International Water Alliance Saxony

Hydrologic effects of climate change in the Western Bug Basin

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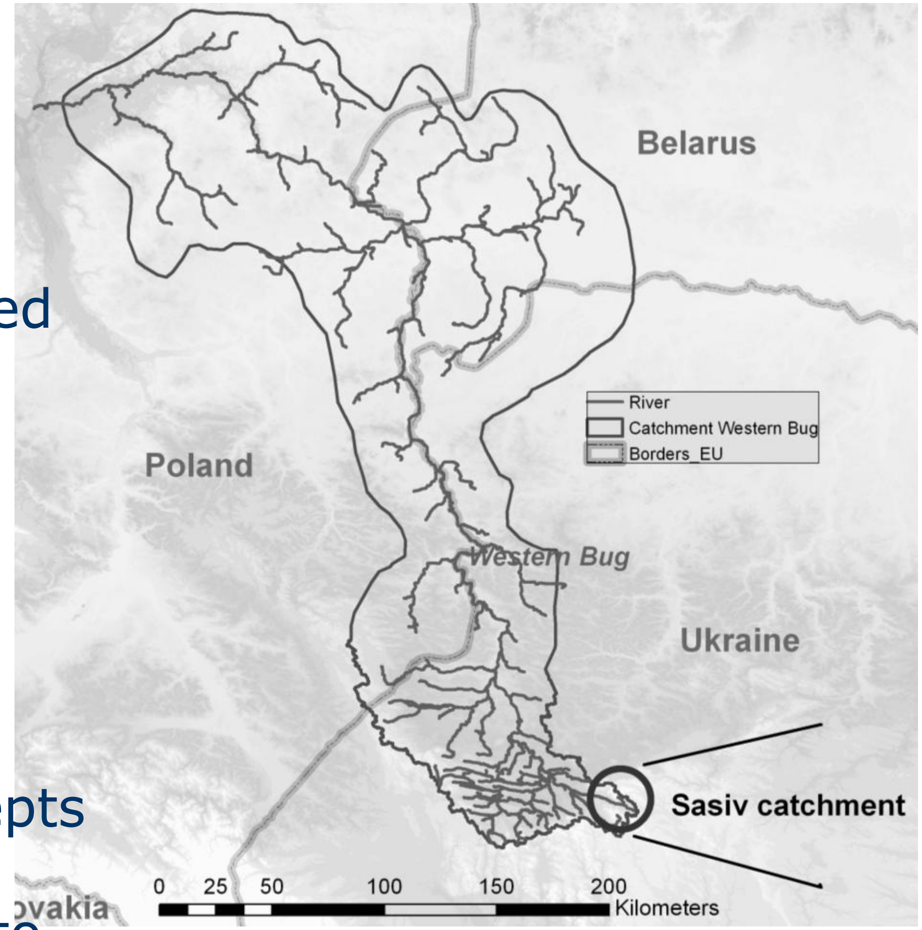
Motivation

- Project “IWAS - International Water Alliance Saxony”
  - 5 regions in the world – different water problems
  - Context: Integrated Water Resource Management – IWRM
  - Consideration of future scenarios for a sustainable water management

Motivation

- Ukraine, Western Bug:
  - Problems: bad water quality, insufficient water treatment, intensive agriculture, complicated institutional conditions
  - Aims: system analysis; model based test of management options; future scenarios; governance and technical concepts
  - Water balance as pre-requisite to determine the matter balance

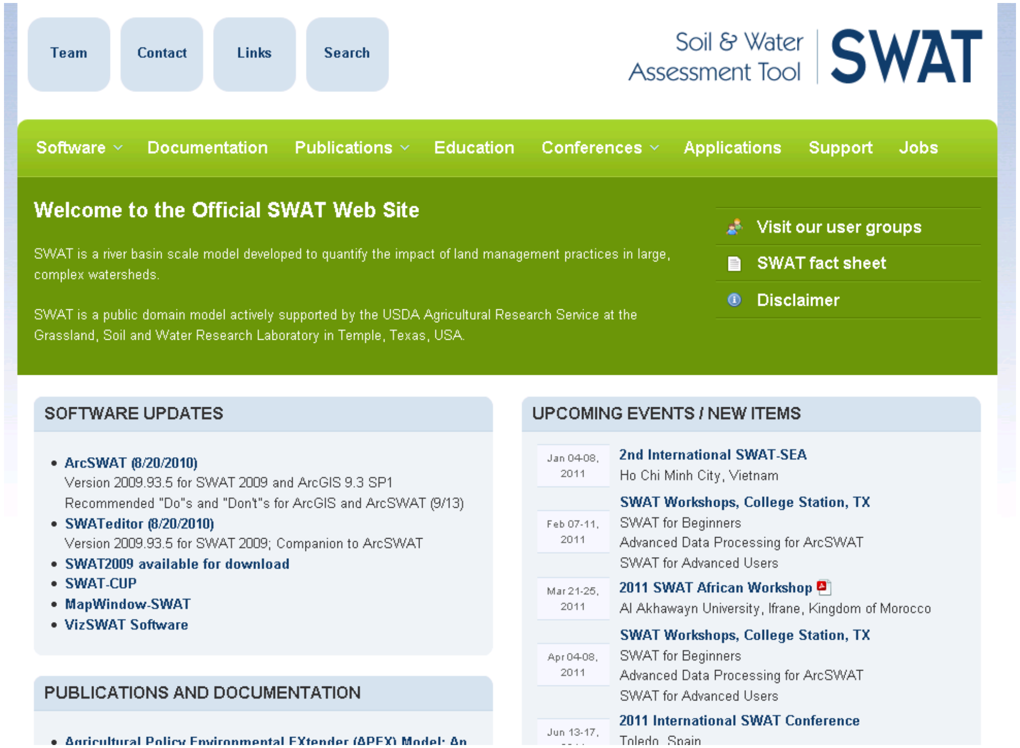


Sasiv (107 km²)

Model SWAT

- Soil and Water Assessment Tool (http://swatmodel.tamu.edu/)

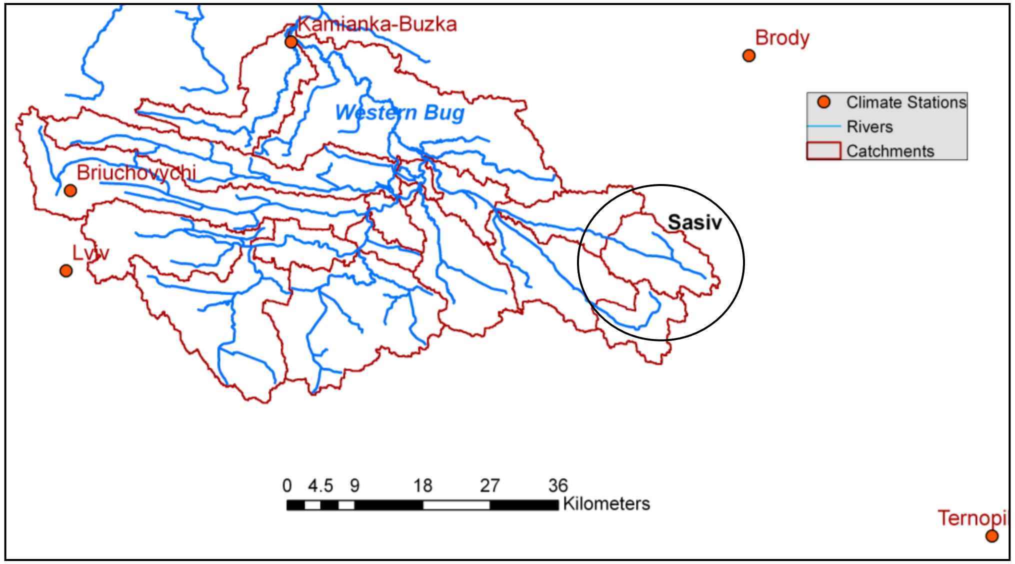
- Public domain
- Process oriented river basin scale model
- Quantify water and matter fluxes and the impact of land management practices in large, complex watersheds



Data and investigation area

Model input data

- Daily meteorological data
  - Precipitation
  - Temperature (Max, Min)
  - Global radiation
  - Relative humidity
  - Wind speed



⇨ Sources of historical data (1961-2008):

- http://eca.knmi.nl/ and http://www.ncdc.noaa.gov
- Rostotsky Landscape Geophysical Station in Briuchovychi (Ivan Franko University Lviv)

Low precipitation gauge density:
- in Germany 50 times more gauges

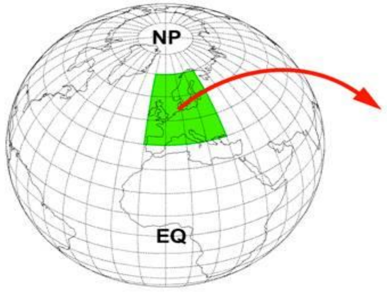
Data and investigation area

Model input data: Future projections

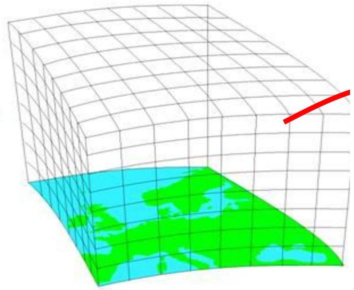
- 2051-2080, Emission scenario SRES-A1B

- Global Climate Model (GCM): ECHAM5/MPIOM
  - Spatial resolution: ~ 130 km

- Regional Climate Model (RCM): REMO
  - Spatial resolution: ~ 25 km



Global Model


Regional Model

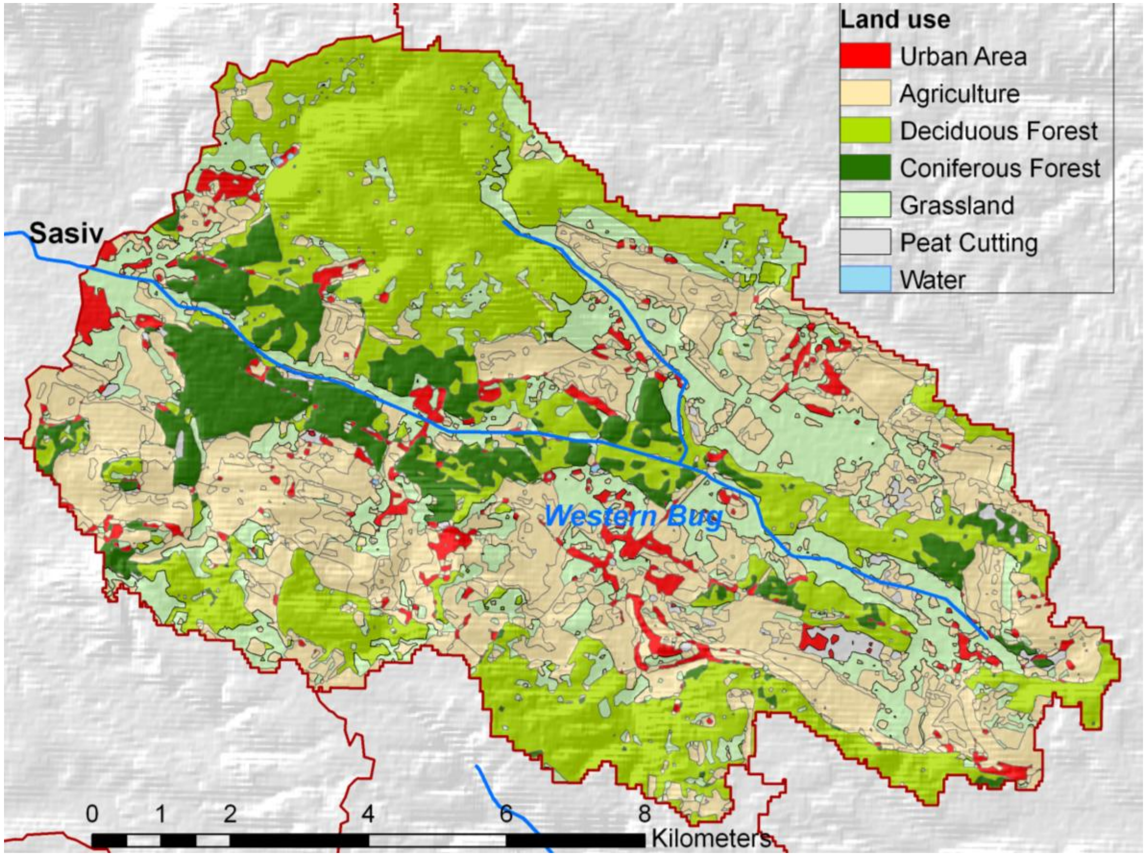
- Use of the grid-cell with minimum distance to centre of the catchment

Data and investigation area

Digital Elevation Model
(range: 200 – 480m)
Source: http://srtm.csi.cgiar.org/

Landcover: Landsat-TM5
(15m resolution, 1989)

- CORINE landcover classification scheme



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Landuse

Industrial farming

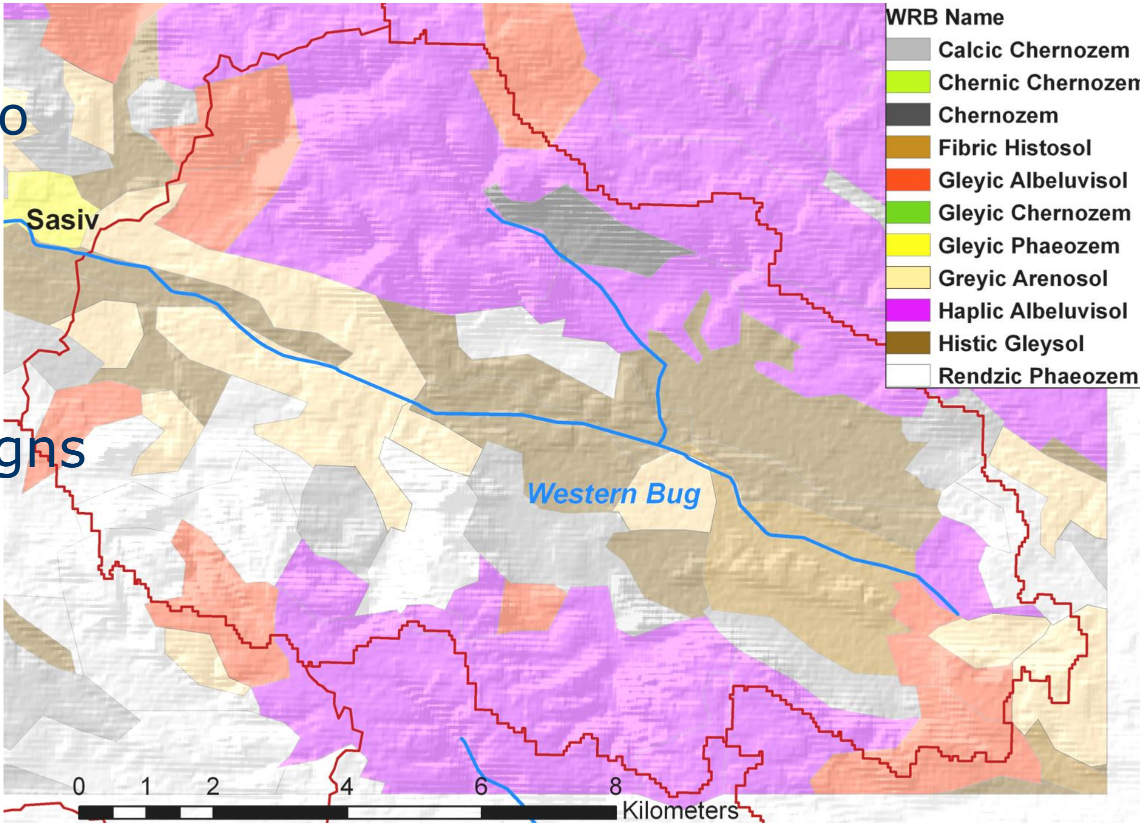
Subsistence farming

- No details about:
    - Crops: (cereals, corn, potatos, cabbage)
    - Plant characteristics (LAI etc.)
    - Drainage

Drainage dykes

Soil

- Scale 1:200.000; map of 1969, no information below forest
- Filling of gaps using a complex approach
- Classification according to WRB
- derivation of soil and hydraulic parameters together with ukrainan experts and field campaigns





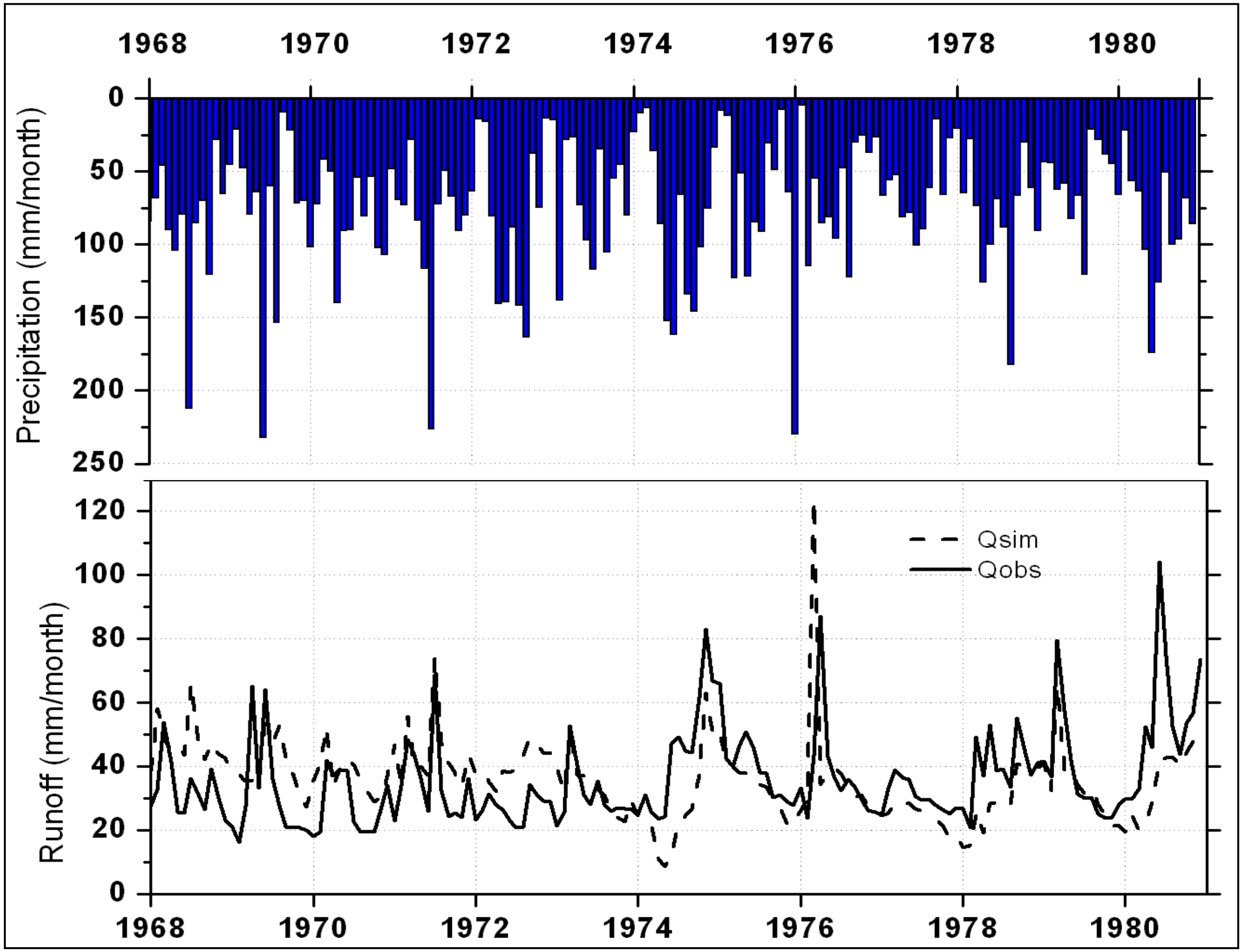


Past water balance

Results of SWAT modelling:

-Problems with representativity of gauges (precipi-tation, radiation)

-contrary trends for runoff (positive) and precipitation (negativ) ?



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Past water balance

Results of SWAT modelling:

Period	Precipitation (mm)	Snow fall (%) *1	Runoff (%) *1	Evapotranspi-ration (%) *1	Potential Evapotranspi-ration (%) *1
1968-1990	881	17	49	48	79

*1 in % from precipitation

- Bias corrected precipitation

Future water balance

Climatological comparison

(observation 1961-90 / scenario 2051-80)

- Mean yearly precipitation

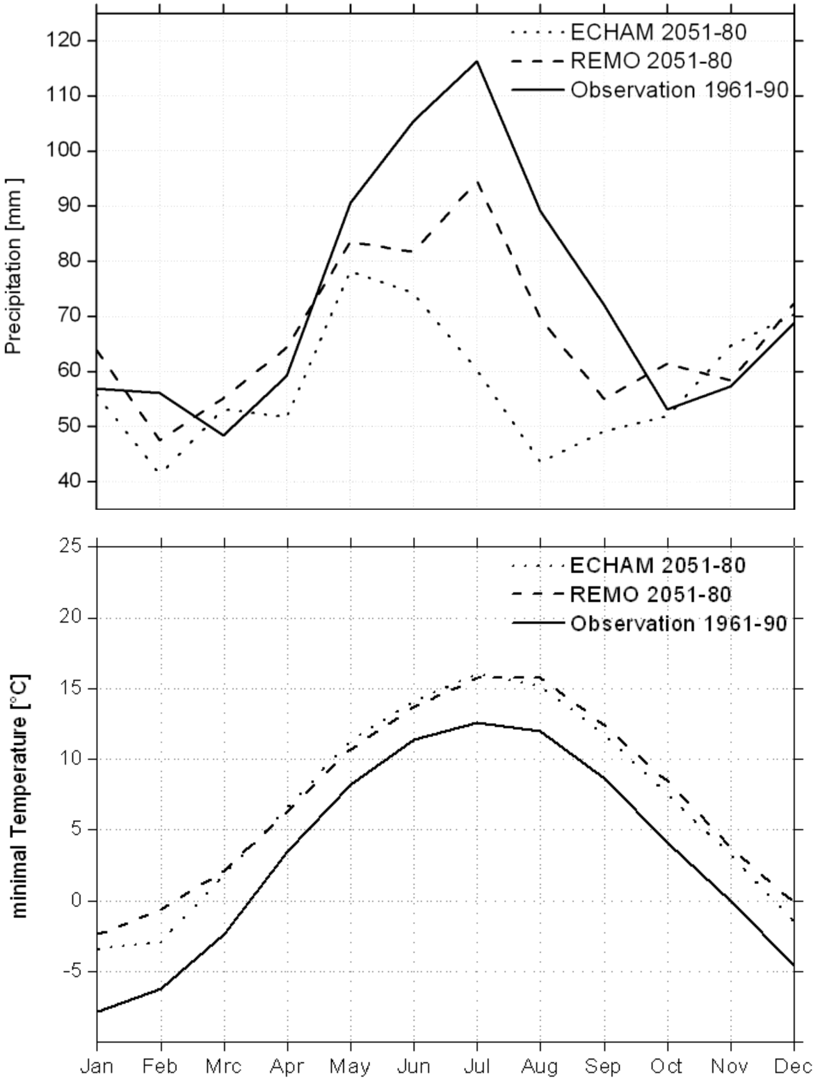
  REMO –8% and ECHAM -20%

- Mean yearly Tmax +1.8 K;

  Tmin +3.6 K

- Not shown:
  - Rel. Humidity REMO 0%

    ECHAM +8%
  - Wind +13%
  - Global radiation +3%



Future water balance

Results of SWAT modelling:

Period	Precipitation (mm)	Snow fall (%) *1	Runoff (%) *1	Evapotranspi-ration (%) *1	Potential Evapotranspi-ration (%) *1
1968-1990	881	17	49	48	79
2051-2080	**Trend** ↓	↓	↓	↑	↑
REMO	812	14	37	59	114
ECHAM	700	12	44	51	103

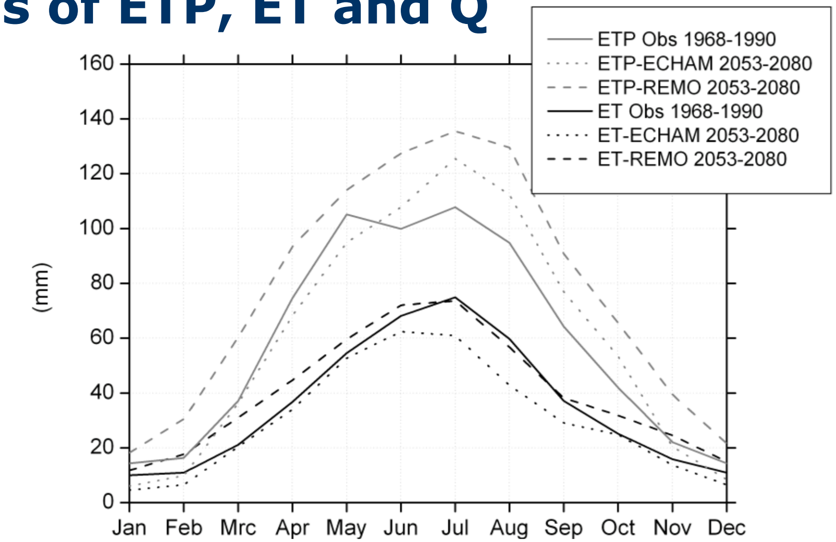
*1 in % from precipitation

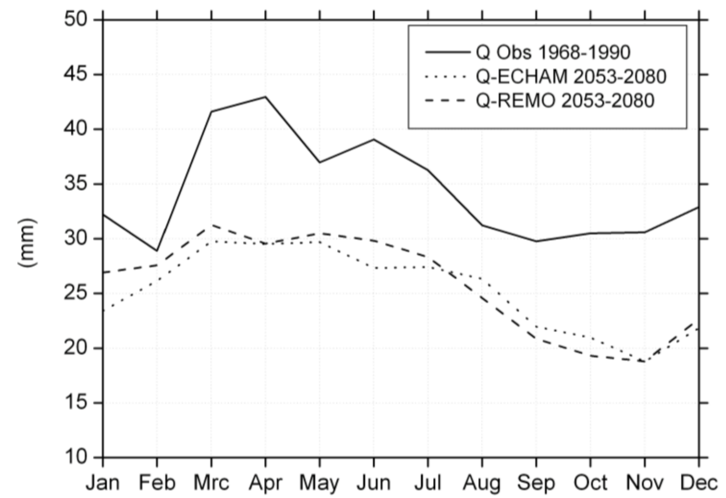
Future water balance

Results of modeling: Absolute changes of ETP, ET and Q

- Potential Evapotranspiration (ETP):
- ECHAM: +30mm
- REMO: +230mm
- Evapotranspiration (ET): ECHAM: -70mm
- REMO: +50mm

- Runoff (Q): ECHAM: -100mm
  REMO: -110mm





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Conclusions

- Different climate signals of climate models ECHAM and REMO
- Changes of water balance recognizable
  - Less precipitation - less frequent and less snow
  - Increased Potential Evapotranspiration; Evapotranspiration unclear
  - Decreased runoff throughout the year: similar hydrographs → critical, because of decreasing dilution of contaminants, especially in autumn
  - Water stress for plants in late summer

Conclusions

- Uncertainty of water balance still high; reasons:
  - Meteorological stations do not properly represent catchment (esp. rainfall and global radiation)
  - Accuracy of input data (discharge, climate, soil, land use, drainage)
  - Uncertain results of the climate models

Outlook

- Improvement of input data
  - New data sources: satellite → LAI; other climate observation networks …

  “Which observation networks exist?”

  “How is the reliability and availability of climate observations from agricultural networks?”

- Better future water balance estimations using
  - Regional Climate Model simulations (CosmoCLM) and
  - Projections of land use changes

Thank you for your attention!

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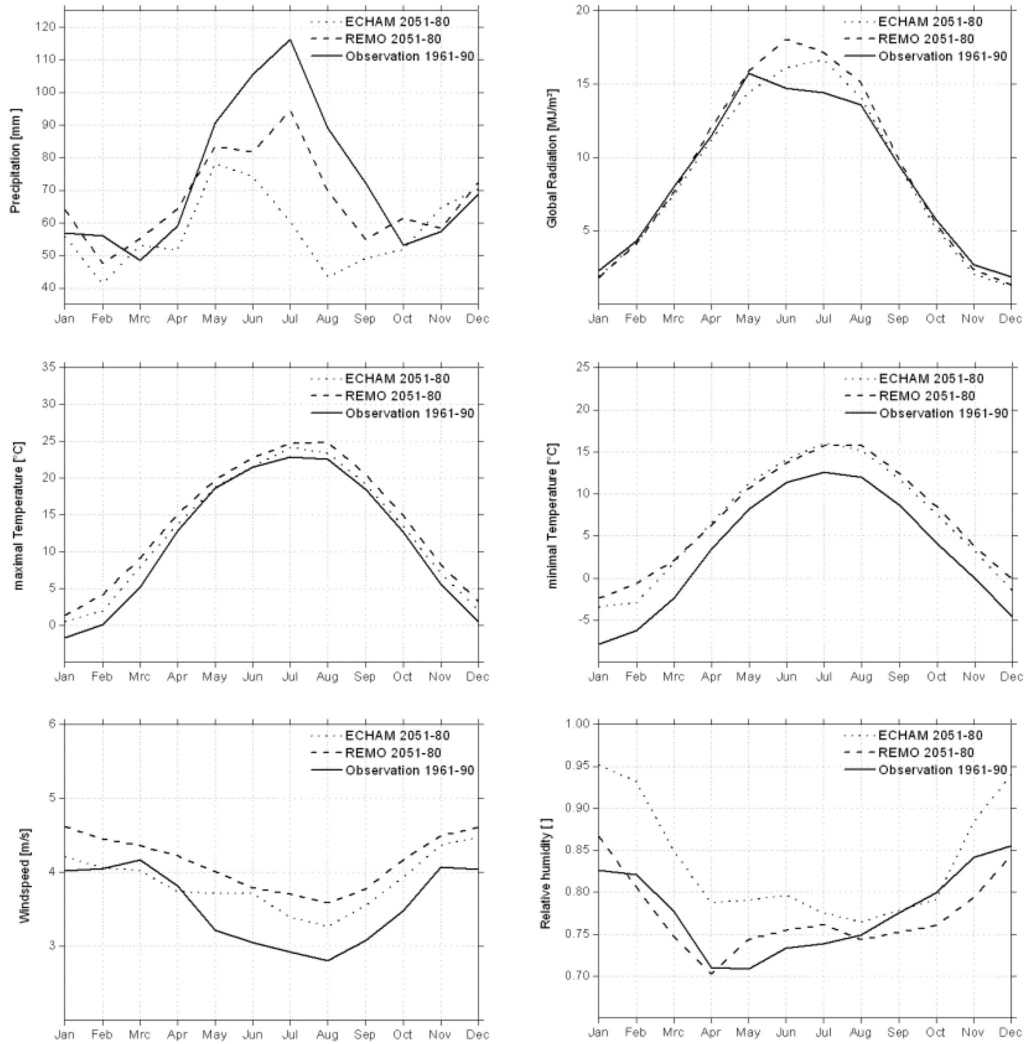
ECHAM 2051-80
REMO 2051-80
Observation 1961-90
Precipitation [mm]
Global Radiation [MJ/m²]
maximal Temperature [°C]
minimal Temperature [°C]
Windspeed [m/s]
Relative humidity [ ]
Jan Feb Mrc Apr May Jun Jul Aug Sep Oct Nov Dec