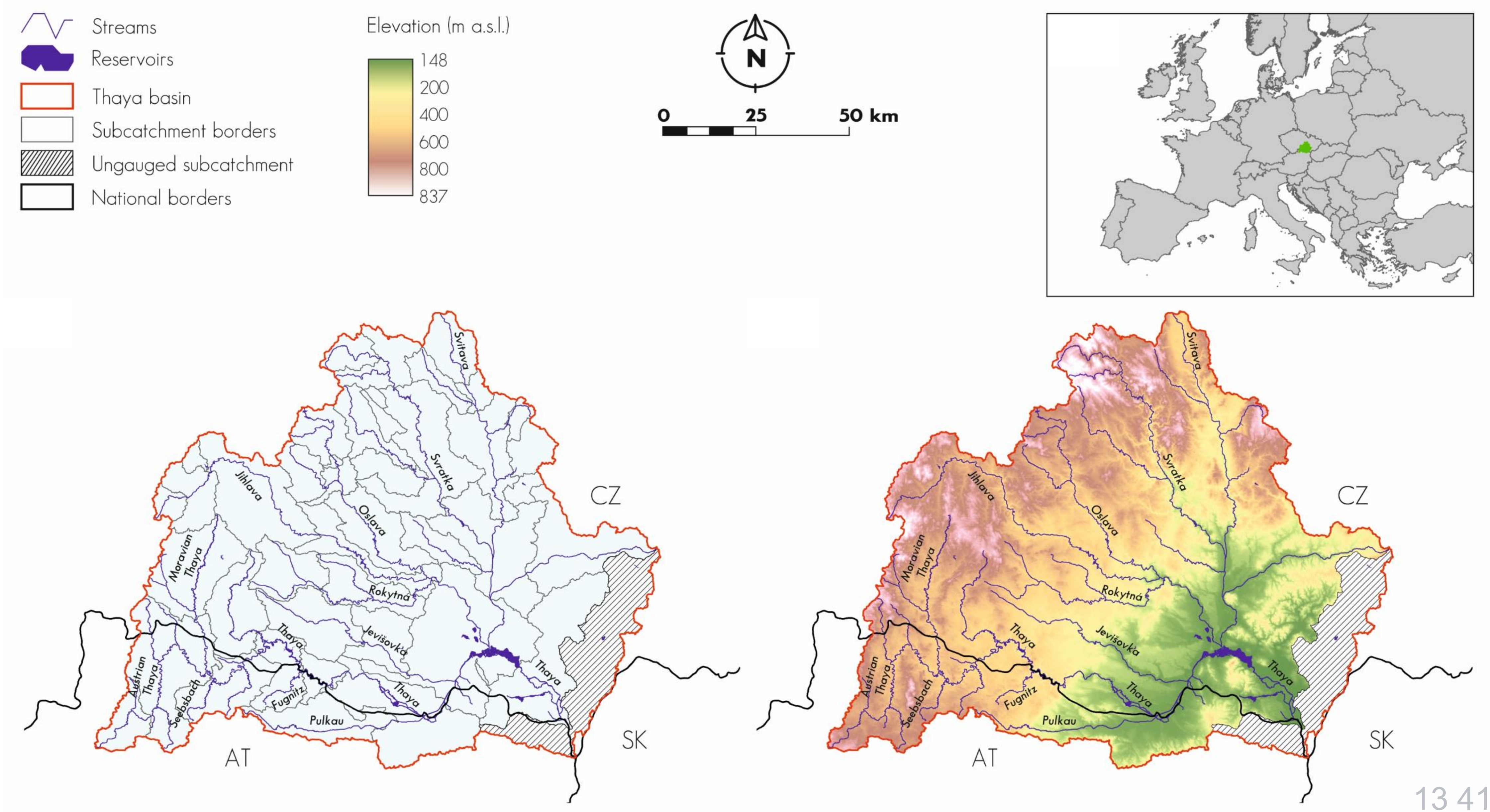
GLOBAL CHANGE
RESEARCH INSTITUTE CAS

Disentangling the runoff decline in the Thaya River basin using in situ and Earth observations

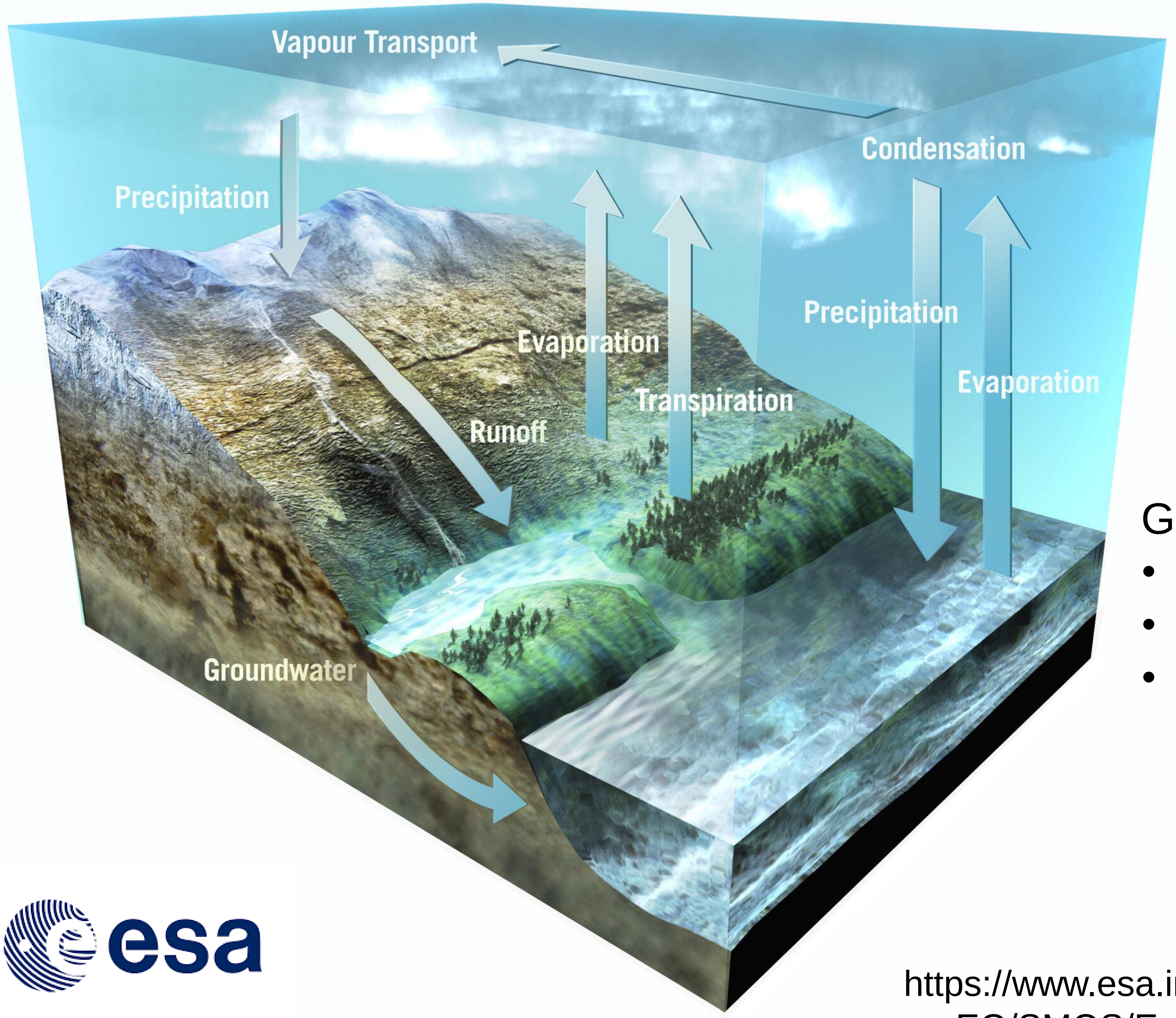
Fischer et al.

2023-06-27

Thaya river basin



13 419 km²

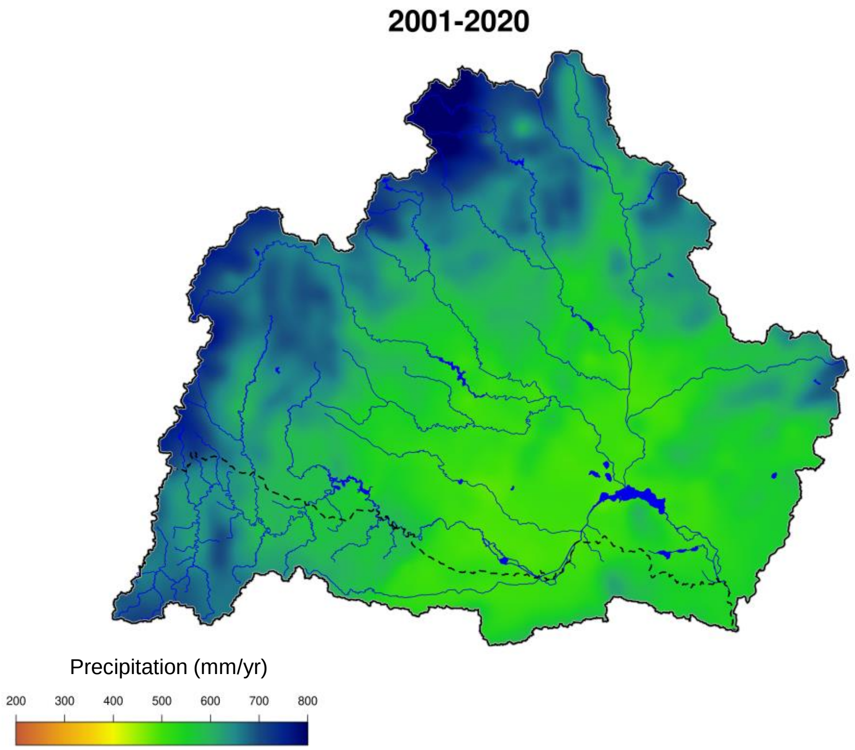


Global land water balance

- precipitation: 806–864 mm/yr
- evapotranspiration: 535–544 mm/yr
- runoff: 274–329 mm/yr

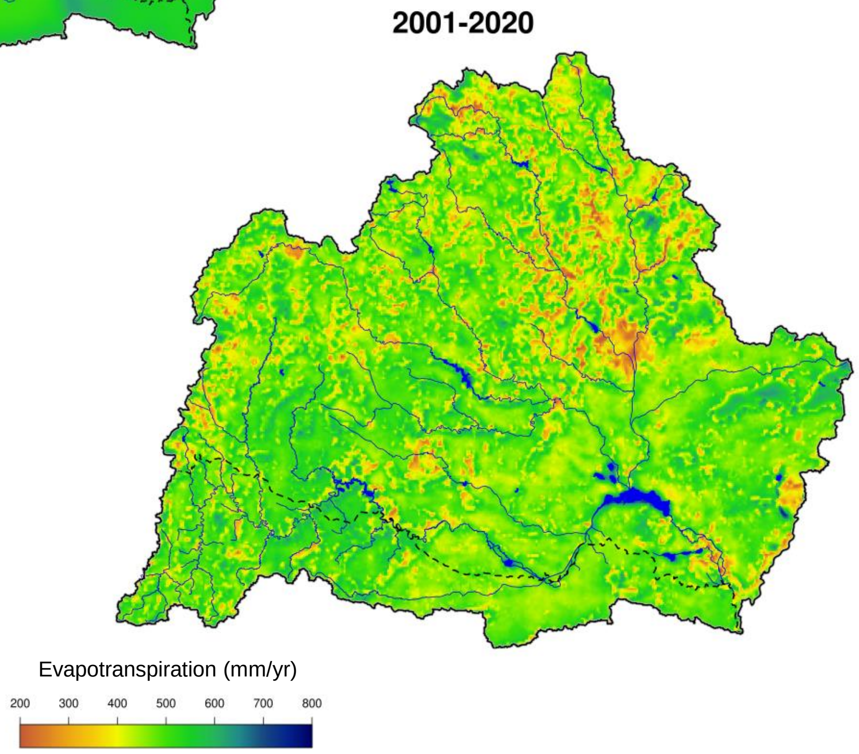
https://www.esa.int/Applications/Observing_the_Earth/FutureEO/SMOS/Earth_s_water_cycle

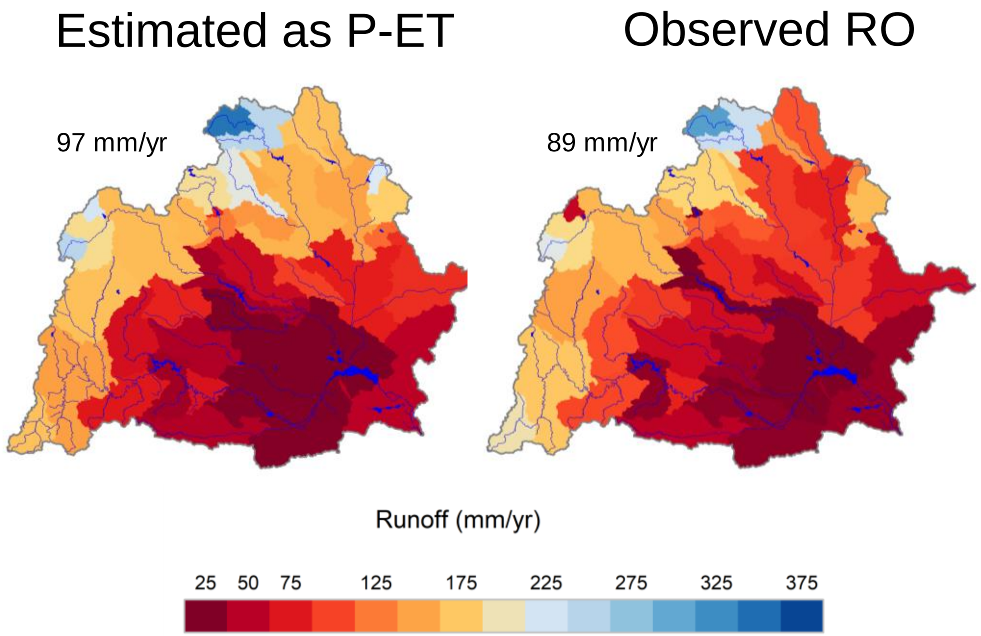
European Space Agency



Thaya river basin water balance (2001-2020)

- precipitation: 598 mm/yr
- evapotranspiration: 485 mm/ yr
- runoff: 89 (97) mm/yr





Actual evapotranspiration is a significant part of water balance, yet the most challenging to measure

precipitation

runoff

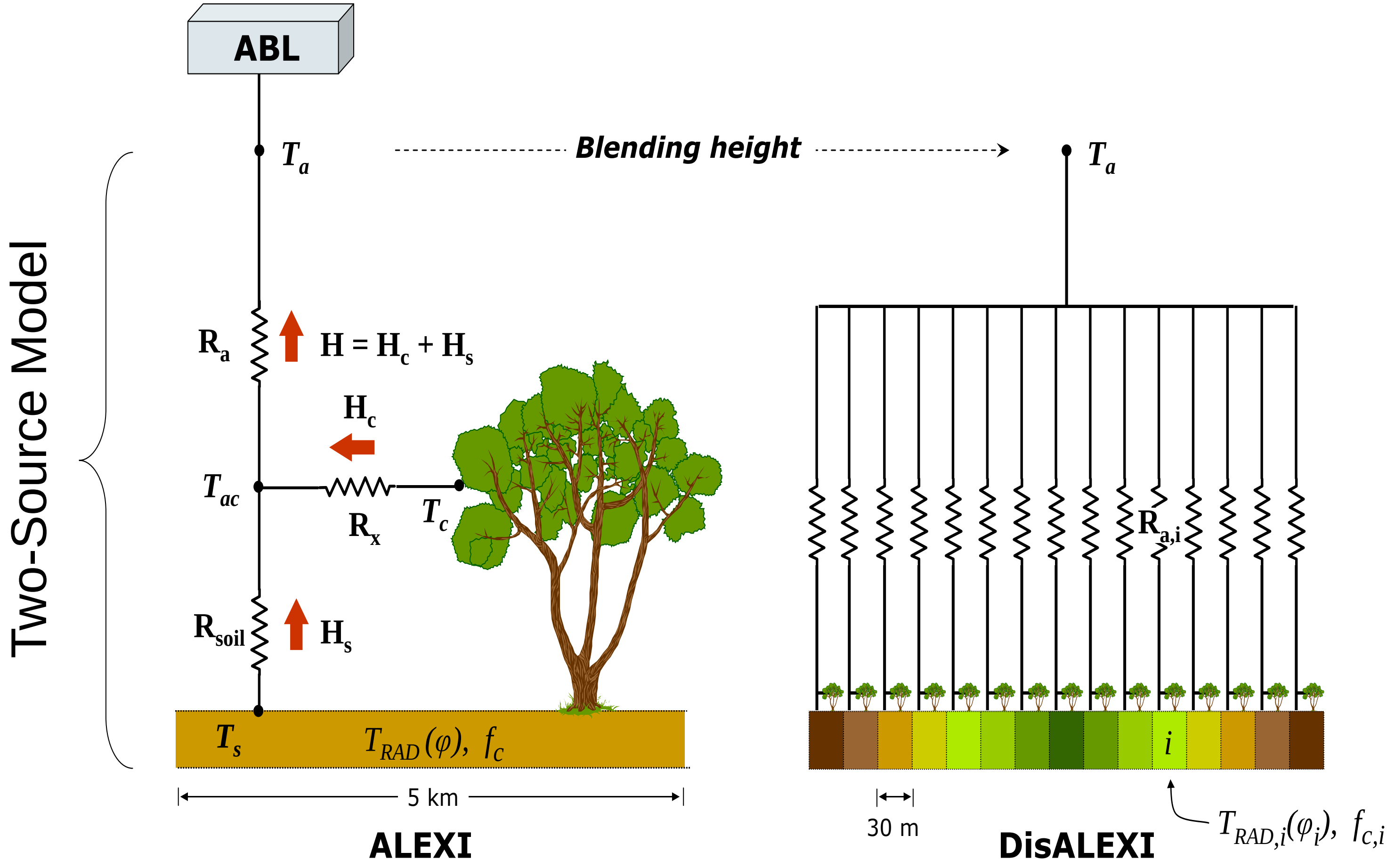
evapotranspiration

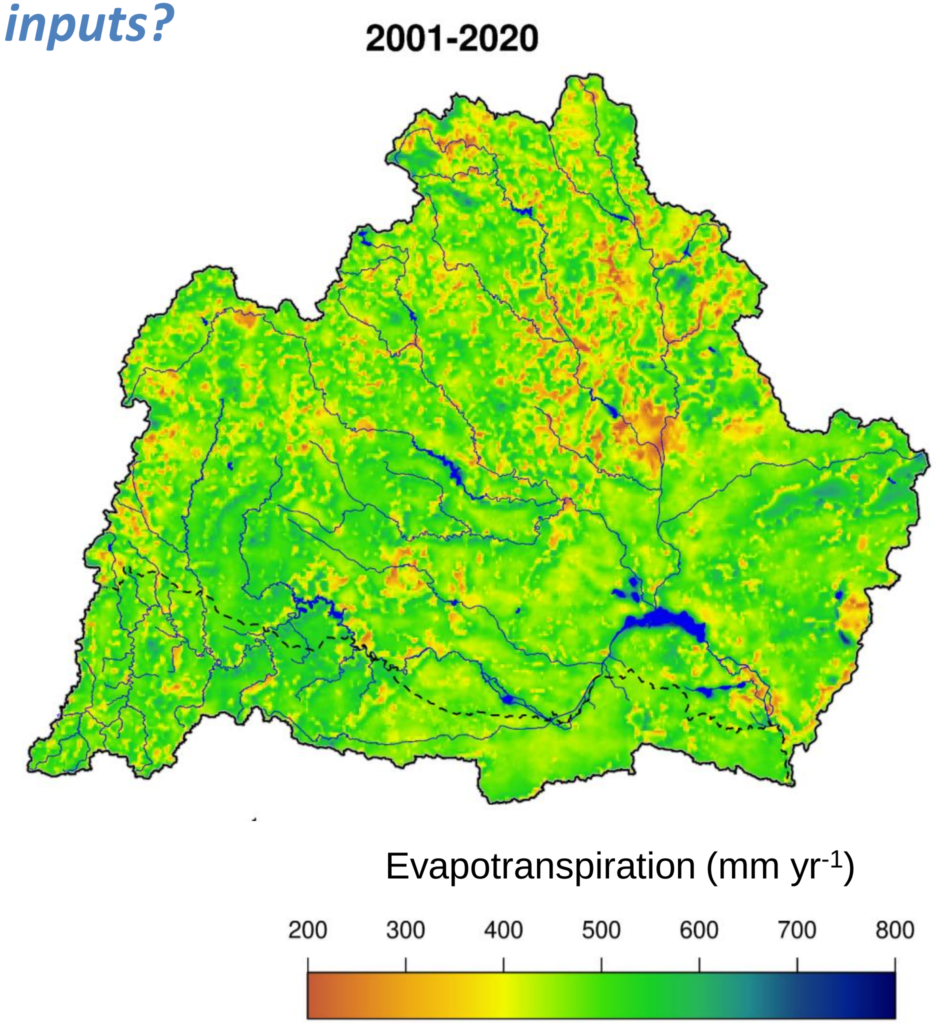
?

Remote sensing actual evapotranspiration – ALEXI and DisALEXI

Measurement of land surface temperature and solving surface energy balance

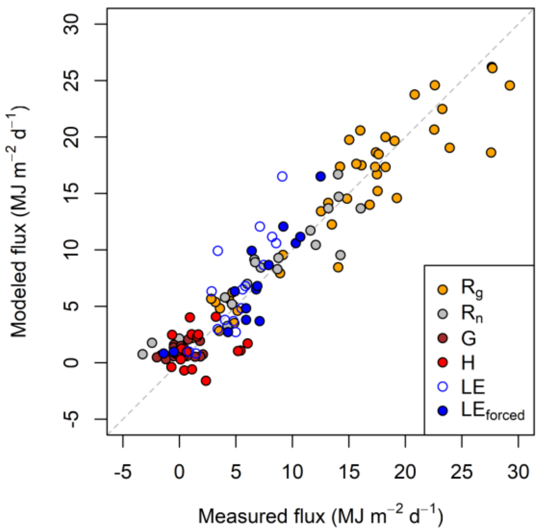
„How much water loss is required to keep the soil and vegetation at the observed temperatures under given known radiative energy inputs?

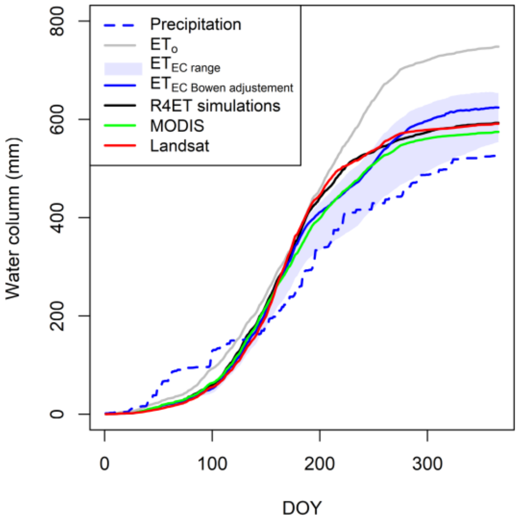


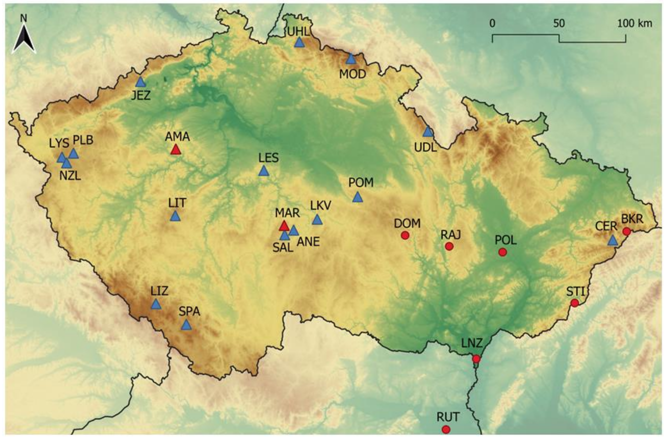


Remote sensing actual evapotranspiration – ALEXI and DisALEXI

Comparison of disaggregated ALEXI fluxes with eddy covariance







Flux towers (eddy covariance)

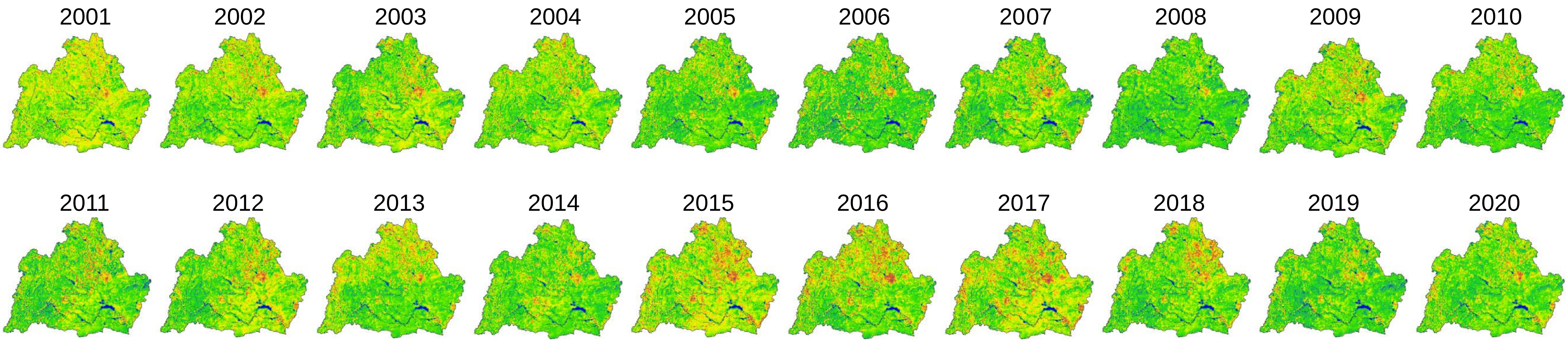
BKR – Bílý Kříž, N. spruce forest, 875 m a.s.l.
DOM – Domanínek, poplar plantation, 540 m a.s.l.
LNZ – Lanžhot, floodplain forest, grassland, 155 m a.s.l.
POL – Polkovice, cropland, EC+BLS, 192 m a.s.l.
RAJ – Rájec, N. spruce forest, 625 m a.s.l.
RUT – Rutzendorf, cropland, EC+BLS, 150 m a.s.l.
STI – Štítná, beech spruce forest, 550 m a.s.l.

Small forest catchments (mass balance)

ANE – Anneský potok, N. spruce, 26 ha, 520 m a.s.l.
CER – Červík, N. spruce, 181 ha, 802 m a.s.l.
JEZ – Jezeří, beech, 260 ha, 758 m a.s.l.
LES – Lesní potok, beech, 63 ha, 471 m a.s.l.
LIT – Litavka, N. spruce, 179 ha, 774 m a.s.l.
LIZ – Liz, N. spruce, 94 ha, 942 m a.s.l.
LYS – Lysina, N. spruce, 25 ha, 881 m a.s.l.
MOD – Modrý potok, alpine cover, 254 ha, 1301 m a.s.l.
NZL – Na zeleném, N. spruce, 60 ha, 786 m a.s.l.
PLB – Pluhův Bor, N. spruce, 21 ha, 764 m a.s.l.
POM – Polomka, beech, 66 ha, 614 m a.s.l.
SAL – Salačova Lhota, N. spruce, 200 ha, 640 m a.s.l.
SPA – Spálenec, N. spruce, 53 ha, 826 m a.s.l.
UDL – U dvou louček, N. spruce, 30 ha, 922 m a.s.l.
UHL – Uhlířská, N. spruce, 80 ha, 818 m a.s.l.

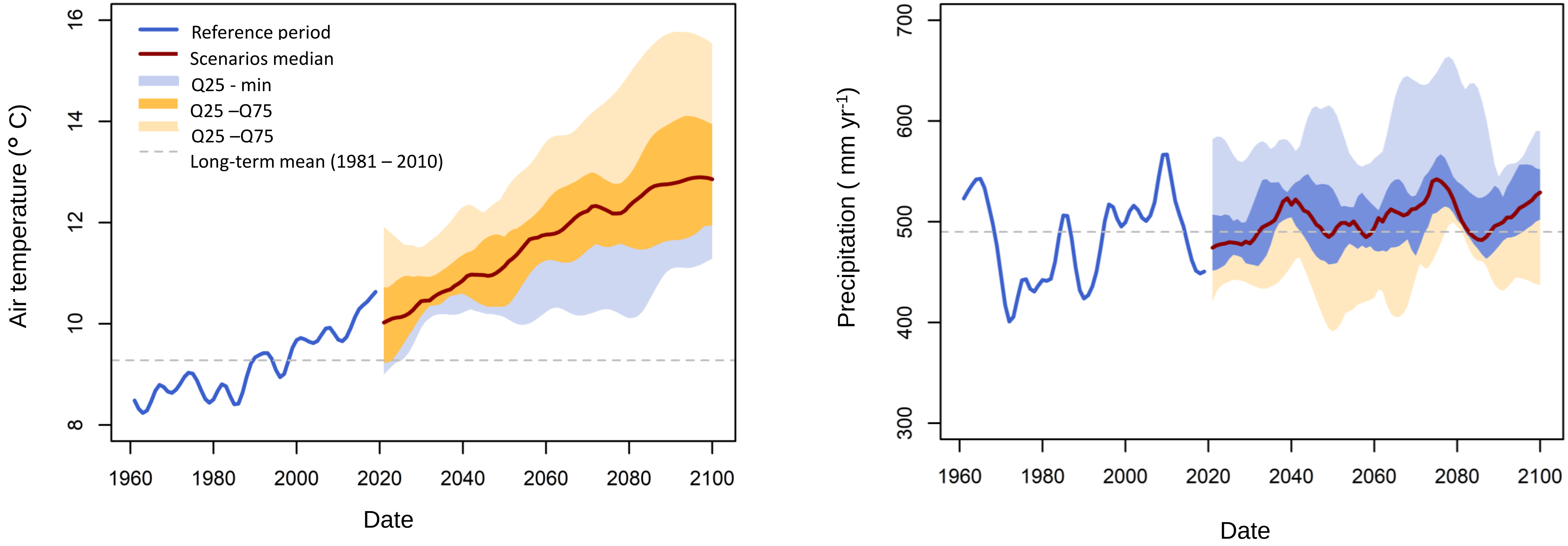
Cropland/forest catchments (mass balance)

AMA – Amálie, EC+BLS, 771 ha, 432 m a.s.l.
MAR – Martinický potok, EC+BLS, 11327 ha, 545 m a.s.l.



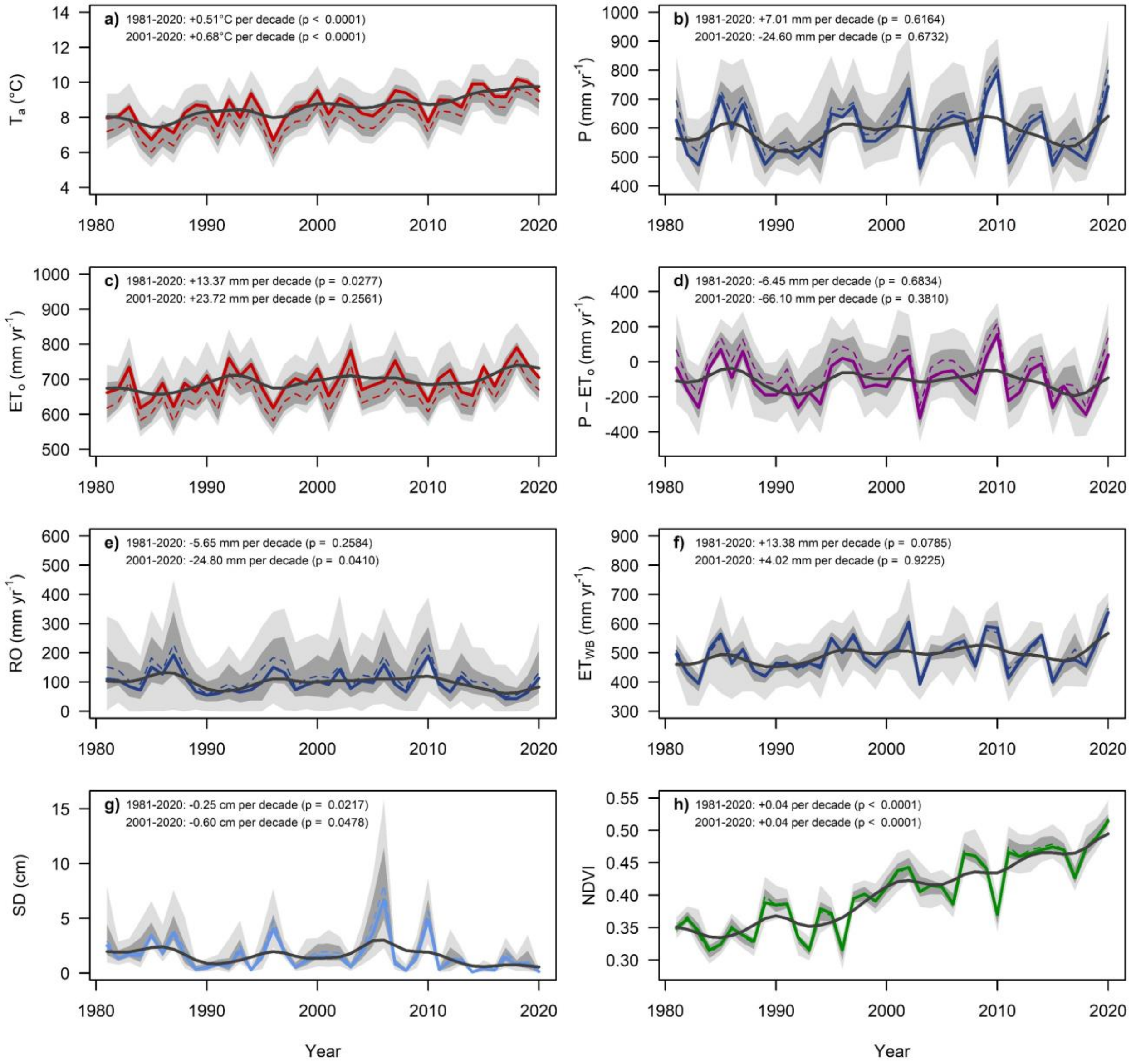
What are the trends in hydroclimate?

Climate change in the region

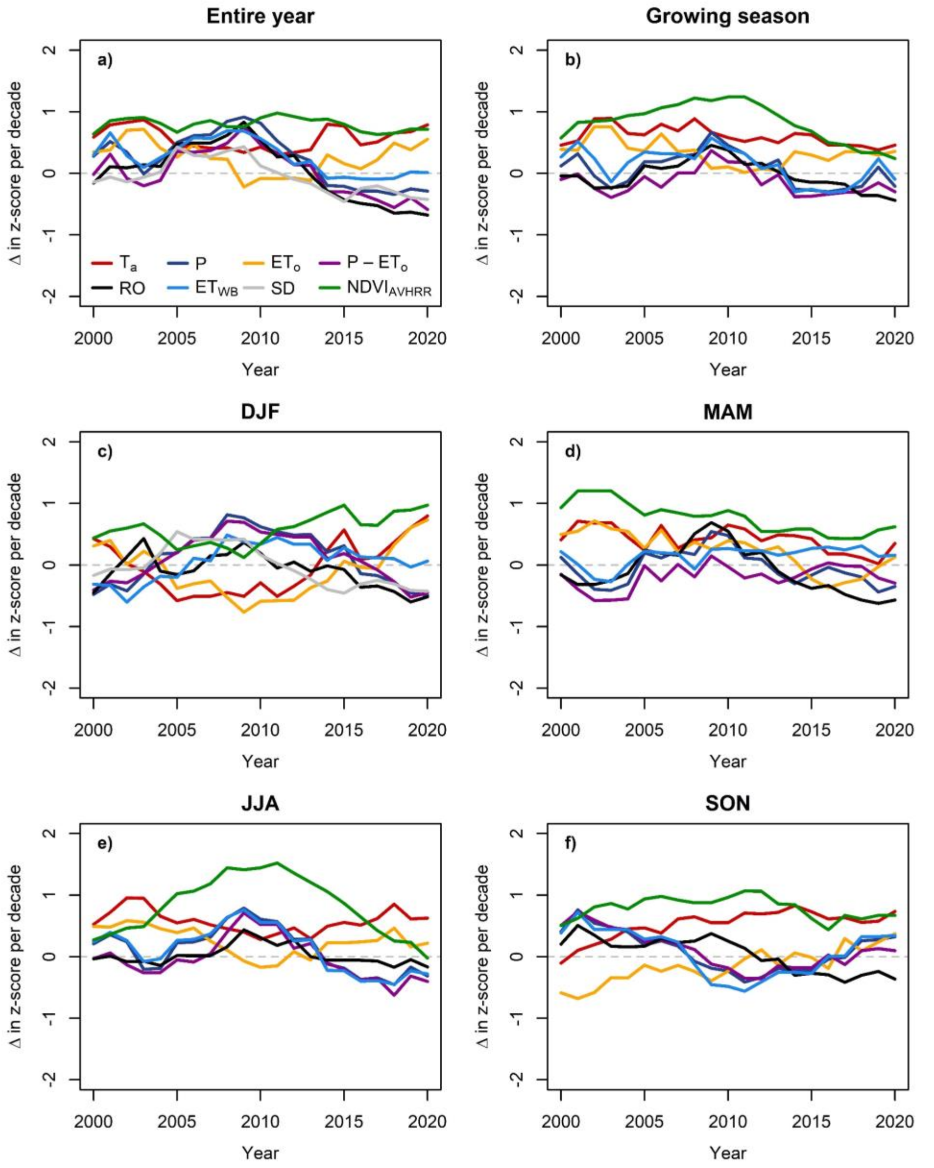


According to most of climate projections, temperature will increase while precipitation will remain similar in the Central Europe.

Trends in Thaya river basin 1981-2020

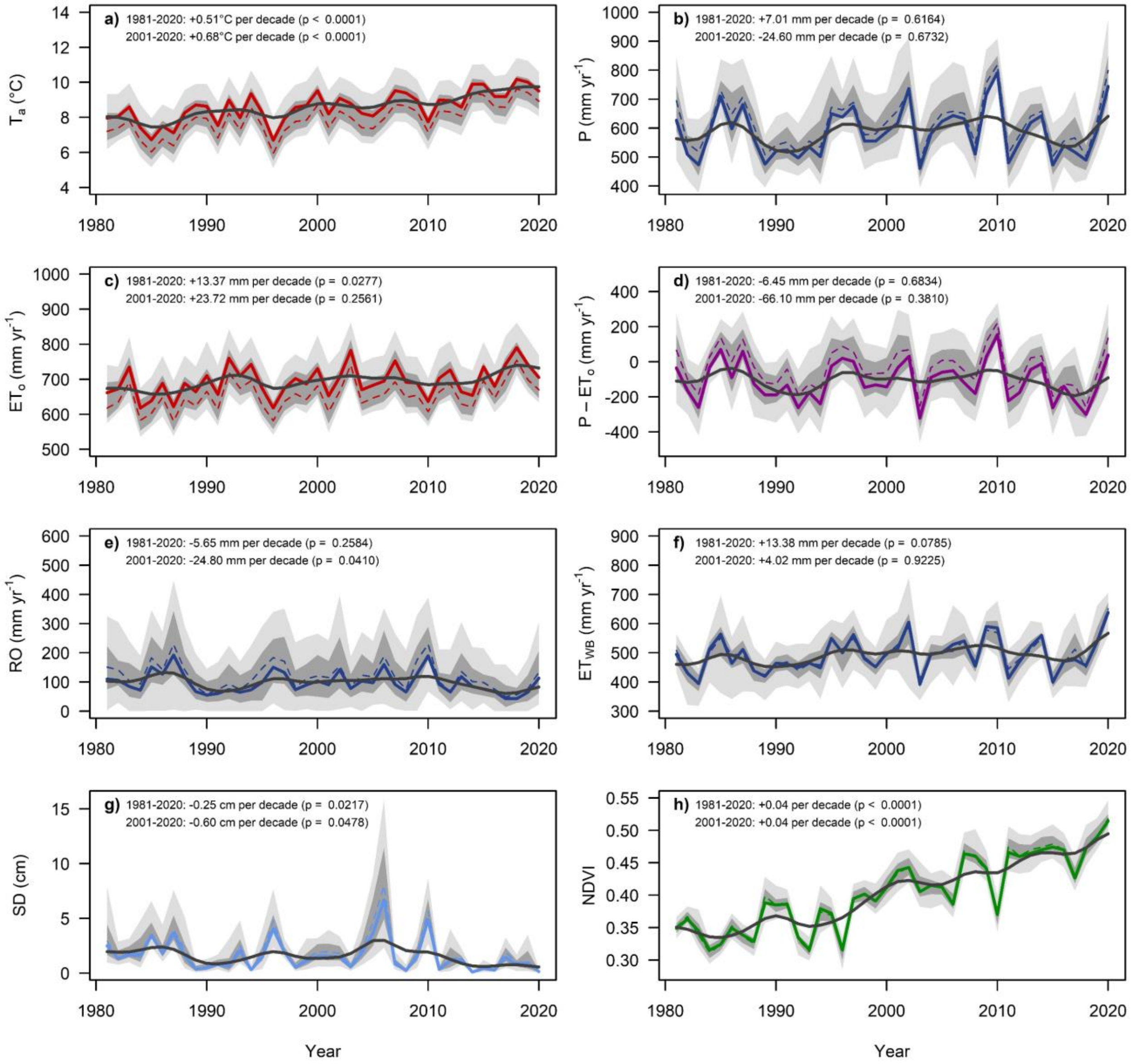


Running trends (20yrs window)

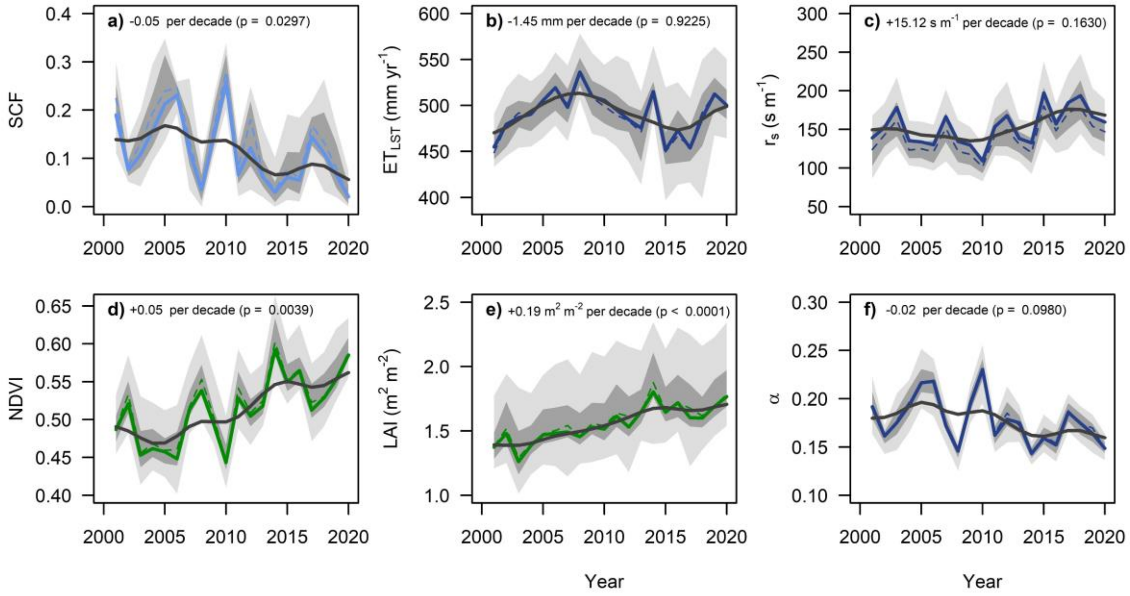


Trends in Thaya river basin 1981-2020 and 2001-2020

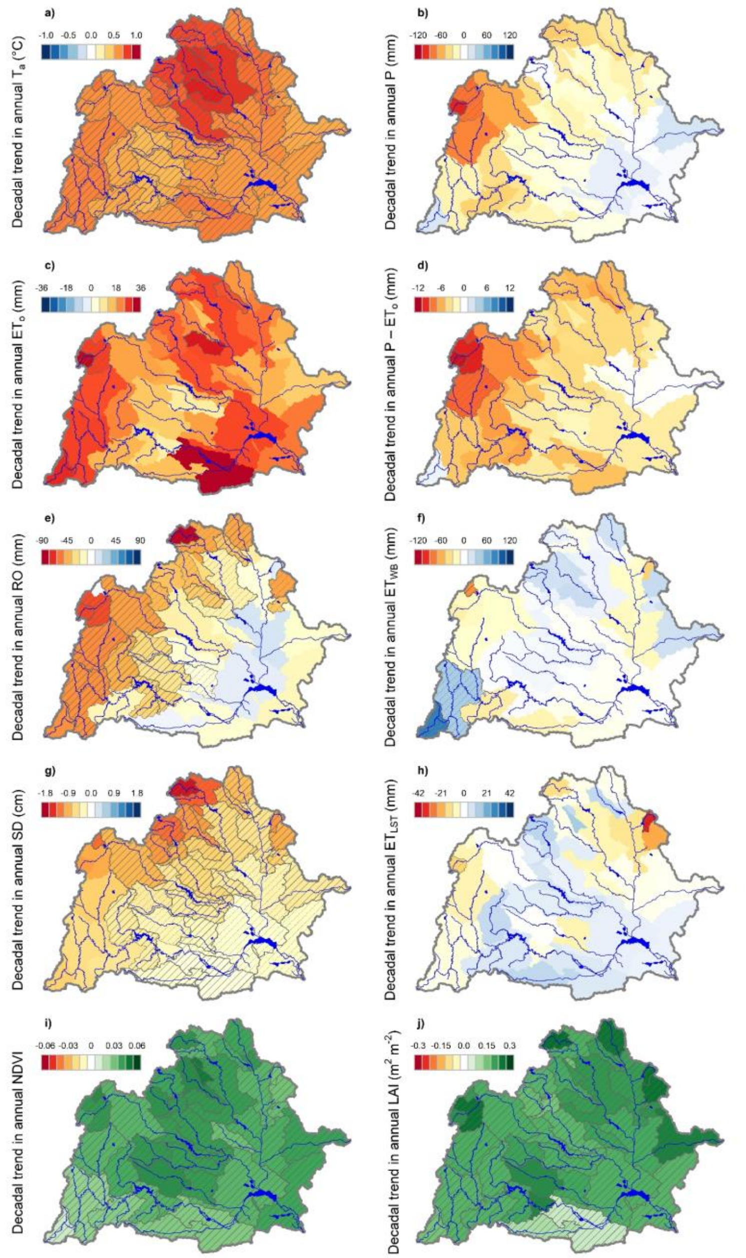
1981-2020



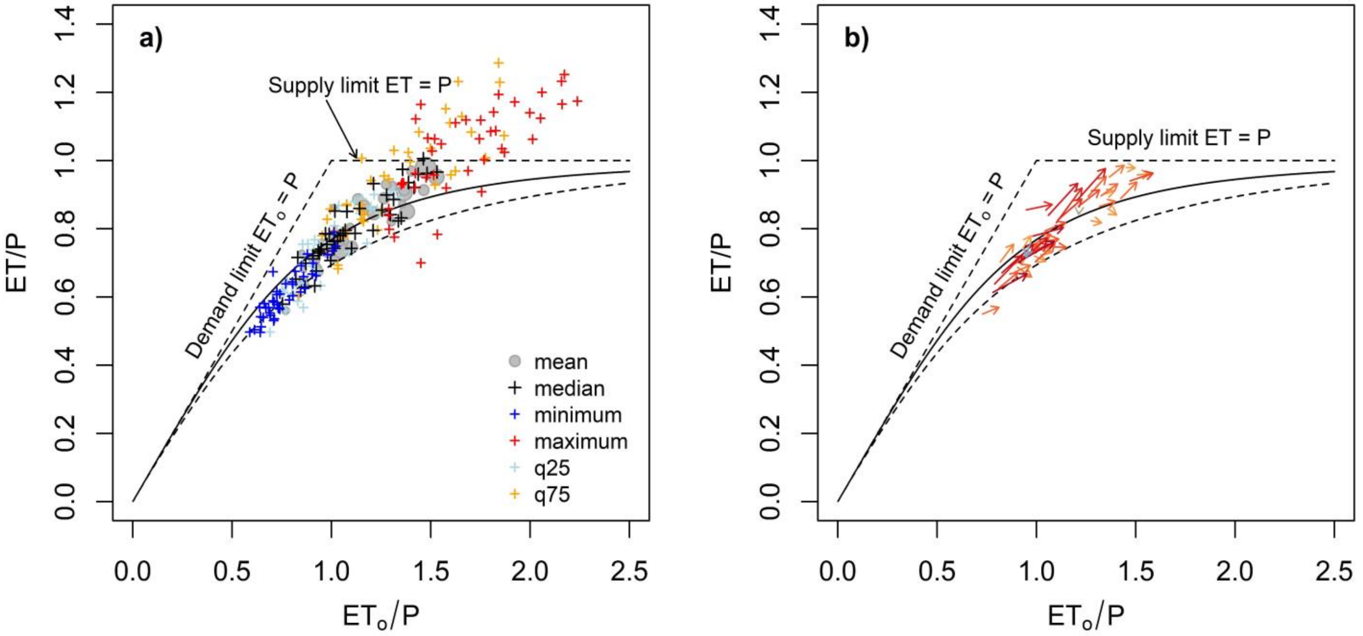
2001-2020



Trends in Thaya river basin 2001-2020

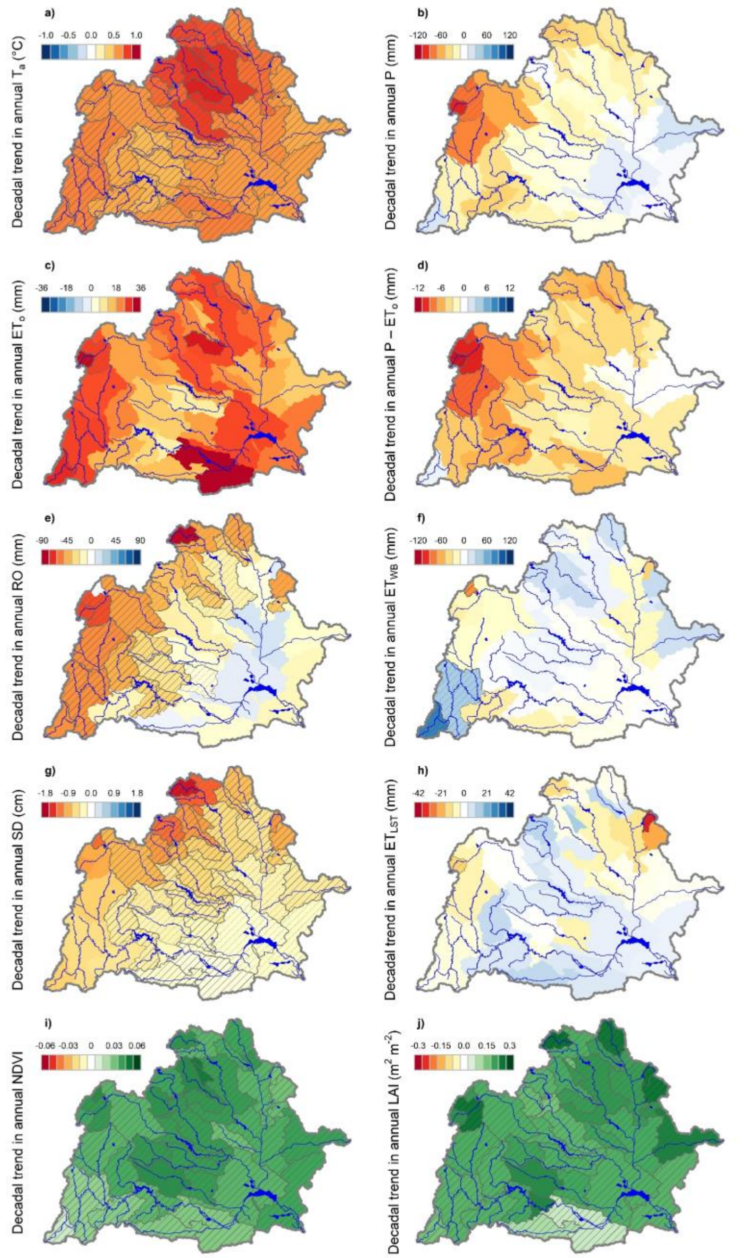


Budyko framework and trends

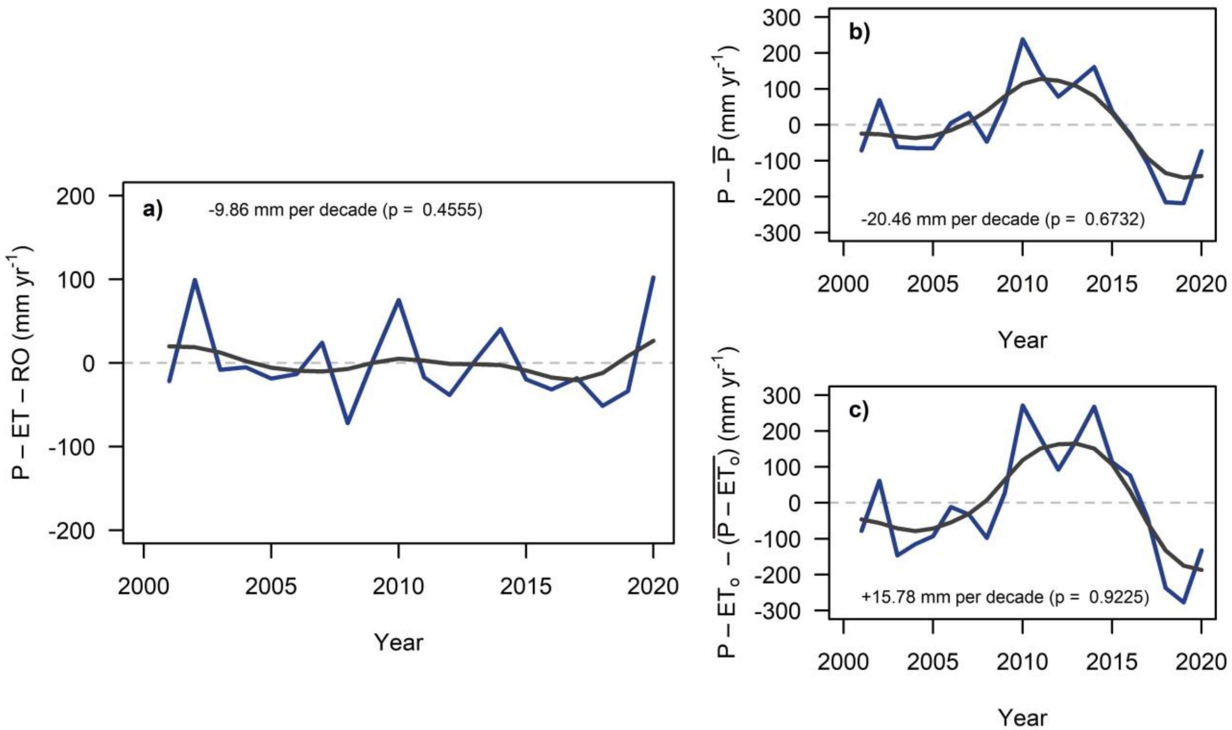


n=2.76

Trends in Thaya river basin 2001-2020

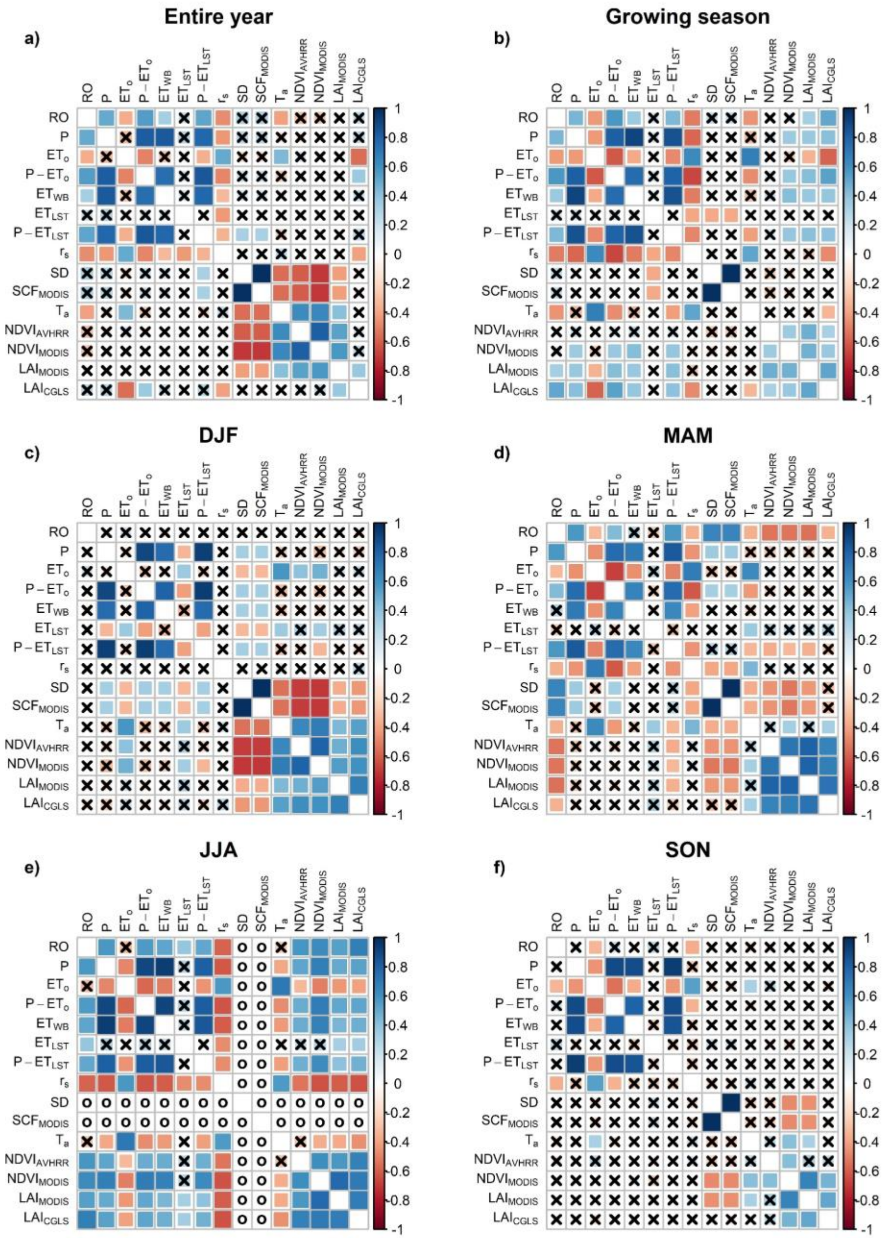


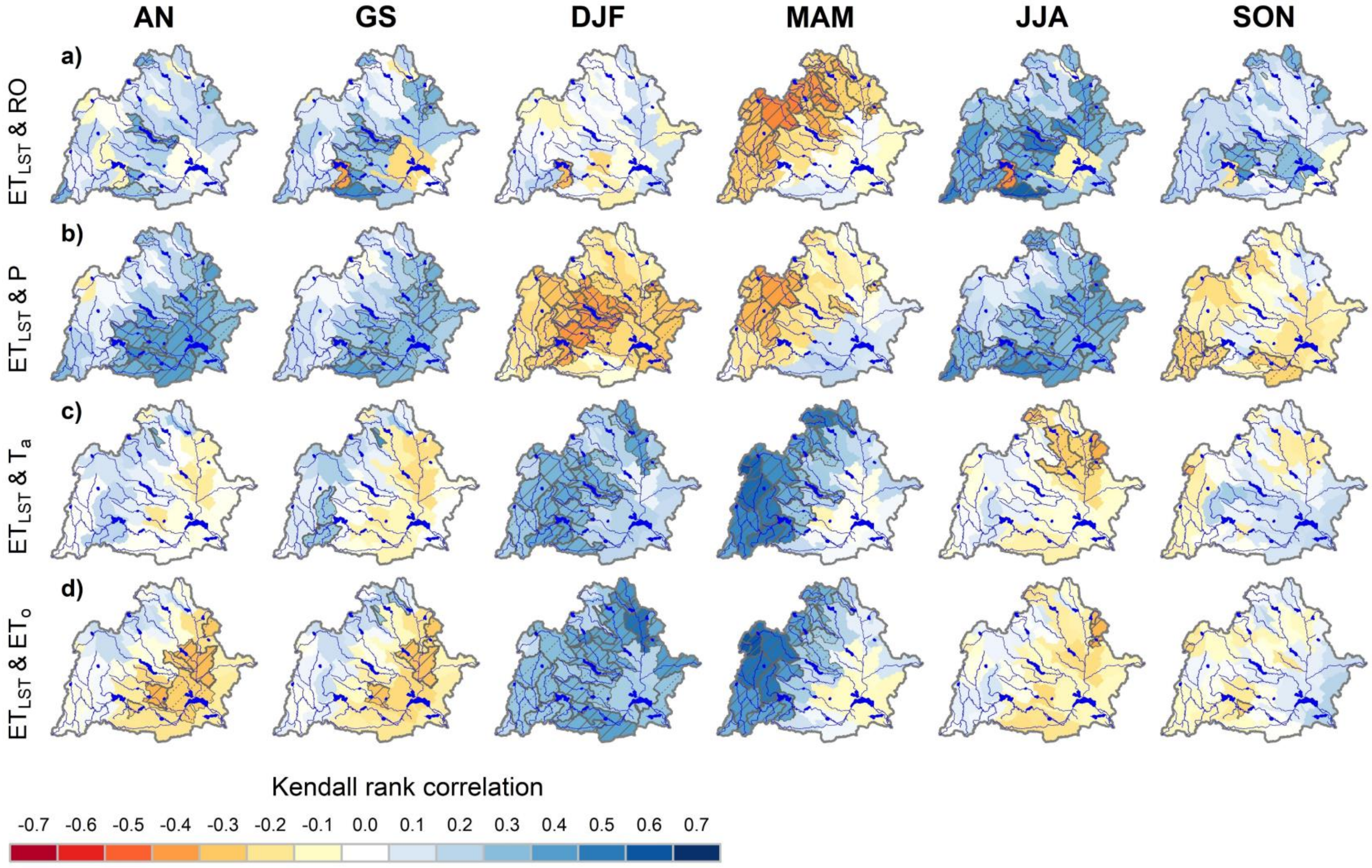
Overall cumulative water balance



How are the variables related?

Correlation analysis





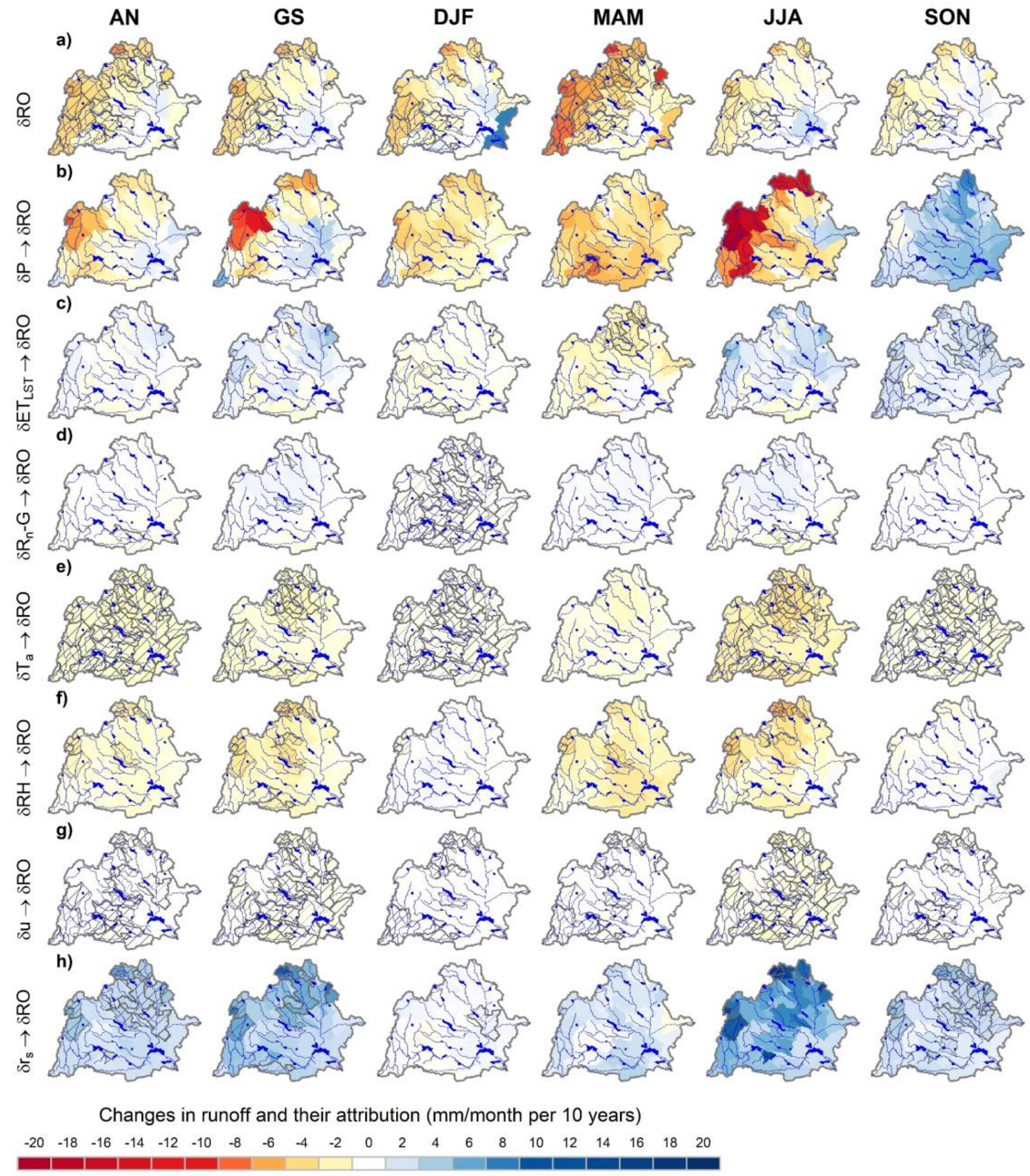
Attribution analysis

Simple analytical framework relating runoff trends to trends in the main climatological variables

$$\delta \mathrm{RO} \approx \delta P - \delta \mathrm{ET}$$

$$\delta \mathrm{ET} \approx \frac{\partial \mathrm{ET}}{\partial T_{\mathrm{a}}}\delta T_{\mathrm{a}} + \frac{\partial \mathrm{ET}}{\partial (R_{\mathrm{n}} - G)}\delta (R_{\mathrm{n}} - G) + \frac{\partial \mathrm{ET}}{\partial \mathrm{RH}}\delta \mathrm{RH} + \frac{\partial \mathrm{ET}}{\partial u}\delta u + \frac{\partial \mathrm{ET}}{\partial r_{\mathrm{s}}}\delta r_{\mathrm{s}}$$

Attribution analysis



Simple analytical framework relating runoff trends to trends in the main climatological variables

$$\delta \mathrm{RO} \approx \delta P - \delta \mathrm{ET}$$

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Where to find more?

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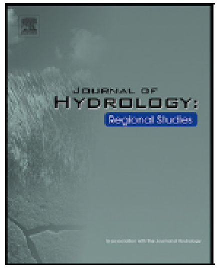

Attributing the drivers of runoff decline in the Thaya river basin[☆]

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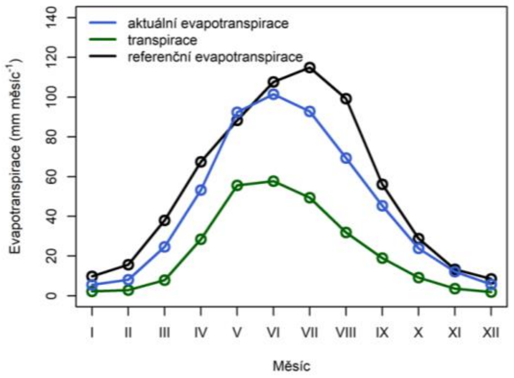
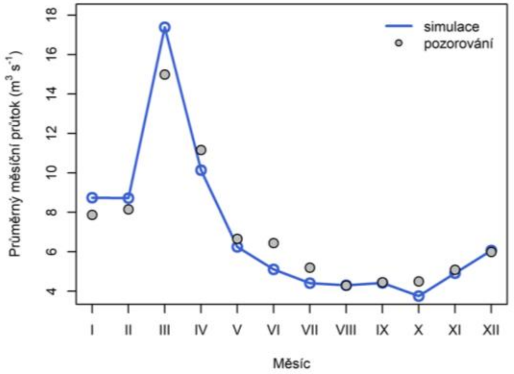
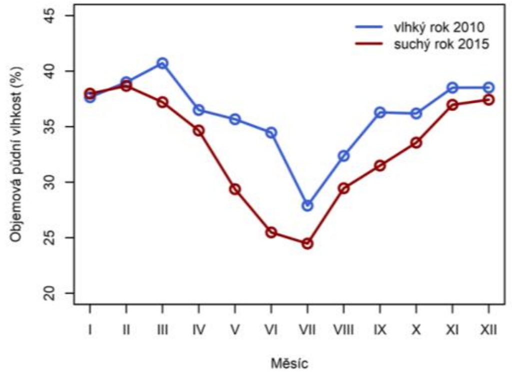
Conclusions

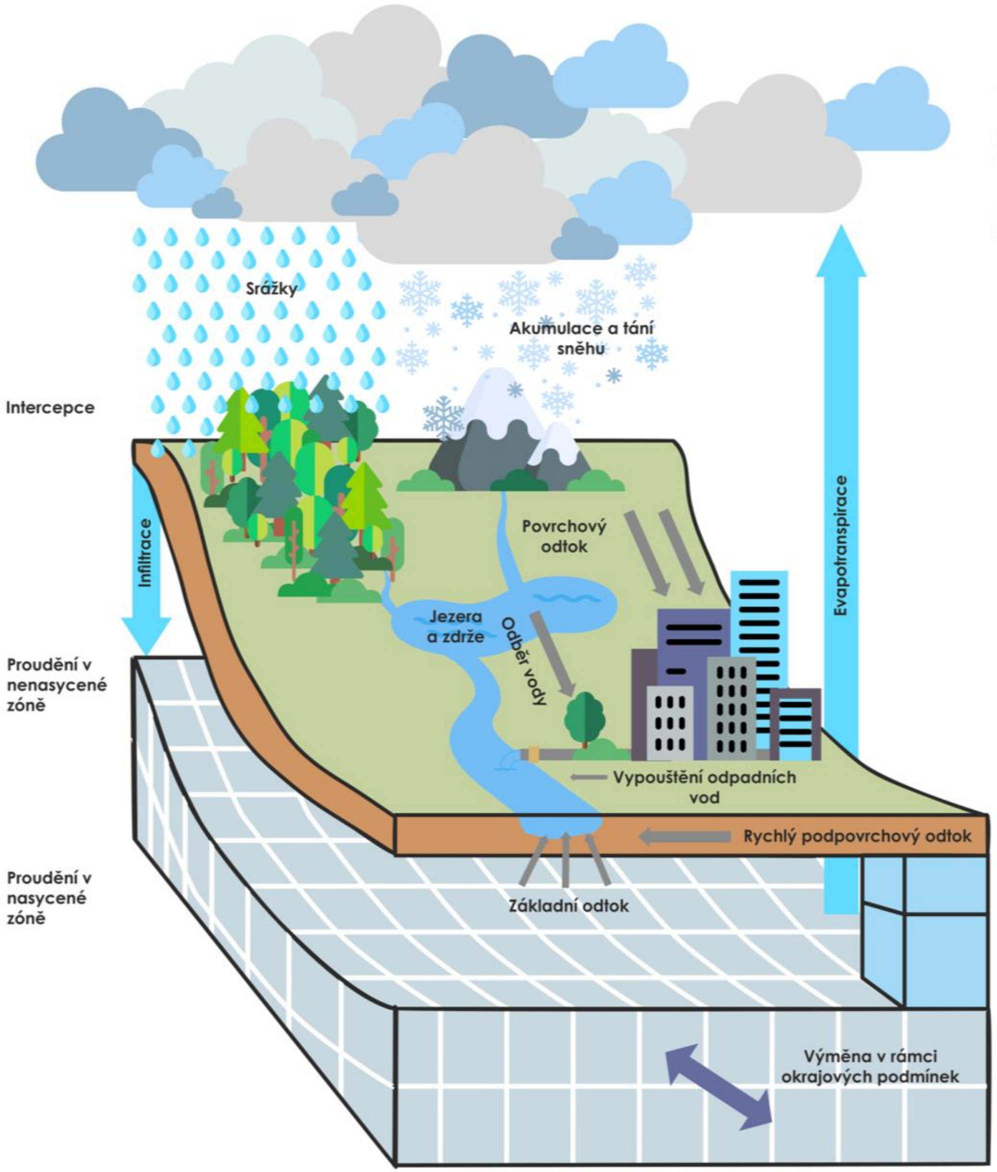
- Climate change in Thaya river basin can be simplified into warming with stagnating precipitation.
- This is characterized by increase in spring evapotranspiration but its decrease in summer – altitudinal gradient important.
- Overall runoff decreases – altitudinal gradient important.
- Adaptation measures are needed but complex evaluation is required first.

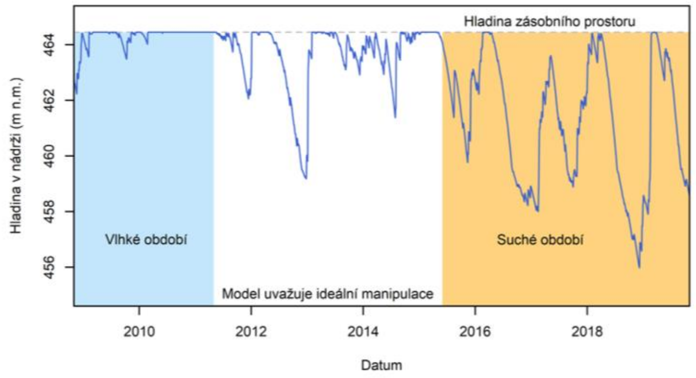
Distributed model MIKE SHE – work at the Thaya river basin

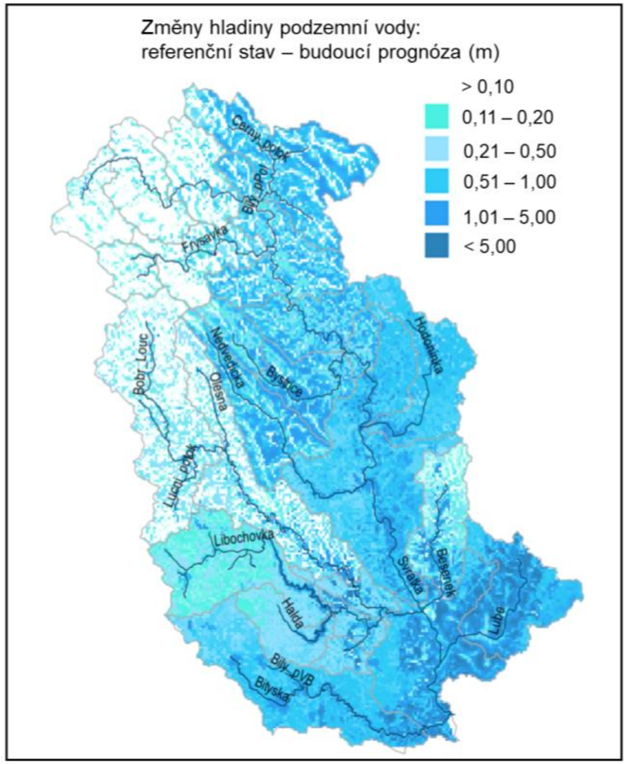












Thank you for your attention!