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Rijkswaterstaat
Ministry of Infrastructure and the Environment

TU Delft Deltares

Sensitivity of hydrological predictions to ecosystem adaptation in response to climate change: the effect of time-dynamic model parameters

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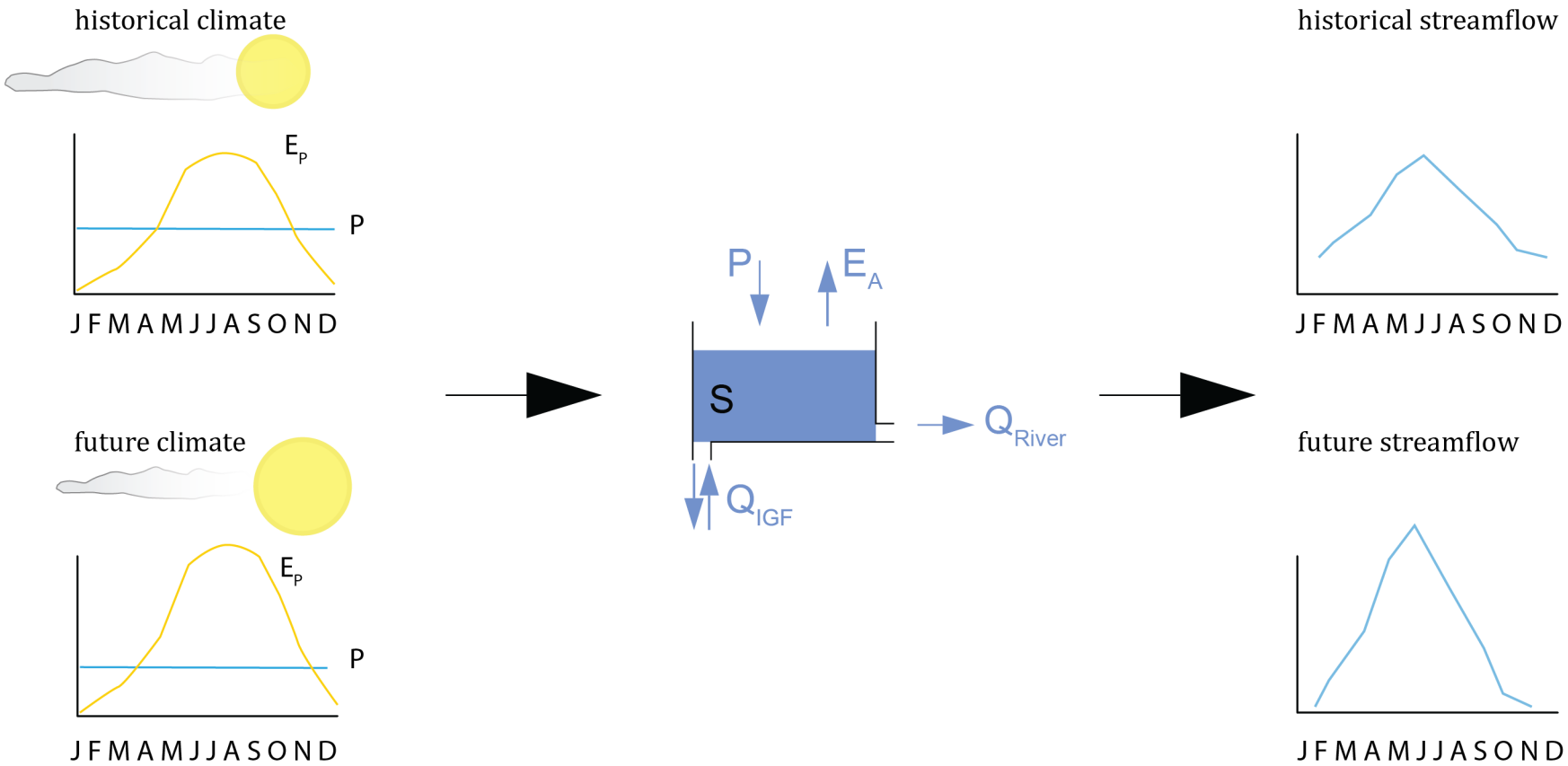
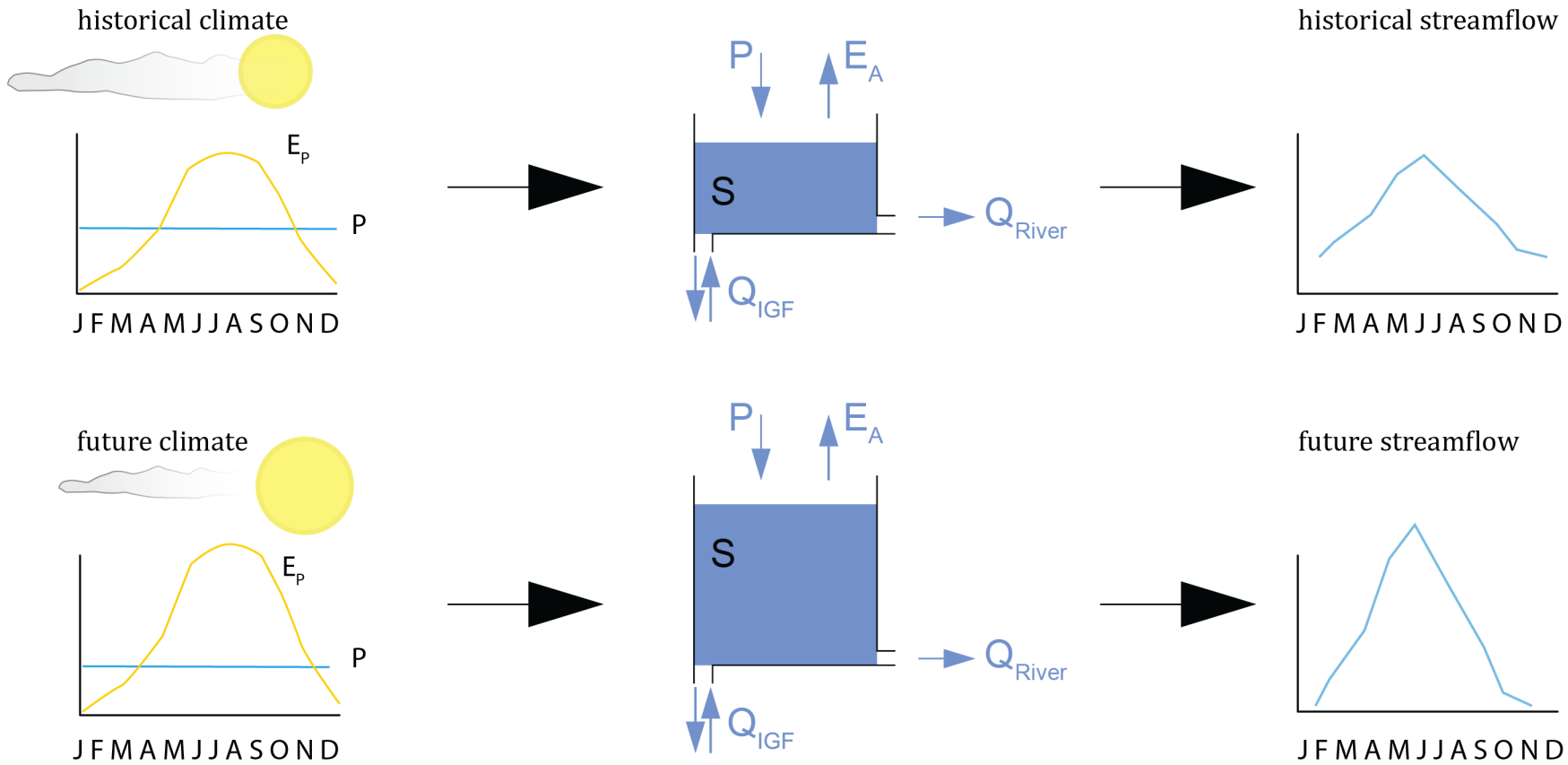
If climate changes, how should we change our models?

Source: NOS

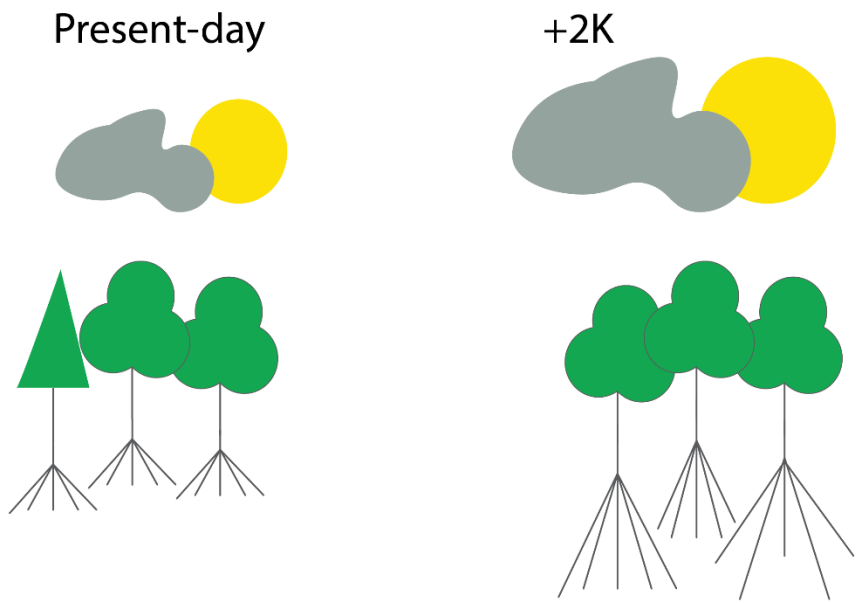
Stationary model



Adaptive model in response to climate change



Non-stationarity of hydrological system

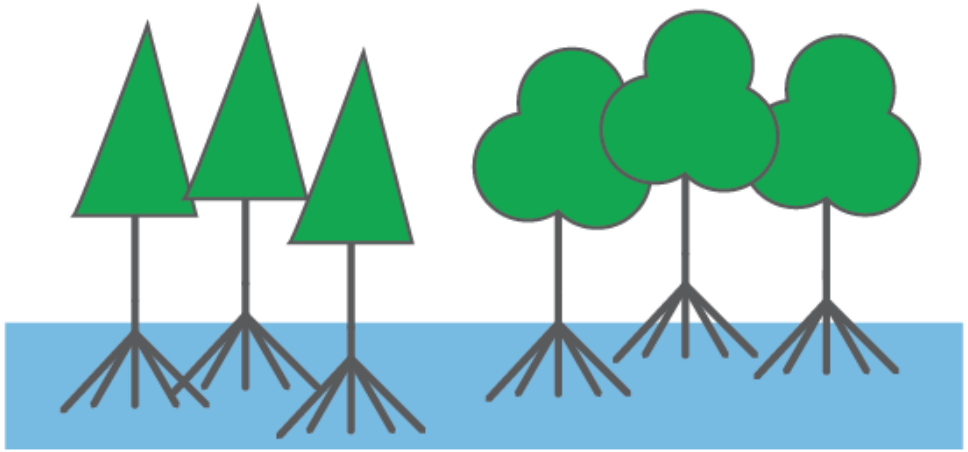


Shift in dominant species

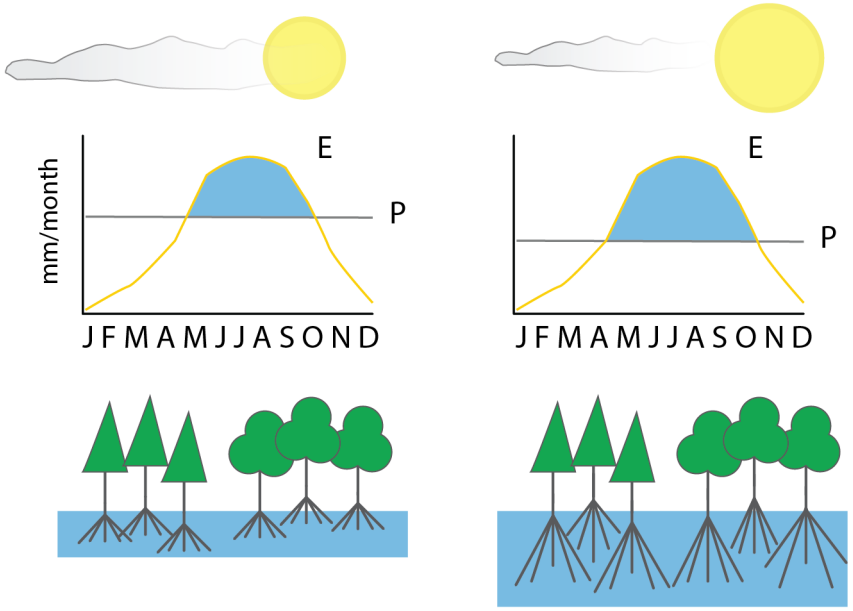
Ecosystem likely adapt their root-zone storage capacity

Root-zone storage capacity

Maximum volume of water in the pores of the unsaturated soil which is available to the roots of vegetation for transpiration



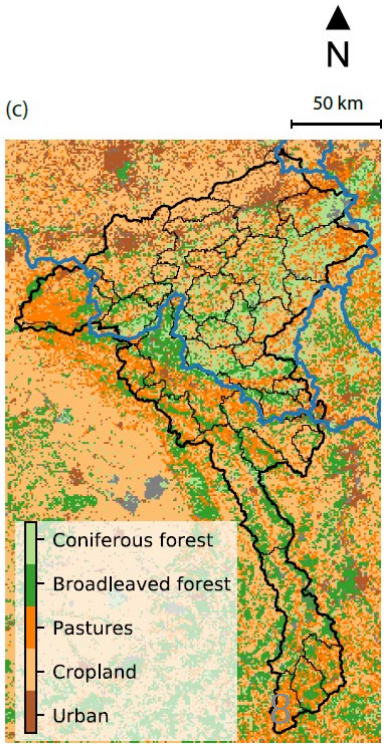
Climate dependency of the root-zone storage capacity



hypothesis

Changes in the **predicted hydrological response** as a result of **+2K global warming** in comparison to current day conditions are more pronounced when explicitly considering an **adapted root-zone storage capacity** to reflect changes in seasonality and magnitude of hydro-climatic variables as well as potential land-use changes.

Case study: the Meuse river basin

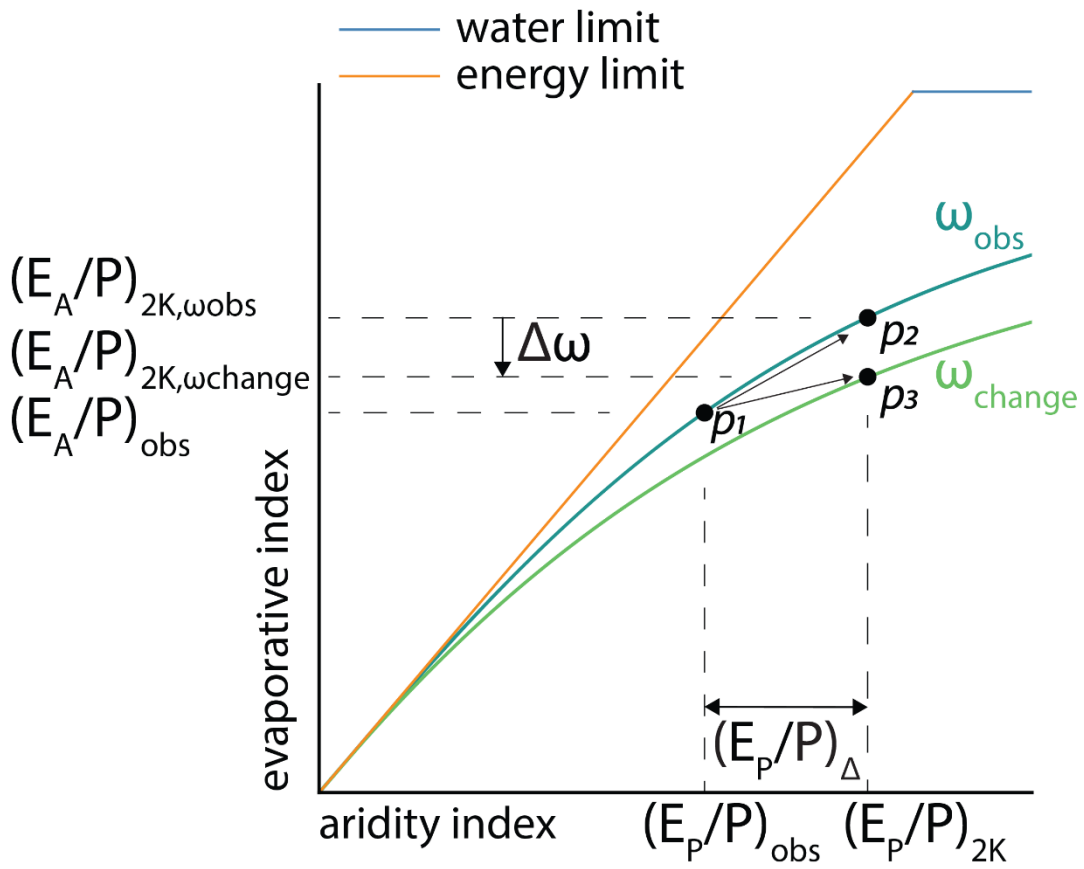


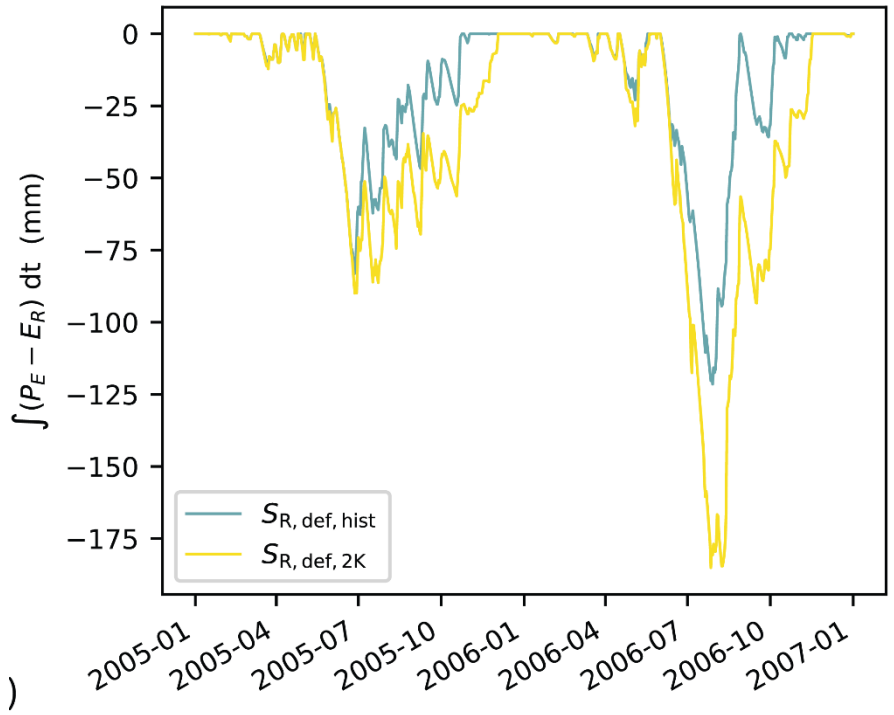
Land use variability in the Meuse

Methods: data and hydrological model scenarios

Scenario name	Historical climate forcing run with:	+2K climate forcing run with:
Benchmark stationary scenario $2K_A$	Historical root-zone storage capacity	Historical root-zone storage capacity
Adaptive scenario $2K_B$		Adapted root-zone storage capacity due to climate change
Adaptive scenario $2K_C$ & Adaptive scenario $2K_D$		Adapted root-zone storage capacity due to climate change & potential land use change

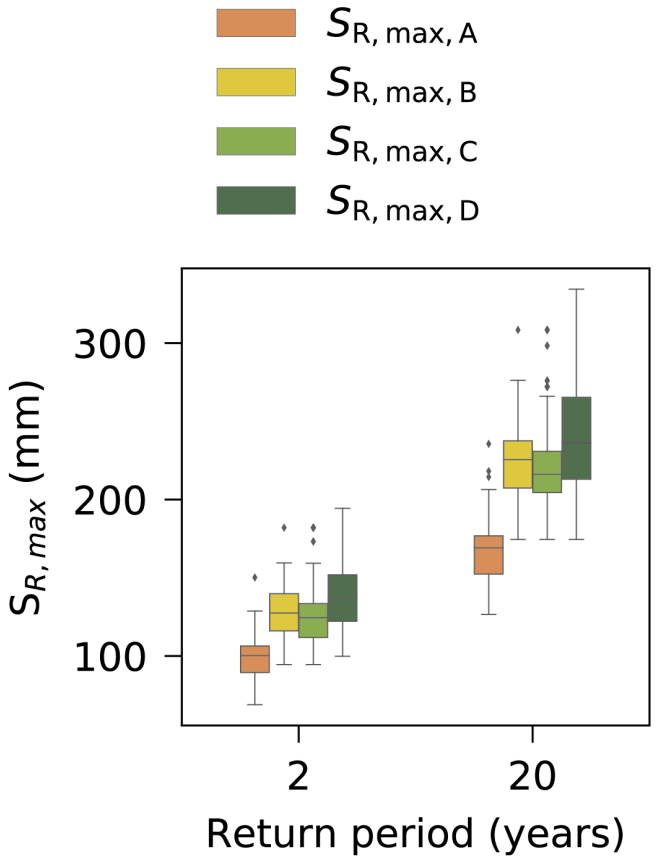
Methods: Budyko framework and water balance method to estimate root-zone storage capacity





Results: changes in estimated root-zone storage capacity parameter

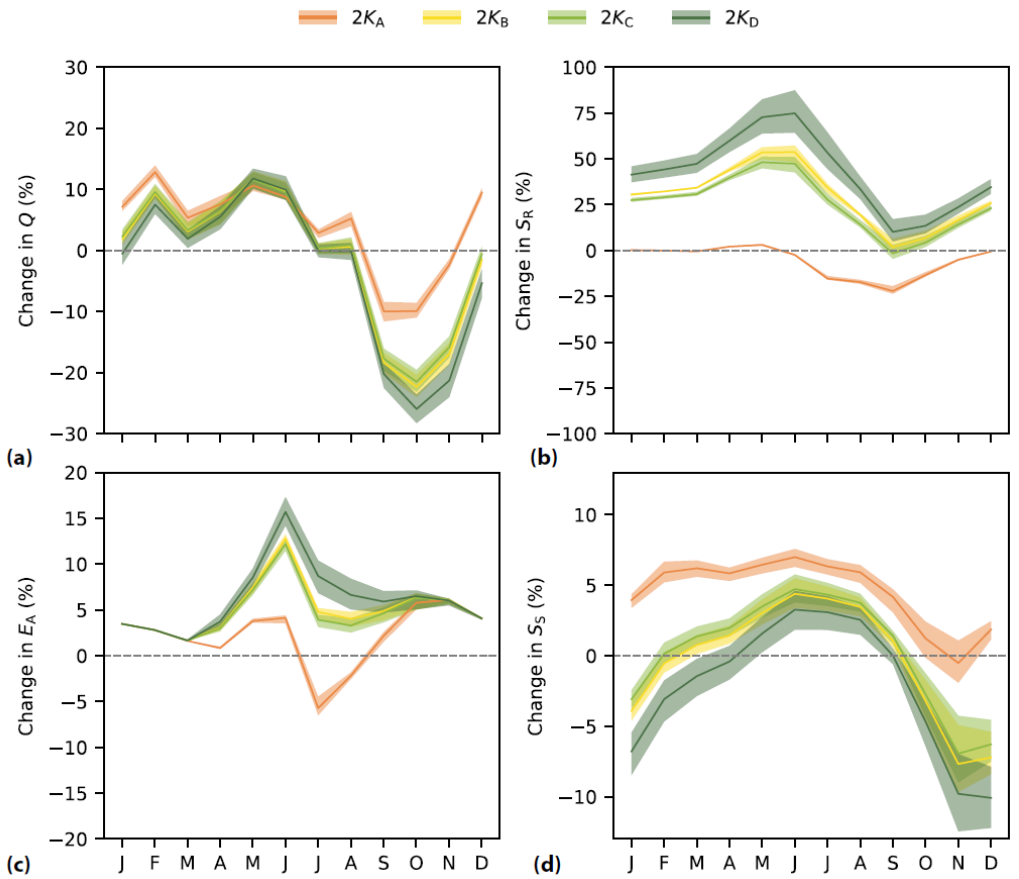
Increase of the root-zone storage capacity parameter ($S_{R,max}$) with approx. 34% due to more pronounced seasonality with drier summers under 2K global warming.



Results: change in hydrological respons under +2K global warming for the 4 scenarios

The adaptive model scenarios show in comparison to the benchmark stationary scenario:

- Additional increase in actual evaporation: up to +14 % in summer months
- Additional decrease in streamflow: up to -15 % after summer
- Additional decrease in groundwater storage: up to -10 % after summer



Limitations and conclusions

- Climate projections can directly be used to estimate how the root-zone storage capacity may adapt to changing climatic conditions (here, increase of 34%).

- Adaptive models with time-dynamic model parameters may show a substantially different hydrological response in response to climate change than commonly used stationary models

- Assume that ecosystems have had the time to adapt!

Thank you!

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