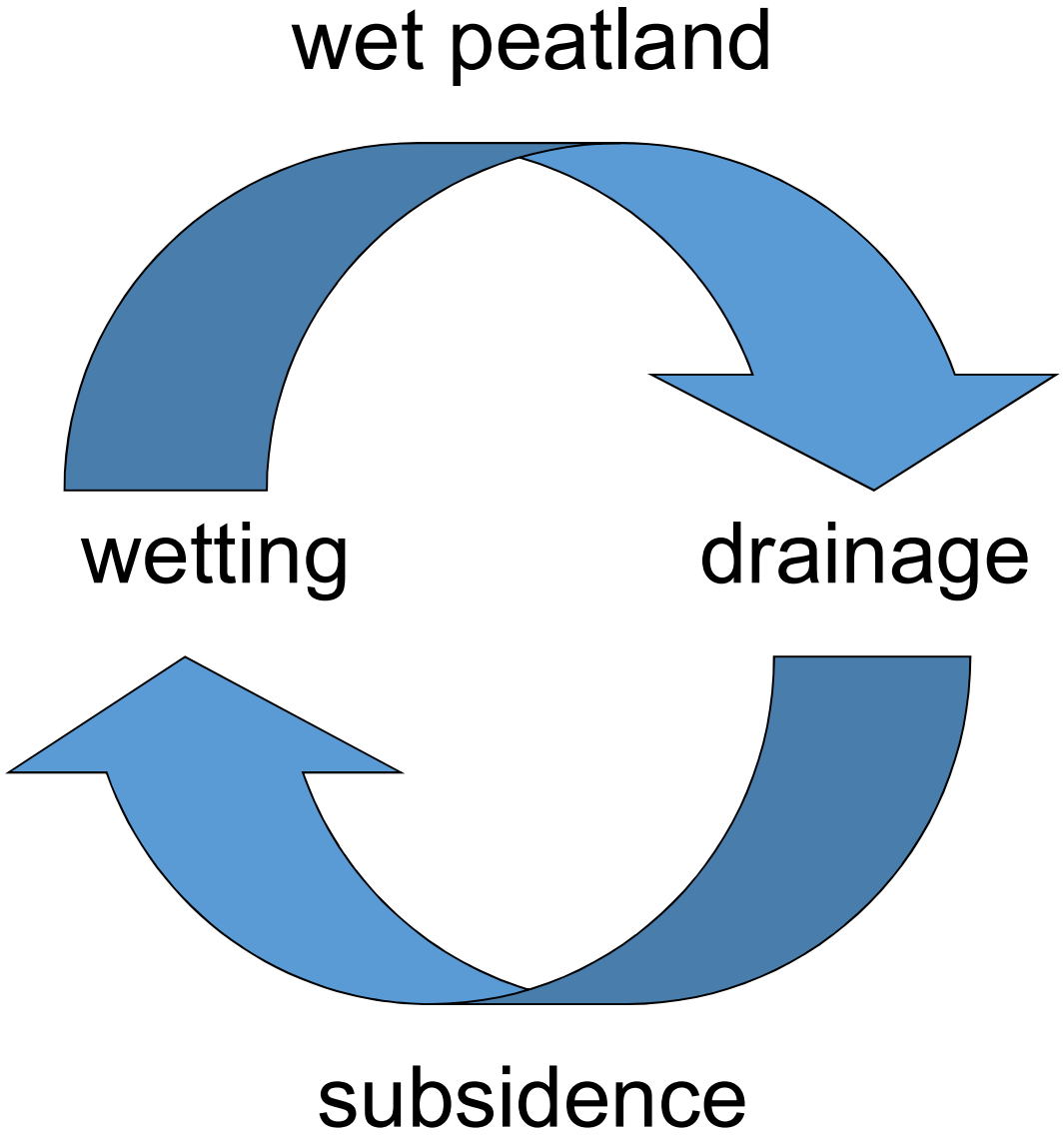


Drained peatland = peat degradation



(NABU 2012, verändert)

… the “*devil’s cycle*”
of peatland utilisation…



Bavaria: 3 m loss since 1836

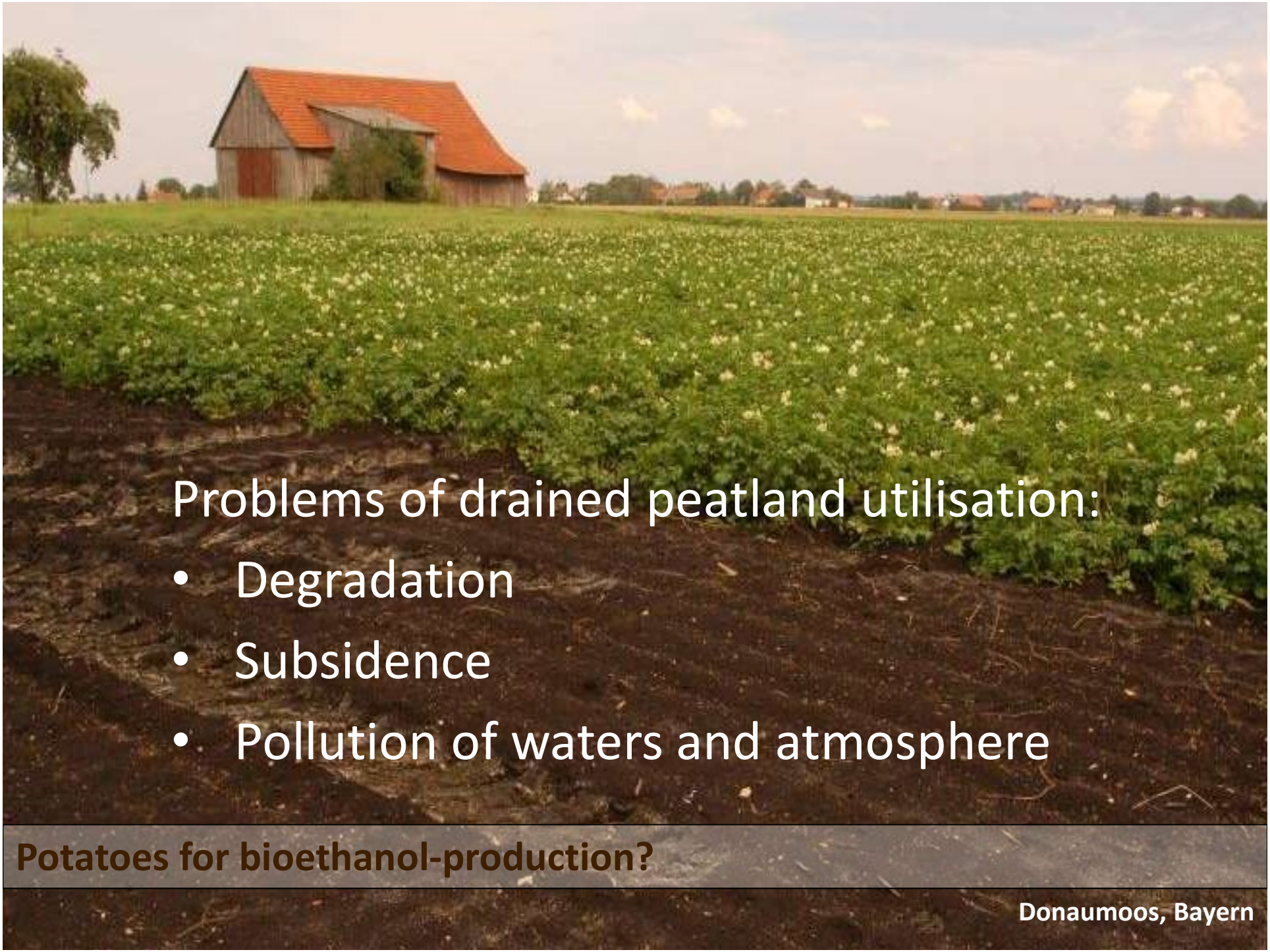
UK: 4 m loss since 1870

Subsidence

Subsidence

Loss of peat

- –temperate zone: 1-2 cm a^{-1} (Akker 2008, Leifeld *et al.* 2011)
- –tropics: ~ 5 cm a^{-1} (Hoojer *et al.* 2012)


Problems of drained peatland utilisation:
• Degradation
• Subsidence
• Pollution of waters and atmosphere
Potatoes for bioethanol-production?
Donaumoos, Bayern

Maize for biogas on a drained peatland


Alfa alfa in Randow-lowlands

Excavated trensgressioin mire after abandonment of peat industry

eadow dominated by golden foxtail grass (Alopecurus pratensis)

Production of silage on degraded fen peatland in the Randow-lowland in Brandenburg

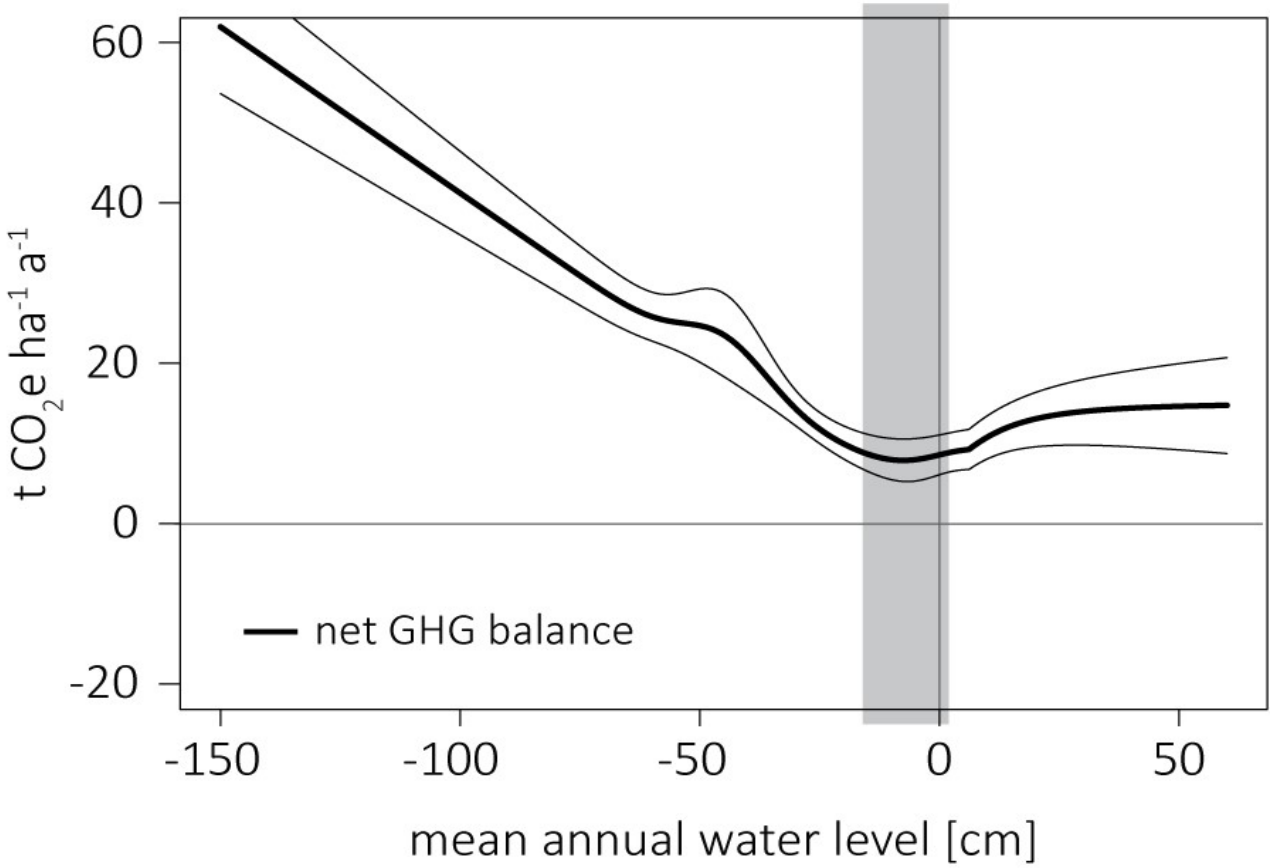
N-losses from drained peatlands

Tab. 5.5: Stickstoffflüsse (in kg N ha^{-1} a^{-1}) typischer Niedermoorstandorte des norddeutschen Tieflands (Daten nach: Trepel et al. 2000, Schleuß et al. 2002, Schrautzer 2004).

Vegetation type	sedges	wet meadow	ext. grassland	int. grassland
Nutzung	keine	1 Schnitt	Weide	3 Schnitte
Medium water table	-10 cm	-25 cm	-25 cm	-50 cm
Inputs				
Deposition	20	20	20	20
fertilzation	0	0	60	160
Mineralisation	30	100	100	300
Outputs				
harvest	0	80	60	200
Denitrifikation	20	30	50	80
N-leaching	5	10	15	20
Input sum	50	120	180	480
Output sum	25	120	125	300
N-Saldo (Einträge – Austräge)	25	0	55	180
Assessment	peat formation	peat losses	peat loss and eutrophication	

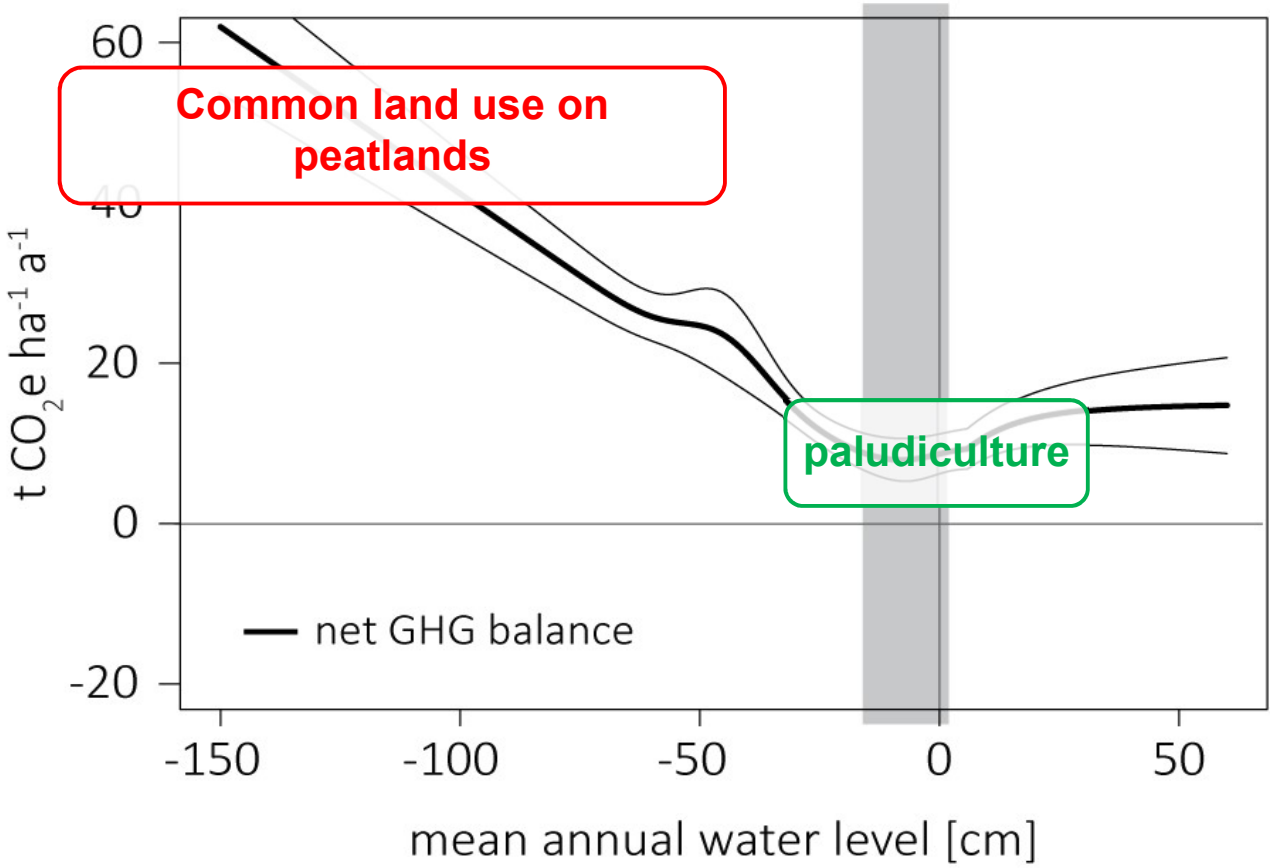
Holsten & Trepel 2013

GHG-Emissions and water level



→ **High water levels are needed!**

GHG-Emissions and water level



→ **Land use Change is needed!**

New concept → Paludiculture*

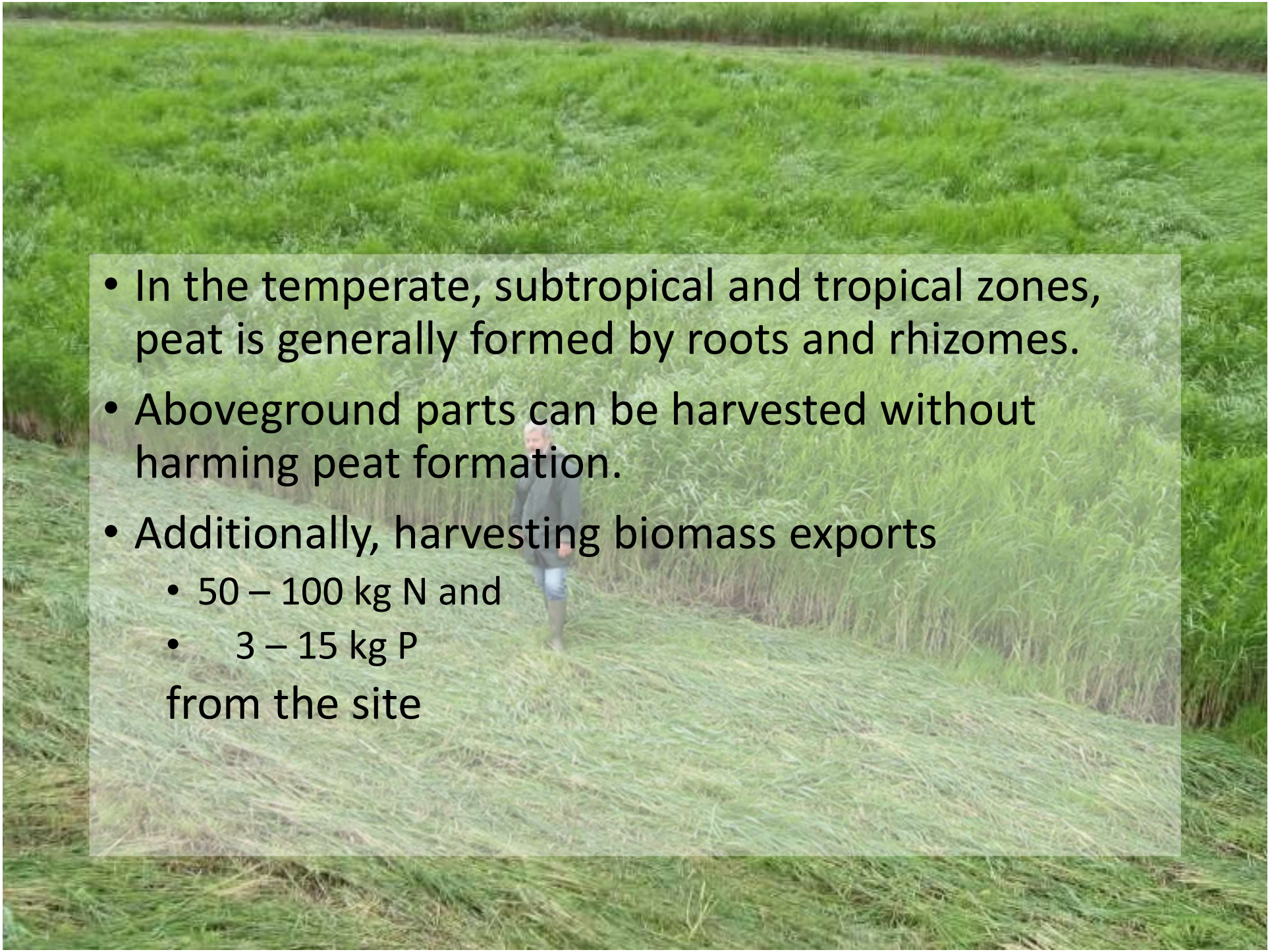
- Paludiculture is an innovative alternative to conventional drainage-based peatland agri- and silviculture
- Ideally the peatlands should be so wet that peat is conserved and peat accumulation is re-installed.
- Paludiculture uses that part of net primary production that is not necessary for peat formation (80-90% of NPP).

*„palus“ – lat.: swamp

Rewetting and paludiculture

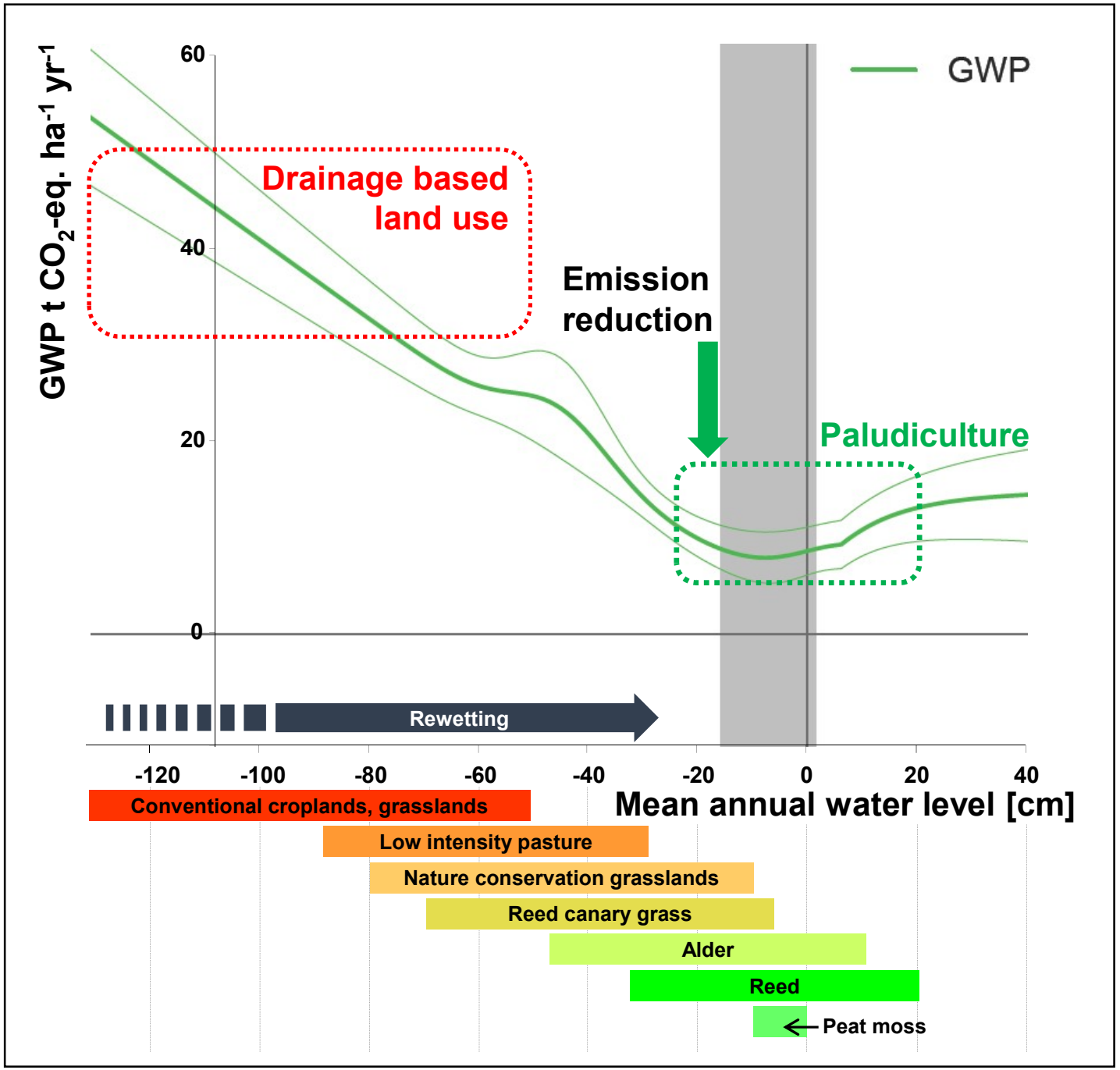
Establishment of a sink for nutrients and pollutants

- Reduction of environmental burden from the whole catchment
  - Greenhouse gases
  - Nutrients
- Function as „Wetland Buffer Zones“ (kidneys in the landscape)
  - Sedimentation, reduction, sequestration
  - Export of nutrients by harvesting biomass
  - Elimination (denitrification)
  - Carbon sink



- In the temperate, subtropical and tropical zones, peat is generally formed by roots and rhizomes.
- Aboveground parts can be harvested without harming peat formation.
- Additionally, harvesting biomass exports
  - 50 – 100 kg N and
  - 3 – 15 kg P

  from the site


GWP t CO_2-eq. ha^{-1} yr^{-1}
60
40
20
0
GWP
Drainage based land use
Emission reduction
Paludiculture
Rewetting
-120
-100
-80
-60
-40
-20
0
20
40
Mean annual water level [cm]
Conventional croplands, grasslands
Low intensity pasture
Nature conservation grasslands
Reed canary grass
Alder
Reed
Peat moss

Reasons and potential for rewetting of degraded peatlands

- Reasons
  - Restoration of ecosytem services
  - Minimise environmental problems
- Potential
  - All degraded peatlands
  - Except:
    - infrastructure,
    - settlements,
    - lack of water, …….

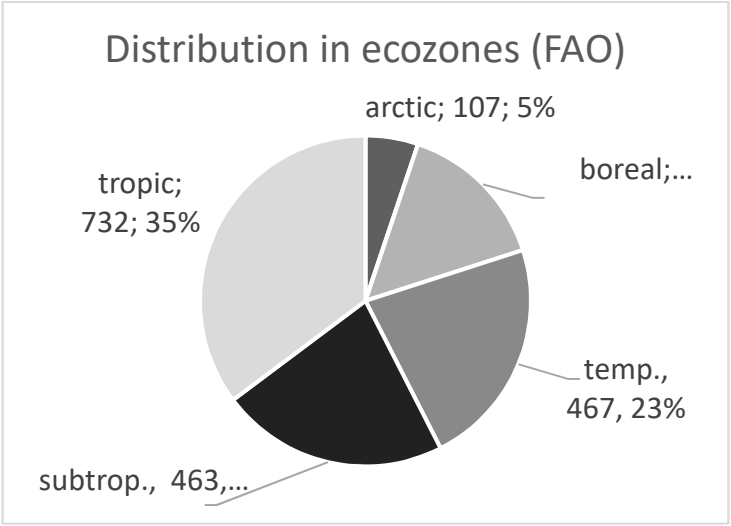
Reasons and potential for implementation of paludiculture

- Reasons
  - Needs for productive land
  - Production of raw materials
- Potential
  - All degraded peatlands
  - Except:
    - infrastructure,
    - settlements,
    - areas with high biodiversity potential …….

Wetland plants as new crops to safe old peat!

DPPP – Database of <u>Potential</u> Paludiculture Plants (Abel et al. 2013)

- 1131 wetland plants registered
- Information about:
  - plant characteristics and morphology,
  - distribution and natural habitat,
  - modes of cultivation and propagation,
  - utilisation options



Paludiculture Potential of wetland plants

source: wikimedia

promising potential

perennials, above ground biomass is of main interest, market demand exists or a commercialisation is very likely in future, information how to manage these crops are available; e.g. *Phragmites australis* (Common Reed)

good potential

same like above but experiences in cultivating failed, research needed; e.g. lots of wild berries, medical plant; e.g. *Drosera* ssp. (Sundew)

limited potential

market demand was assumes to be limited (only traditionally used), or

the peat preservation is not likely (annuals), → adjusting management to safeguard peat preservation?; e.g. *Oryza sativa* (Rice)

no potential

only gathering of wild populations possible, or

could be cultivated in mixed cultures in small proportion , e.g. *Comarum palustre* (Purple Marshlocks)

Examples for paludiculture in the temperate zone

Sedges (Carex spp.),
3 – 12 t DM/ha*a →for energy (combustion, biogas)

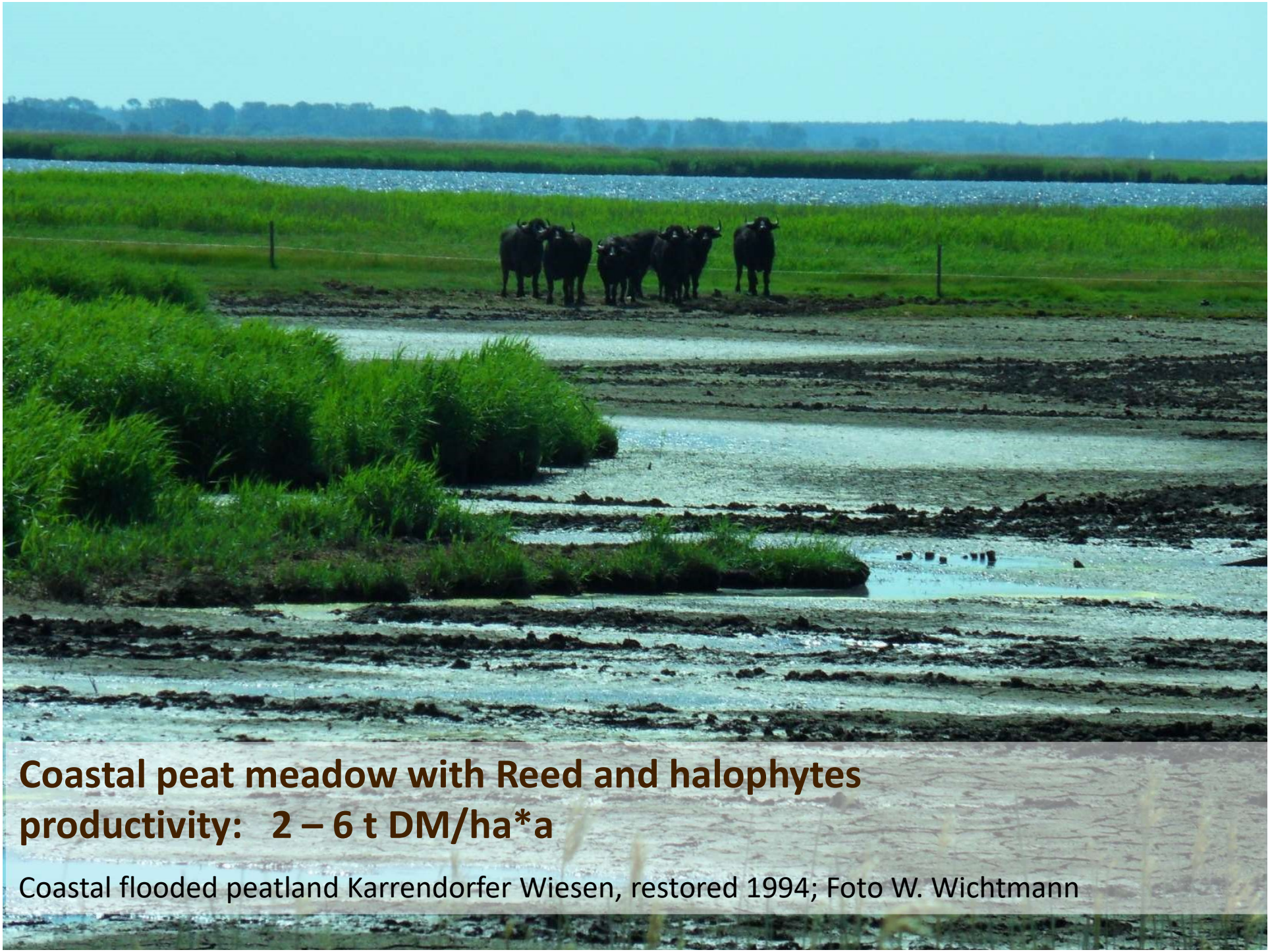
Wet meadow with Reed Canary Grass, Segdes and herbs
productivity: 2 – 5 t DM/ha*a → for energy (direct combustion)

Polder Seewiese at Lake Kummerow, rewetted ~2000; Foto W. Wichtmann 2016

Mecklenburg-Vorpommern

Heating plant Malchin

- Landcare in rewetted peatlands
- Production of biomass for energy
- Produce heat for grid supply



Coastal peat meadow with Reed and halophytes
productivity: 2 – 6 t DM/ha*a

Coastal flooded peatland Karrendorfer Wiesen, restored 1994; Foto W. Wichtmann

Reed canary grass (*Phalaris arundinacia*),
productivity: 3.5 – 15 t DM/ha*a →for energy (combustion, biogas)

Briquetting wet meadow biomass in Poland

Fotos: L. Lachmann

Glyceria maxima (needs fluctuating water level)

3 – 15 T DM/a →silage for fodder, biogas

Cattail (*Typha* spec.)
Productivity : 5 - 22 t DM/ha*a →for construction, insulation, fodder

Typha Insulation Board

- Developed by typha technik (Werner Theuerkorn, Bavaria)
- Unique combination of insulation and construction characteristics
- Magnesite + leafs of *T. angustifolia*
- Promising market demand but ! Biomass not available!
- Idea: Cultivation of biomass and production of boards within one company

Required Quality

Requirements on raw material:

- high quality biomass needed
- Leafs, not stems → *Typha angustifolia* (flowering less)
- High productivity (>15t ha^{-1}): dense stands → longer leaf sheats

Typha products from NAPORO

- Form bodies made from Typha fibres
  - 70 – 100% Typha fibres
  - Low weight
  - Extreme good technical characteristics
  - Alternative products are from plastics
  - 90% energy reduction compared with wood

Advantages of the new raw material from Cattail

- Typha is growing worldwide
- Grows under peat conserving conditions
- No competition with production of comestibles
- High sorption of CO_2 (more than forests)
- Purification of nutrient loaded waters
- No fertilization and no pest control necessary

Common Reed (*Phragmites australis*)
productivity: 3 – >25 t DM/ha*a →for construction material, energy

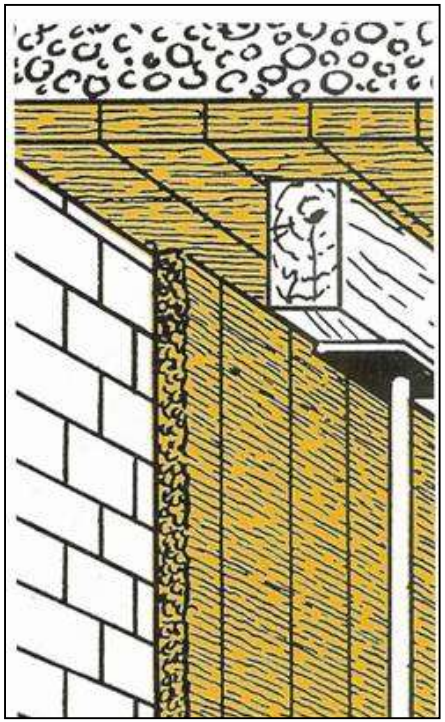
Planting reed on drained peatland before rewetting…

Thatch – high quality demands

thatching a roof on Rugia island

Foto: F. Tanneberger

Insulation materials from common reed



Fotos: S. Wichmann

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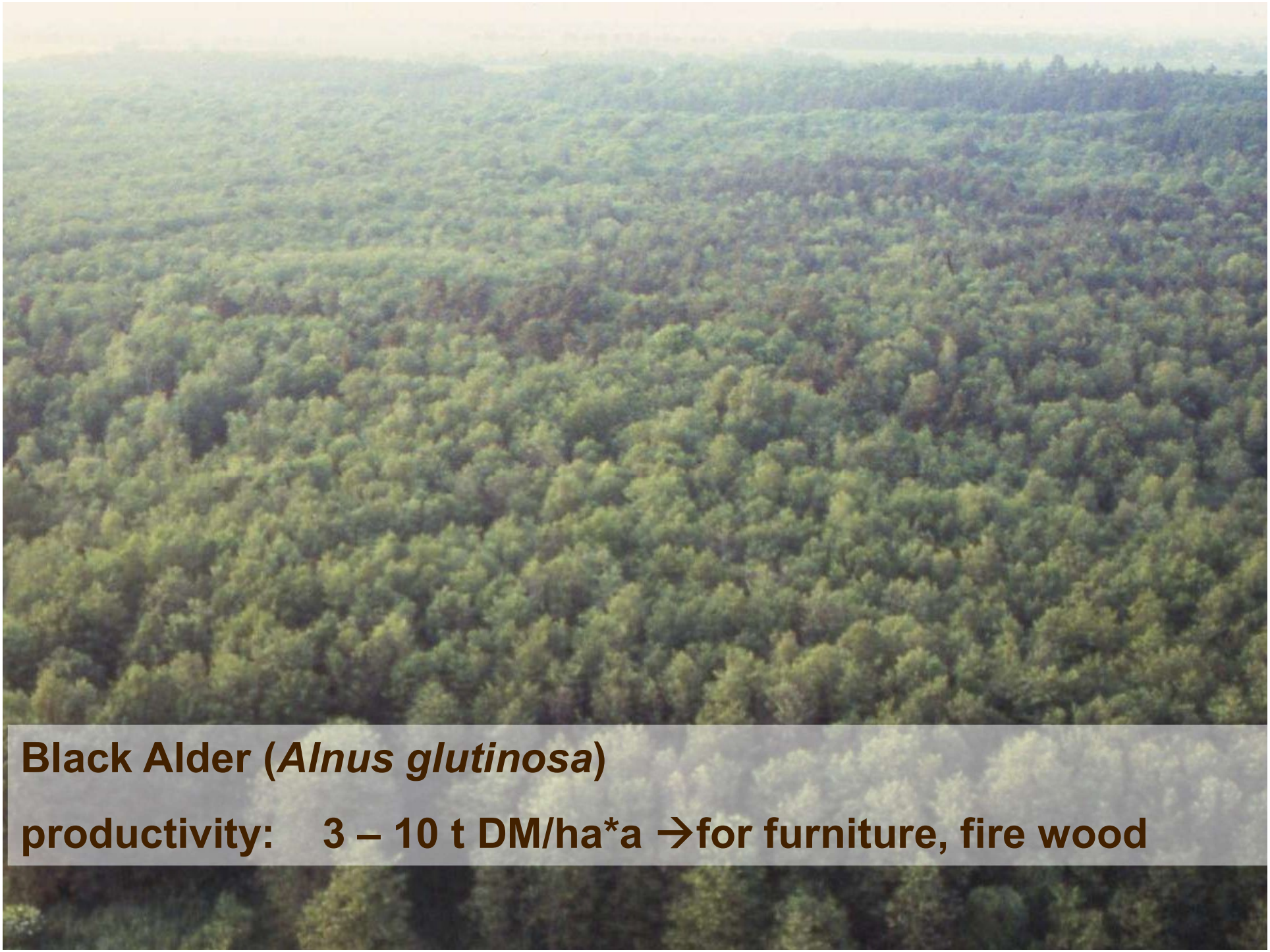
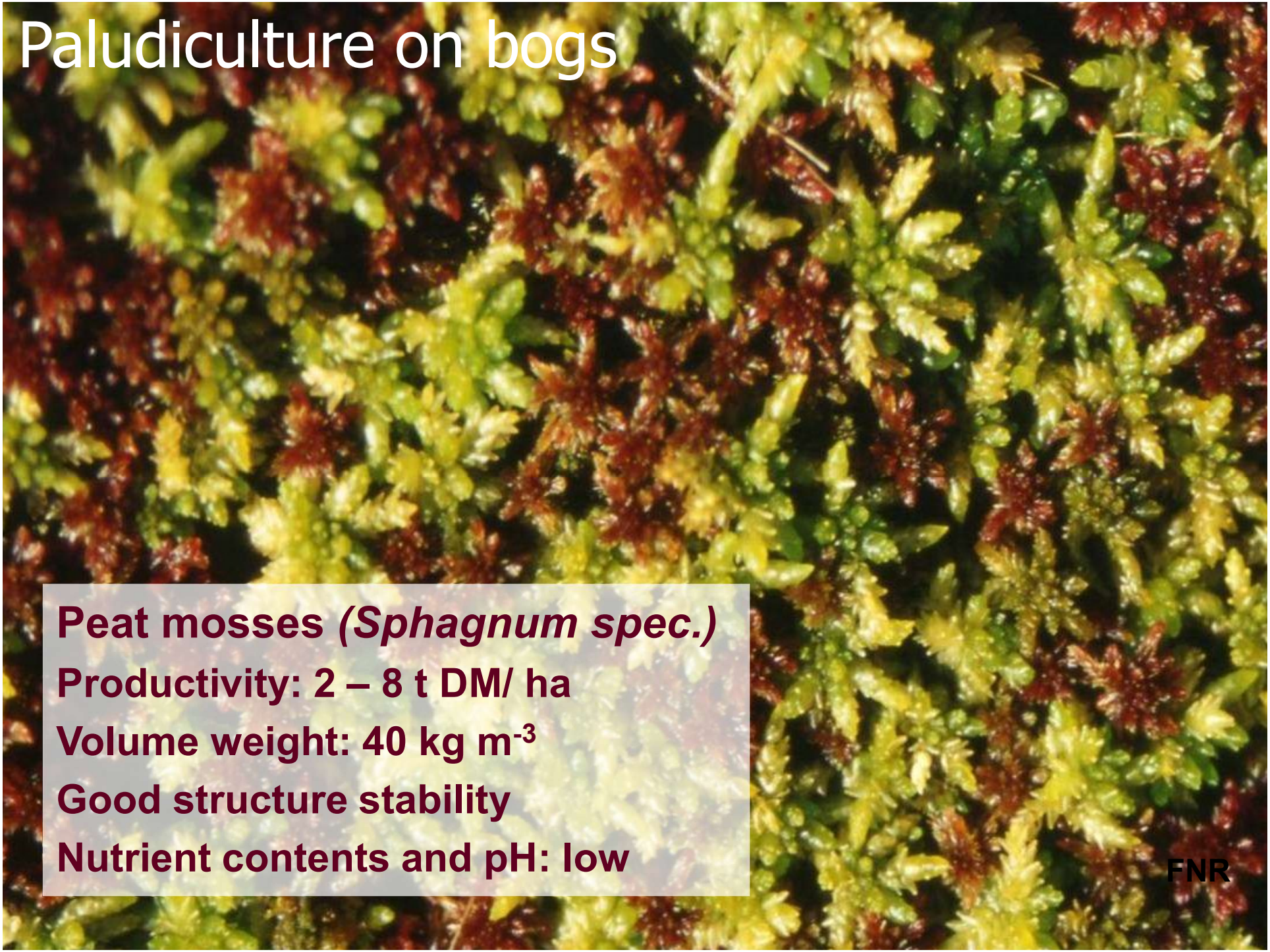


Black Alder (*Alnus glutinosa*)

productivity: 3 – 10 t DM/ha*a →for furniture, fire wood

Paludiculture on bogs



Peat mosses *(Sphagnum spec.)*

Productivity: 2 – 8 t DM/ ha

Volume weight: 40 kg m^{-3}

Good structure stability

Nutrient contents and pH: low

FNR

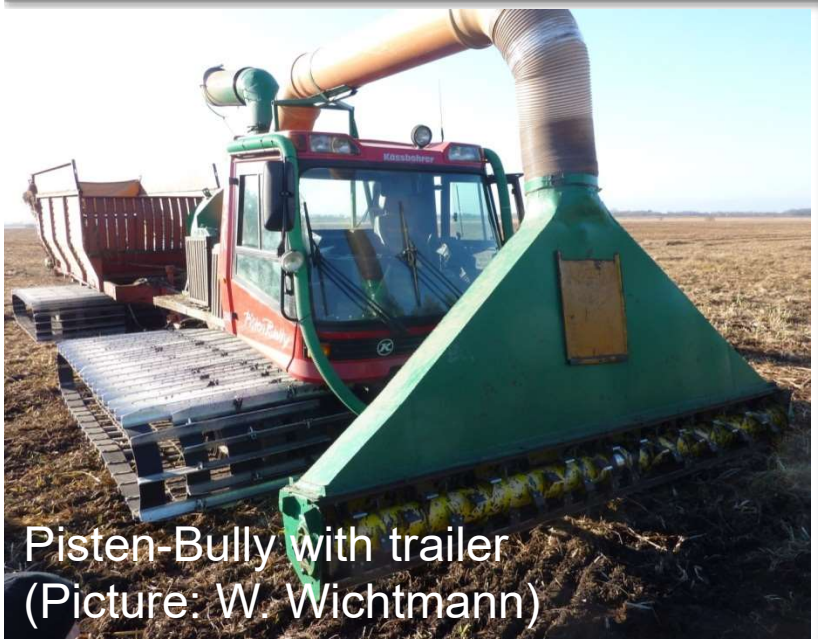
April 2011


After implementation of
Sphagnum paludiculture
Half year after spreading Sphagnum on bare peat, Nov. 2011

Harvesting

Ratrak mowing device with trailer
(Picture: L. Lachmann)

Caterpillar mounted mowing and baling device (Picture: S. Wichmann)



Pisten-Bully with trailer
(Picture: W. Wichtmann)

Seiga based field chopper
(Picture: W. Wichtmann)





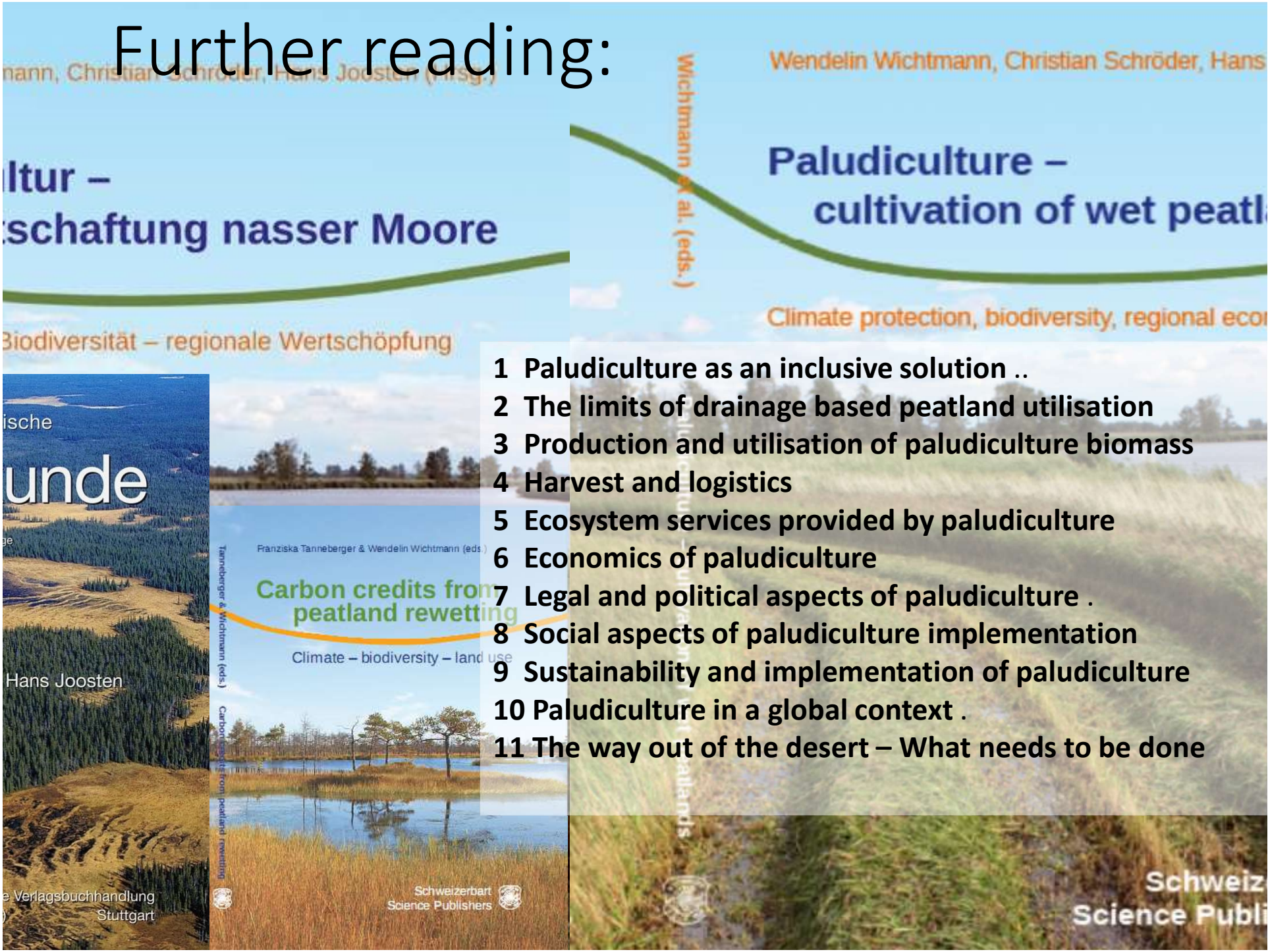





Ecosystem services that can always be achieved by paludiculture

- **Restauration of degraded peatlands**
- **Climate protection**
  - Regional cooling effect (by evaotranspiration)
  - Reduction of GHG emisions
  - Prevention from peat fires
- **Protection of waters**
  - Nutrient retention
  - Export of nutrients with biomass
- **Production of raw materials** and substitution of foss fuels….and as well **Perspectives** for regional development , agriculture & tourism, …

Further reading:



1 Paludiculture as an inclusive solution ..
2 The limits of drainage based peatland utilisation
3 Production and utilisation of paludiculture biomass
4 Harvest and logistics
5 Ecosystem services provided by paludiculture
6 Economics of paludiculture
7 Legal and political aspects of paludiculture .
8 Social aspects of paludiculture implementation
9 Sustainability and implementation of paludiculture
10 Paludiculture in a global context .
11 The way out of the desert – What needs to be done

Thanks for listening !

http://www.moorwissen.de/
http://www.succow-stiftung.de
http://duene.botanik.uni-greifswald.de
http://greifswaldmoor.de
http://paludiculture.de

Ecosystem services

ОАО «Торфобрикетный завод «Лидский»

What can always be achieved by paludiculture:

- **Restauration of degraded peatlands**
- **Climate protection**
  - Regional cooling effect (by evaotranspiration)
  - Reduction of GHG emisions
  - Prevention from peat fires
- **Protection of waters**
  - Nutrient retention
  - Export of nutrients with biomass
- **Production of raw materials** and substitution of fossil fuels….and as well **Perspectives** for regional development , agriculture & tourism, …

Wetlands and nutrients removal

Meta Analysis by Land et al. 2016

Land *et al. Environ Evid (2016) 5:9*
DOI 10.1186/s13750-016-0060-0

Environmental Evidence

SYSTEMATIC REVIEW Open Access

How effective are created or restored freshwater wetlands for nitrogen and phosphorus removal? A systematic review

Magnus Land[1*], Wilhelm Granéli[2,3,5], Anders Grimvall[4], Carl Christian Hoffmann[5], William J. Mitsch[3], Karin S. Tonderski[6] and Jos T. A. Verhoeven[7]

Abstract

Background: Eutrophication of aquatic environments is a major environmental problem in large parts of the world. In Europe, EU legislation (the Water Framework Directive and the Marine Strategy Framework Directive), international