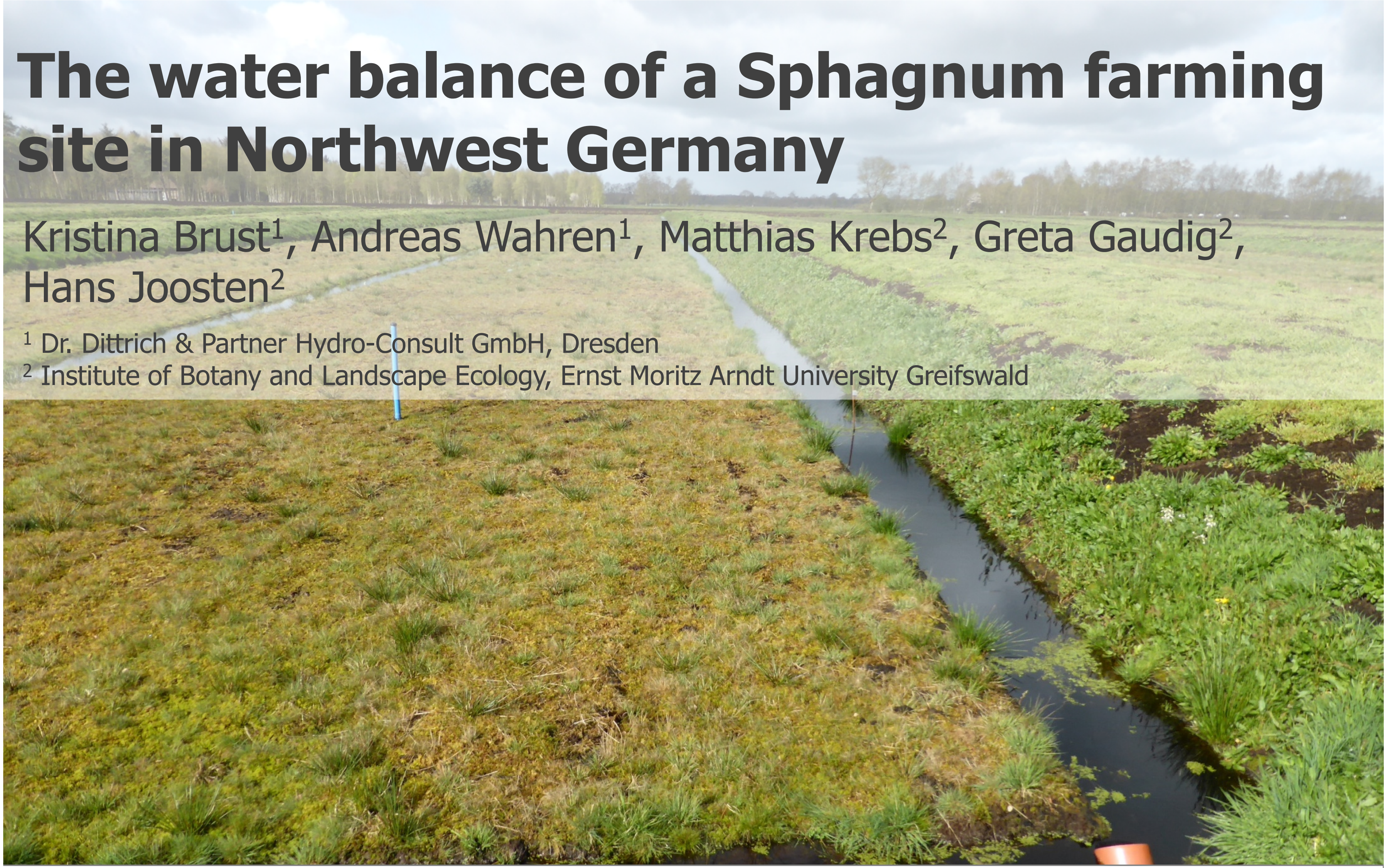
The water balance of a Sphagnum farming site in Northwest Germany

Kristina Brust[1], Andreas Wahren[1], Matthias Krebs[2], Greta Gaudig[2], Hans Joosten[2]

[1] Dr. Dittrich & Partner Hydro-Consult GmbH, Dresden
[2] Institute of Botany and Landscape Ecology, Ernst Moritz Arndt University Greifswald



Gefördert durch:

Bundesministerium für Ernährung und Landwirtschaft

aufgrund eines Beschlusses des Deutschen Bundestages

Dr. Dittrich & Partner
Glacisstraße 9a
D -01099 Dresden

Hydro-Consult GmbH
Tel.: +49 351 4014793
Fax: +49 351 4014796

www.hydro-consult.de – info@hydro-consult.de

MOOSGRÜN

Sphagnum farming

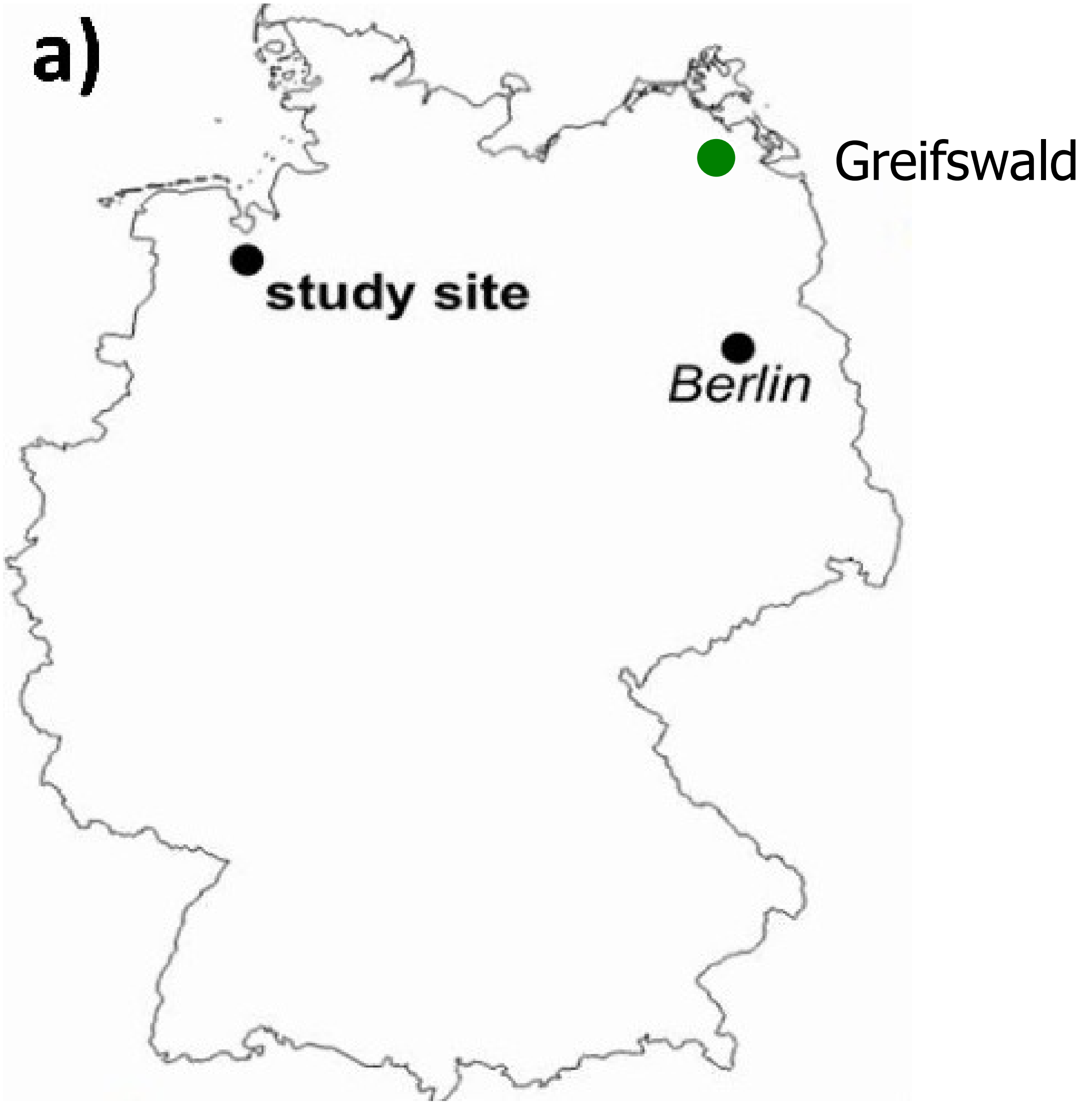
- field studies have demonstrated the feasibility of Sphagnum farming
- under natural conditions atmospheric water supply would provide enough water
- in drained landscape precipitation alone cannot ensure permanent wet conditions, particularly not in summer when evapotranspiration exceeds precipitation

→Sphagnum farming sites require a water management system enabling irrigation, avoiding flooding

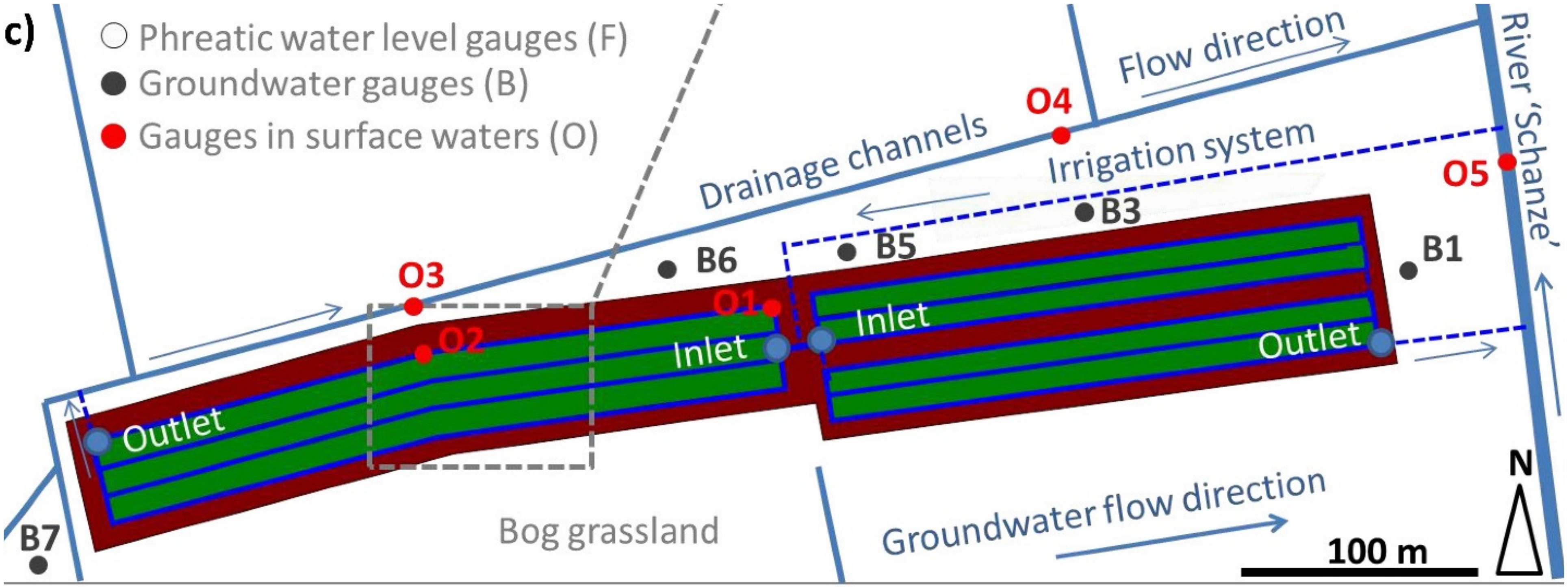
Investigation of water balance

1. In which periods do excesses and deficits occur?
2. What are the main sources of water loss?
3. How much water is needed to maintain the water table close below *Sphagnum* surface throughout the year?

Sphagnum farming site Hankhauser Moor



Sphagnum farming site Hankhauser Moor



Brust et al. submitted

study site on former bog grassland

Stratigraphy: former bog grassland ‚Hankhauser Moor'

- uppermost 30-50 cm were degraded

Stratigraphy: former bog grassland ‚Hankhauser Moor‘

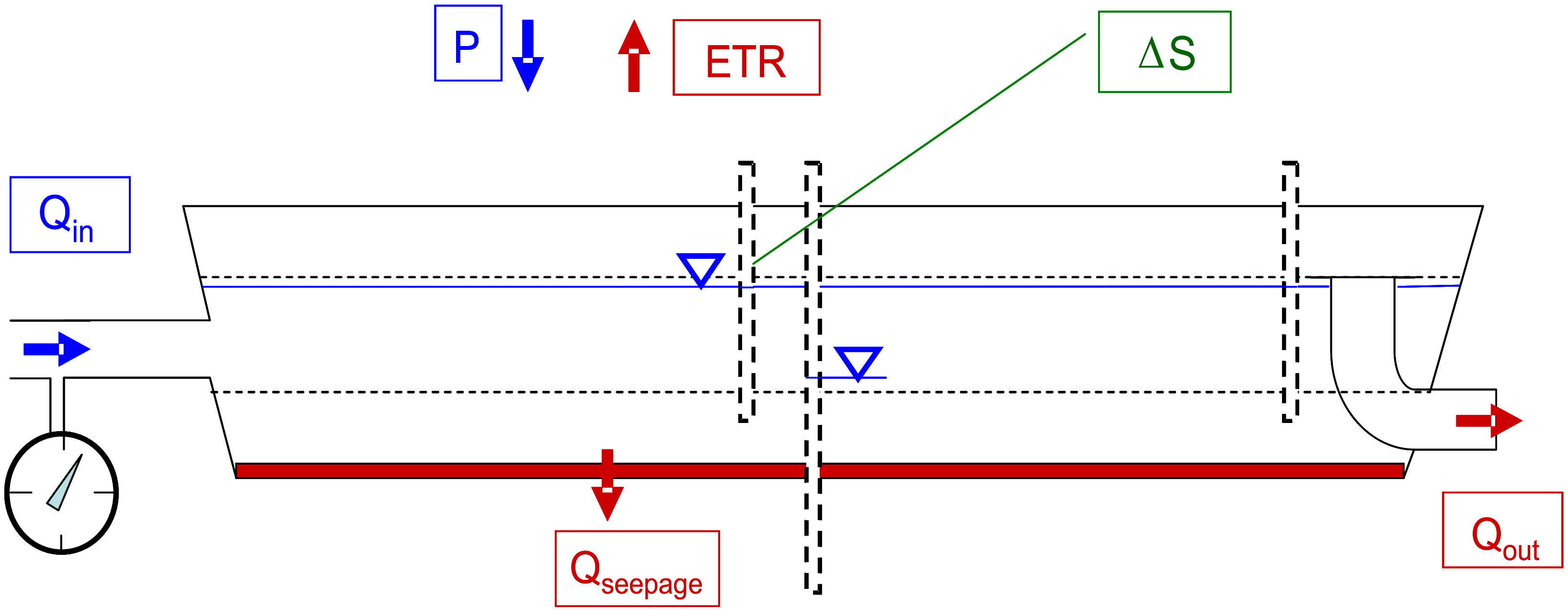
- uppermost 30-50 cm were degraded → layer removed
- high saturated hydraulic conductivity 120cm/day in upper peat layer
- with increasing depth – hydraulic conductivity decreases

→ very limited vertical seepage

→ horizontal fluxes to adjacent drained areas

Components for calculating the water balance

$$P + Q_{in} = ETR + Q_{seepage} + Q_{out} \pm \Delta S$$



Brust et al. submitted

water input	P … precipitation, Q_{in} … inflow
water losses	ETR … evapotranspiration, $Q_{seepage}$ … seepage, Q_{out} … outflow
plus/minus	ΔS … change of water storage

Components for calculating the water balance

- a combined concept of modelling and measurement:

Measured:

- P at weather station and for long-term simulations station Bremen 1993-2013


© Uni Greifswald

Components for calculating the water balance

- a combined concept of modell and measurement:

Measured:

- P at weather station and for long-term simulations station Bremen 1993-2013
- Q_{in} and Q_{out} via surface water in outlet → calculation

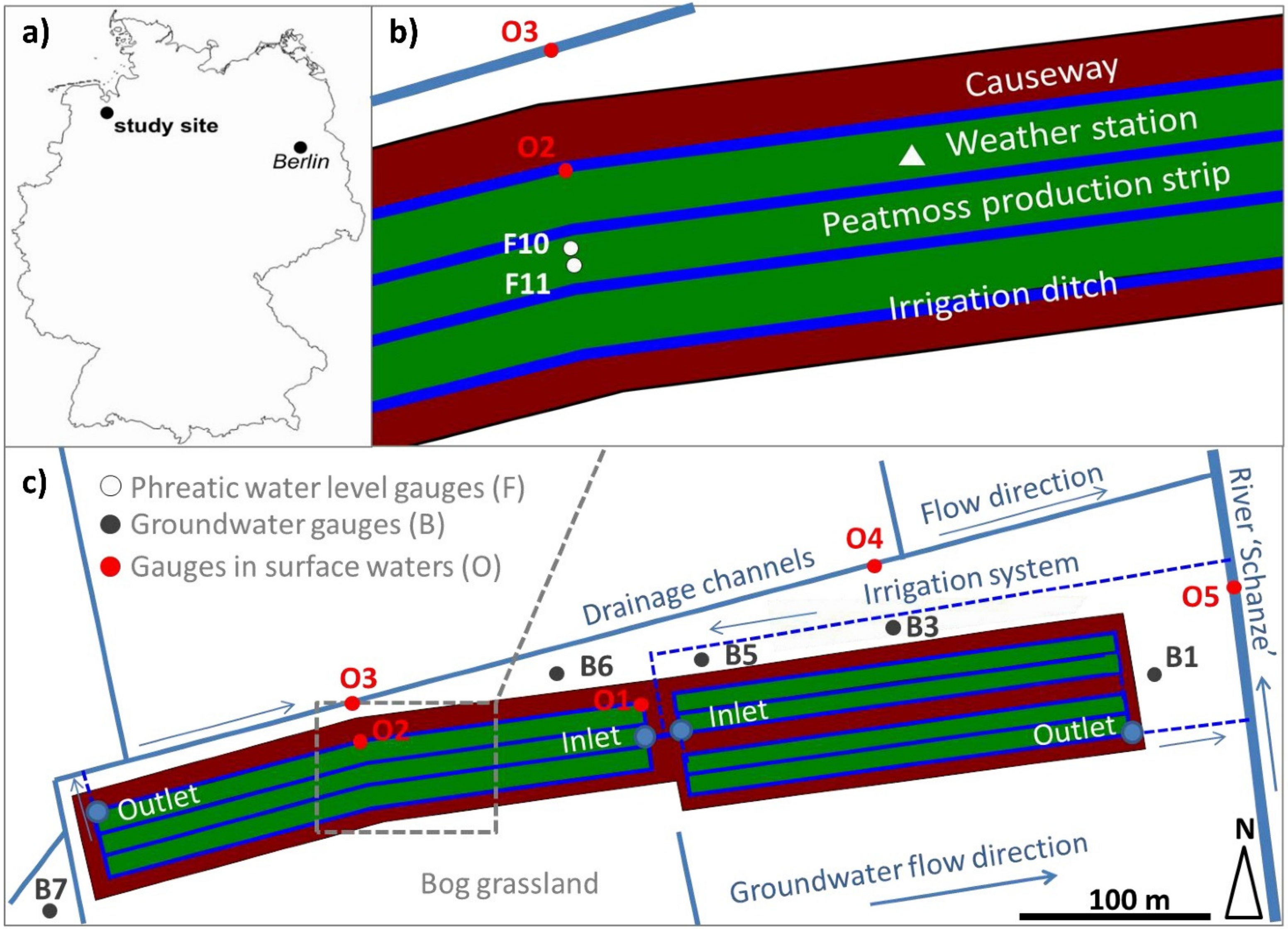
Components for calculating the water balance

- a combined concept of modell and measurement:

Measured:

- P at weather station and for long-term simulations station Bremen 1993-2013
- Q_{in} and Q_{out} via surface water in outlet → calculation
- phreatic, surface and ground water level

Study design



Brust et al. submitted

Components for calculating the water balance

- a combined concept of modell and measurement:

Measured:

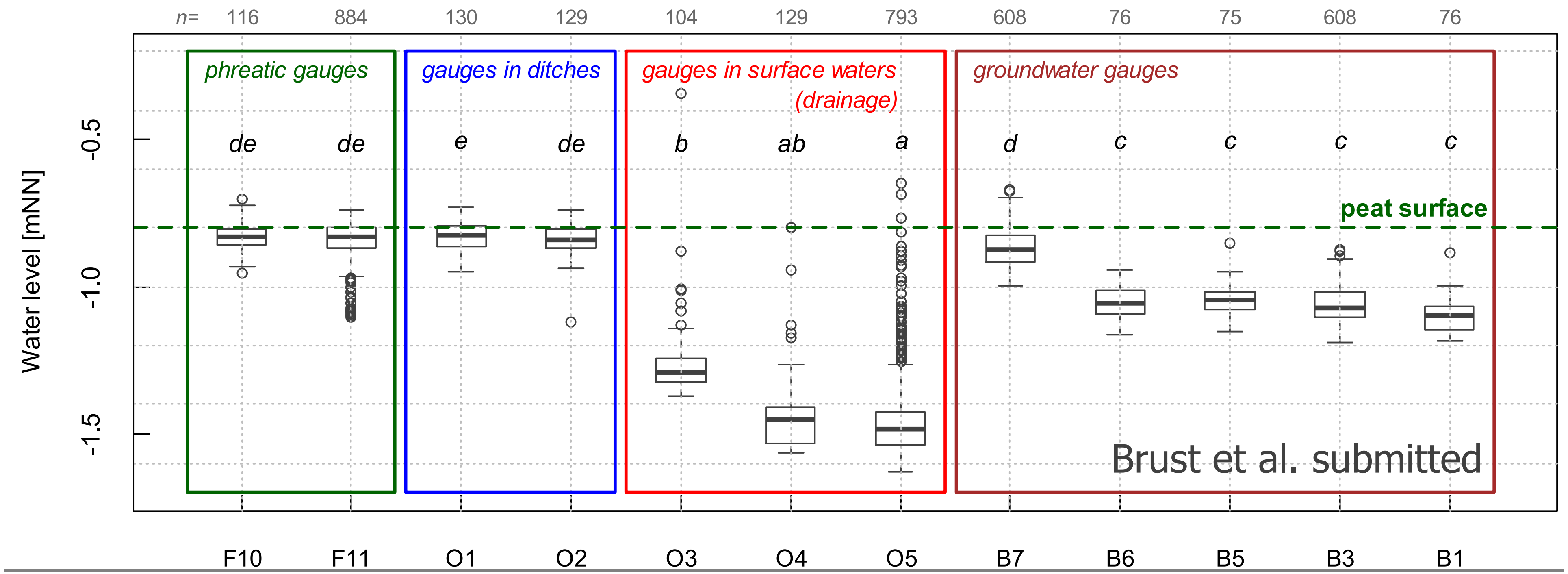
- P at weather station and for long-term simulations station Bremen 1993-2013
- Q_{in} and Q_{out} via surface water in outlet → calculation
- phreatic, surface and ground water level

Modelled:

- ETR modelled via Romanov-Approach, ET from water surface (ditches) via Dalton-approach
- $Q_{seepage}$ via phreatic, surface and groundwater level → modelled with the package Visual MODFLOW
- Δ S modelled with change of water level

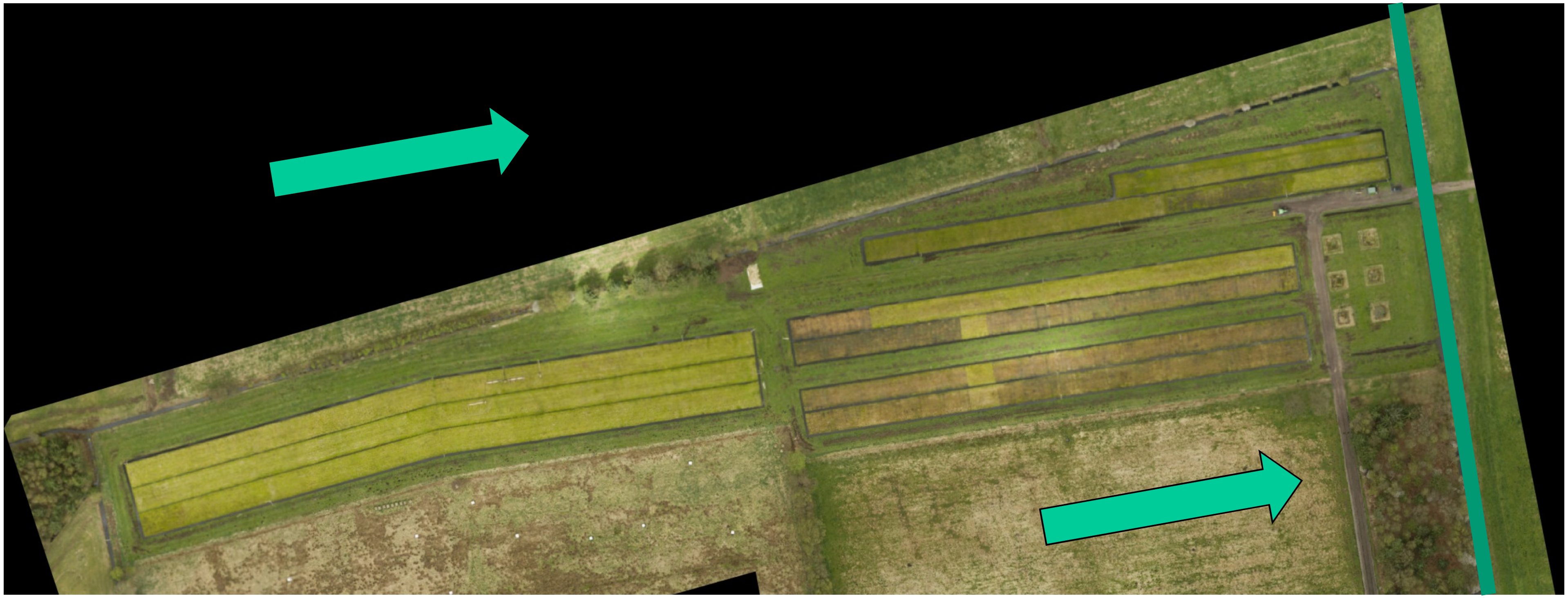
Water levels (August 2011 – October 2013)

- phreatic water levels near peat surface and similar to water levels in the irrigation ditches
- water levels in drainage ditches and Schanze considerably lower
- groundwater level between level of phreatic water and that of drainage ditches



Ground water flow

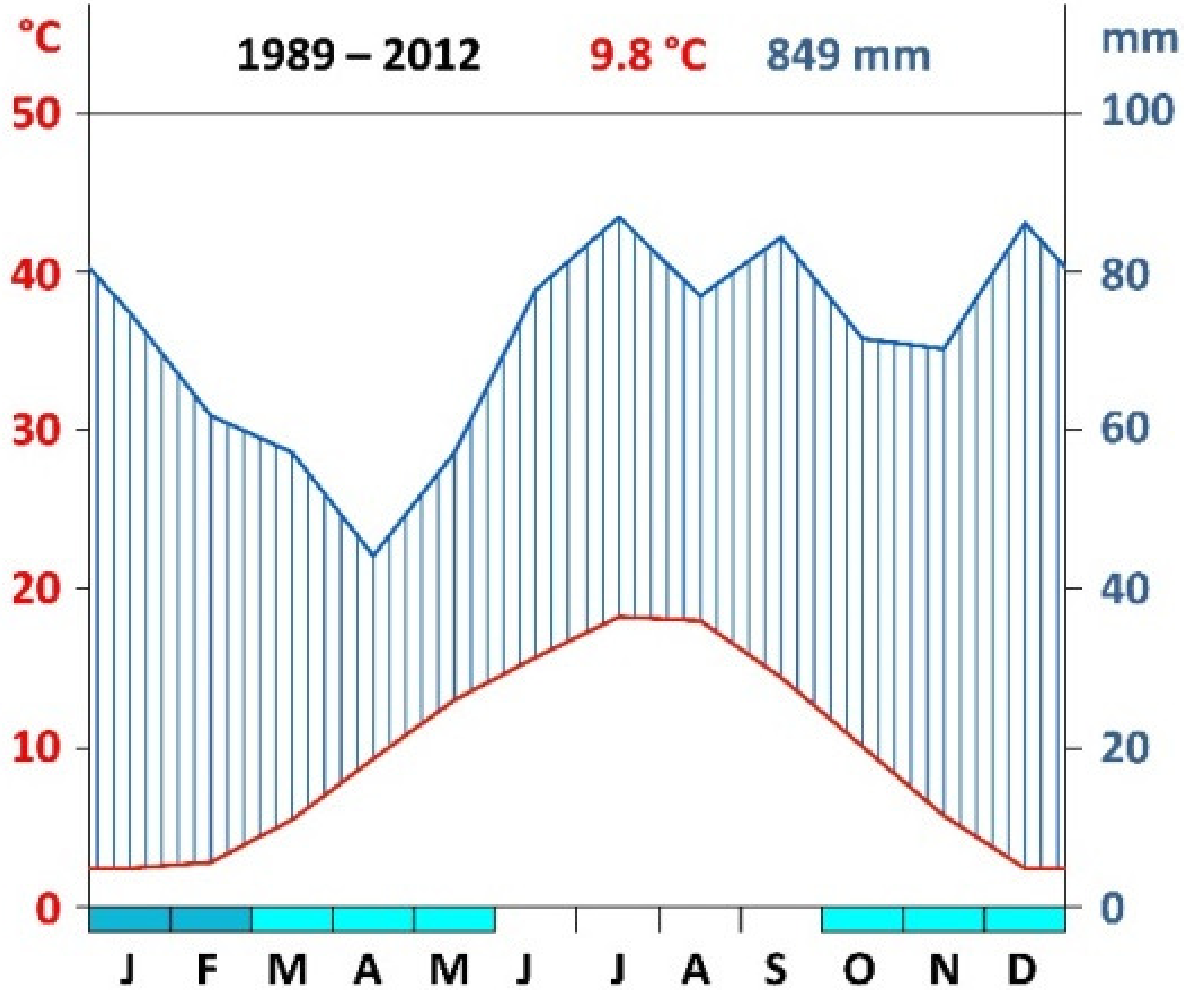
River Schanze



In which periods do excesses and deficits occur?

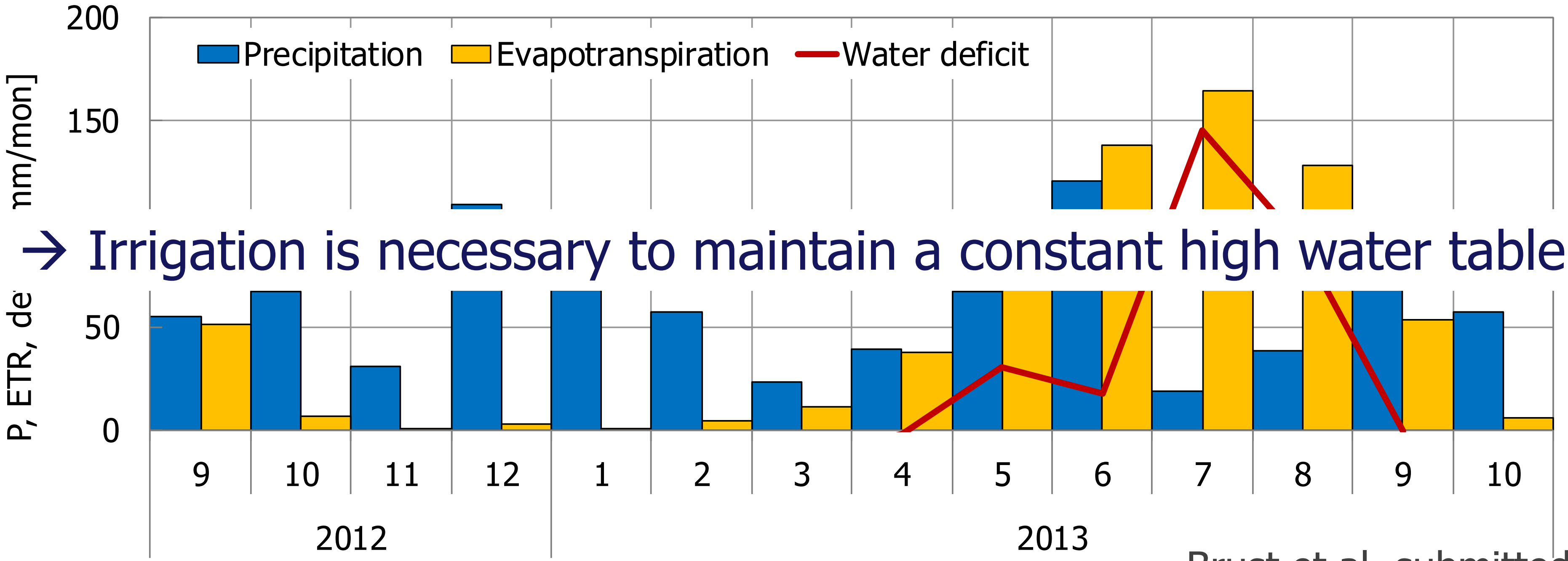
- Driest period in spring

Brust et al. submitted



In which periods do excesses and deficits occur?

- 2013 dry year: 709 mm compared to ø 849 mm yr^{-1}(1989-2013)
- annual cycle of ETR → spring and summer: ETR > P
- winter: ETR < P
- summer: ETR > P, water deficit: 280 mm in summer 2013

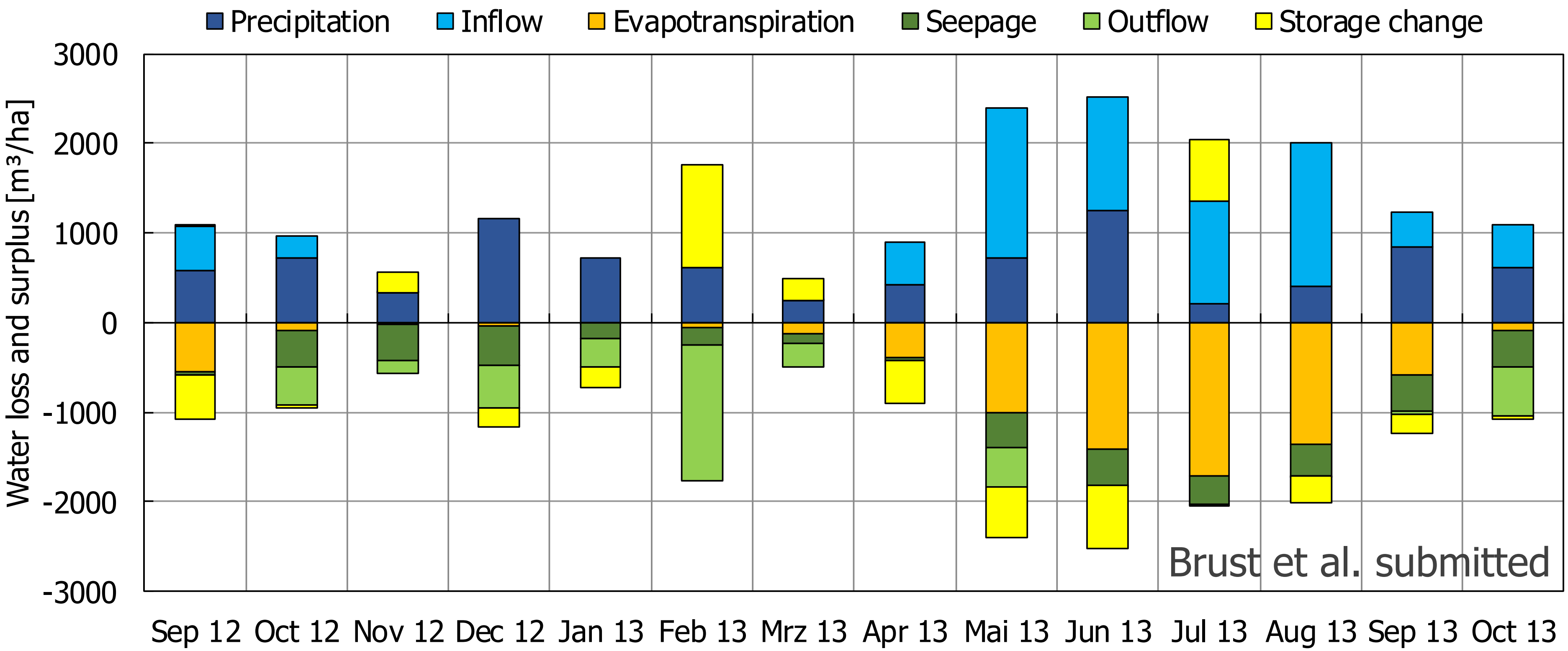


→ Irrigation is necessary to maintain a constant high water table

Brust et al. submitted

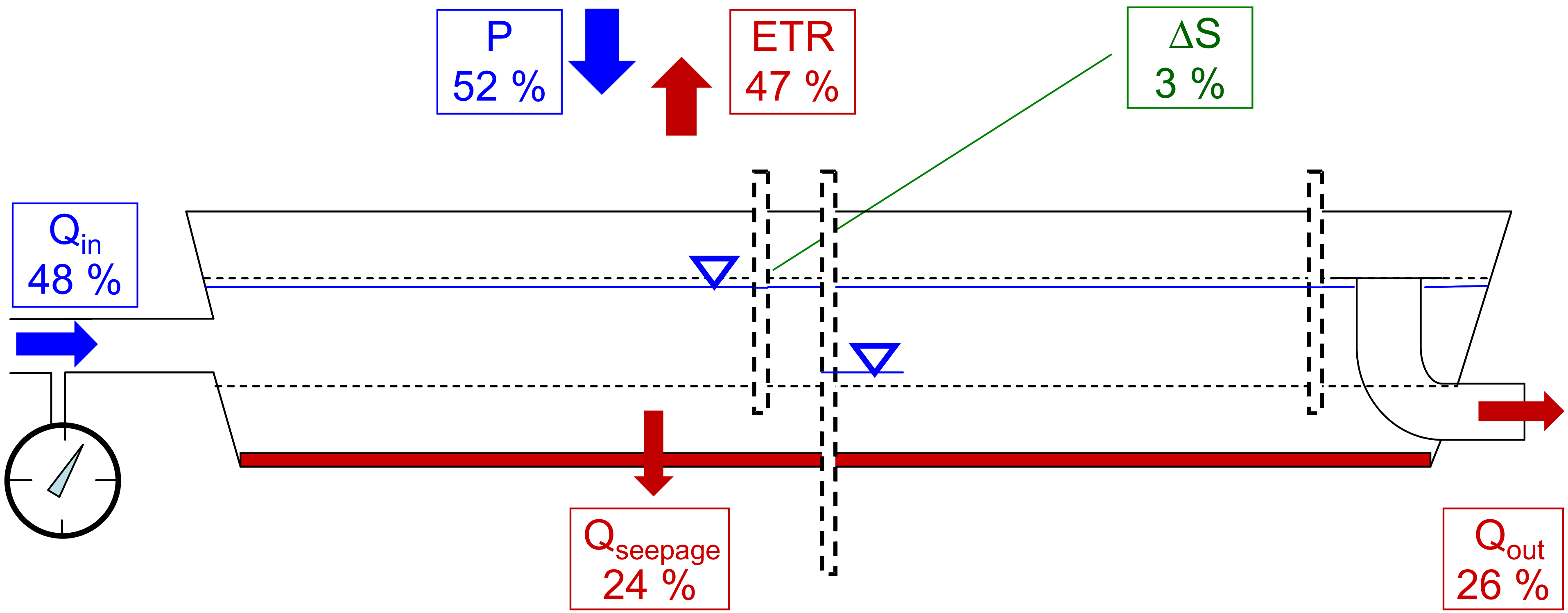
In which periods do excesses and deficits occur?

- annual cycle of ETR → largest impact on water balance
- summer: ETR largest output flux → deficits: compensated with irrigation
- winter: outflow via ditches (water excess)



What are the maion sources of water loss?

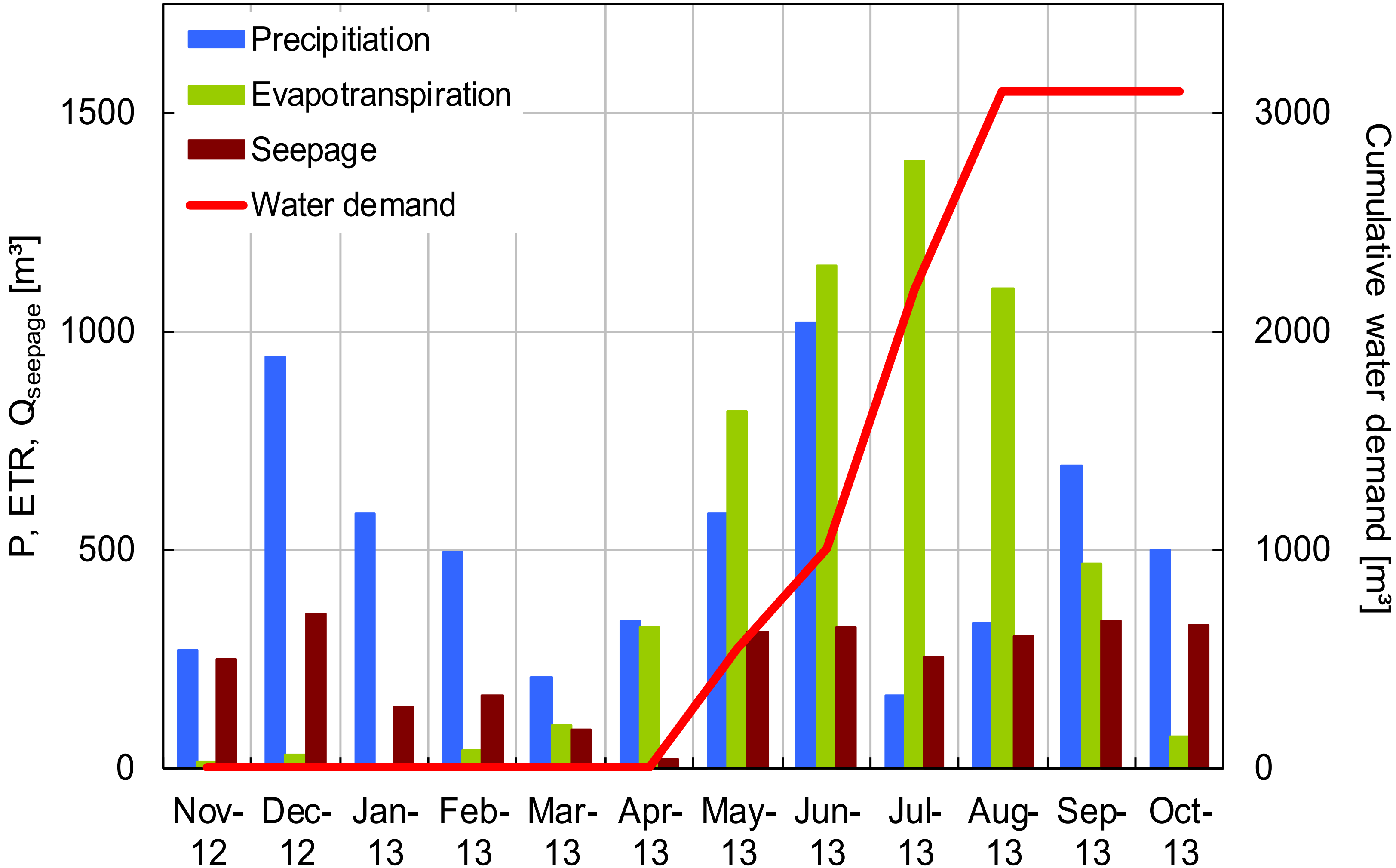
- 47% of incoming water is lost via ETR
- losses by seepage accounted for 24% of the total water losses



Brust et al. submitted

How much water is needed to maintain water table high?

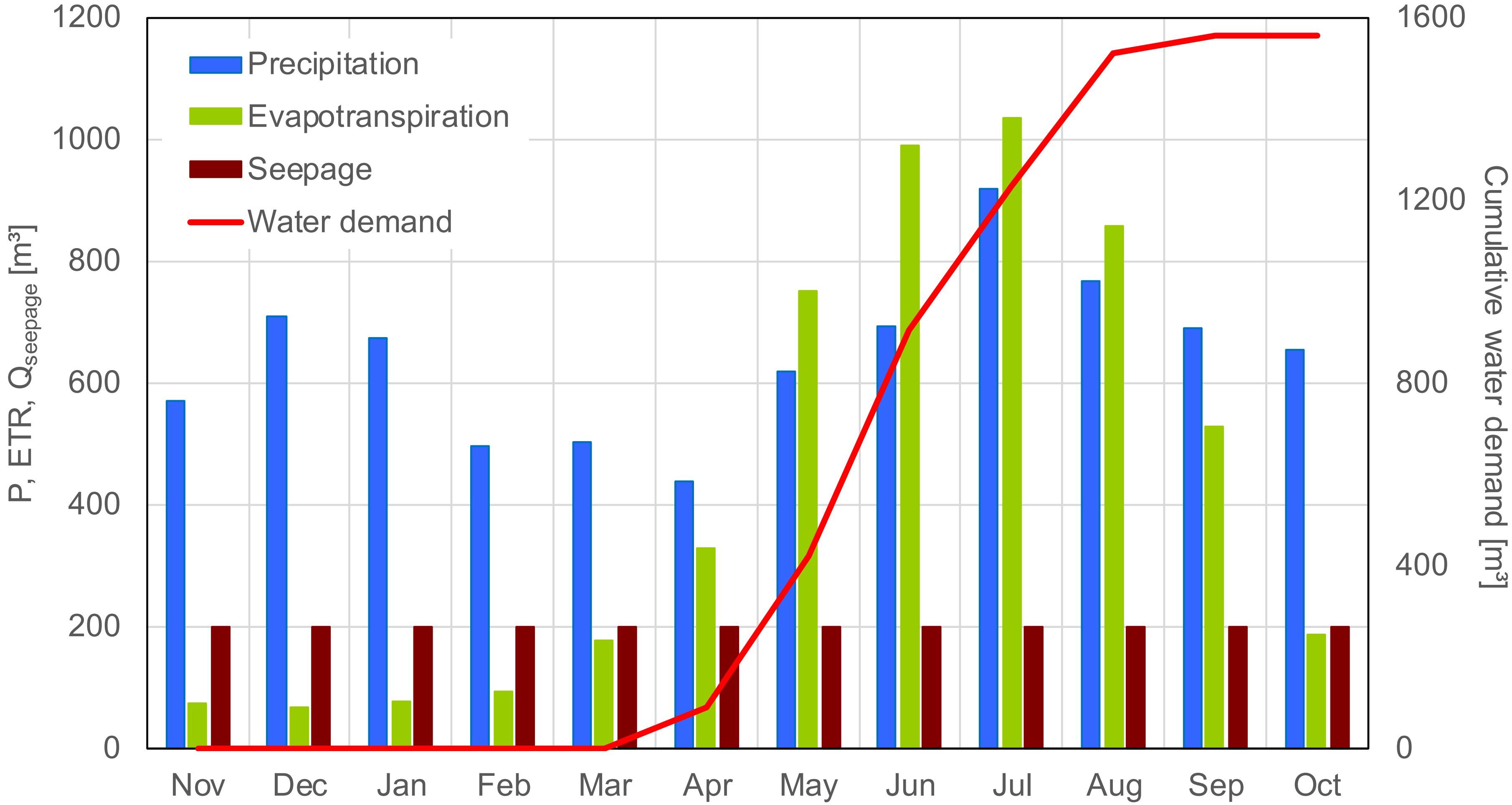
- water demand trial site (8640 m²): 3100 m³ for the hydrological year 2013



Brust et al. submitted

How much water is needed to maintain water table high?

- Long term: mean water demand: 1600 m³/ha and year



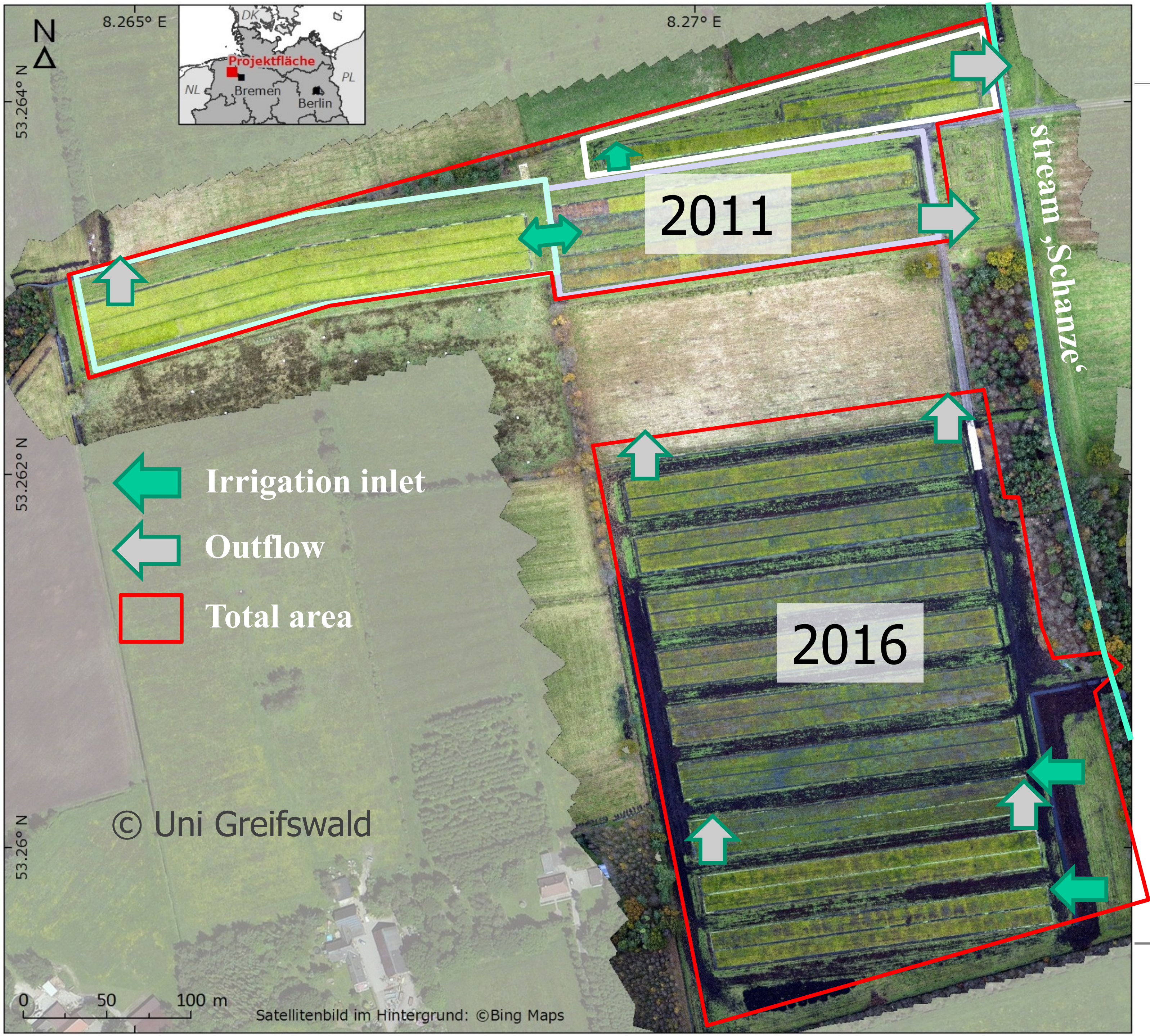
Brust et al. submitted

- ETR high due to the all-year high water table → advection enhances ETR (oasis-effect)
- $Q_{seepage}$ 24% → horizontal fluxes to adjacent drained peatland

→ extra losses could be reduced, if the *Sphagnum* site would be surrounded by wetter areas and/or a larger size of the farming site

- measured Q_{in} overestimated (malfunction of irrigation system in 2013)
- modelled water demand: ~1600 m³ per year and hectare

- Establishment of a Sphagnum farming site on drained bog proved to be successful
- With controlled management the water levels were kept almost constantly close to surface level to ensure optimal growth of *Sphagnum* mosses
- Water demand is high compared to ideal site conditions
- Losses will decrease (lateral seepage, advection → evapotranspiration) with increasing size of the Sphagnum farming site
- Approach to assess necessary irrigation volumes is transferable to other sites when considering site-specific characteristics



8.265° E
8.27° E
N
53.264° N
53.262° N
53.26° N
DK
Projektfläche
NL
Bremen
Berlin
PL
2011
2016
stream ‚Schanze'
Irrigation inlet
Outflow
Total area
© Uni Greifswald
0
50
100 m
Satellitenbild im Hintergrund: ©Bing Maps


Thanks for your attention!
...questions?