IWAS Ukraine

International Water Research Alliance Saxony

Regional climate projections for the Western Ukraine and the impact of climate change on evapotranspiration and runoff

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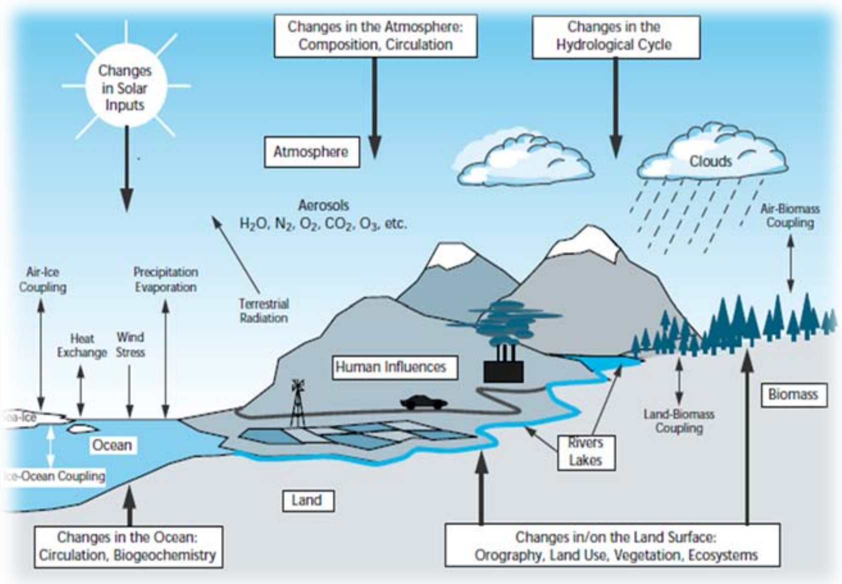
Introduction

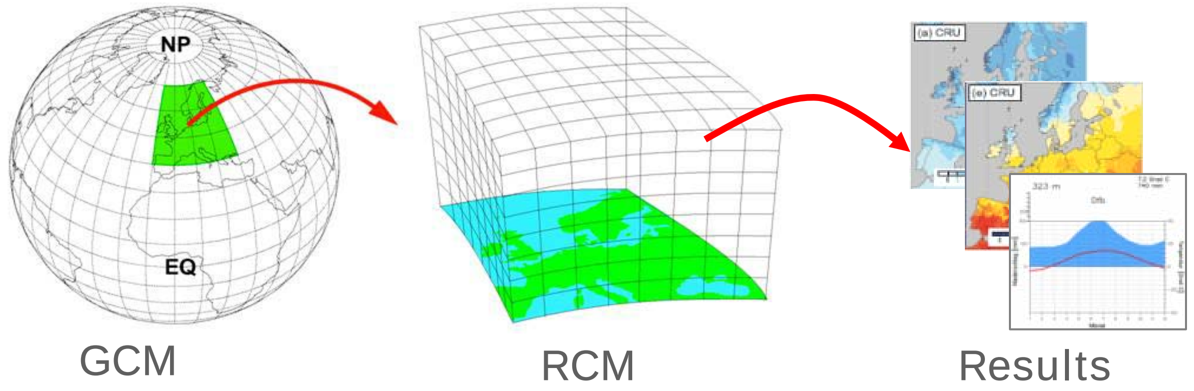


(Source: IPCC 1997)

- The climate system is close connected to the water cycle, vegetation, soil, landuse and the human environment.
- All spheres of our environment are influenced by climate change.
- Analysis of the recent climate and possible changes in future are preconditions for IWRM.
- Future climate change can only be estimated with a climate model.

Regional Climate Modelling

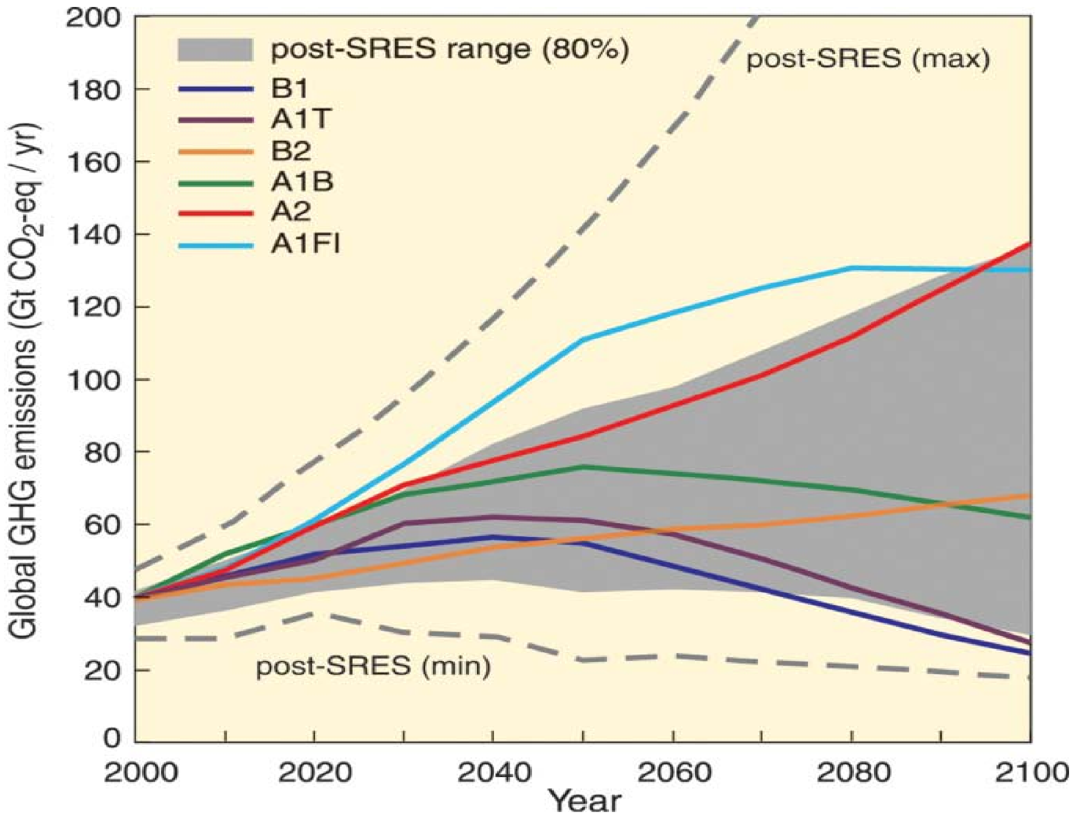
- Is based on Dynamical Downscaling → obtain regional-scale climate conditions from global-scale atmospheric variables that are provided by Global Circulation Models (GCMs).
- Embedding (nesting) of a grid with a finer spatial resolution into the coarse grid of a GCM.
- The results of the GCM serve as forcing at the boundaries of the regional grid.
- Using external parameters (orography, soil, vegetation…) with a higher spatial resolution in the area of interest.
- Parameterizations and physical equations are adapted to the atmospheric processes on the regional scale.



Simulation Approach

Dynamical Downscaling of global climate projections (7km spatial resolution)

- Global Model: ECHAM 5 (forcing)
- Regional Model: COSMO – CLM (CCLM)
- IPCC-Scenarios: B1, A2
- Time periods: 1961-1990, 2021-2050, 2071-2100



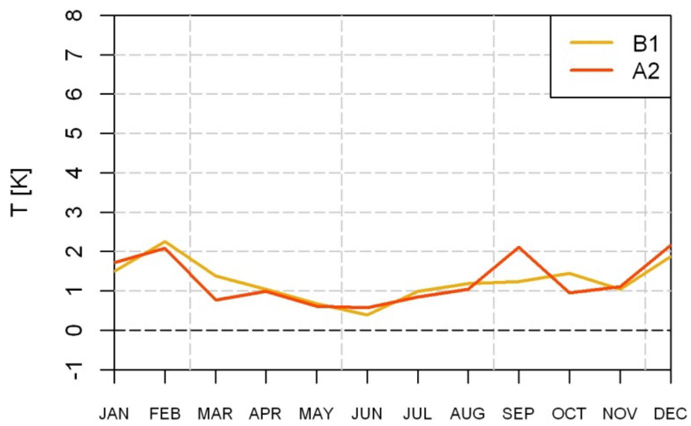
Source: AR4 (IPCC 2007)

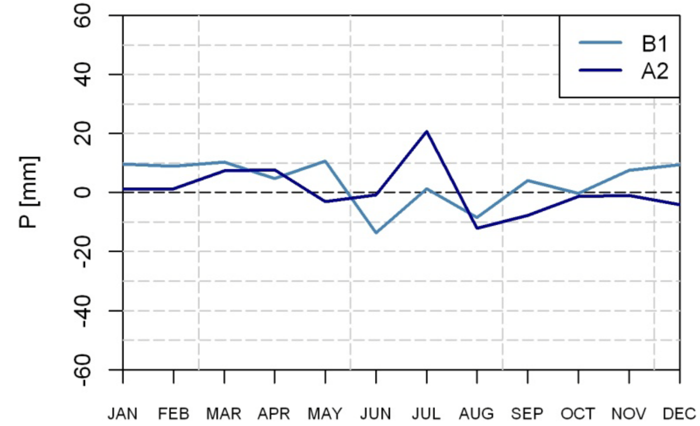
Results – climatic changes

Temperature

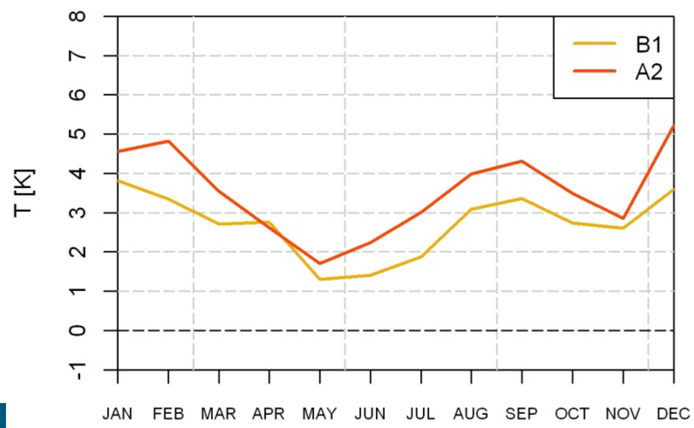
Precipitation

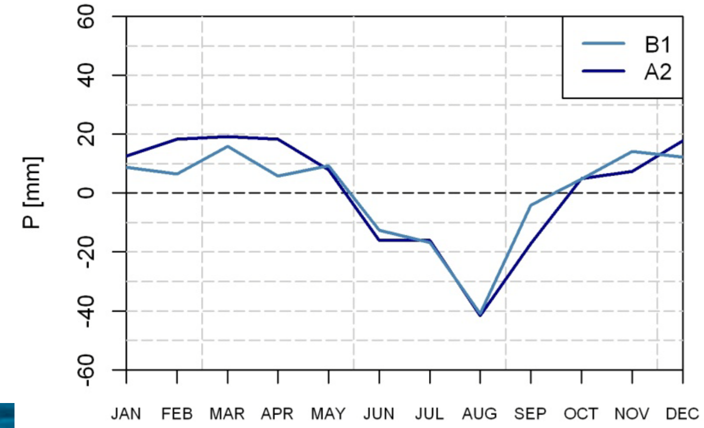
2021-2050





2071-2100



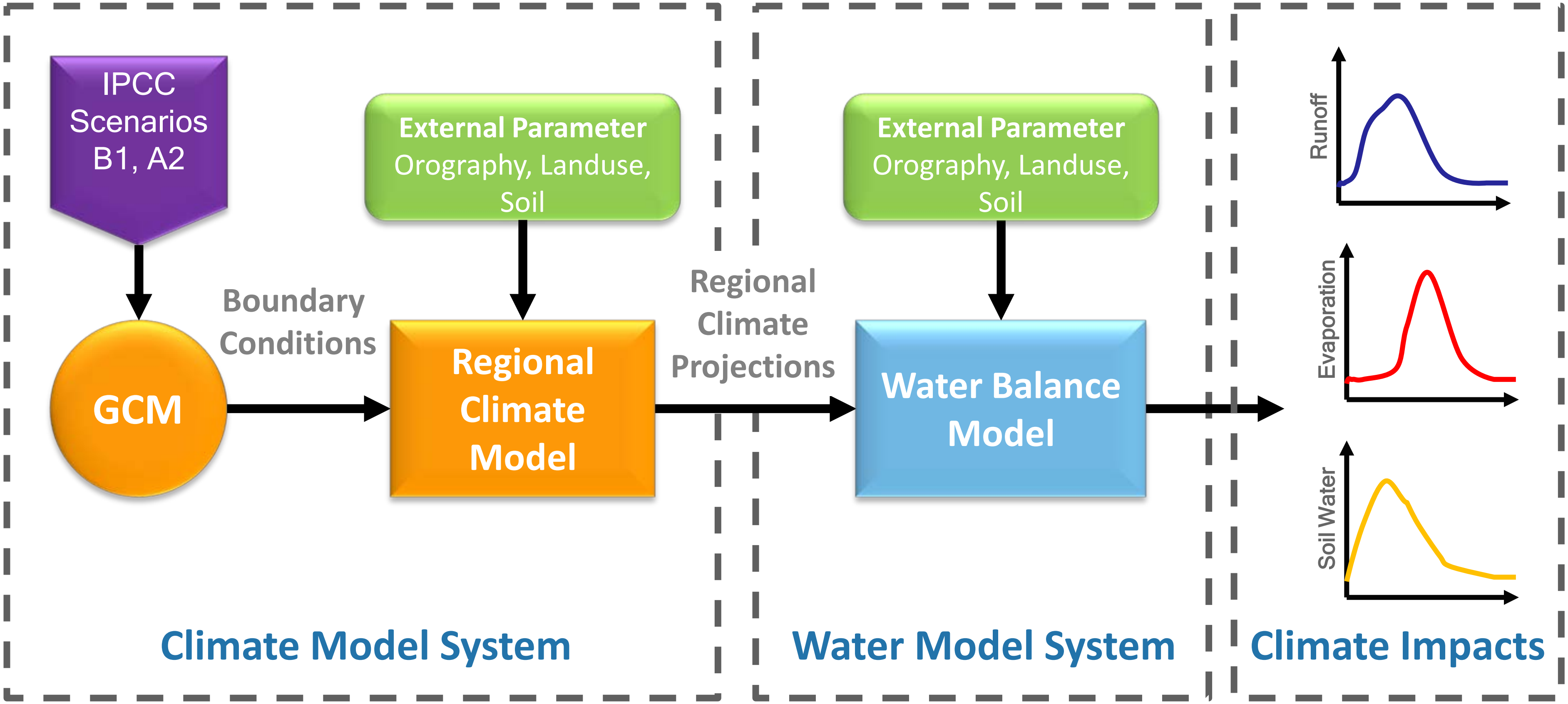


Impact of climate change

- How influence the projected climatic changes evapotranspiration and runoff?
- Complex interactions among meteorological elements, soil and plants have to be analysed.
- This is possible only with a coupled modelling approach.

→ Assessment of the climate change impact onto water balance components (runoff components, actual evapotranspiration) and other socio-economic sectors (e.g. agriculture, ecology, energy)

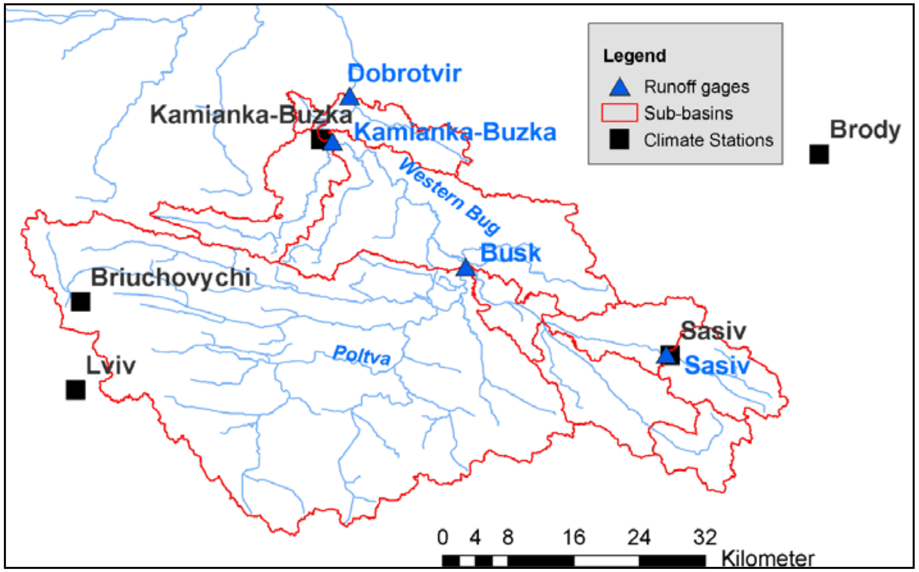
Climate Impact Modelling



Water Balance Modelling

- Investigation Area: Basin Inflow reservoir Dobrotvir – 2616 km²
- Model: Soil and Water Assessment Tool (SWAT) - conceptual river basin scale model for quantification of water and matter fluxes and the impact of changing conditions
  - Parameterization based on input data, SWAT database
  - Adaptations based on Plant Parameter Database of the University Giessen, Germany
  - Calibration: 1981 - 1990

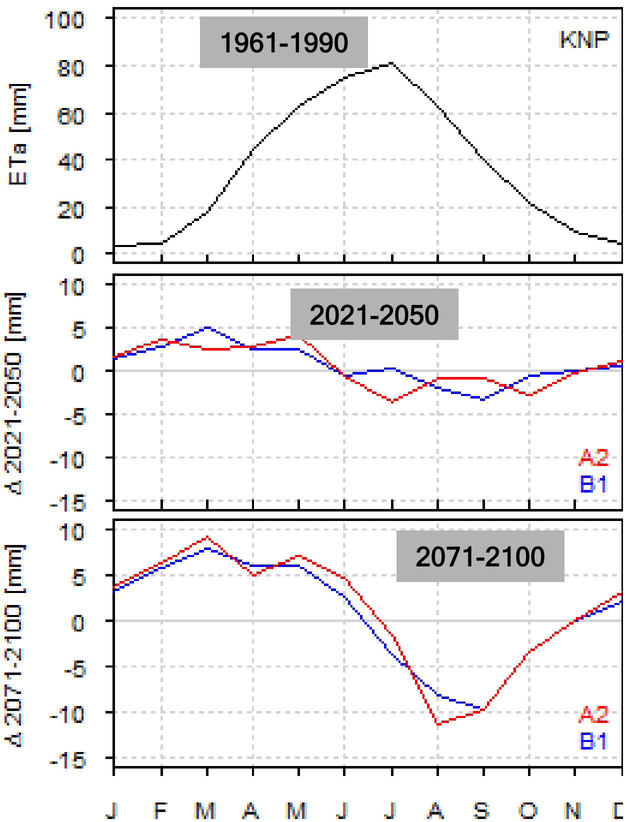
    Validation: 1971 - 1980



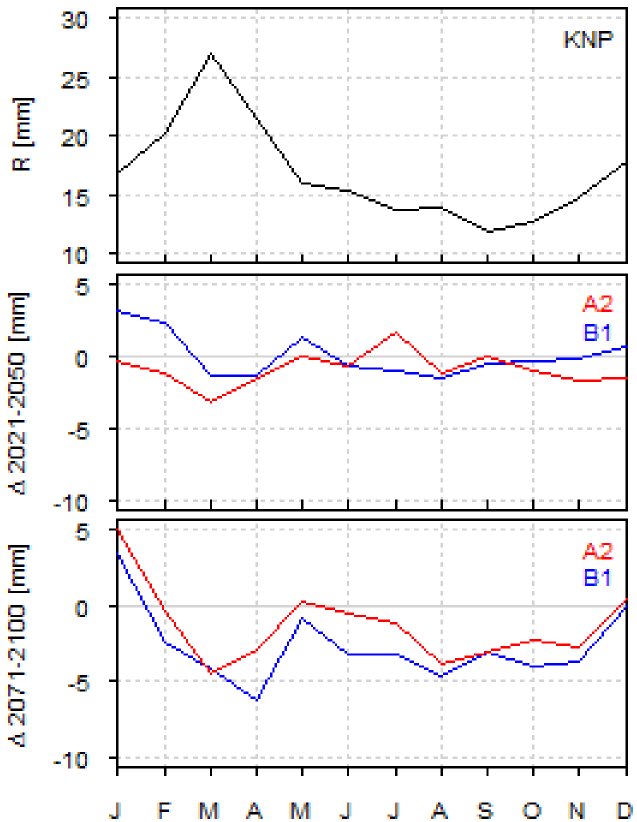
Results - impact of climate change

Regional climate projections : SRES scenarios A2, B1; analysis of periods 2021-50 and 2071-2100

Actual evapotranspiration ETa



Runoff

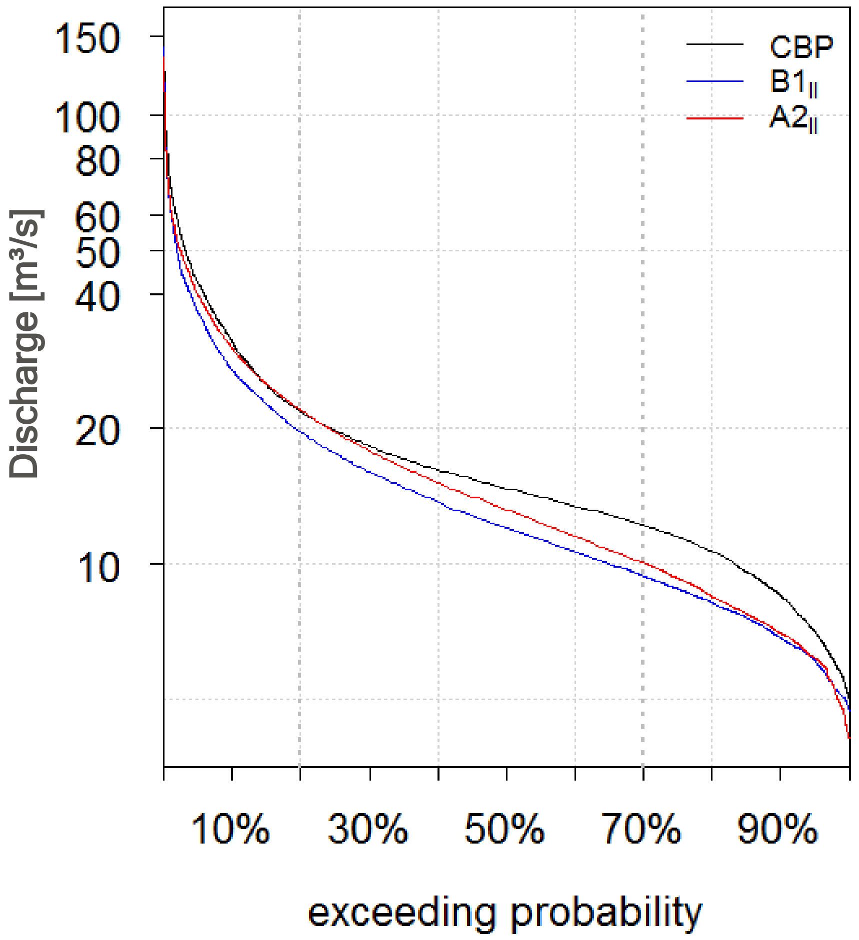


- nearly no impact until 2050
- at the end of century:
  - ➢ ETa increasing in Dec-Jun (due to higher temp.) and decrasing in Jul-Oct (due to water deficit)
  - ➢ Runoff decreasing the whole year, except Dec and Jan (due to water deficit)

Master Thesis: S. Fischer (2012)
Scenarios of future climate and water balance of a Ukrainan basine and its relevance for an IWRM

Flow duration curve

- FDC: probability that a certain discharge is exceeded
- Decreasing flow in 2071-2100 in comparison to present flow conditions (CBP) in all flow segments
- Strongest decrease during low flow and moderate flow conditions
- Reasons: reduced snow melt-induced floods, decrease in summer precipi-tation, increased evapotranspiration and annually reduced soil water storage



Summary and Conclusion

- Positive temperature changes occur in every month and will be intensified up to the end of the century. Strongest temperature increase occurs in winter months.
- There are no clear changes of long-term mean precipitation sums. But, the inner annual distribution changes → decrease in summer and increase in winter.
- Increasing temperatures and solar radiation cause higher actual evapotranspiration rates in winter and spring.
- Decreasing summer and fall rainfall causes soil water depletion, decreasing actual evapotranspiration.
- Runoff is decrasing from spring till fall.
- Implications for water management, agriculture, forestry, ecology.
- Adaptation measures needed, especially for optimal water usage in the basin.

Thank you for your attention!

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