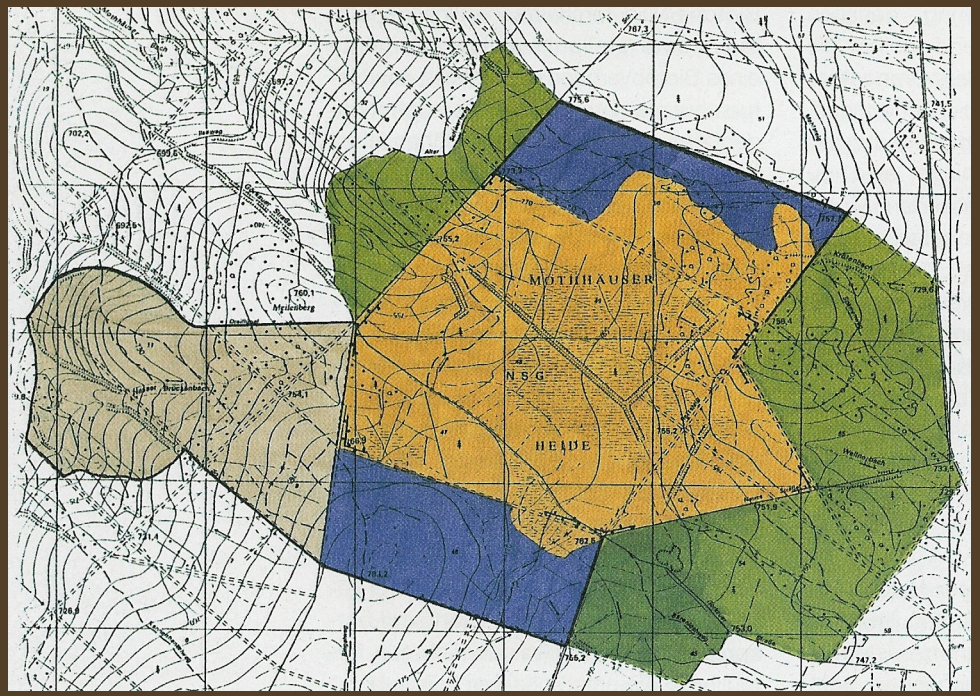
Hydrologic and climatic buffer-zones for mires – literature and own principles

Frank Edom[1)], Dirk Wendel[2)], Ingo Dittrich[3)] & Birgit Solbrig[4)]



1) HYDROTELM - Frank Edom
Naundorfer Str. 18
D-01139 Dresden
Germany
frank.edom@t-online.de

2) TU Dresden, Germany
3) Dr. Dittrich & Partner Hydro-Consult GmbH,Bannewitz, Germany
4) RP Chemnitz, Germany

1) Hydrologic buffer-zones for mires

The protected mire, the rewetted peatland or the regenerating mire or parts of them are called **core-zone**.

Hydrologic buffer-zones are **areas in the surrounding of the core-zone,** which shall **influence to the hydrology** of the core-zone in a way that the mire can exist and develop in agreement with the aim of protection.

This could be:

- Protection against lowering of groundwater-level. (Zone 1)
- Guarantee of a sufficient water-supply. (Zone 2)
- Protection of special vegetation, which needs special nutrient- (and other) conditions influenced by water-transport. (Zone 3)

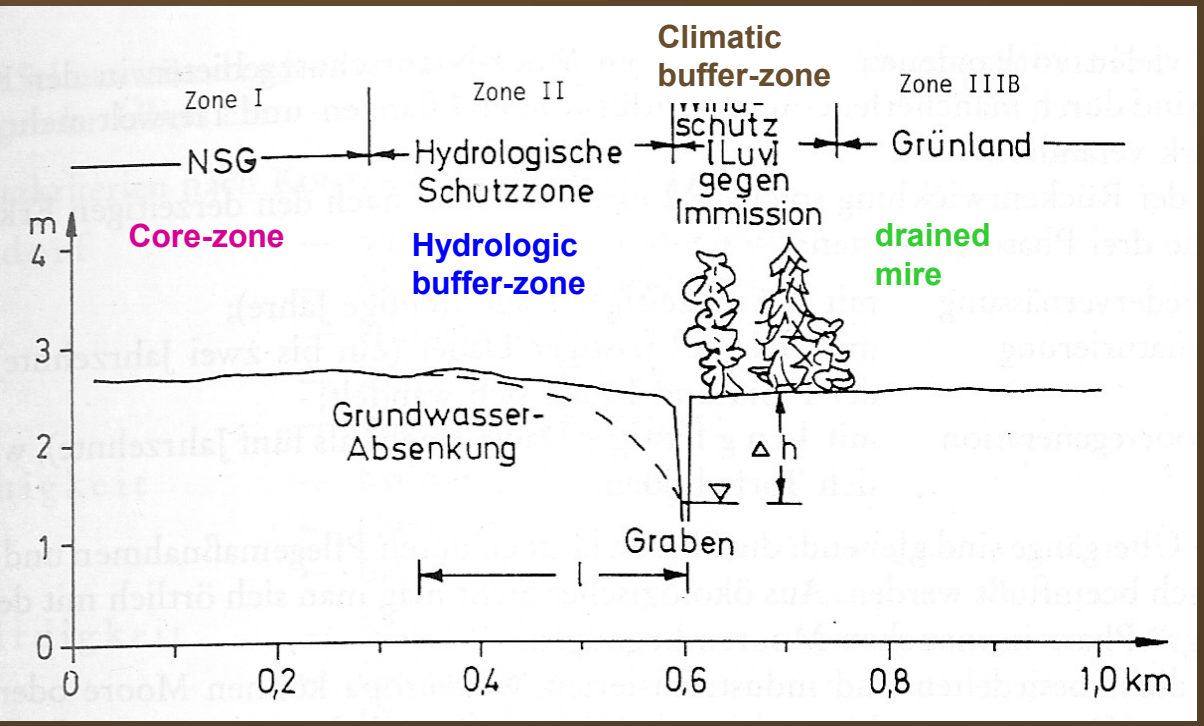
These are **buffer-zones in the strict sense**.

The rewetting of a peatland or regeneration of a mire (core-zone) may also **influence the surrounding areas** (upstream or with communicating groundwater-levels, mostly rising water-level).

In these areas land-use must be adapted to the new conditions.

We call such areas **buffer-zones in a further sense** or influence-zones. (Zone 4)

1.1) Hydrologic buffer-zone 1



The oldest concept of hydrologic buffer-zones for mires in Central Europe and most used in Germany

EGGELSMANN 1975

Rewetting/ protecting of only a part of the peatland/ mire

Empiric equation:

$$L_{SZ} = 200 \cdot k_f \cdot \Delta h$$

EGGELSMANN 1982

Experiences:

EGGELSMANN 1990

Moortyp	**width** Breite in m
Tiefgründiges Hochmoor (> 2 m)	30– 80
Flaches Hochmoor über Feinsand	120–150
Tiefes Niedermoor über Mudde	200–250
Flaches Niedermoor über Sand	
Quellmoor, Bruchwaldmoor	> 350

For a bog with P-ET (year) > 0 and impermeable layer in the ground

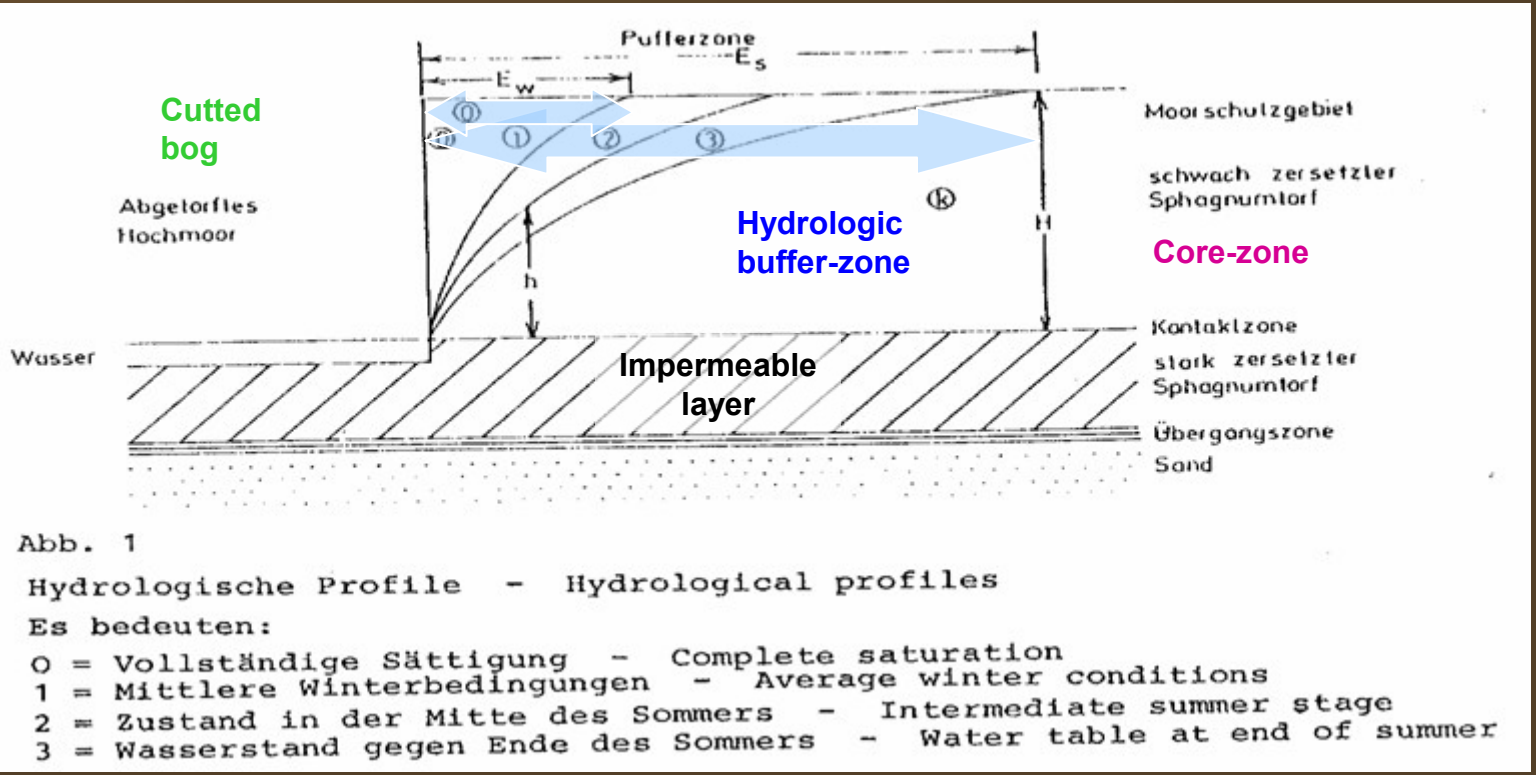


Abb. 1

Hydrologische Profile - Hydrological profiles

Es bedeuten:

0 = Vollständige Sättigung - Complete saturation
1 = Mittlere Winterbedingungen - Average winter conditions
2 = Zustand in der Mitte des Sommers - Intermediate summer stage
3 = Wasserstand gegen Ende des Sommers - Water table at end of summer

VAN DER MOLEN 1981

Winter-equation (steady flow):

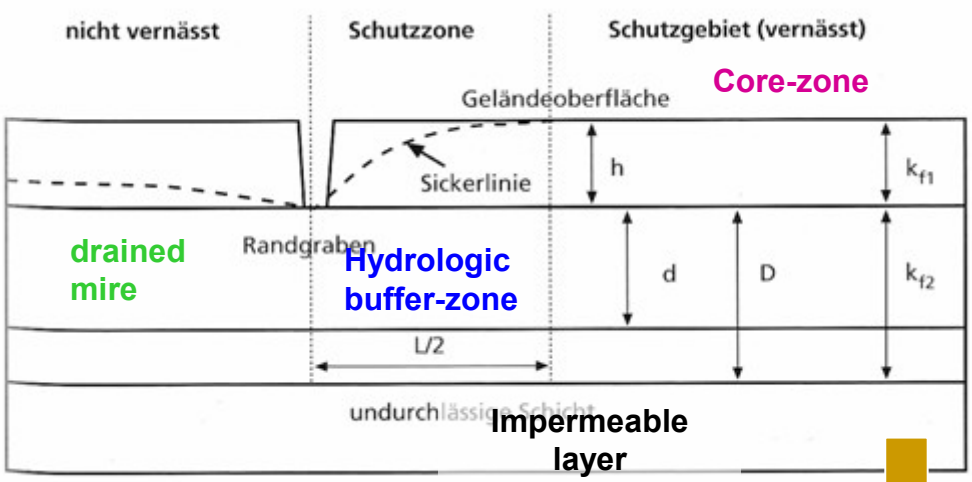
$$L_{Wi} = \Delta h \cdot \sqrt{\frac{k_f \cdot t_{HJ}}{(P-ET)_{Jahr}}}$$

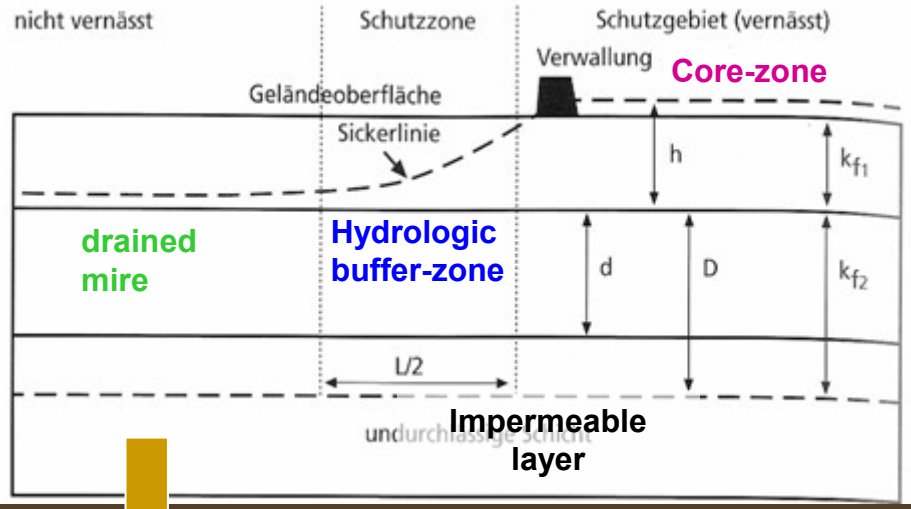
Summer-equation (unsteady flow):

$$L_{So} = 2{,}2 \cdot \sqrt{\frac{k_f \cdot \Delta h \cdot t_{HJ}}{\xi_e}}$$

Only applicable for the conditions of North-West of Central Europe!

For a fen with an impermeable layer in the ground:





Calculated as a half-distance of drains by a proposal of EGGELSMANN (1982) & BLANKENBURG & DIETRICH (2001):

BLANKENBURG & DIETRICH 2001

$$L_{SZ} = \frac{L}{2} = 0{,}5 \cdot \sqrt{\frac{8 \cdot k_{f2} \cdot d \cdot h}{q} + \frac{4 \cdot k_{f1} \cdot h^2}{q}}$$

HOUGHOUDT-ERNST, DIN 1185

For a bog with an permeable layer in the ground:

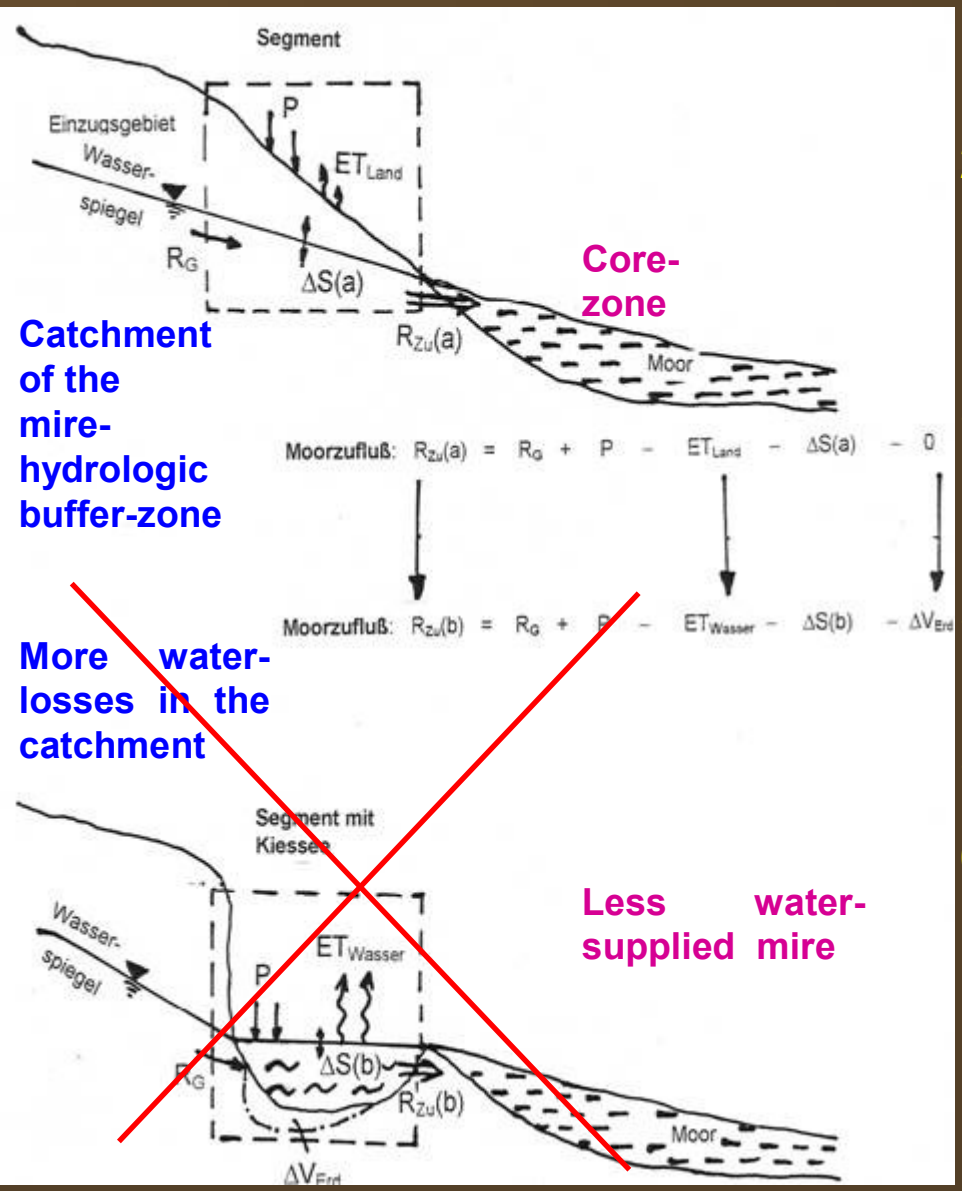
- **unsteady groundwater-modelling**

POELMANN & JOOSTEN 1992

→ **~ 2000 m wide buffer-zone (Groote-Peel national park)**

1.2) Hydrologic buffer-zone 2

EDOM 1999



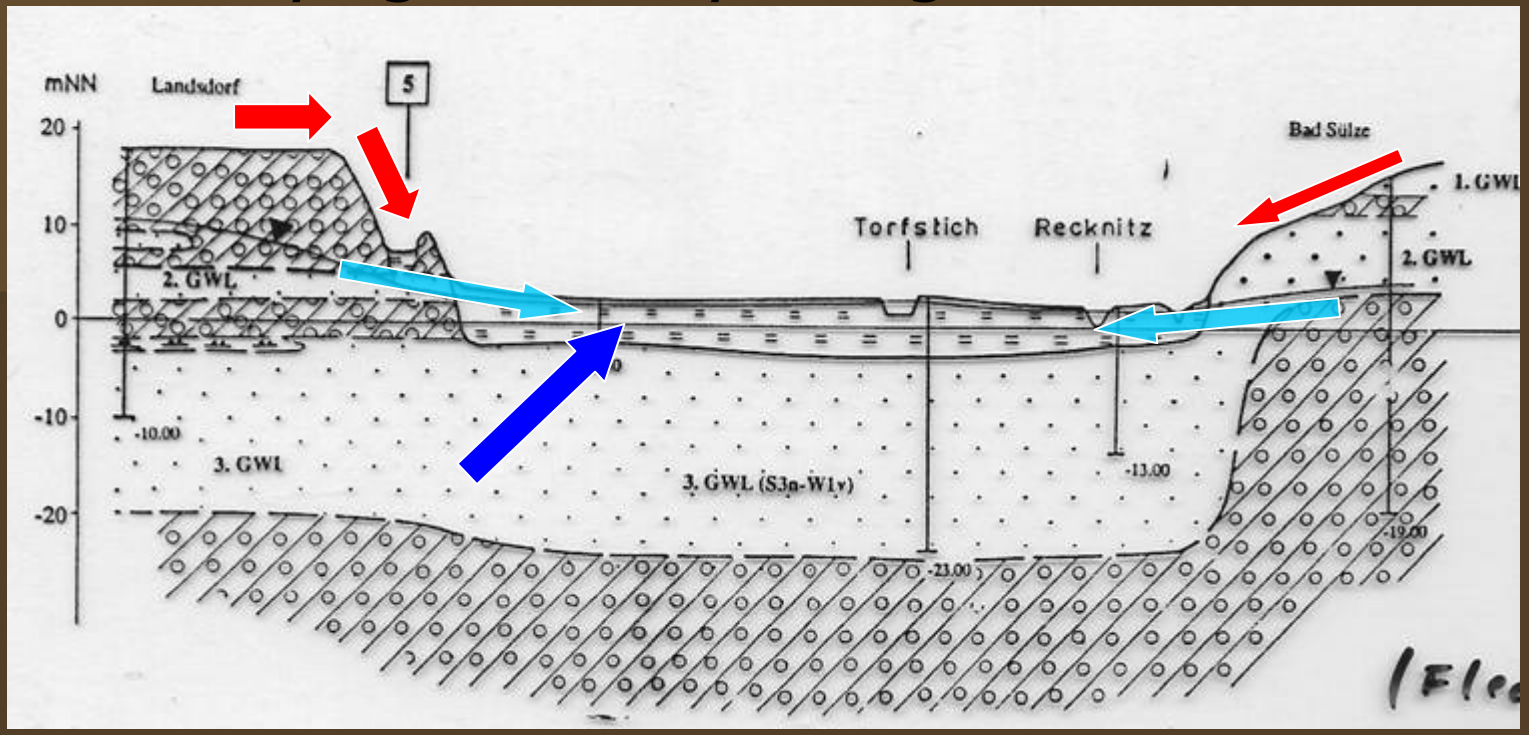
Principles:

2) Changes in land use in the hydrologic catchment may change the water-supply of the mire. Such changes can be:

- Mining, especially beneath the groundwater-level (mostly gravel or coal)
- Afforestation or changes to more transpiring vegetation
- Water use (e.g. drinking water)

6) In the hydrologic catchment the land-use must be organised in a way that the water-supply is optimal/ sufficient for mire-existance or –regeneration.

Identifying of the hydrological catchments

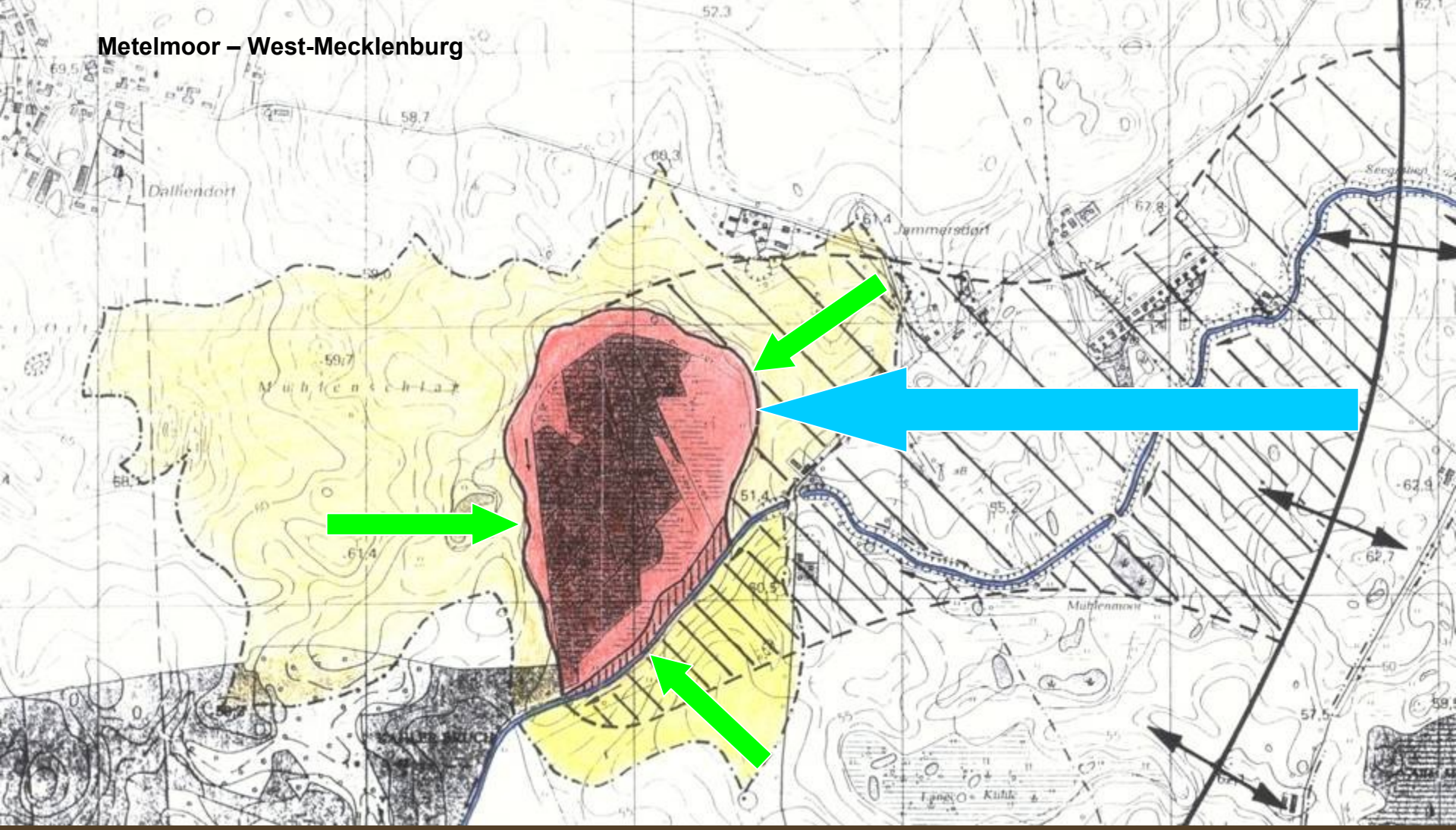


FLECHTNER 1998

water-supply mainly from the second and the third aquifer,, a little bit from surface waters.

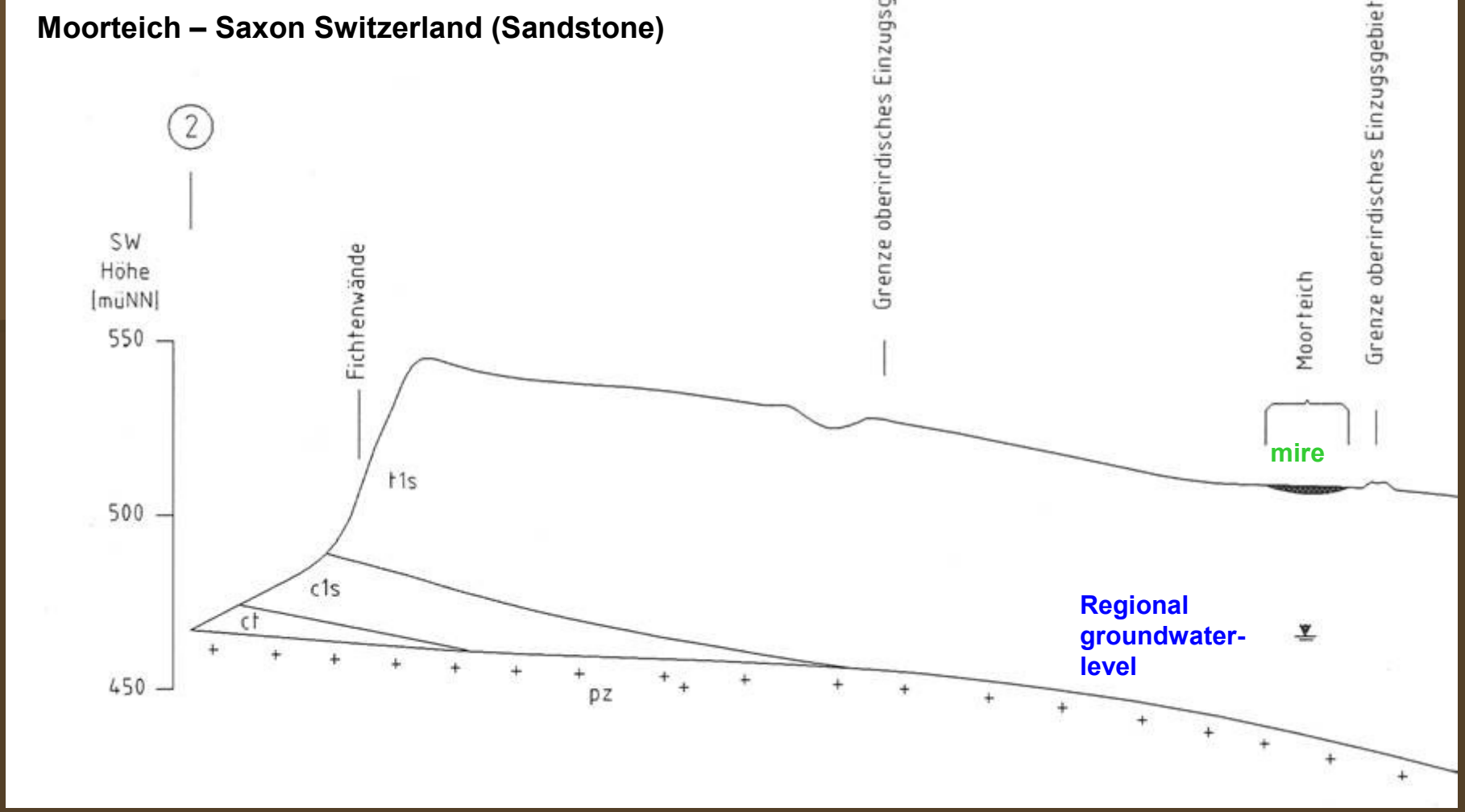
This mire has 3 different hydrological catchments. Two groundwater- and one surface-water catchment.

Metelmoor – West-Mecklenburg



Surface-flow-catchment ≠ Groundwater- catchment

Moorteich – Saxon Switzerland (Sandstone)



Mire **without** a groundwater-catchment and with an ineffective surface-flow-catchment (because of small slope and good infiltration)

Conclusions: Hydrologic buffer-zone 2

1) The - according to the water-supply of the mire - important parts of the catchment-areas must be identified → buffer-zone.

2) The land-use in the buffer-zone can be organised:

- In a protecting way: The water-supply is sufficient.
- In a developing way (improving of water-supply): e.g. forest-cutting, forest-conversion (less coniferous, more structure), reduction of water-abstraction
- In a way of "**planned changing wise-use**": Every planned change in the buffer-zone must be proofed by hydrological expertise. An acceptable extent of the planned change can be found by water-balance-modelling.

1.3) Hydrologic buffer-zone 3 (nutrient-protection)

Swiss experience: BUWAL 1994 (Marti et al.): “Pufferzonenschlüssel” (buffer-zone-key)

→ mostly zones between 20 – 40 m, max. 70 m

- Zone only relates to different agricultural use
- Methods must be improved by hydrogeochemical models!

Zone 3 can be combined with hydro-buffer-zone 2 or with nutrient-accumulating mire-vegetation.

2) Climatic buffer-zones for mires

Climatic buffer-zones are **areas in the surrounding of the core-zone**, which shall **influence to the energy-supply or the air-based matter-(nutrient-) supply** of the core-zone in a way that the mire can exist and develop in agreement with the aim of protection.

This may be:

- Protection against too much evapotranspiration. (Zone 1)
- Protection against atmospheric depositions. (Zone 2)

2.1.1) Climatic buffer-zone 1 -principles

ROMANOV - equation:

$$ET_{Mire} = \alpha \cdot RN + Adv$$

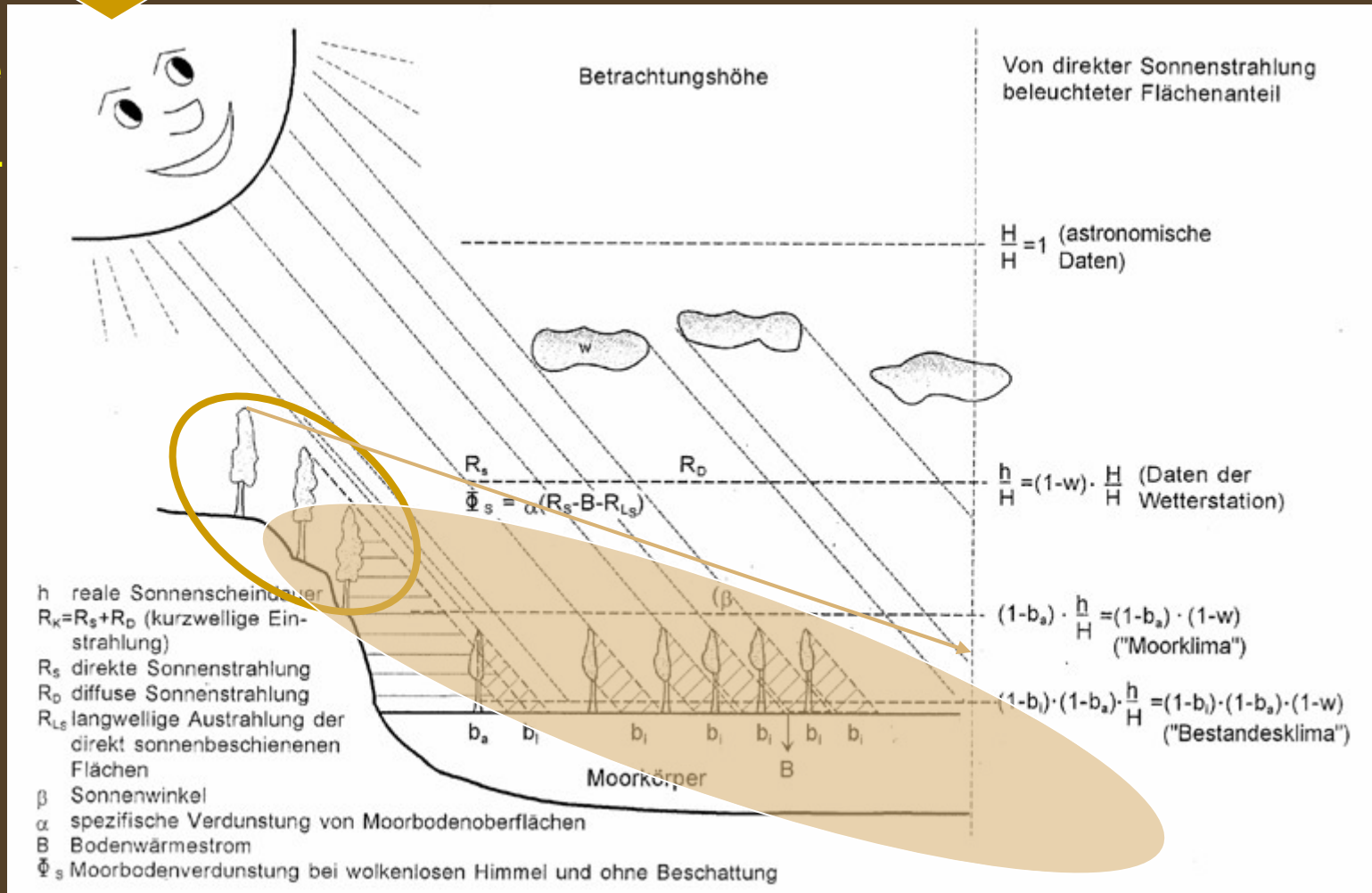
ROMANOV 1961

Influence on radiation:

Filtration of radiation

Forest alongside the mire, (especially effective on a slope)

On the East and on the West side (or in northern countries) an especially long shadow reduces the ET in the morning or afternoon



ROMANOV - equation:

$$ET_{Mire} = \alpha \cdot RN + Adv$$

ROMANOV 1961

Oasis-effect:

For: large mires, centre of large mires, wind-protected mires, mires in wet or cold regions (ROMANOV 1962):

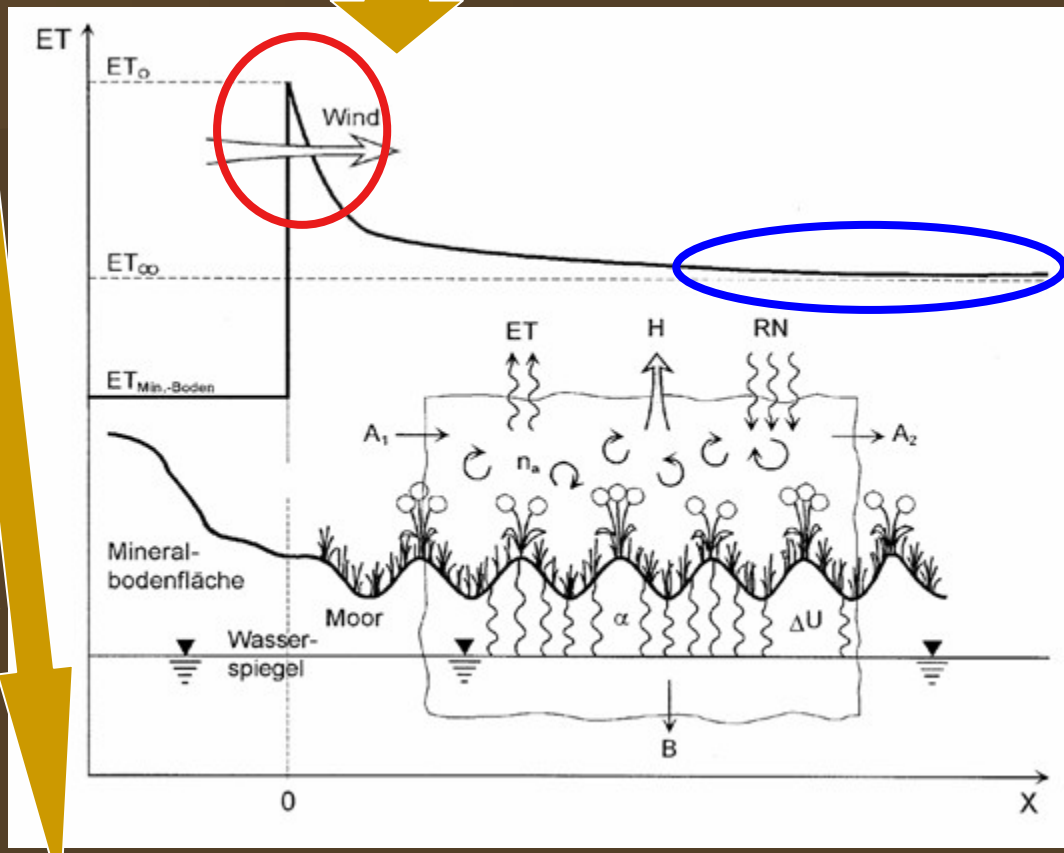
$$ET_{Mire} = \alpha \cdot RN = ET_{\infty}$$

$$Adv \approx 0$$

For: small mires, marginal areas of large mires, wind-exposed mires, mires in dry or warm regions (BAVINA 1967 ….):

Advection can be important !!!

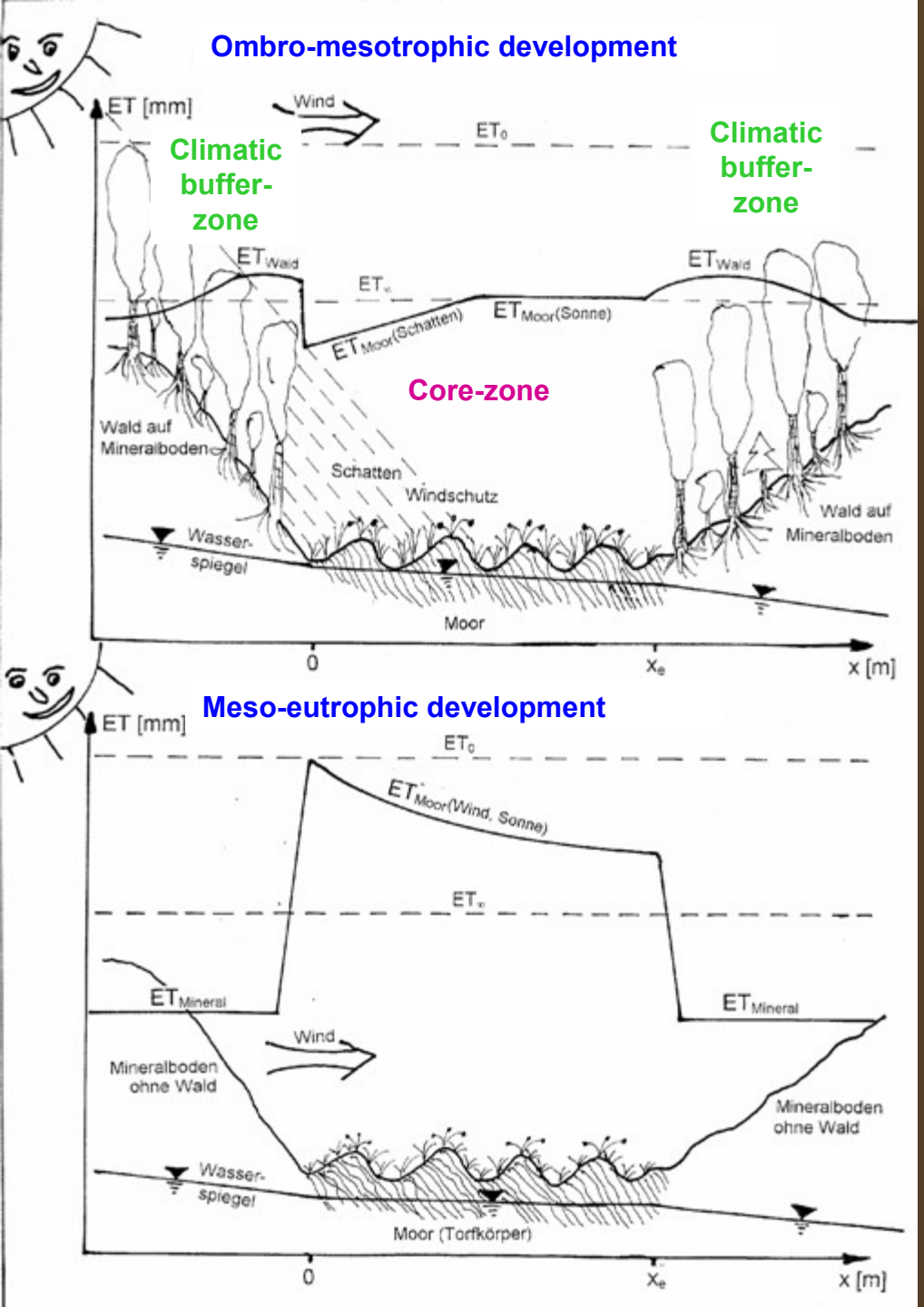
Influence on advection:



equation of oasis-effect:

$$ET(x) = ET_{\infty} + (ET_0 - ET_{\infty}) \cdot e^{-n_a \cdot x} \quad with: n_a = \frac{\chi^2}{10 \cdot \ln \frac{1m}{h_R}}$$

VERŠININ 1976



Combination of the radiation- with the advection-effect for small mires:

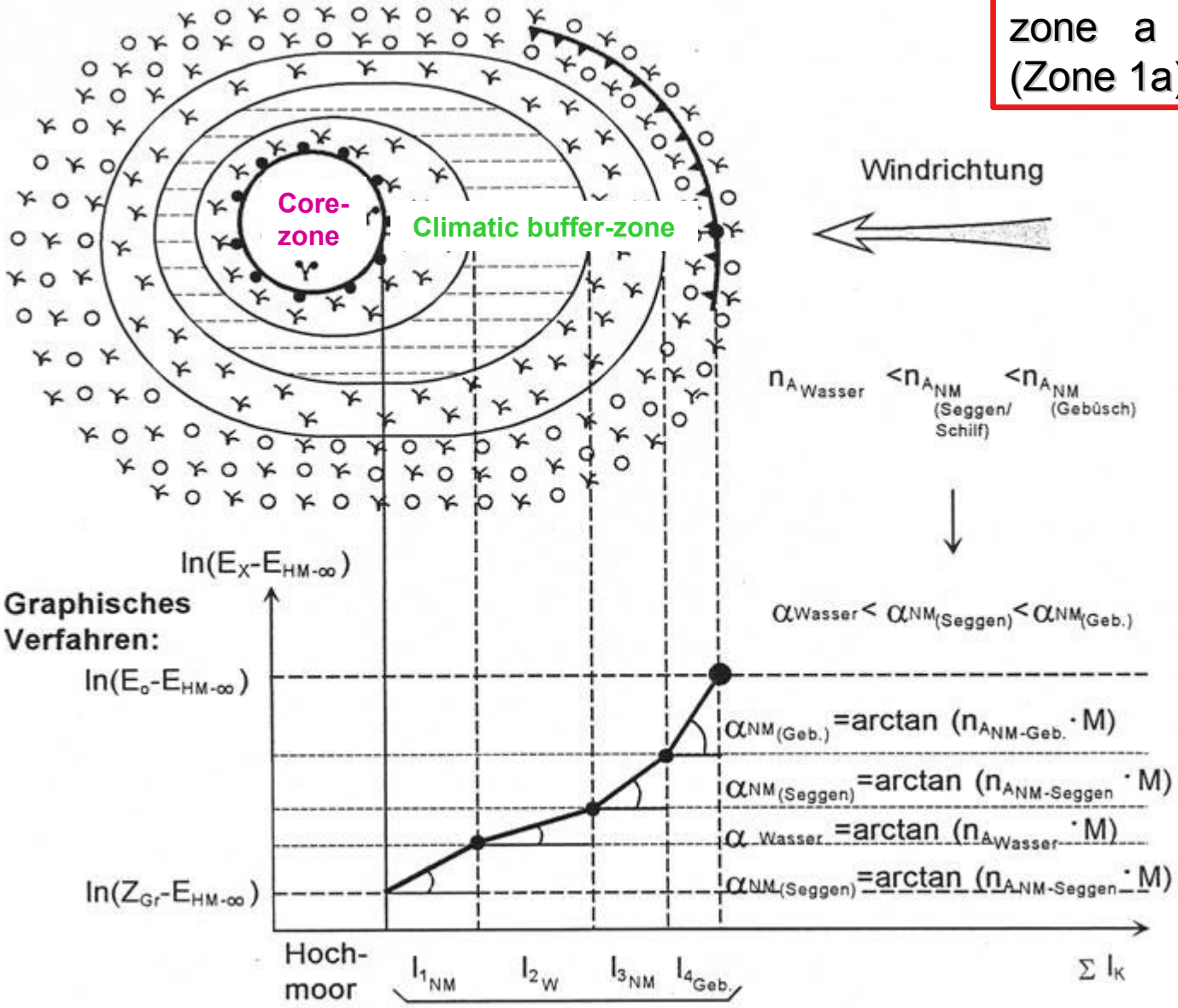
Wind- and radiation-protected mire with small evapotranspiration

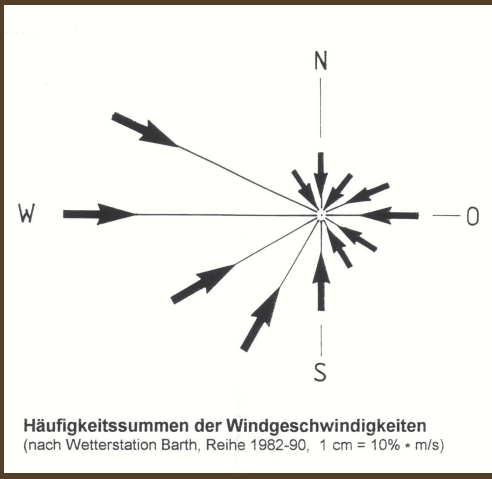
For small ombro- or mesotrophic mires in not very wet landscapes it might be good to establish a climatic buffer-zone with forest. (Zone1b)

Wind- and radiation-exposed mire with large evapotranspiration

For large peatlands, where only a part shall be regenerated or protected as a mire :

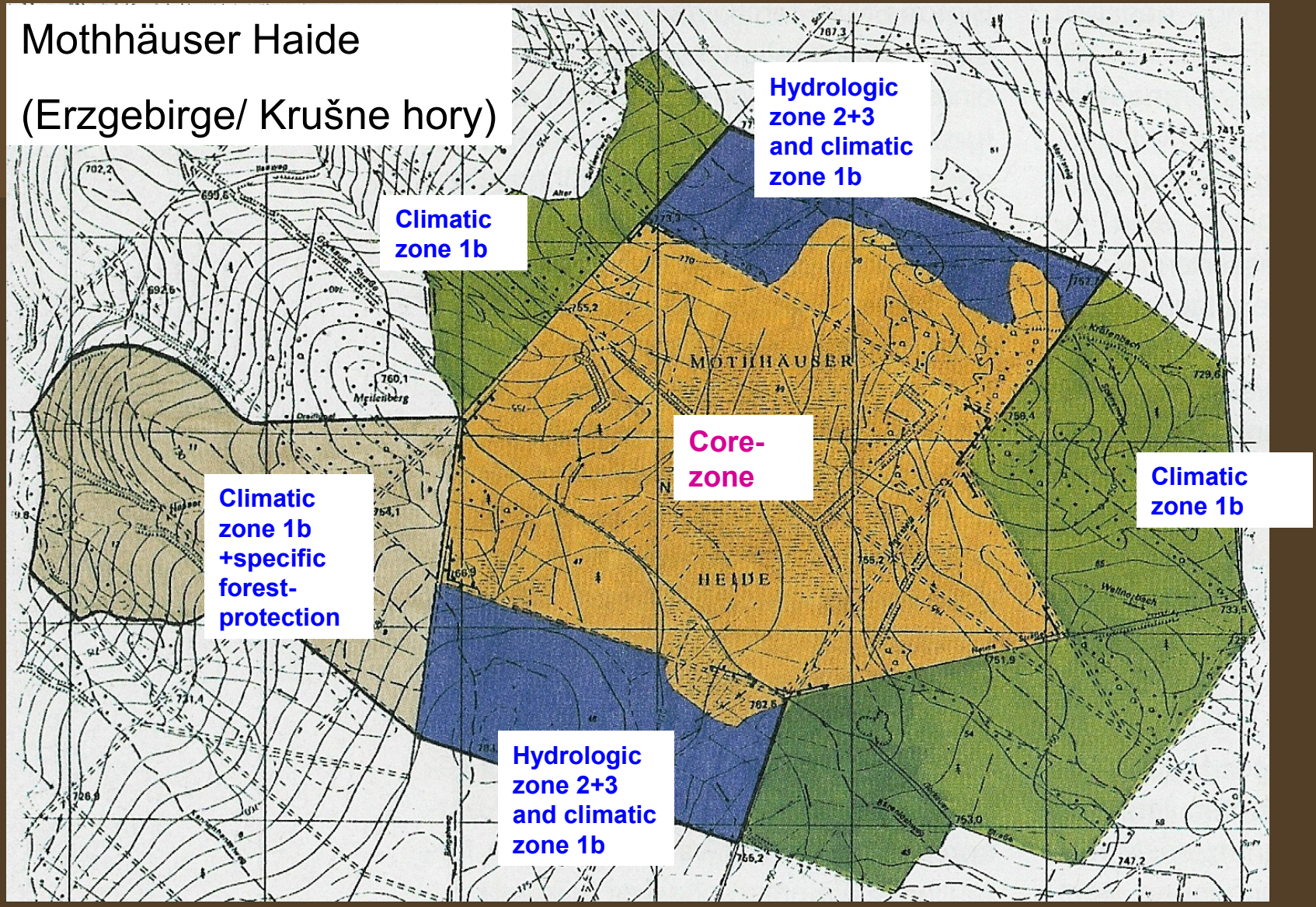
To reduce the ET in the core-zone a minimal area around (Zone 1a) should be rewetted.





Häufigkeitssummen der Windgeschwindigkeiten
(nach Wetterstation Barth, Reihe 1982-90, 1 cm = 10% • m/s)

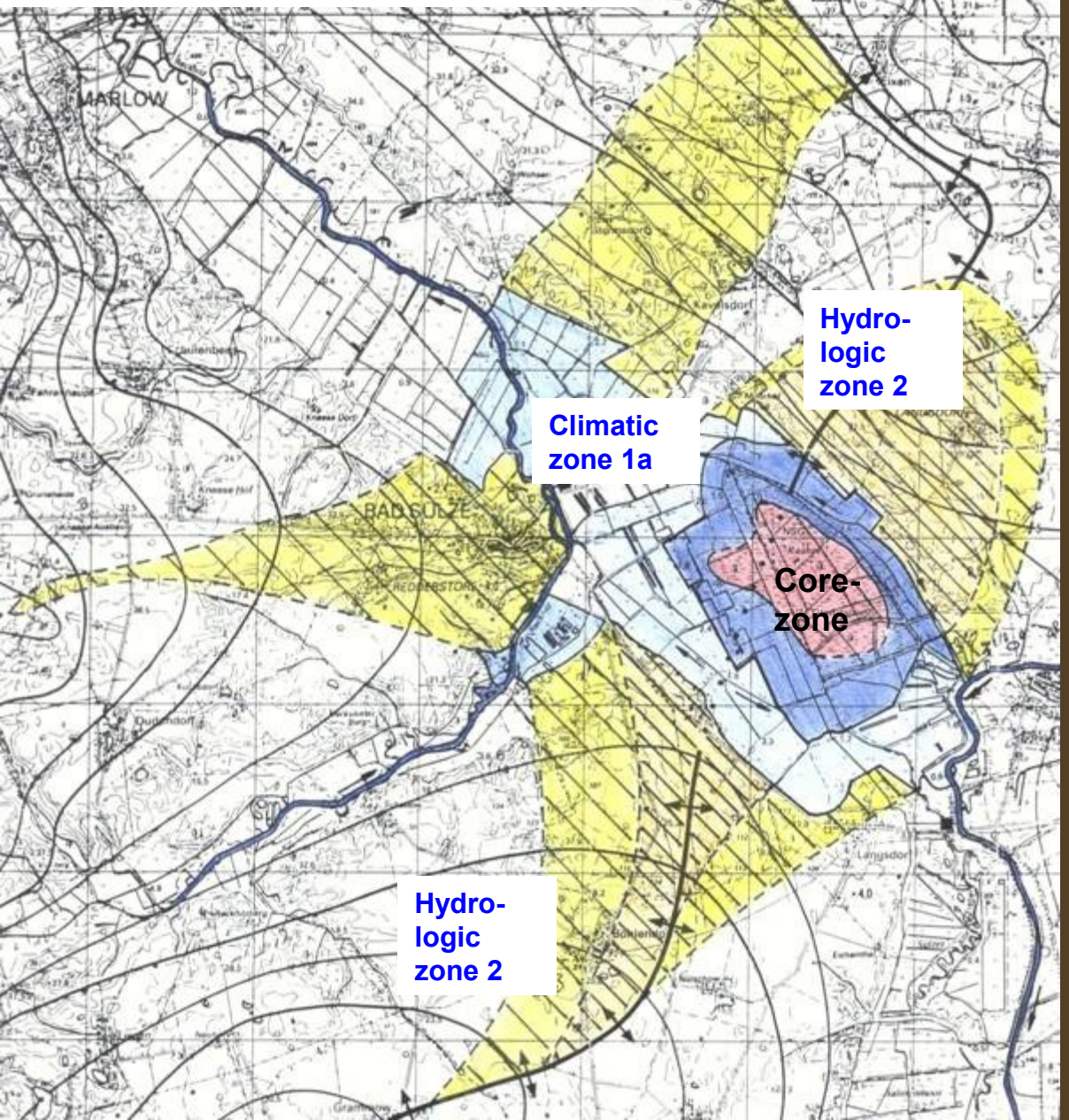
3) Some examples for buffer-zones

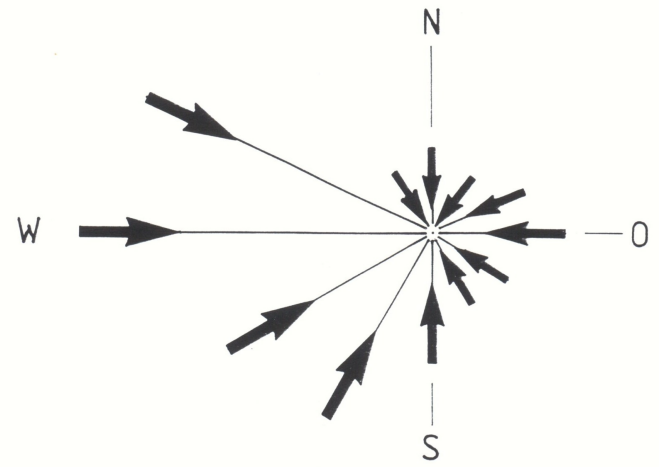


WENDEL 1991, EDOM & WENDEL 1998

Grenztalmoor

(Vorpommern/ NE Germany)

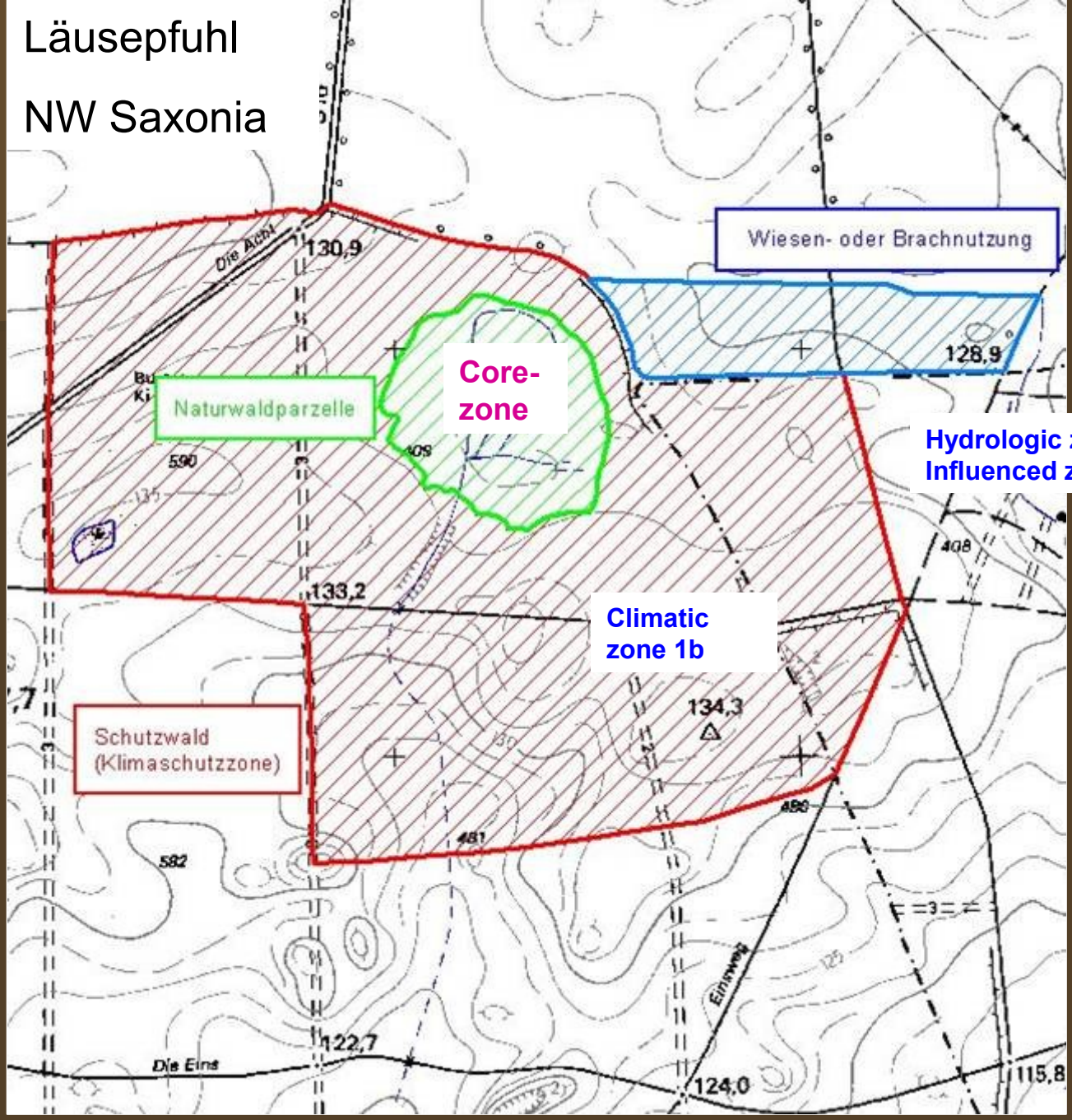




Häufigkeitssummen der Windgeschwindigkeiten
(nach Wetterstation Barth, Reihe 1982-90, 1 cm = 10% * m/s)

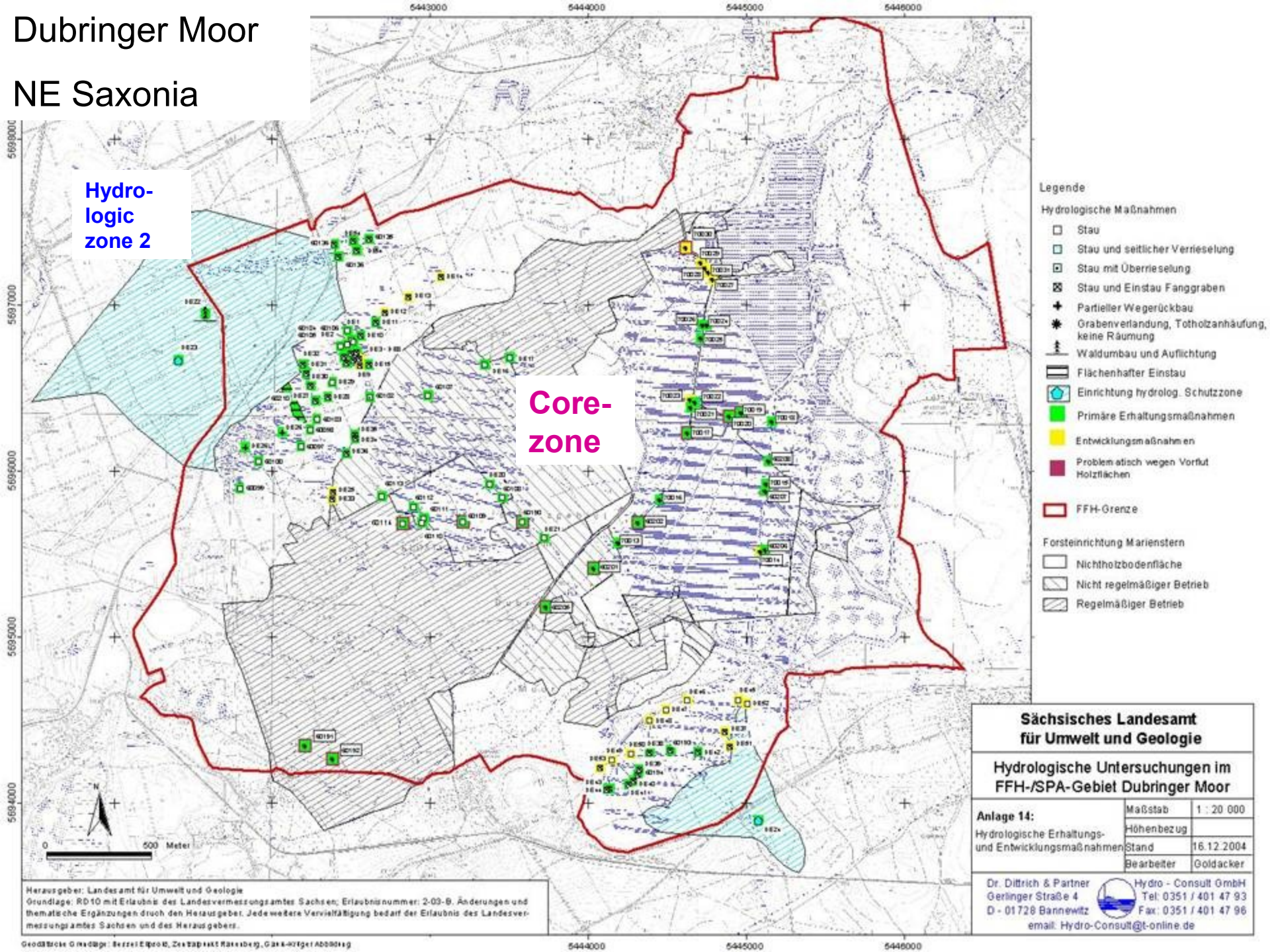
Läusepfuhl

NW Saxonia



Dubringer Moor

NE Saxonia



For succesfull regeneration of more mires in Europe we need buffer-zones!

Thank you for your attention!