A comparison of evapotranspiration rates for willow and reed in a riverine fen

First measurement results

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financed by:

HEINRICH BÖLL STIFTUNG

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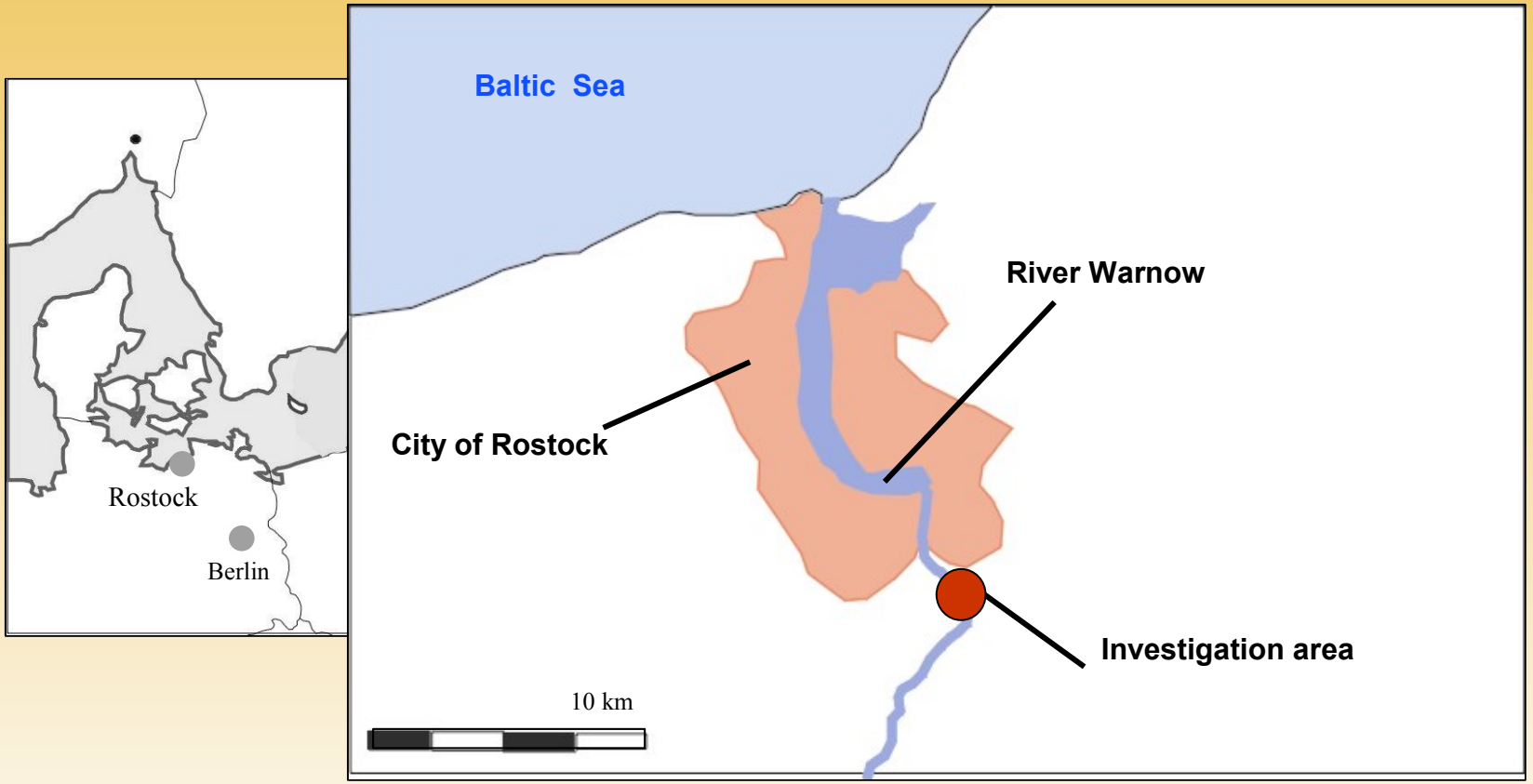
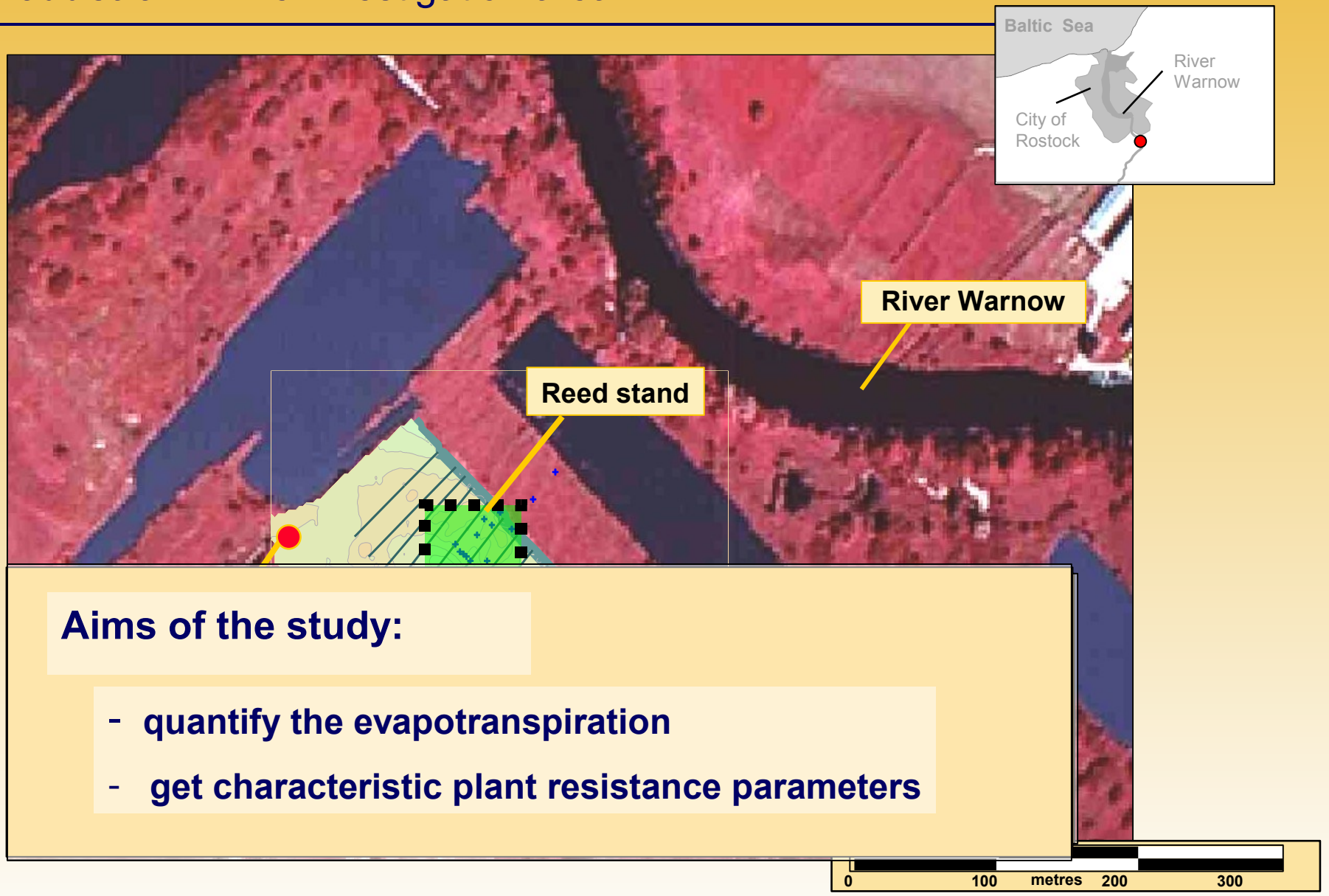
Situation of the area



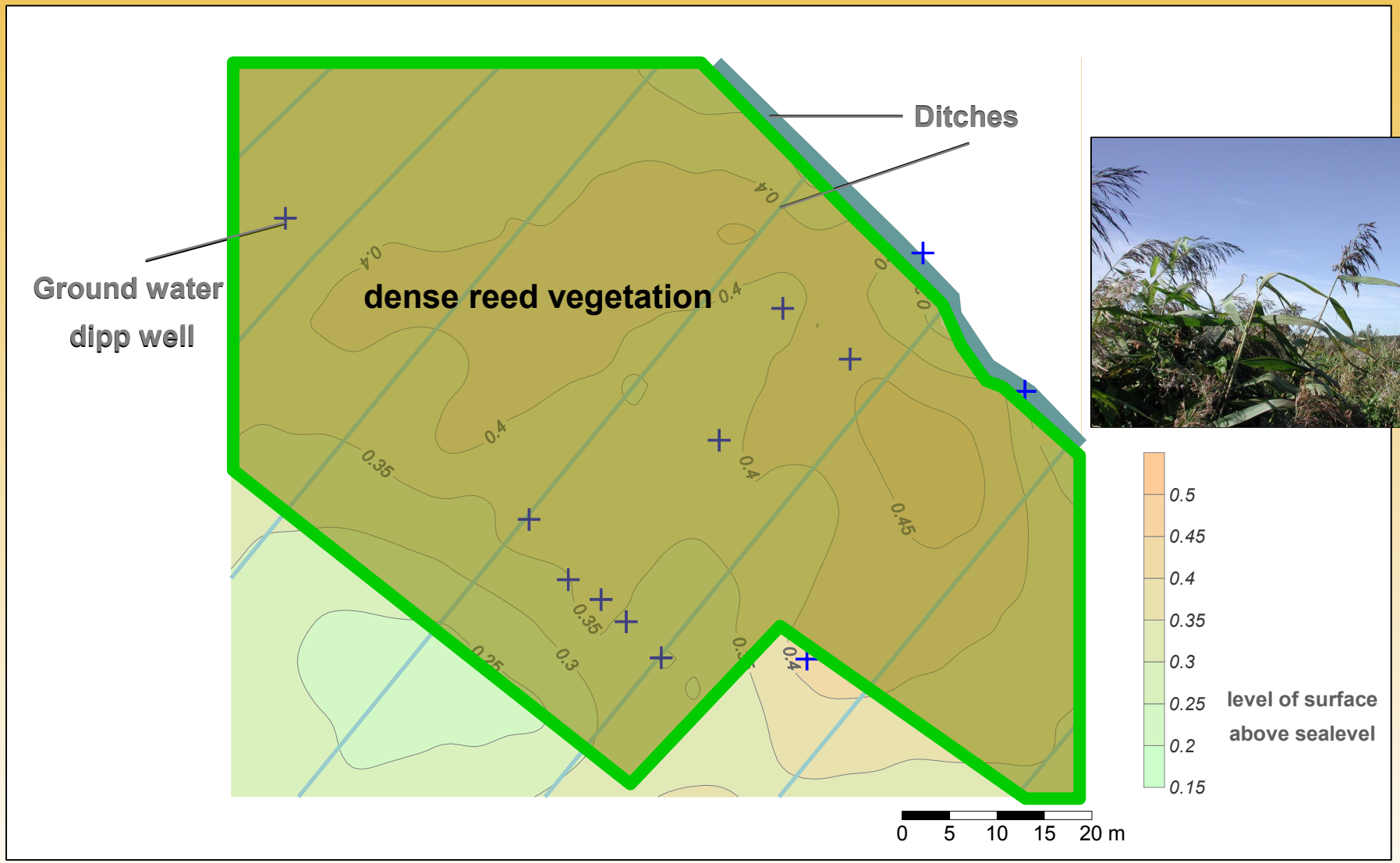
Introduction – The investigation area



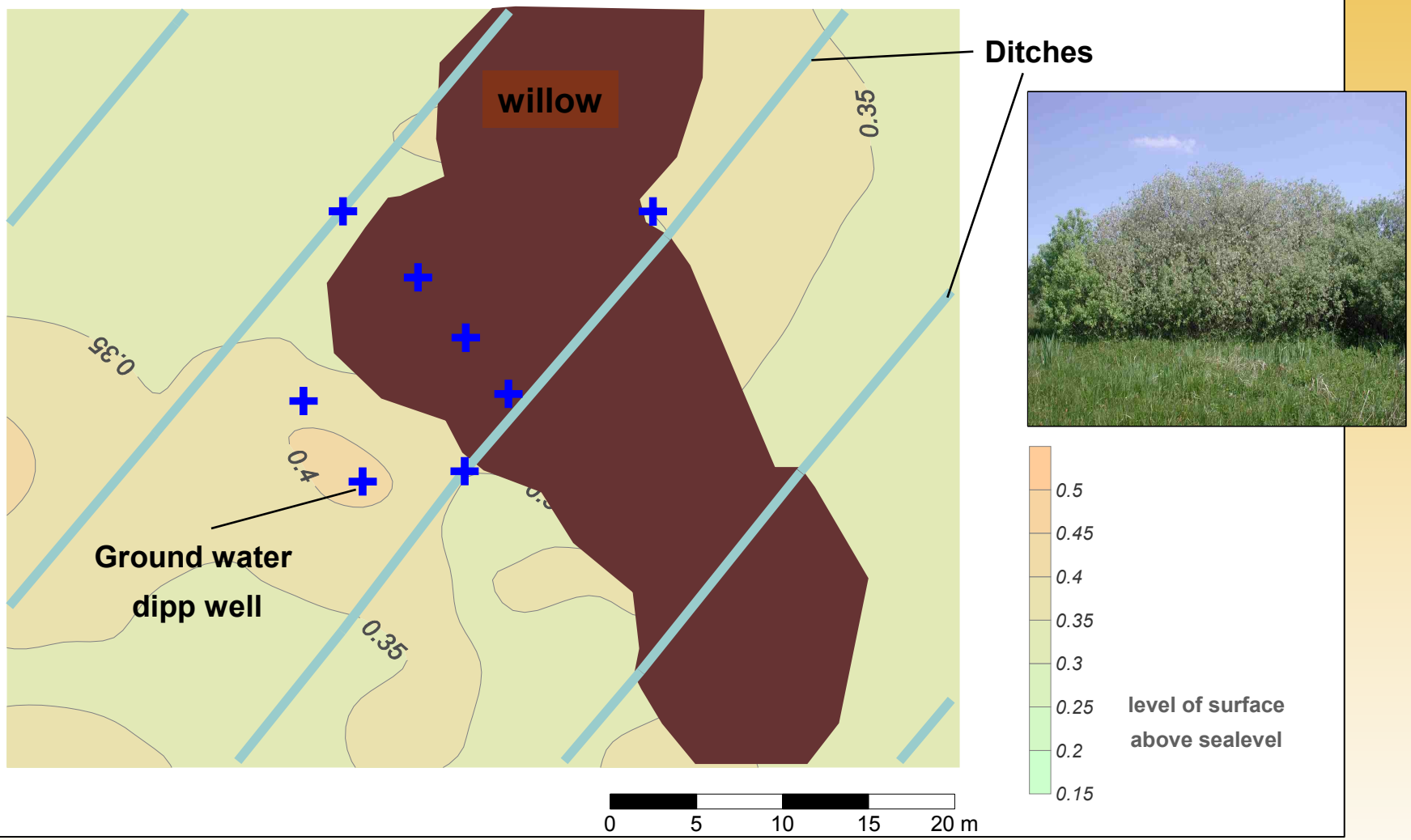
Aims of the study:

- quantify the evapotranspiration
- get characteristic plant resistance parameters

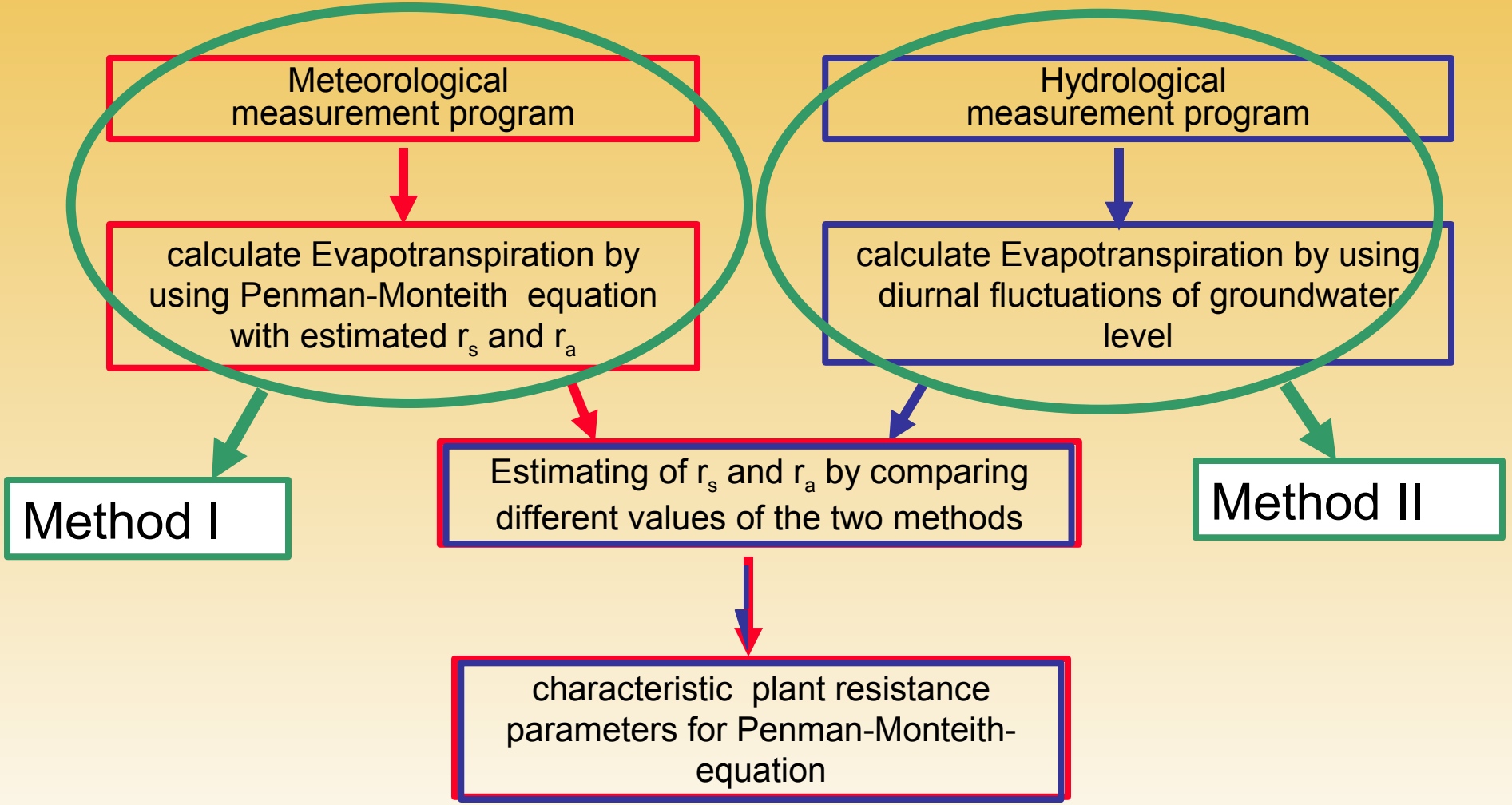
The reed stand



The willow stand



Method


Meteorological measurement program
calculate Evapotranspiration by using Penman-Monteith equation with estimated r_s and r_a
Hydrological measurement program
calculate Evapotranspiration by using diurnal fluctuations of groundwater level
Method I
Estimating of r_s and r_a by comparing different values of the two methods
Method II
characteristic plant resistance parameters for Penman-Monteith-equation

Method I – Meteorological measurement program

Penman - Monteith - equation

$$ETa = \frac{1}{L^*} \times \frac{s \times (Rn - G) + \frac{\rho \times c_p}{r_a} \times (e_s(T) - e)}{s + \gamma \times \left(1 + \frac{r_s}{r_a}\right)}$$

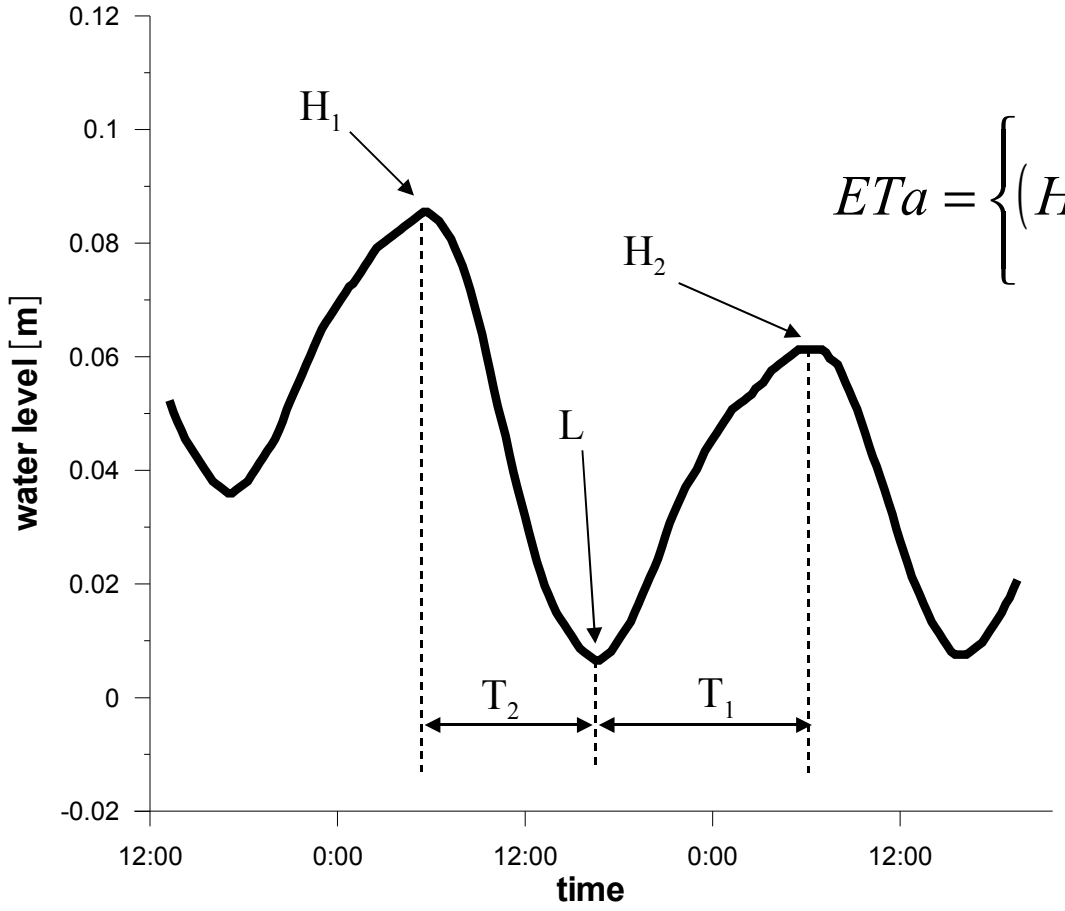
- **constant factors :** air density ρ, specific heat of the air c_p, psychrometric constant γ

- **meteorological variables** ➔ measured

- **botanic/meteorological variables** ➔ estimated parameters for reed and willow

Method II – Hydrological measurement program

Using of ***diurnal ground water level fluctuation*** to calculate the daily evapotranspiration rate



$$ETa = \left\{ \left(H_1 - L \right) + \left[\left(H_2 - L \right) \cdot \frac{T_1}{T_2} \right] \right\} \cdot S$$

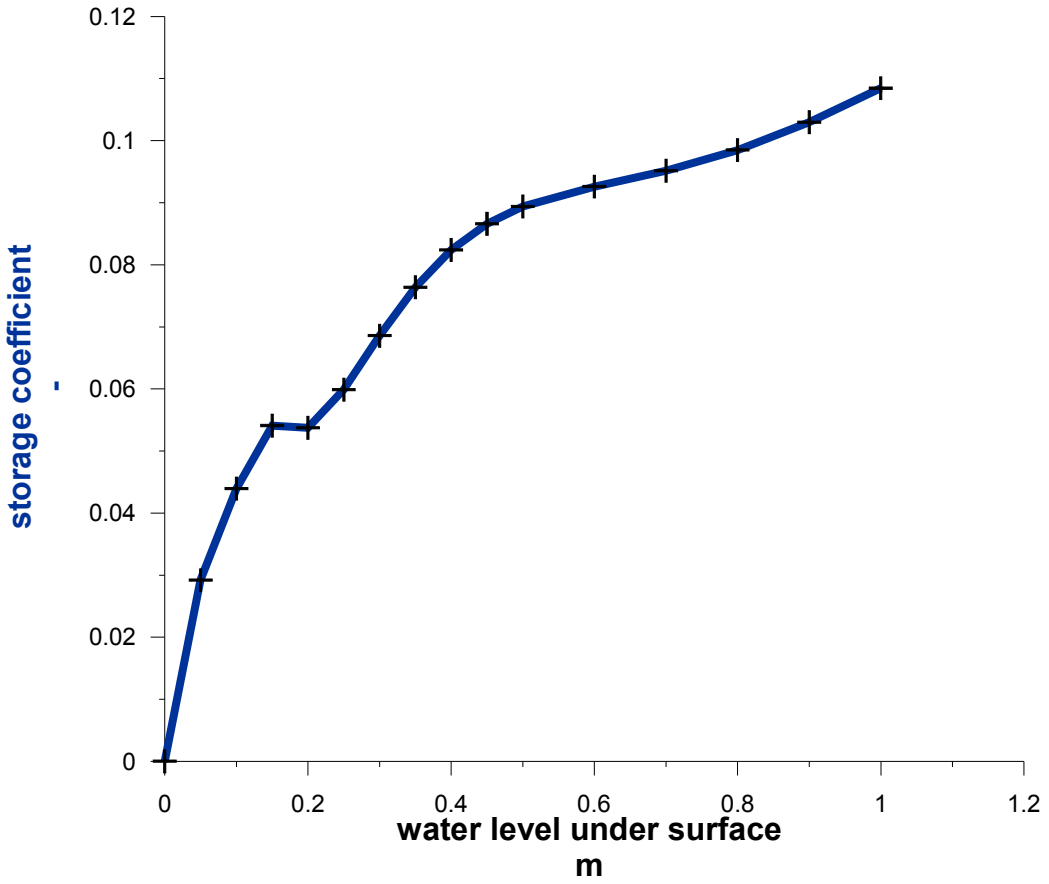
„Draw down recharge method“

(Hays, 2003)

S **= storage coefficient**

Storage coefficient function

The storage coefficient – a ***non constant*** value



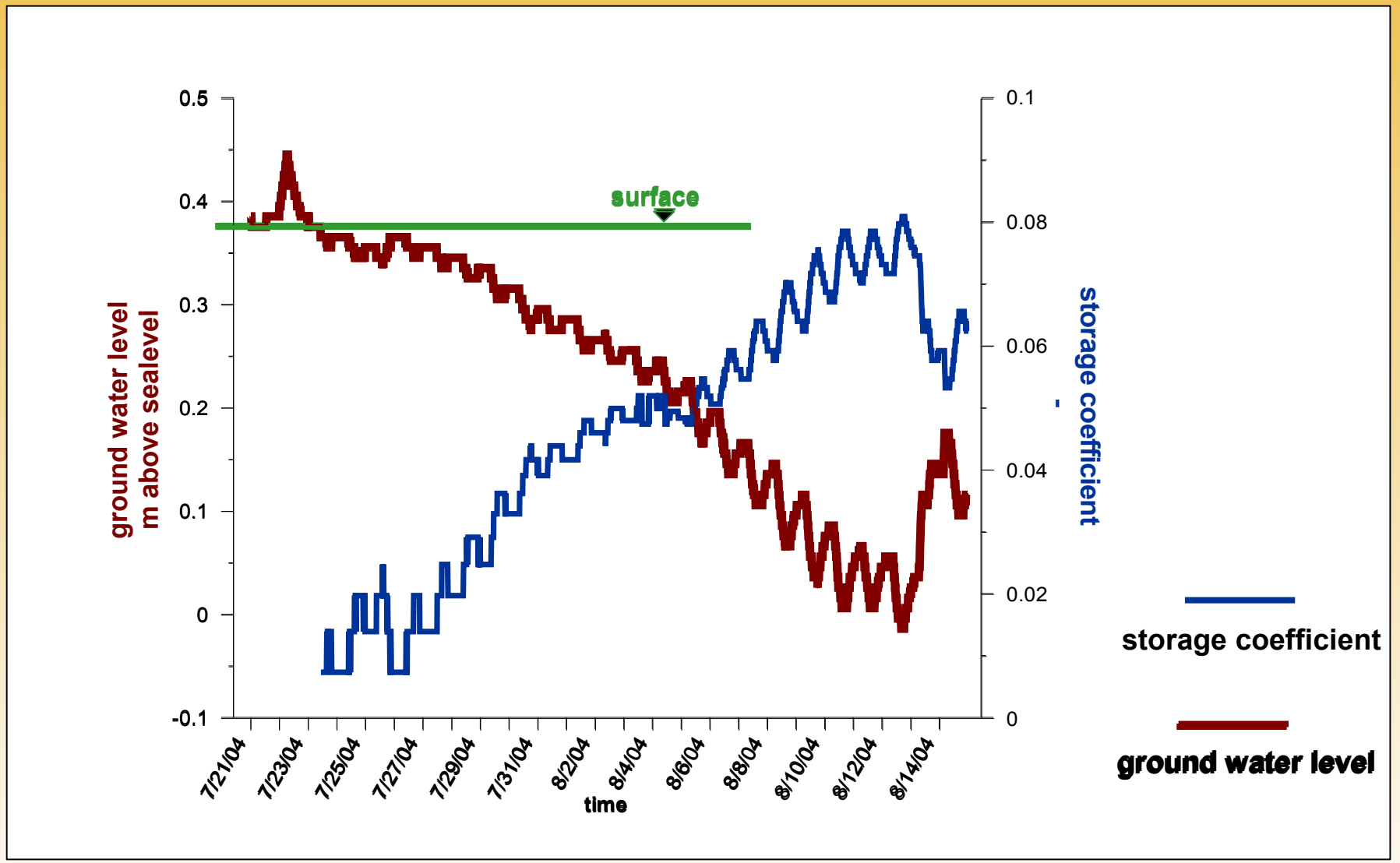
water level under surface (m)	storage coefficient (-)
0.00	0.000
0.05	0.029
0.10	0.044
0.15	0.054
0.20	0.054
0.25	0.060
0.30	0.069
0.35	0.076
0.40	0.082
0.45	0.087
0.50	0.089
0.60	0.093
0.70	0.095
0.80	0.098
0.90	0.103
1.00	0.108

(Trübger 2005)

Including:

- **dual porosity** (based on Durner, 1994)
- **Van Genuchten parameters**

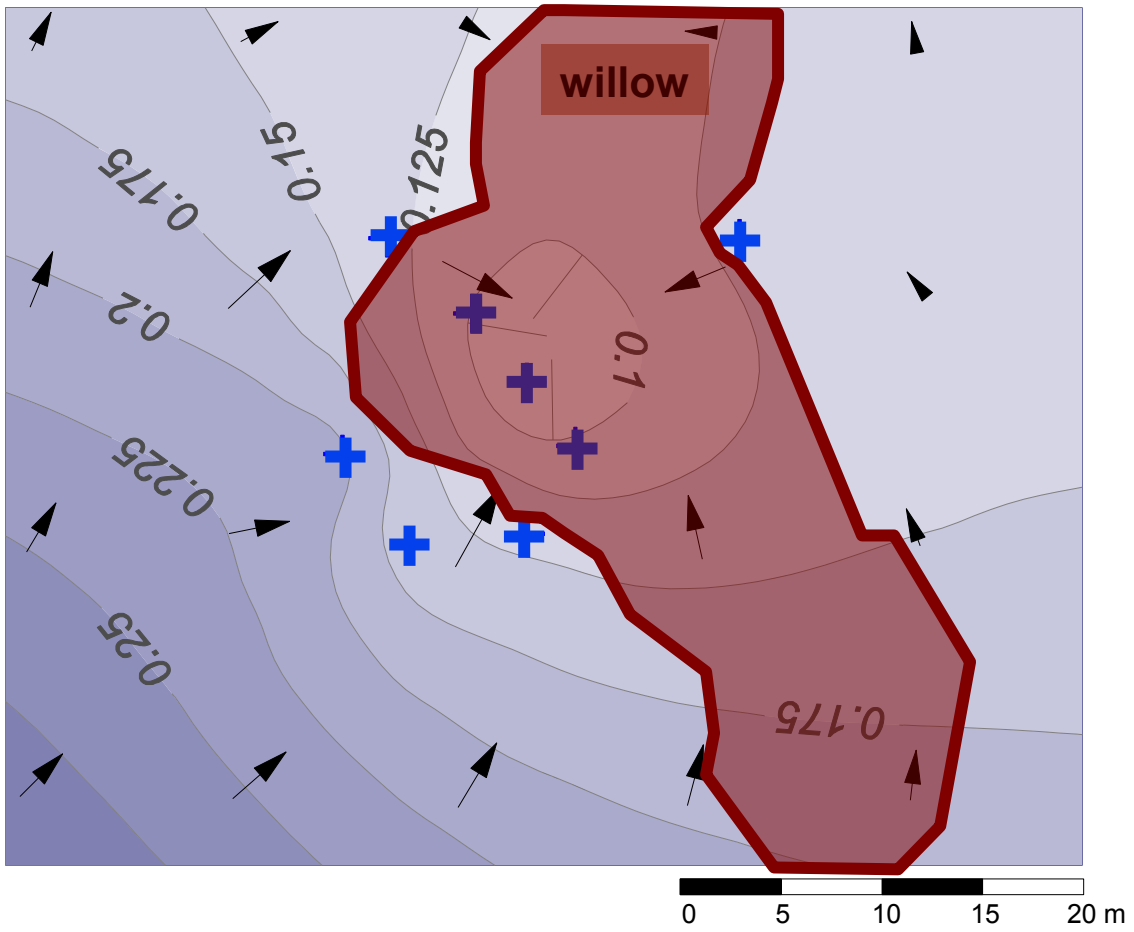
An application of the storage coefficient function



Results – The hydrologic situation on 09.08.2004

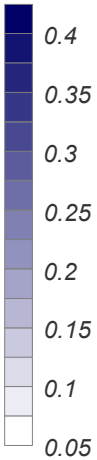
- at the willow stand

➔ cone of depression of groundwater
no significant groundwater flow direction
to the central willow



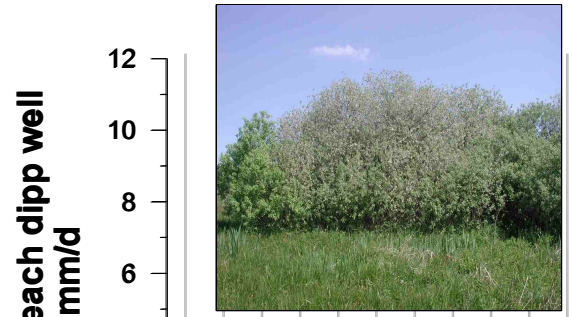
ground water dipp well

flow direction



ground water level
m above sealevel

Results – The Draw down recharge method – at the *willow* stand



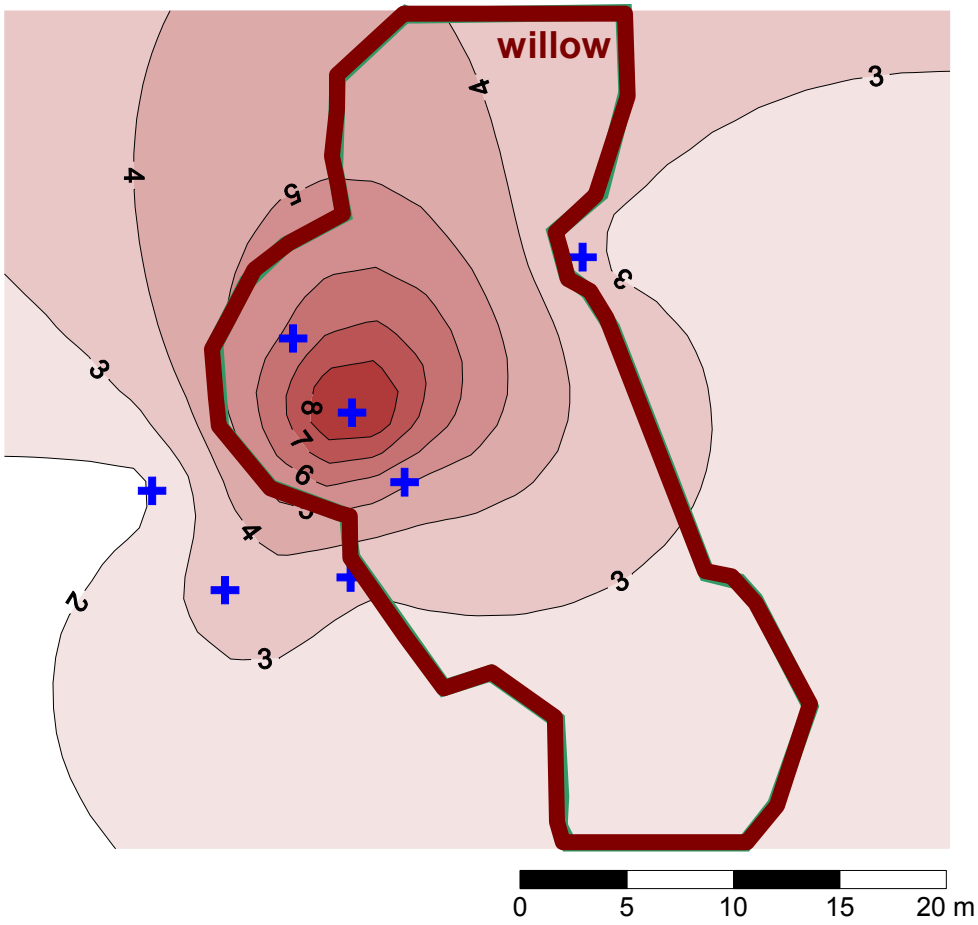
evapotranspiration-rates from wells **beneath** the willow

evapotranspiration-rates from wells **outside** the willow

ground water level - an example of the willow stand

Results – The Draw down recharge method – at the *willow* stand

➔ maximum Eta in the central willow



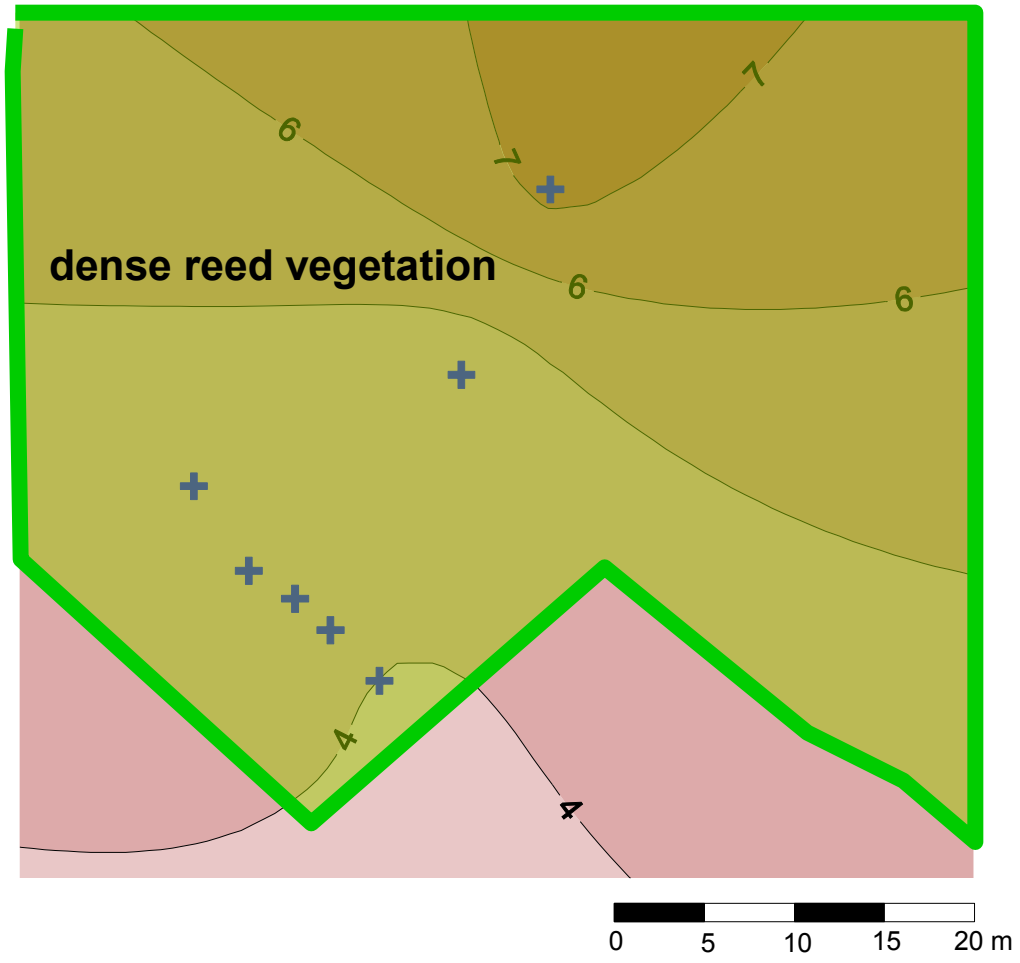
ground water dipp well

9
8
7
6
5
4
3
2
1

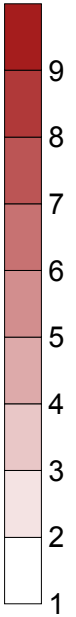
evapotranspirationrates
mm/d

Results – The Draw down recharge method – at the *reed* stand

➔ uniform distribution of Eta at the reed stand

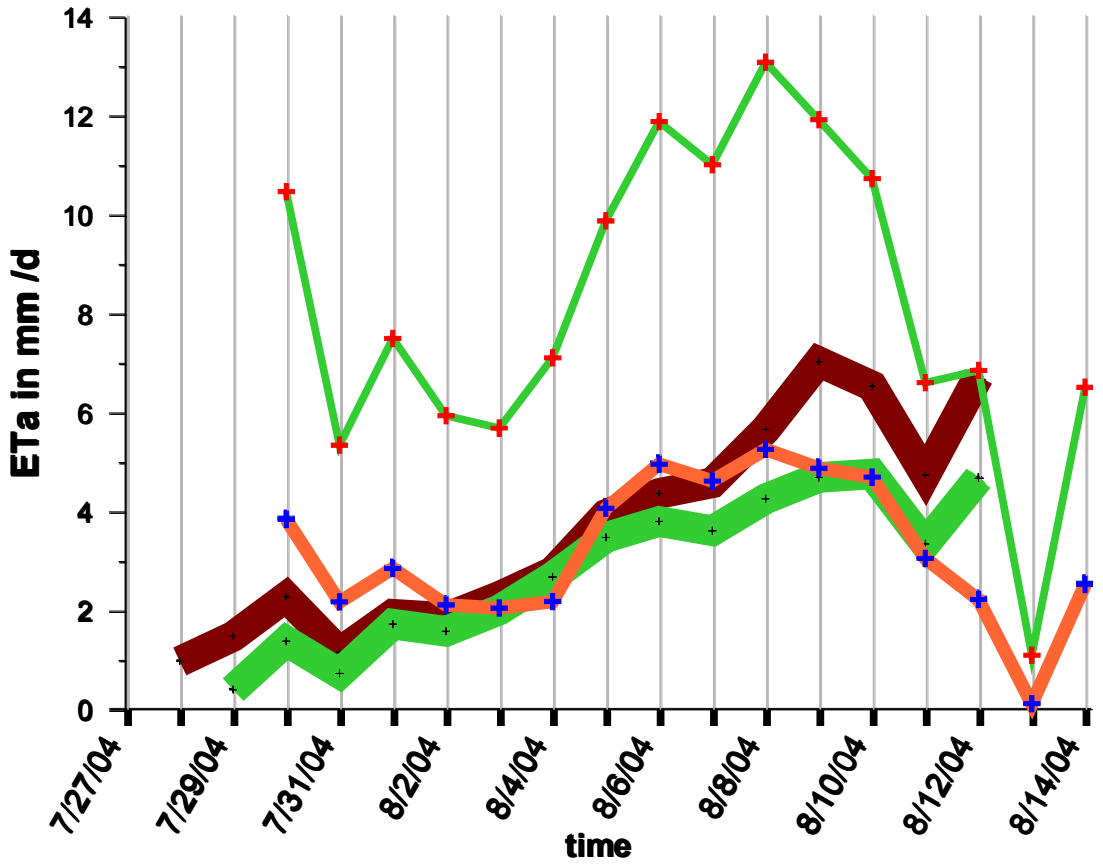


ground water dipp well



evapotranspirationrates mm/d

Results – A comparison



Penman – Monteith:

Eta - willow

Eta - reed

Draw down recharge Method:

Eta - willow

Eta - reed

Final remarks

- **this estimation shows differences between the Eta rates for willow and reed in the following areas (based on diurnal ground water fluctuations):**

  ➔ cone of depression of ground water beneath the willow

  ➔ the area distribution of Eta at the two stands

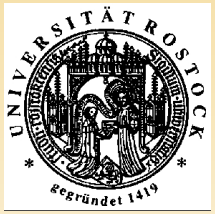
  ➔ max Eta $_{willow}$ = 10,0 mm/d - max Eta $_{reed}$ = 7,0 mm/d

  cf. previous literature: 8,8 to 10,0 mm/d 7,0 to 10,0 mm/d

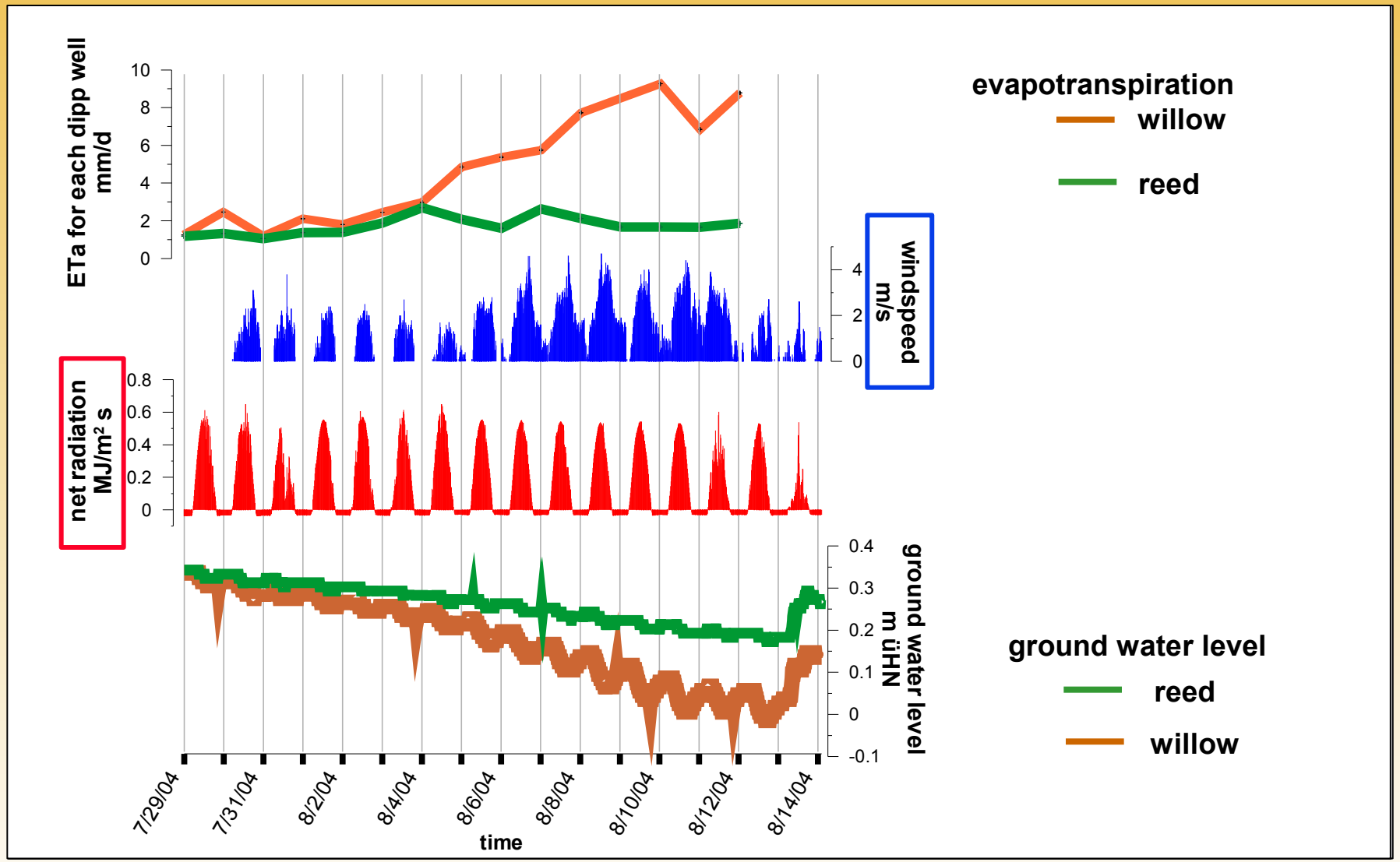
- **the using of Penman-Monteith equation with plant resistance factors should be used with caution**

- **Eta could be calculated more simply and more accurately by using diurnal ground water fluctuations**

Thank You for
Your attention



The „oasis-effect“



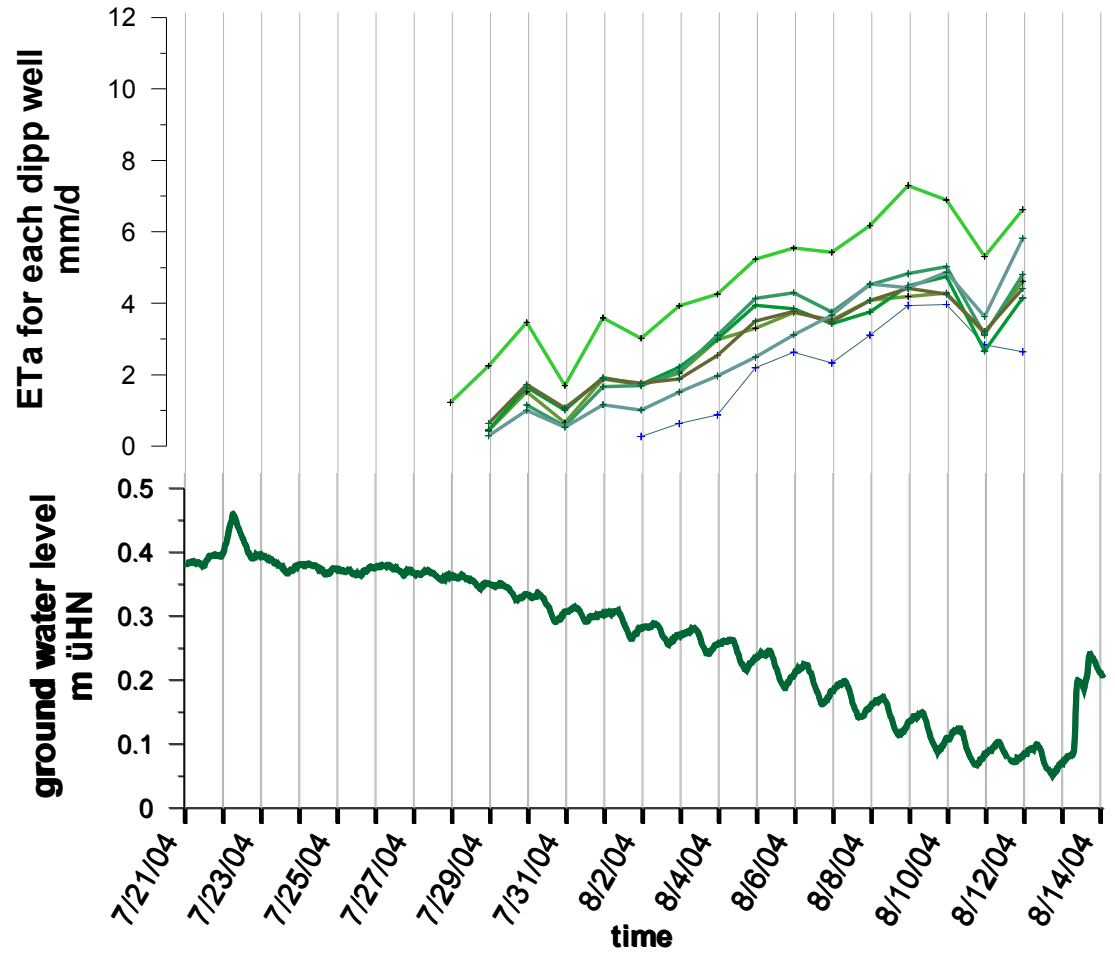
Method II - Hydrological measurement program

The willow site

View to the willow stand

Groundwater dip well

Results – The Draw down recharge method – at the *reed* stand



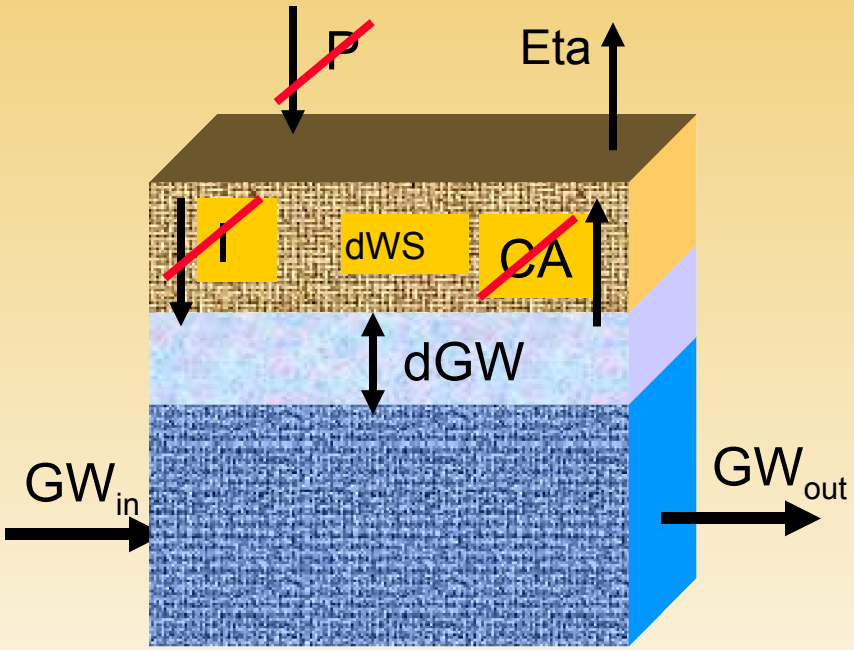
Evapotranspiration-rates from all wells at the reed stand

Ground water level - an example of the reed stand

Method II – Hydrological measurement program

accounting equation:

$$Eta = \cancel{P} + \cancel{I} - \cancel{CA} - dWS - dGw + (GW_{in} - GW_{out})$$



P - precipitation

I - influent seepage

CA - capillary action

dWS - Water storage

dGW – ground water fluctuation

GWin - inflow GW

GWout - outflow GW

$$Ea = dGW$$