Impact of soil properties on plant community composition in riparian forests near Bratislava
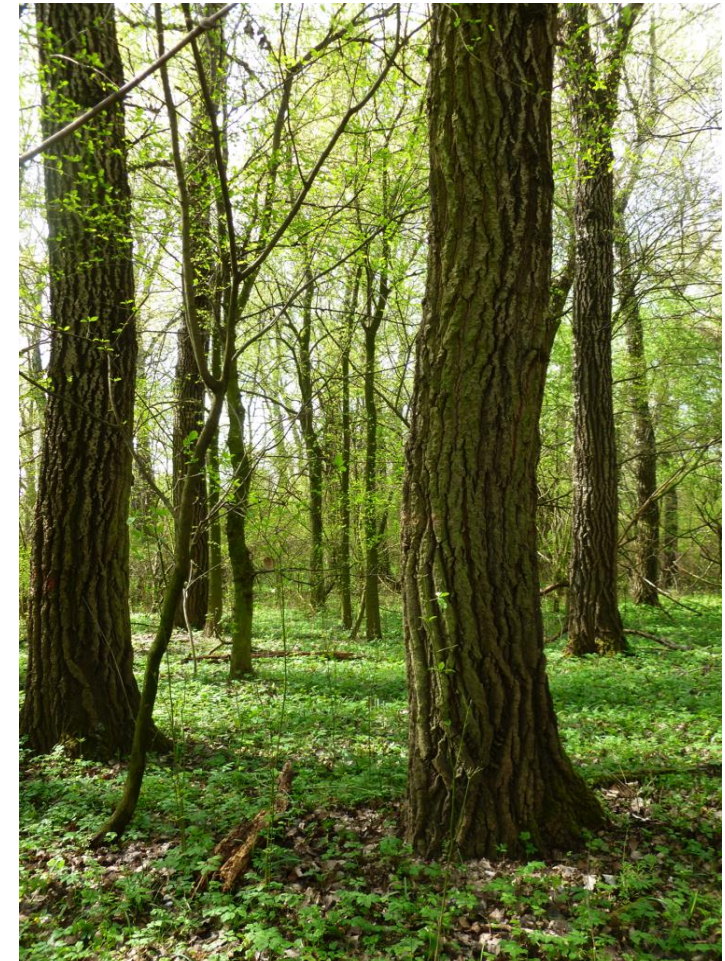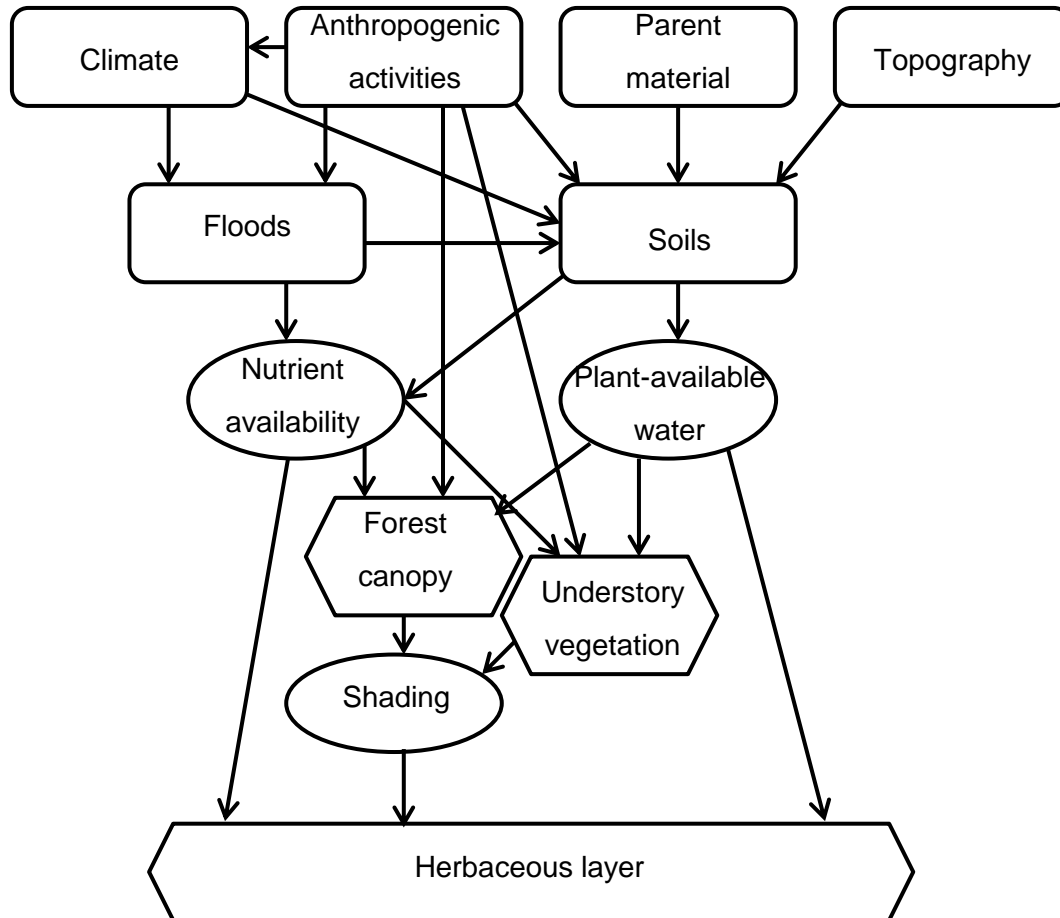
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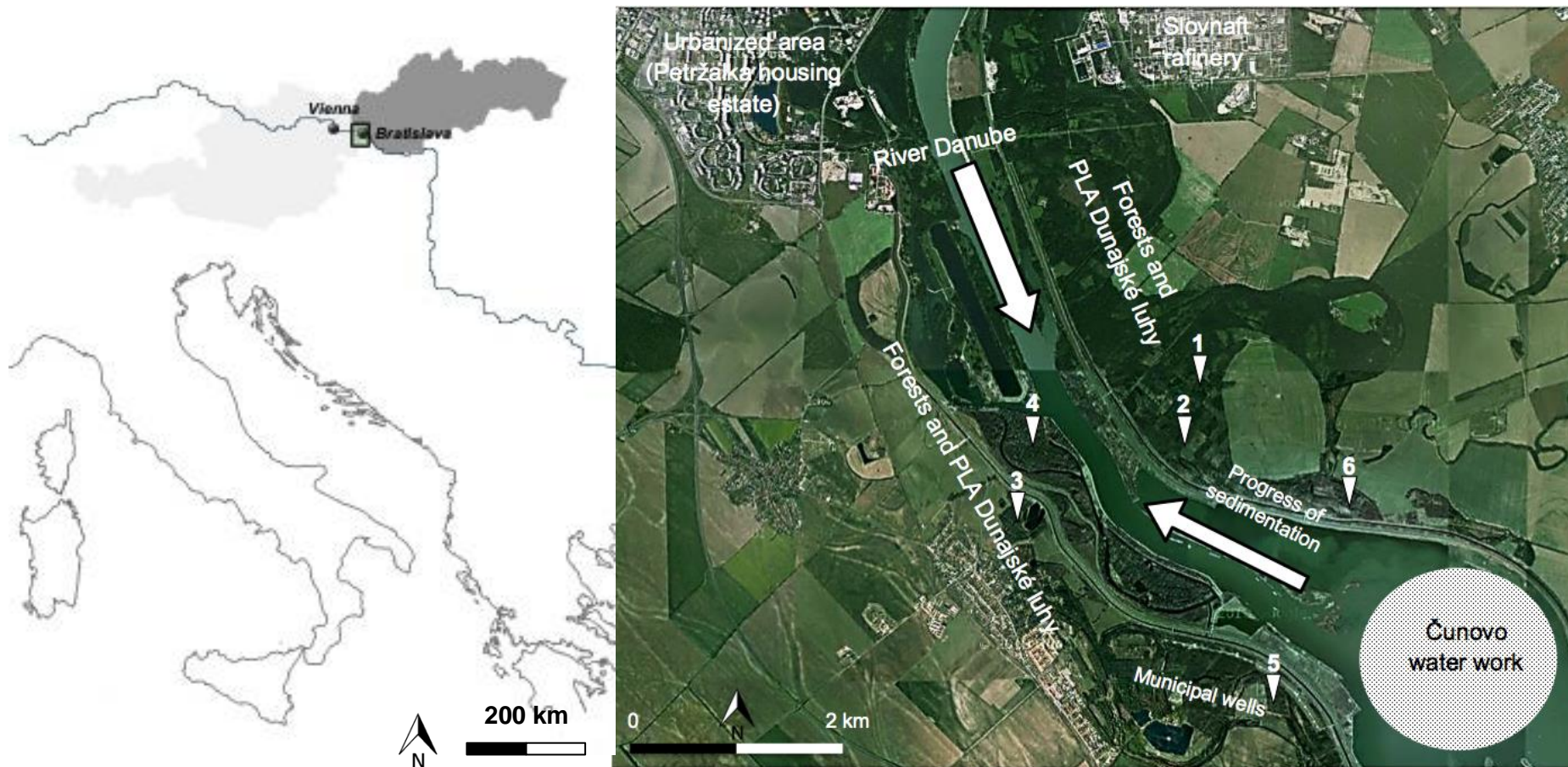# Riparian soft-woods in a dynamic environment

Rational

Fluvisols downstream of Bratislava developed under different sedimentation conditions. The local variation in soil properties is caused by

- the construction of floodprotection dikes, hydropower plants and the channelization of the River Danube in the past centuries,
- topography,
- duration of pedogenesis as well as
- anthropogenic influences like groundwater use, sediment removal, forest management etc.

» abiotic and biotic factors influence soil properties and the vegetation cover
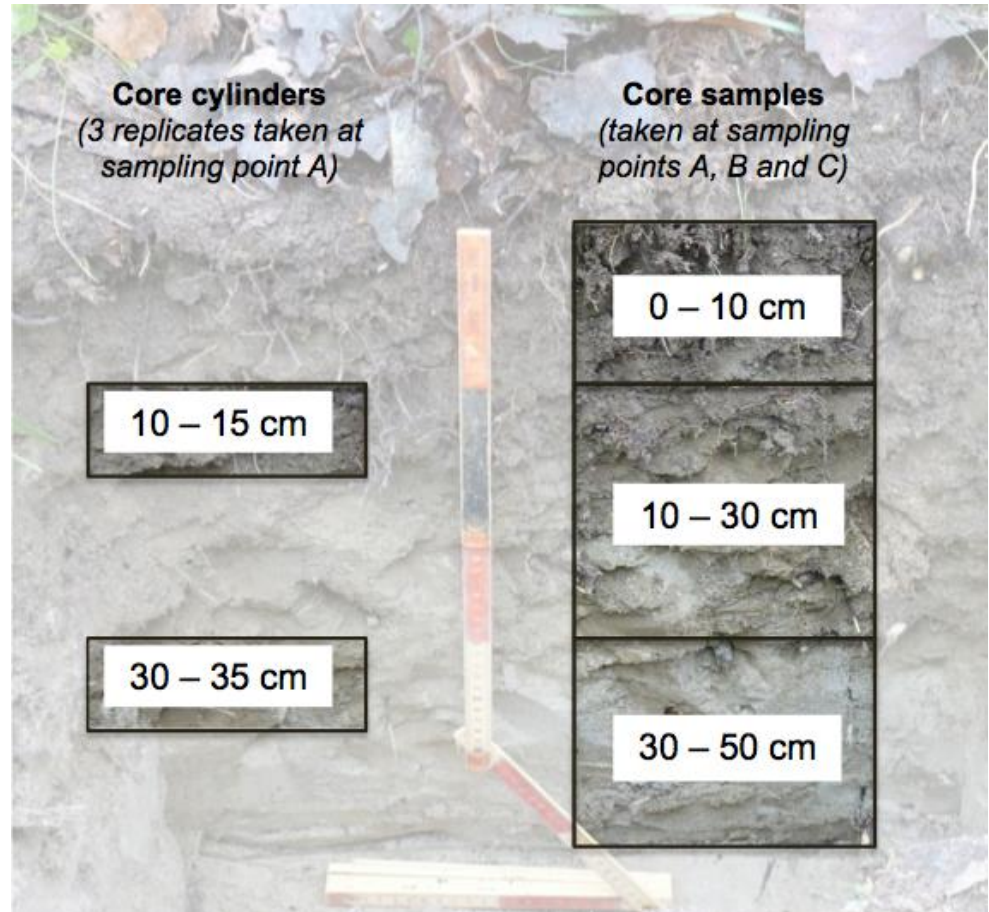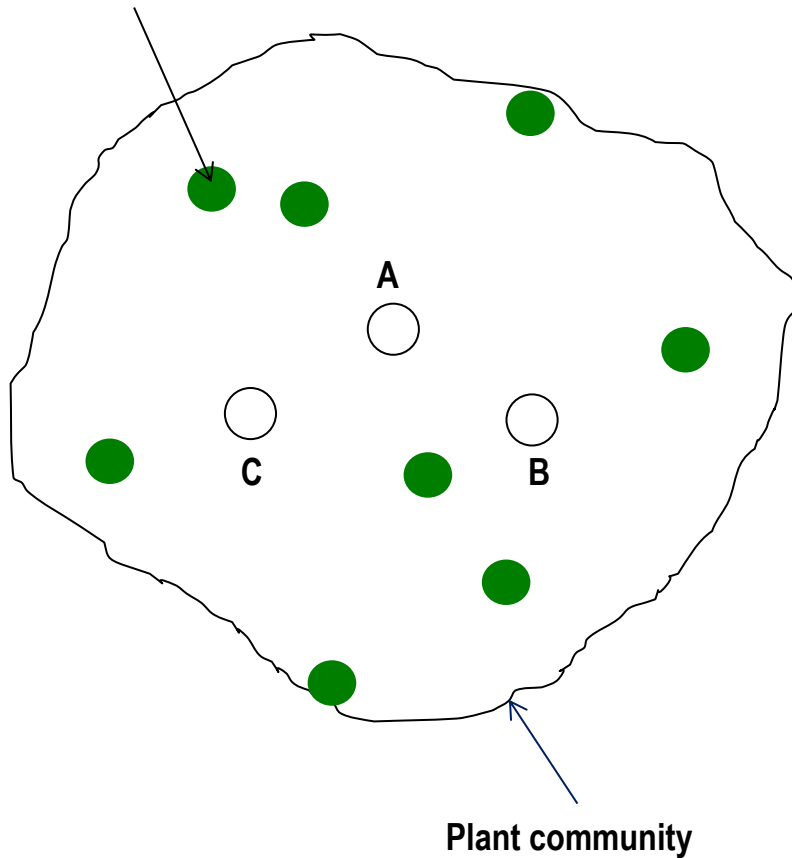
→ Which abiotic factors influence plant species composition of the herbaceous layer the most?

Study Area

Sampling design

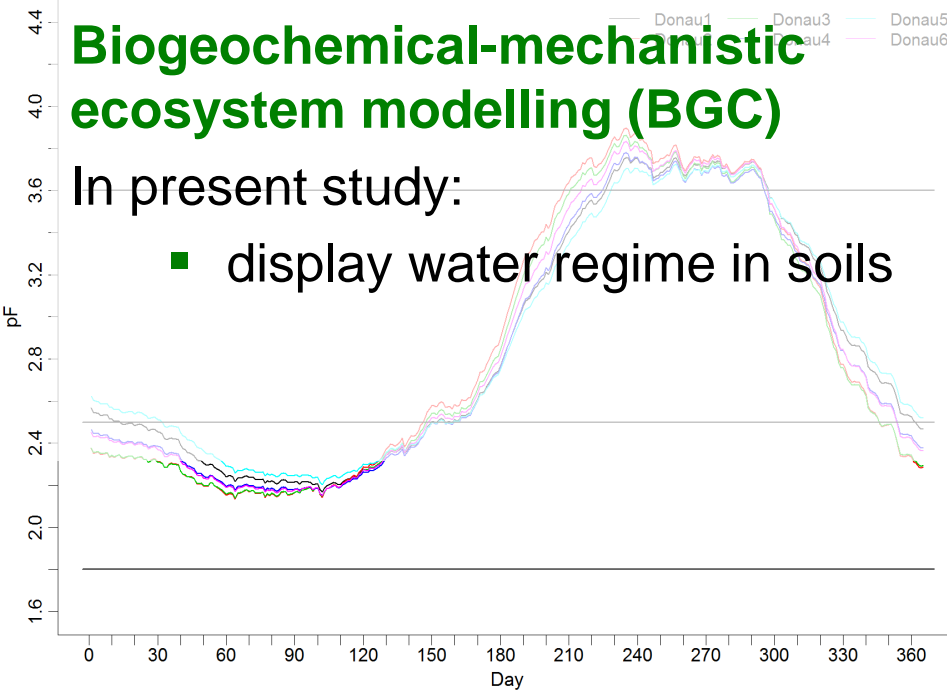**Populus alba of similar tree age and tree density**

A

C   B

Plant community

Core cylinders
(3 replicates taken at sampling point A)

10 – 15 cm

30 – 35 cm

Core samples
(taken at sampling points A, B and C)

0 – 10 cm

10 – 30 cm

30 – 50 cm

Chemical Analyses

Determination of

- soil acidity
- carbonate
- P and K (CAL method)
- soluble anions

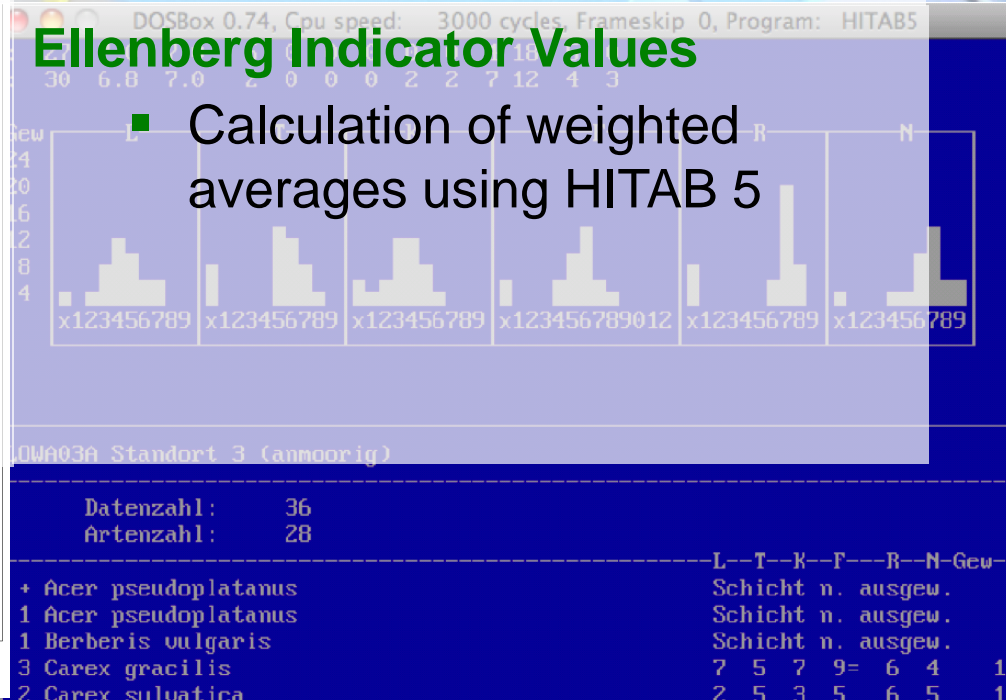**Physical Analyses**

Determination of

- bulk density
- particle size distribution
- pore size distribution
- water retention characteristics

Biogeochemical-mechanistic ecosystem modelling (BGC)

In present study:

- display water regime in soils
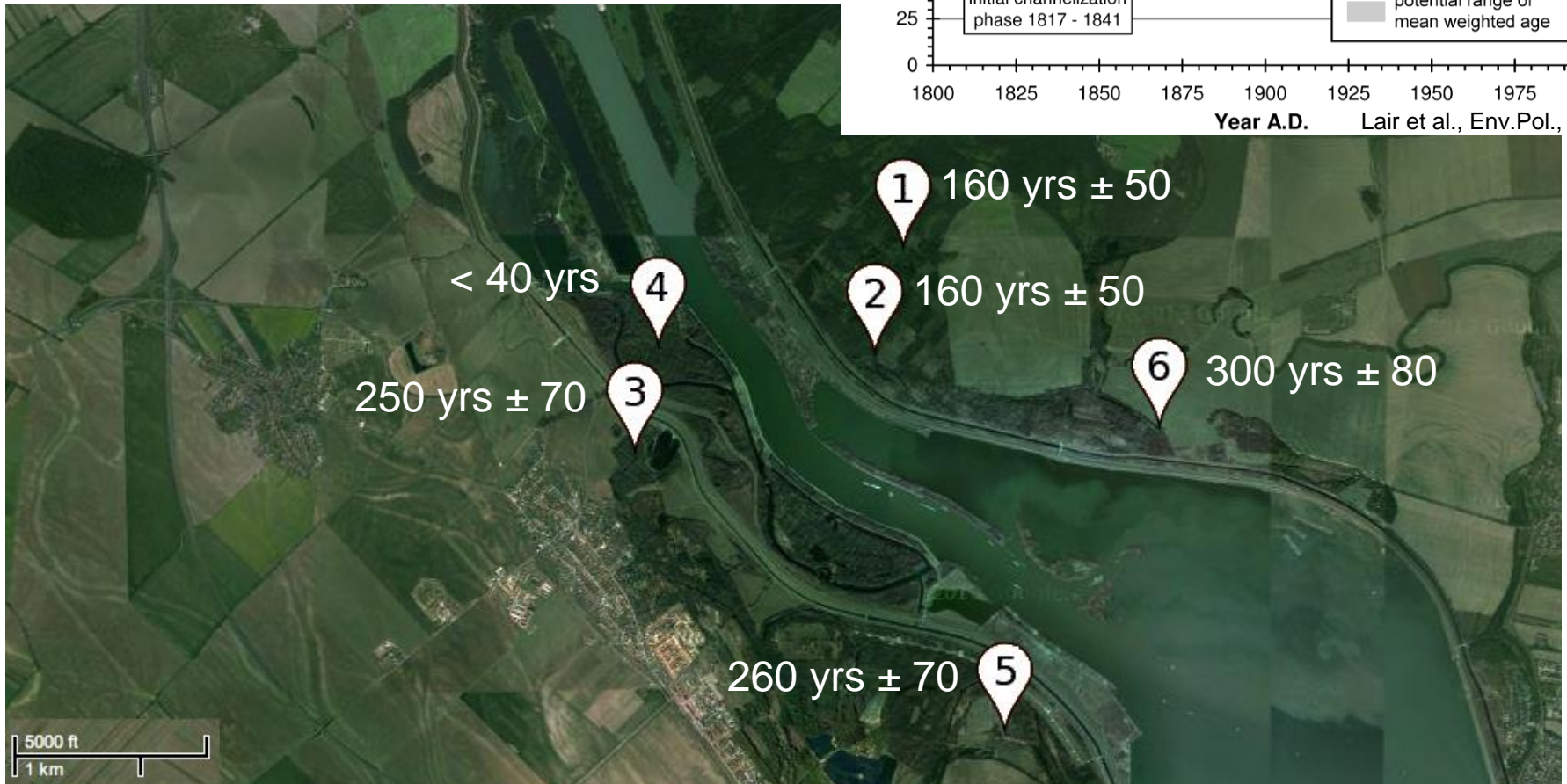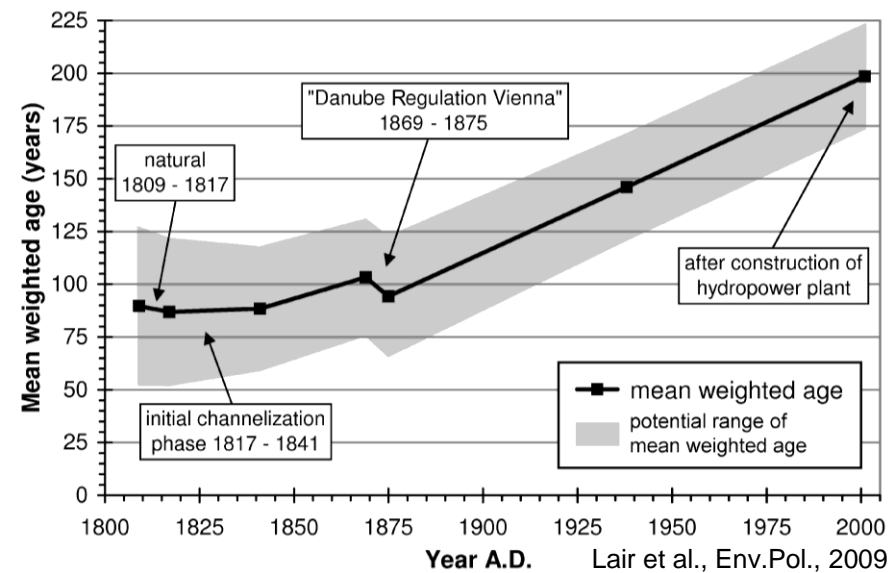
Ellenberg Indicator Values

- Calculation of weighted averages using HITAB 5

Results

Soil age (0-30 cm) estimated using historical maps and crystallinity of pedogenic iron oxides

Lair et al., Env.Pol., 2009

① 160 yrs ± 50

② 160 yrs ± 50

④ < 40 yrs

⑥ 300 yrs ± 80

③ 250 yrs ± 70

⑤ 260 yrs ± 70

Differences in herbaceous layer composition indicated by phytosociological plant indicators (Ellenberg)
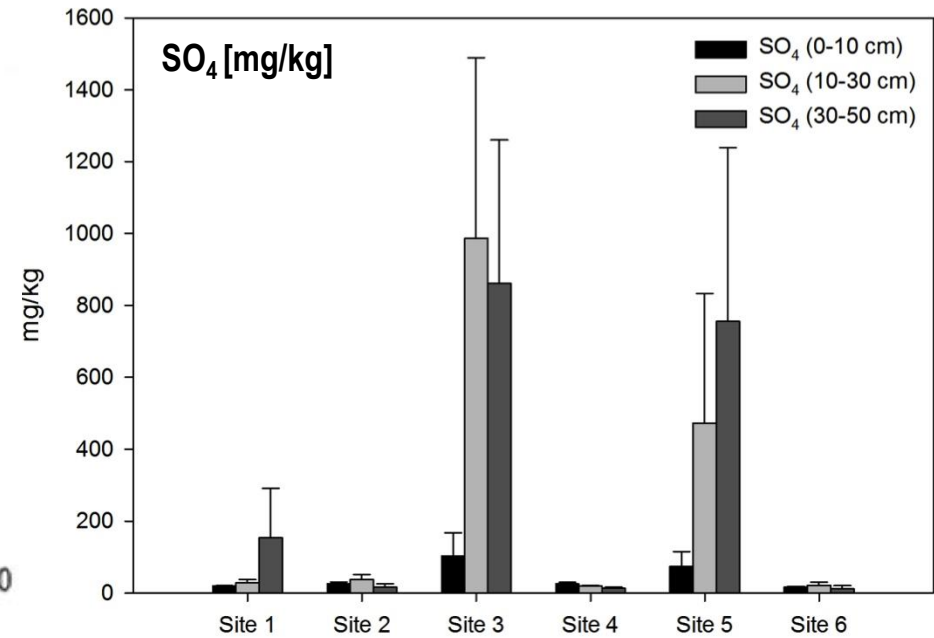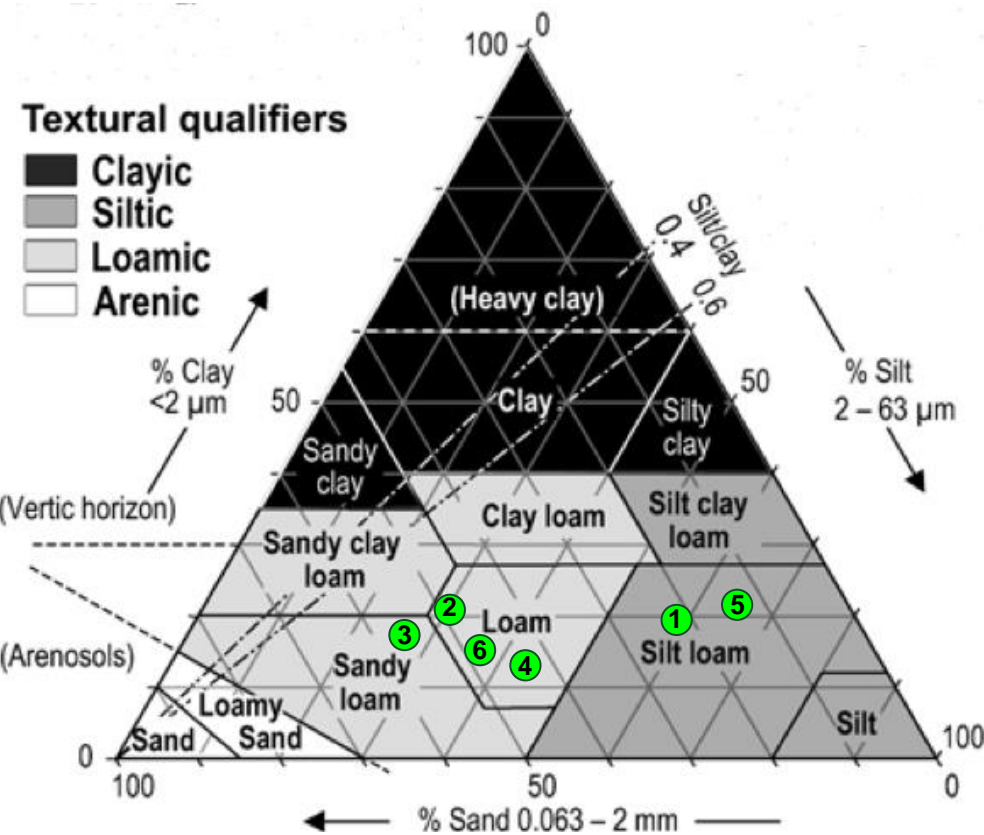

- Data basis: Braun-Blanquet plant data

- Principal component (PC) 1: nutrient / water availability

- PC 2: shading

Difference of measured soil properties between the studied sites

Multivariate Analysis of Variance (MANOVA) detects whether groups differ along a combination of interrelated dimensions

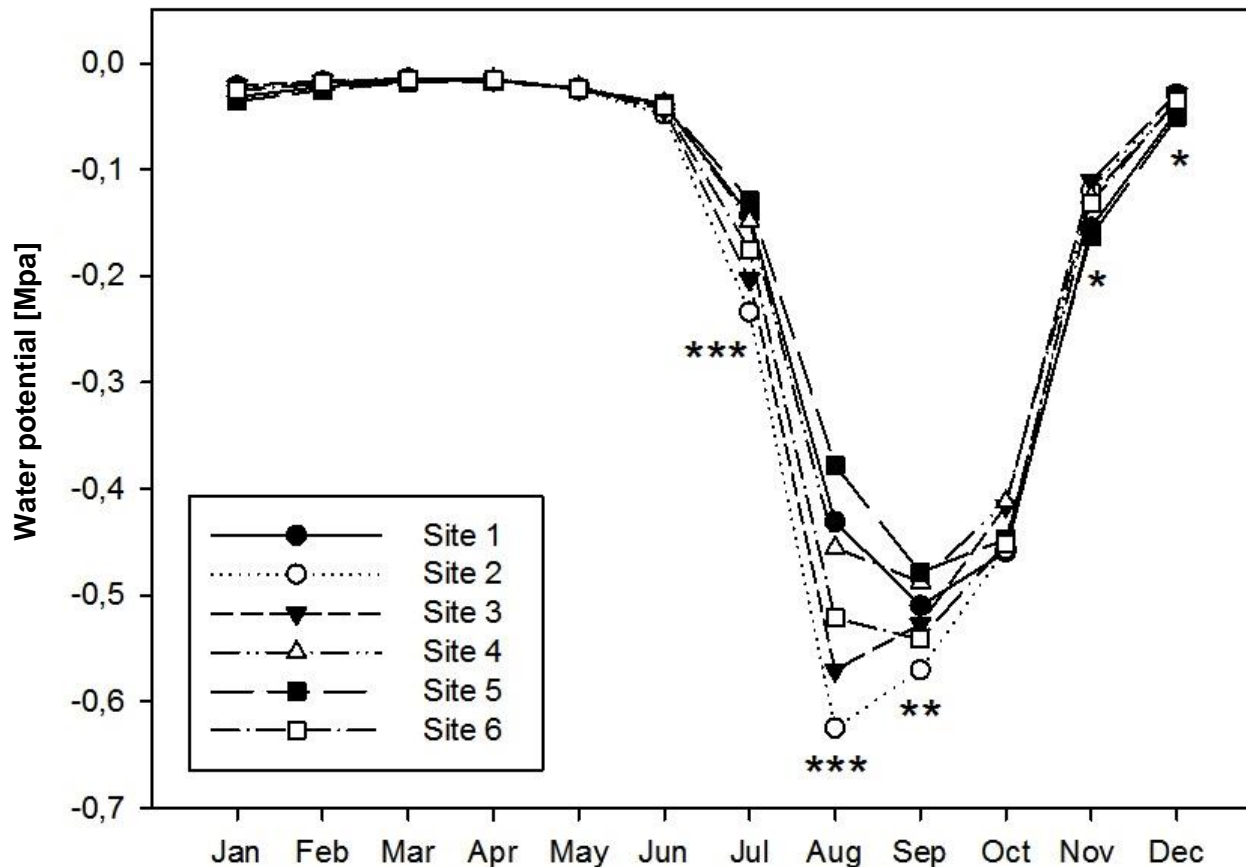| Soil characteristic	Test Statistic	Level of Significance
Soil texture · Coarse sand · Medium sand · Fine sand · Silt · Clay	$H(25) = 72.23$	$p < 0.001$
Water retention characteristics · Wide macropores · Narrow macropores · Mesopores · Micropores · Available field capacity	$H(20) = 95.23$	$p < 0.001$
Nutrient stock · Cl, K, NO_2, NO_3, PO_4, SO_4	$H(45) = 184.11$	$p < 0.001$

Particle size distribution and SO$_4$ content at the sites
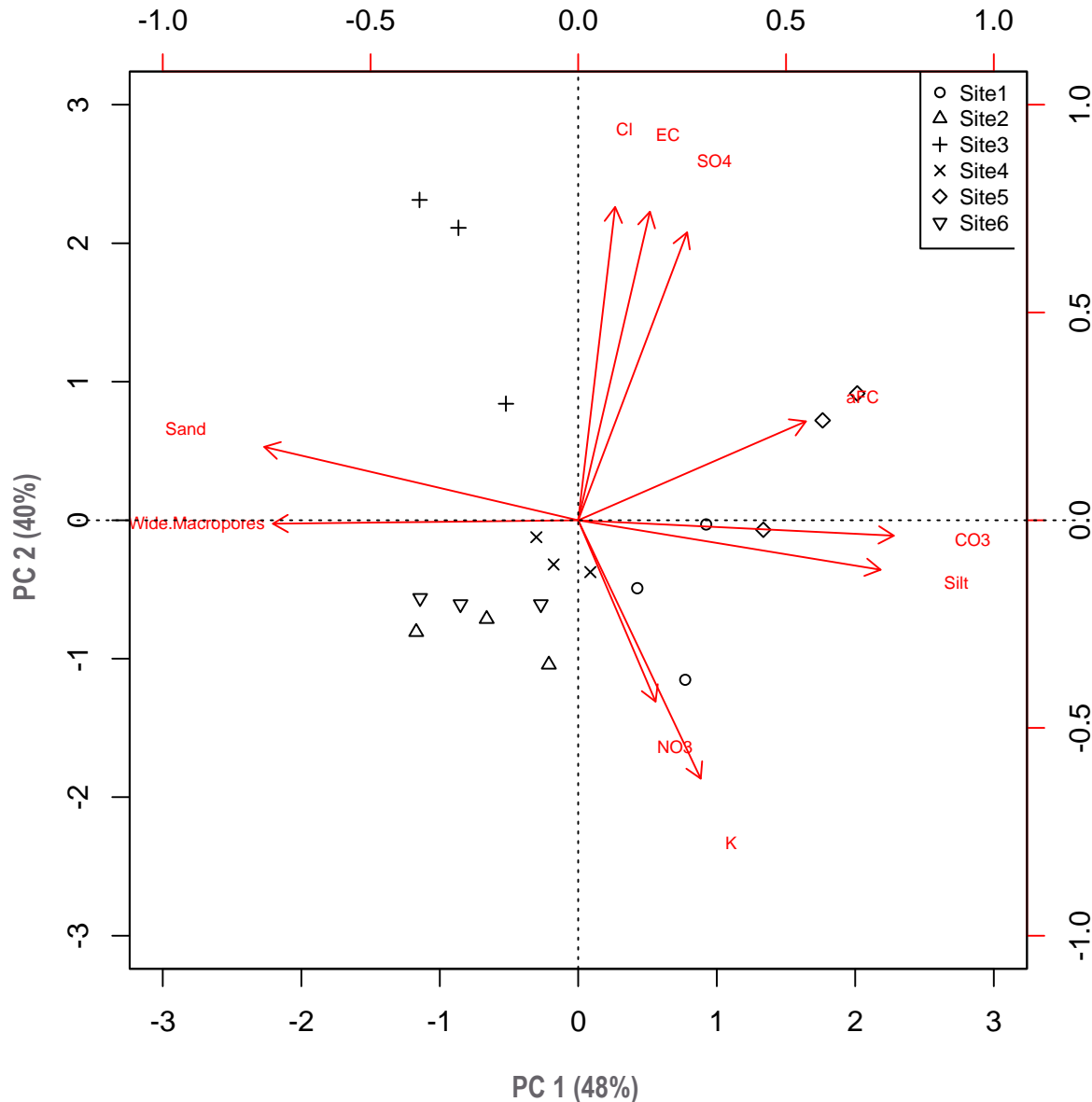

FAO, 2014

Water availability in soils modelled with BGC

Mean annual precipitation: 560 mm
Mean annual evapotranspiration: 460 mm
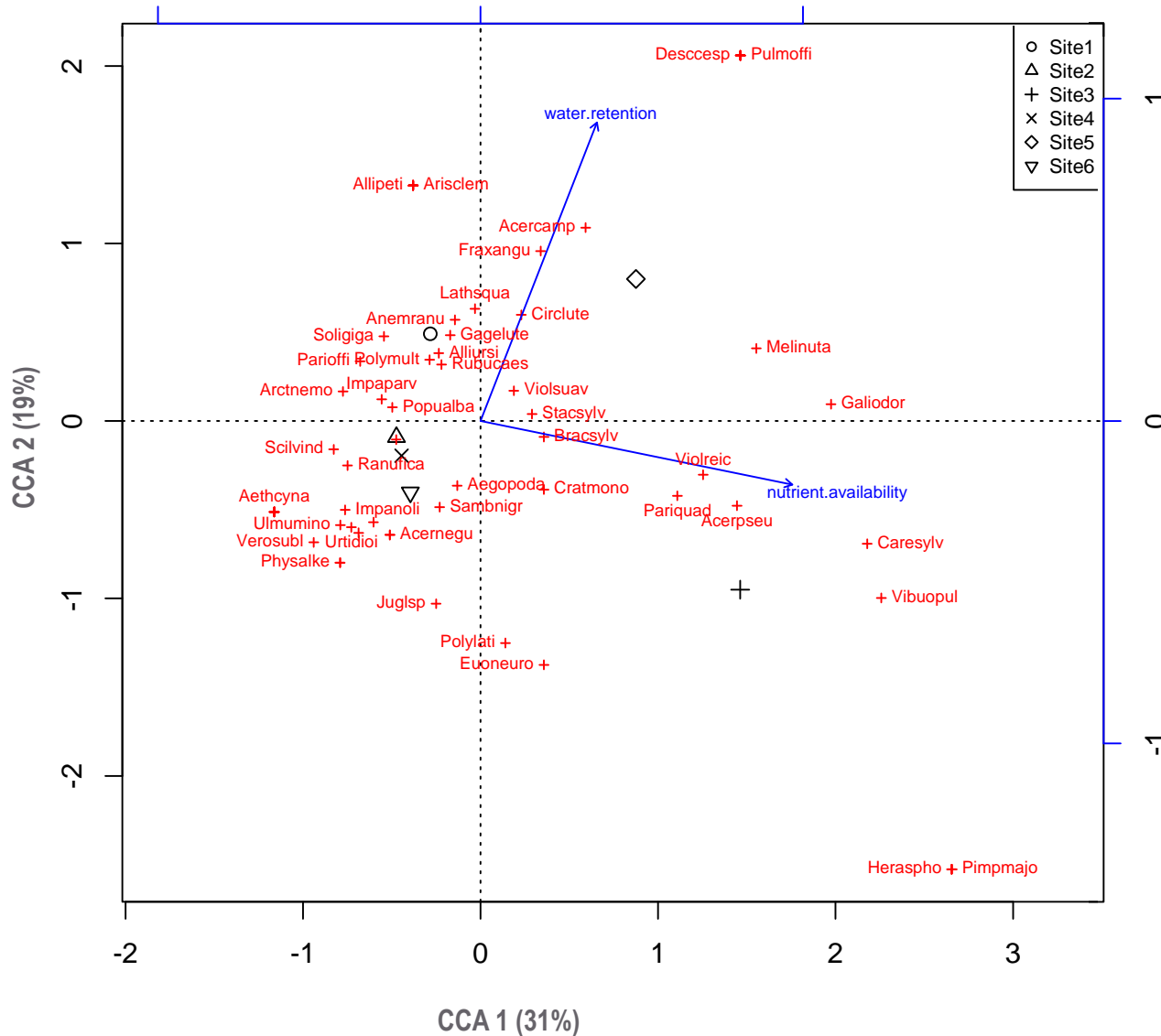Modelled depth: 70 cm without groundwater influence

BGC-model
- Mean for past 10 years
- Fast drying of soil / low water availability (August–October)
- → Competitive pressure until autumn

Principal Component Analysis of soil parameters

- Data basis: Weighted mean of 10 chemical and physical soil parameters (0-50 cm soil depth)

- Principal component PC 1: texture, water retention, $CaCO_3$

- PC 2: nutrient status

Relating plant community composition to soil conditions

- Data basis: Principal components of PCA, Braun-Blanquet data

- Constrained canonical axis (CCA) 1: water retention

- CCA 2: nutrient status

Conclusions

➢ in the study area, herbaceous layer composition is strongly influenced by

- soil particle size distribution
- water retention characteristics
- soil nutrient status

➢ rare flooding and soil age showed no significant impact on the plant community

➢ human activities (i.e. groundwater use) exert decisive influence on plant species composition

→ Preserve habitat heterogeneity in order to promote species richness

Thank you for your attention!