Effect of climate change on hydrology, sediment and nutrient losses in two lowland catchments in Poland

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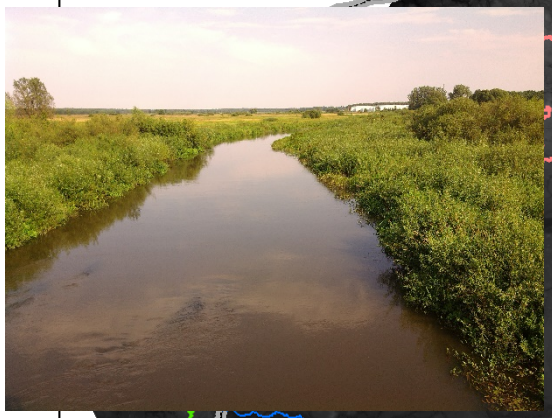
Objective

Application of a dynamic watershed model to quantify climate change impacts on hydrology and nutrient losses in two lowland catchments (Barycz and Upper Narew) being on the extreme opposite edges in terms of land use and water quality.

Location of case studies



Rivers
Upper Narew catchment
Barycz catchment
Wisła River Basin
Odra River Basin
National border

DEM
Altitude [m asl]
2536
-46

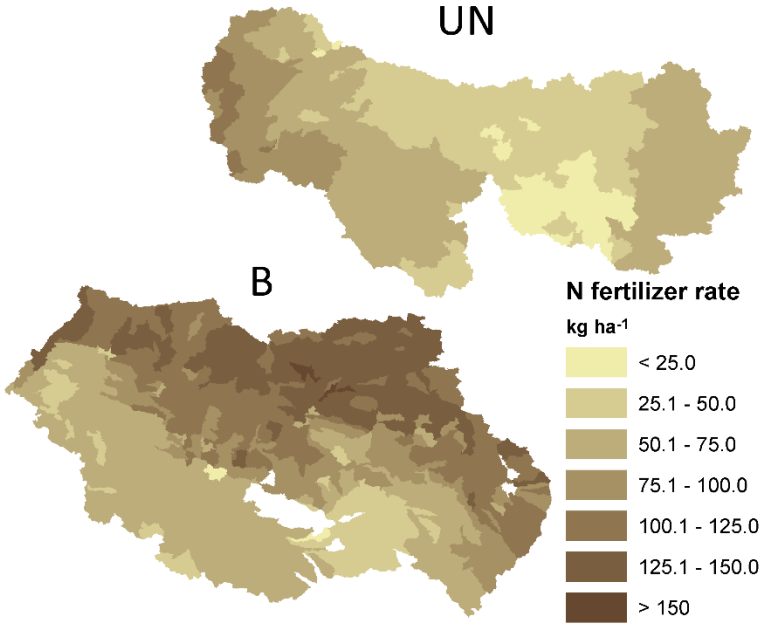
Wisła
Upper Narew
Barycz

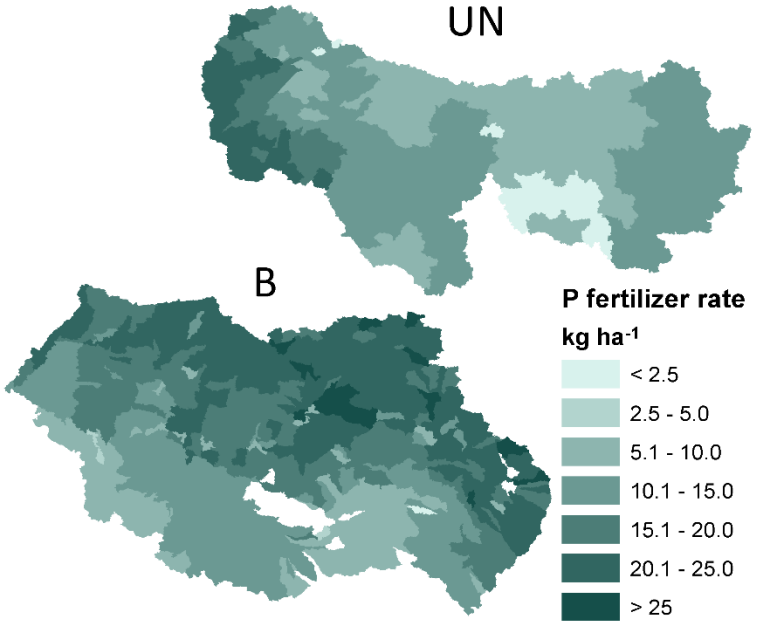
Precipitation: 670mm
Temperature: 7.1°C

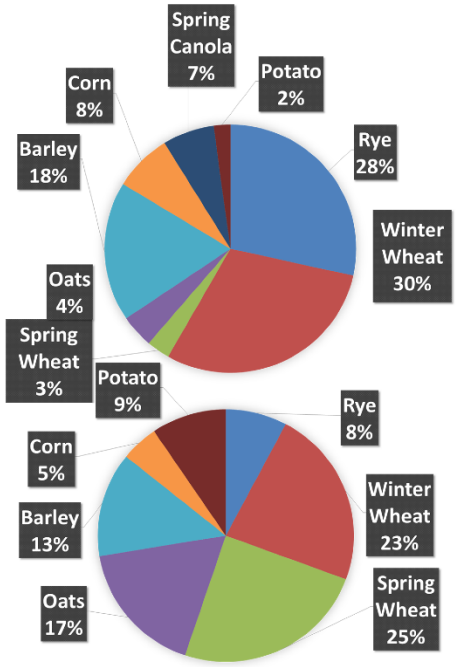
Precipitation: 630mm
Temperature: 8.3°C

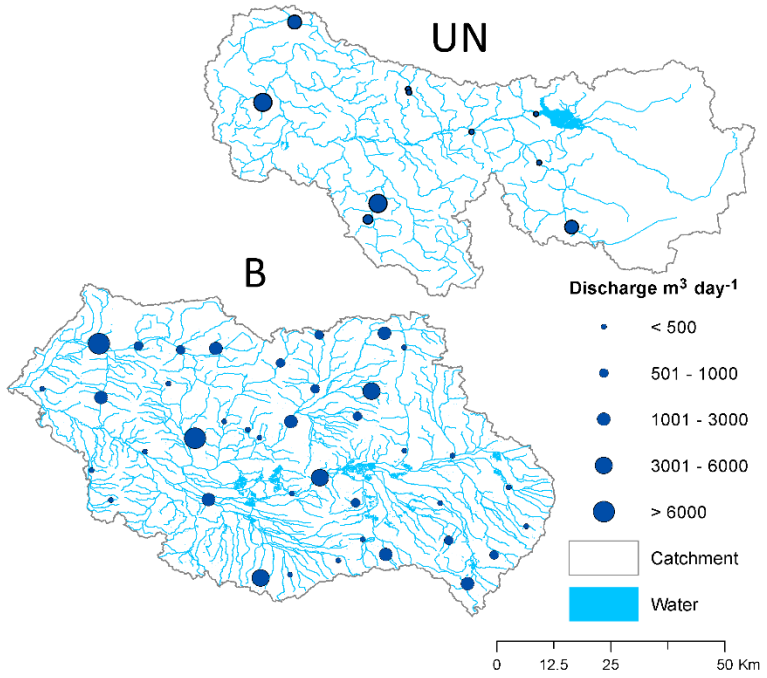
0 50 100 200 km

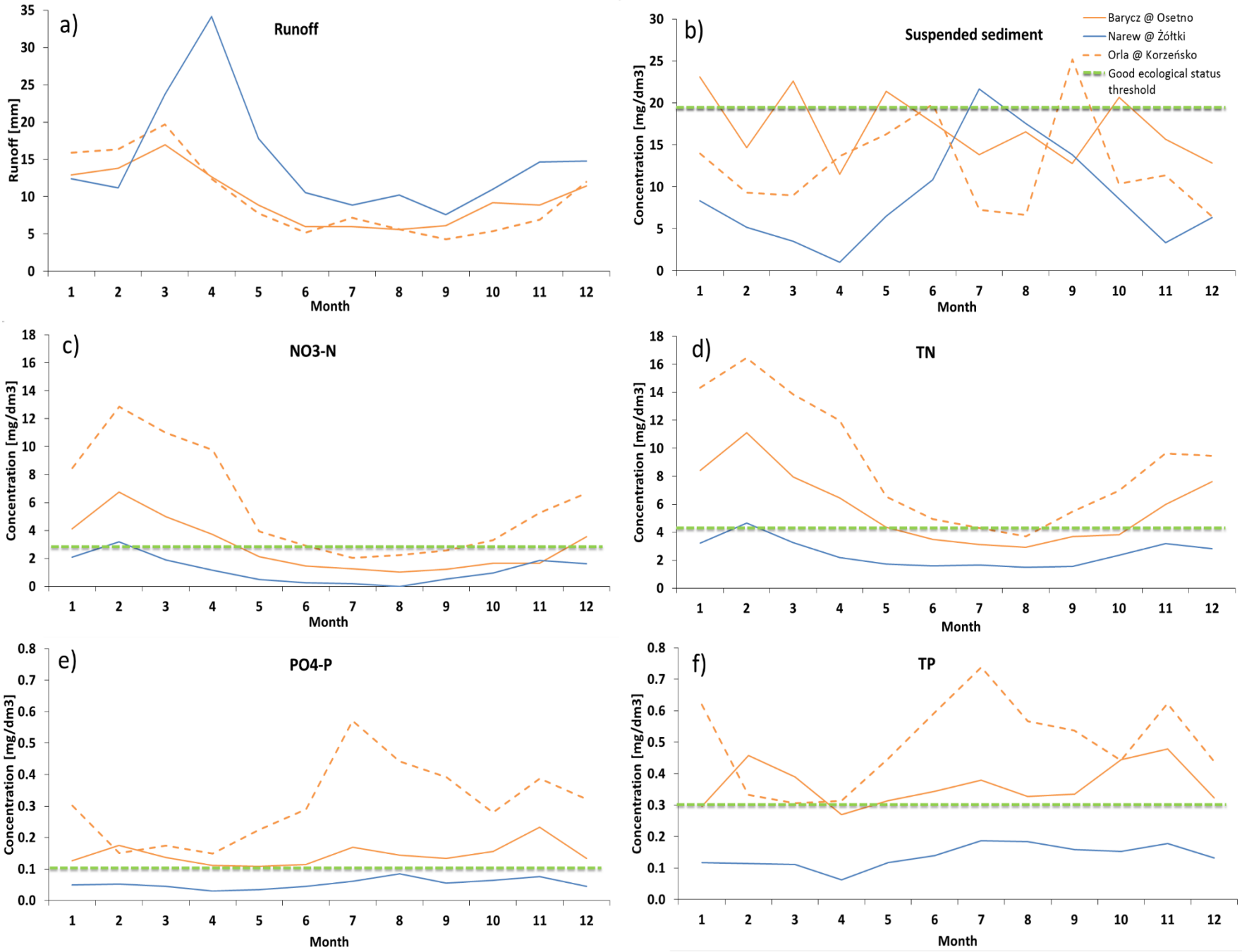
Contrasting characteristics





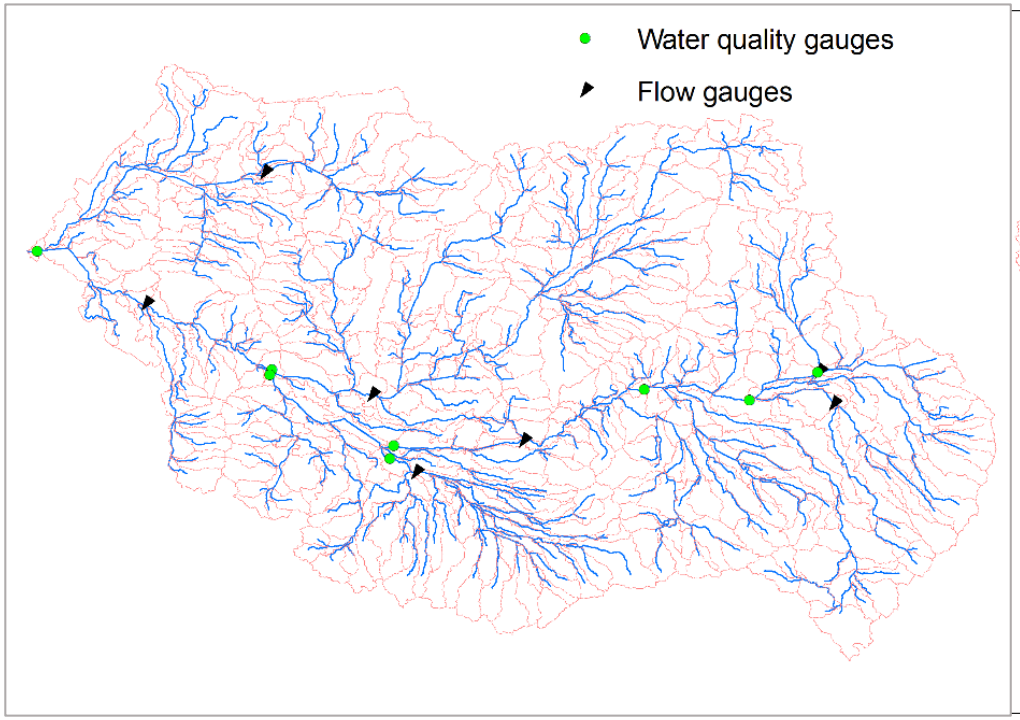




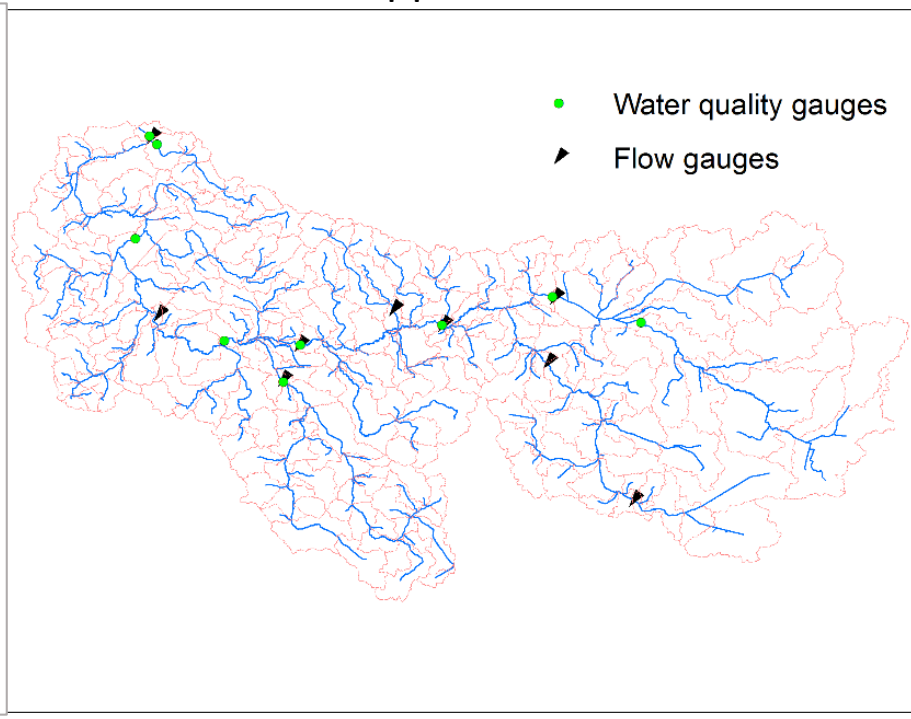

a)
Runoff
Runoff [mm]
Month
b)
Suspended sediment
Concentration [mg/dm3]
Month
Barycz @ Osetno
Narew @ Żółtki
Orla @ Korzeńsko
Good ecological status threshold
c)
NO3-N
Concentration [mg/dm3]
Month
d)
TN
Concentration [mg/dm3]
Month
e)
PO4-P
Concentration [mg/dm3]
Month
f)
TP
Concentration [mg/dm3]
Month

Spatial calibration

Barycz



Upper Narew



Calibrated variables: discharge, sediment, nitrate, total nitrogen, mineral phosphorus, total phosphorus, dissolved oxygen.

Objective function: **Kling-Gupta Efficiency** (Gupta et al. 2009)

$$\mathrm{KGE} = 1 - \sqrt{(r-1)^2 + (\alpha-1)^2 + (\beta-1)^2}$$

r – linear regression coefficient (correlation term)

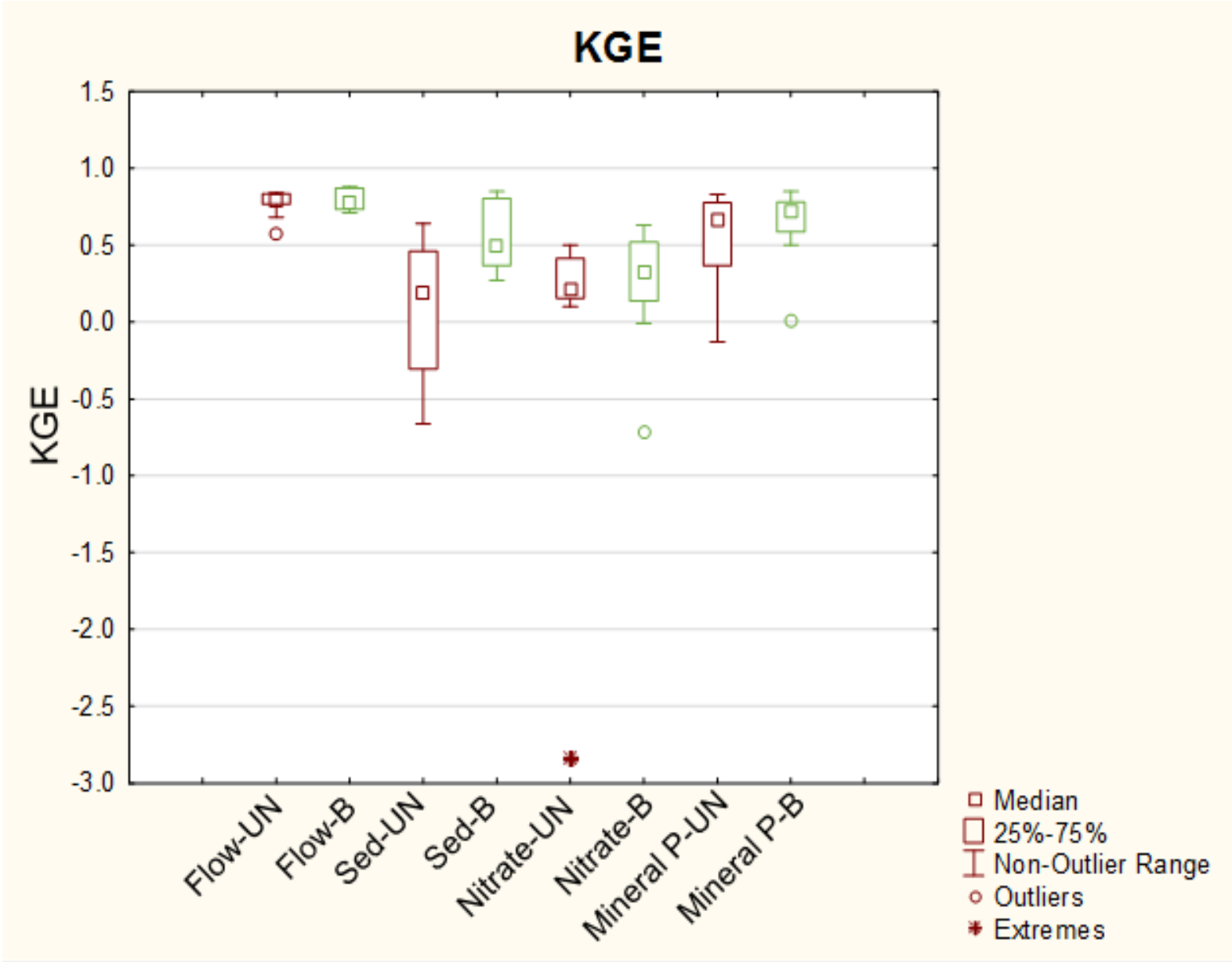
α - ratio of simulated over observed standard deviation (variability term)

β - ratio of simulated over observed mean (bias term)

Calibration results

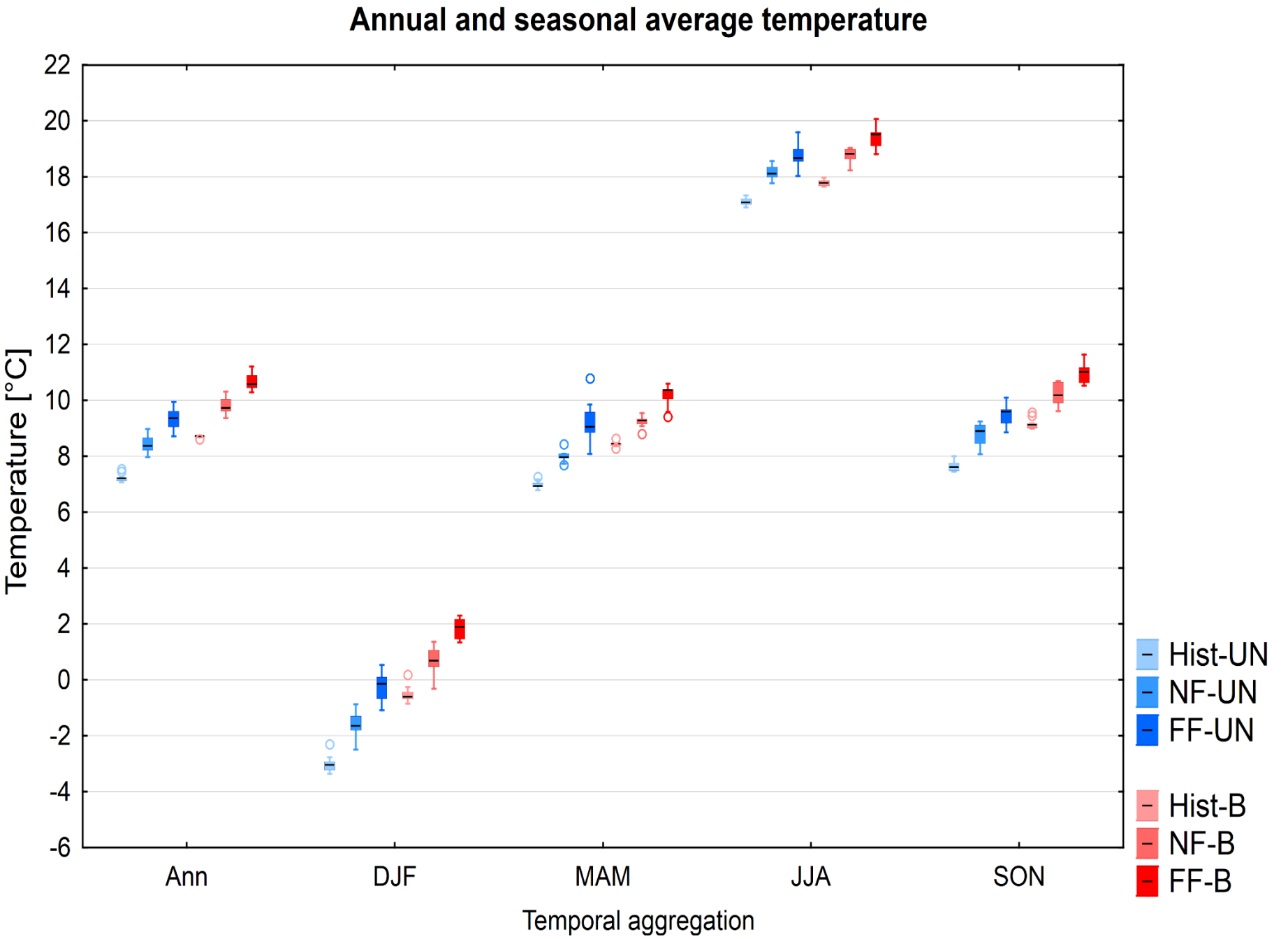
Barycz

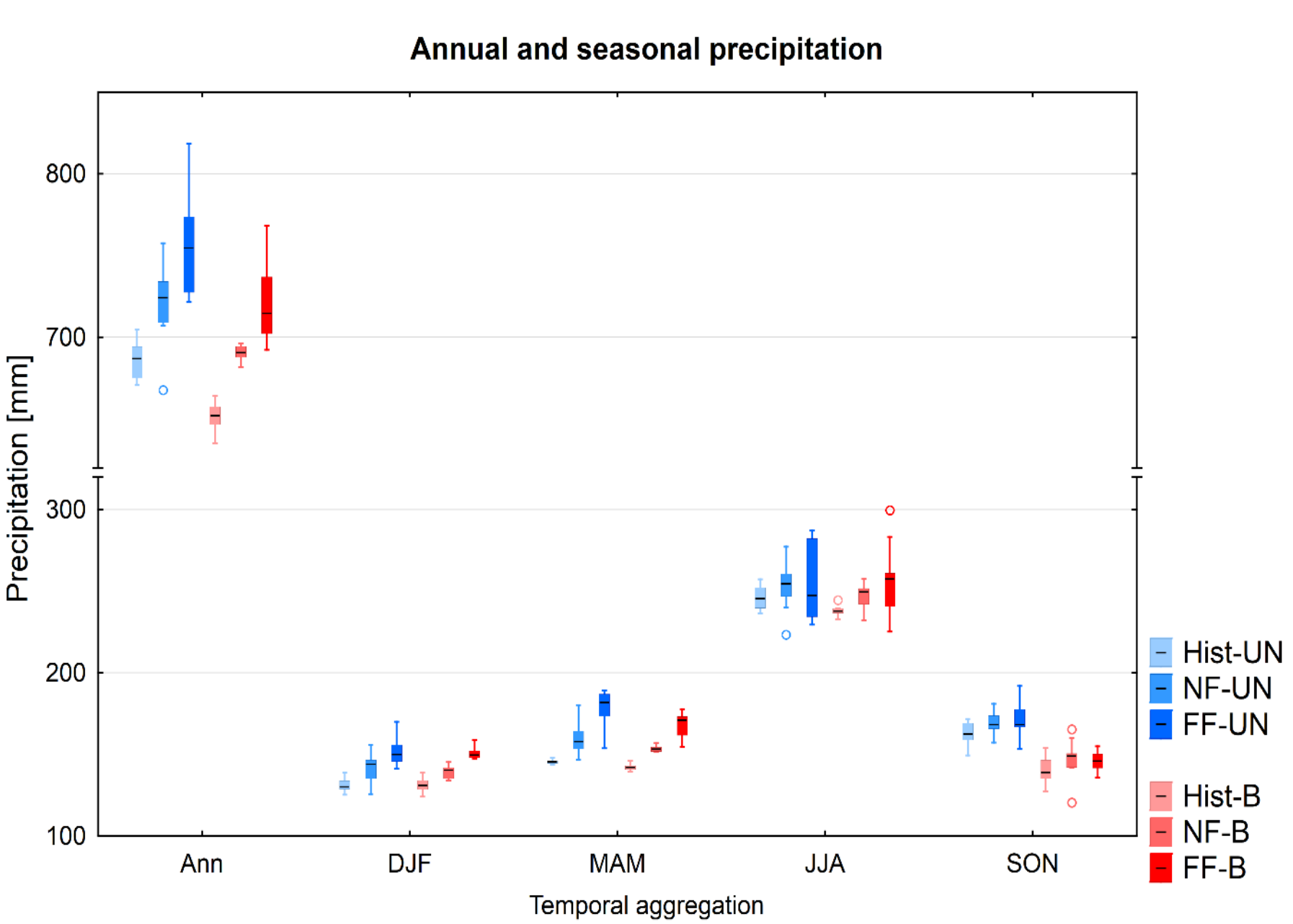
Upper Narew



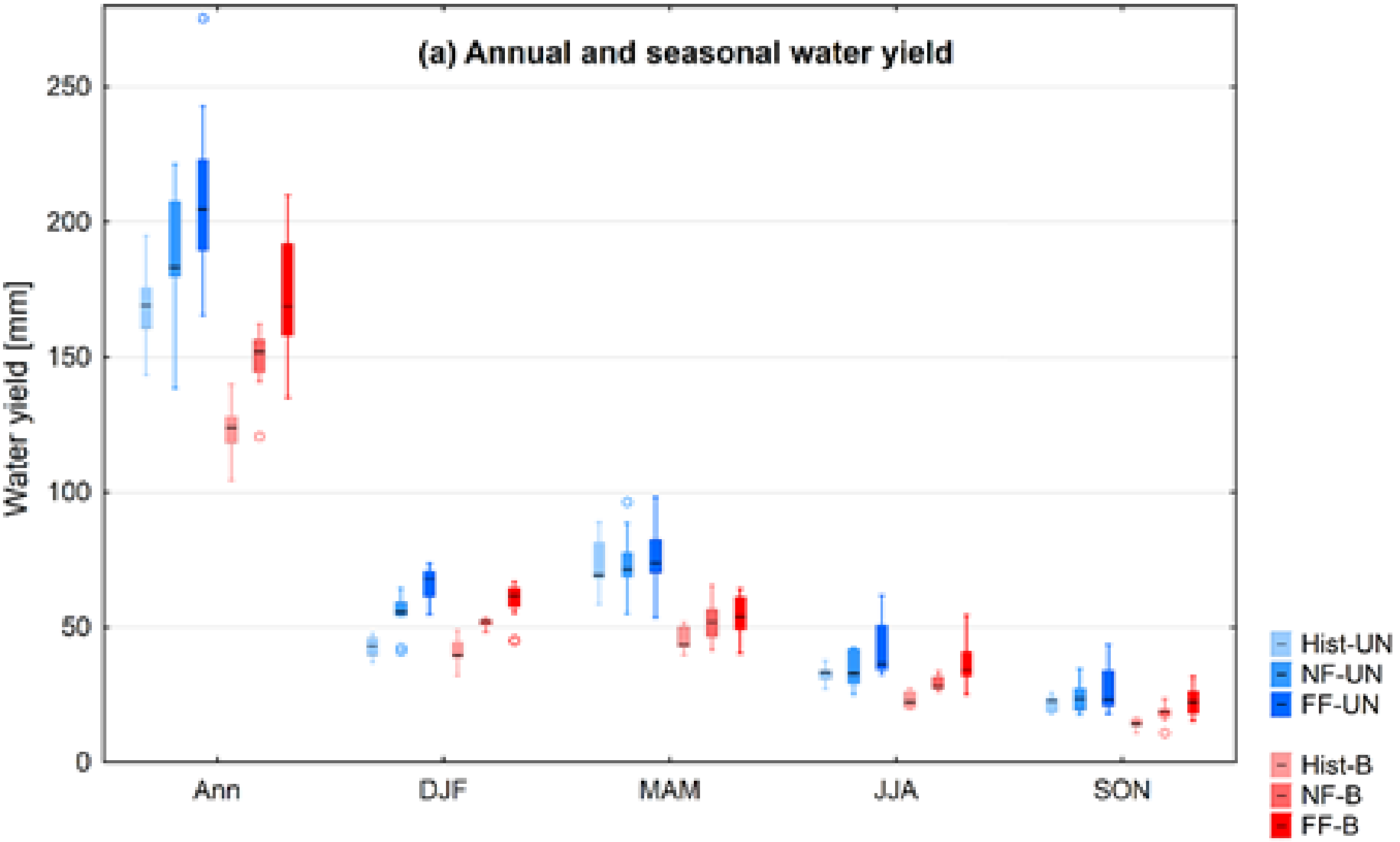
Climate change scenarios

- Ensemble of 9 EURO-CORDEX GCM-RCM projections under RCP 4.5 for two time horizons
  - 2021-2050 Near future (NF)
  - 2071-2100 Far future (FF)
- Bias-corrected using the quantile mapping method for the area of Poland

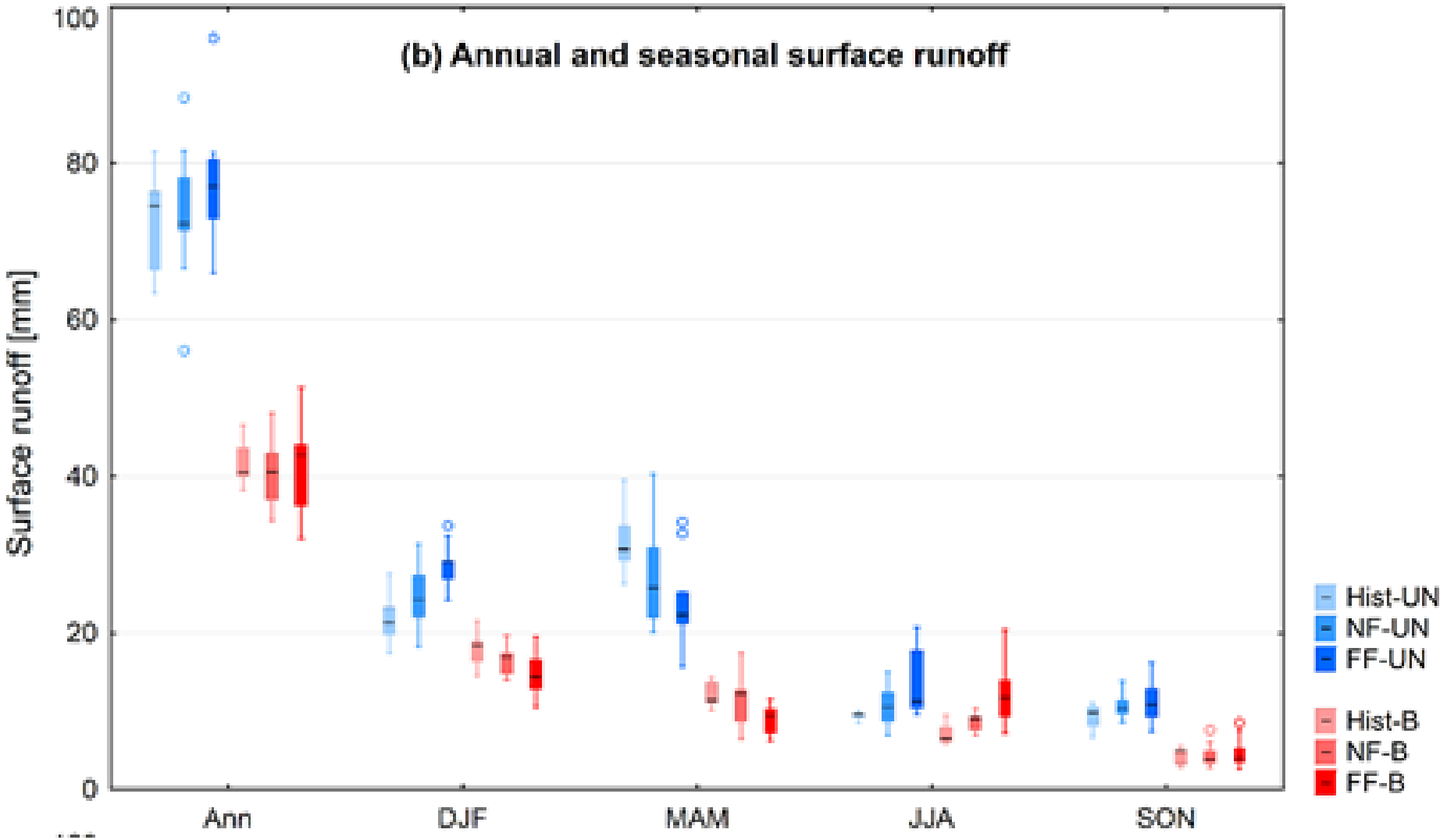

Annual and seasonal average temperature
Temperature [°C]
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
Ann
DJF
MAM
JJA
SON
Temporal aggregation
Hist-UN
NF-UN
FF-UN
Hist-B
NF-B
FF-B


Annual and seasonal precipitation
Precipitation [mm]
800
700
300
200
100
Ann
DJF
MAM
JJA
SON
Temporal aggregation
Hist-UN
NF-UN
FF-UN
Hist-B
NF-B
FF-B

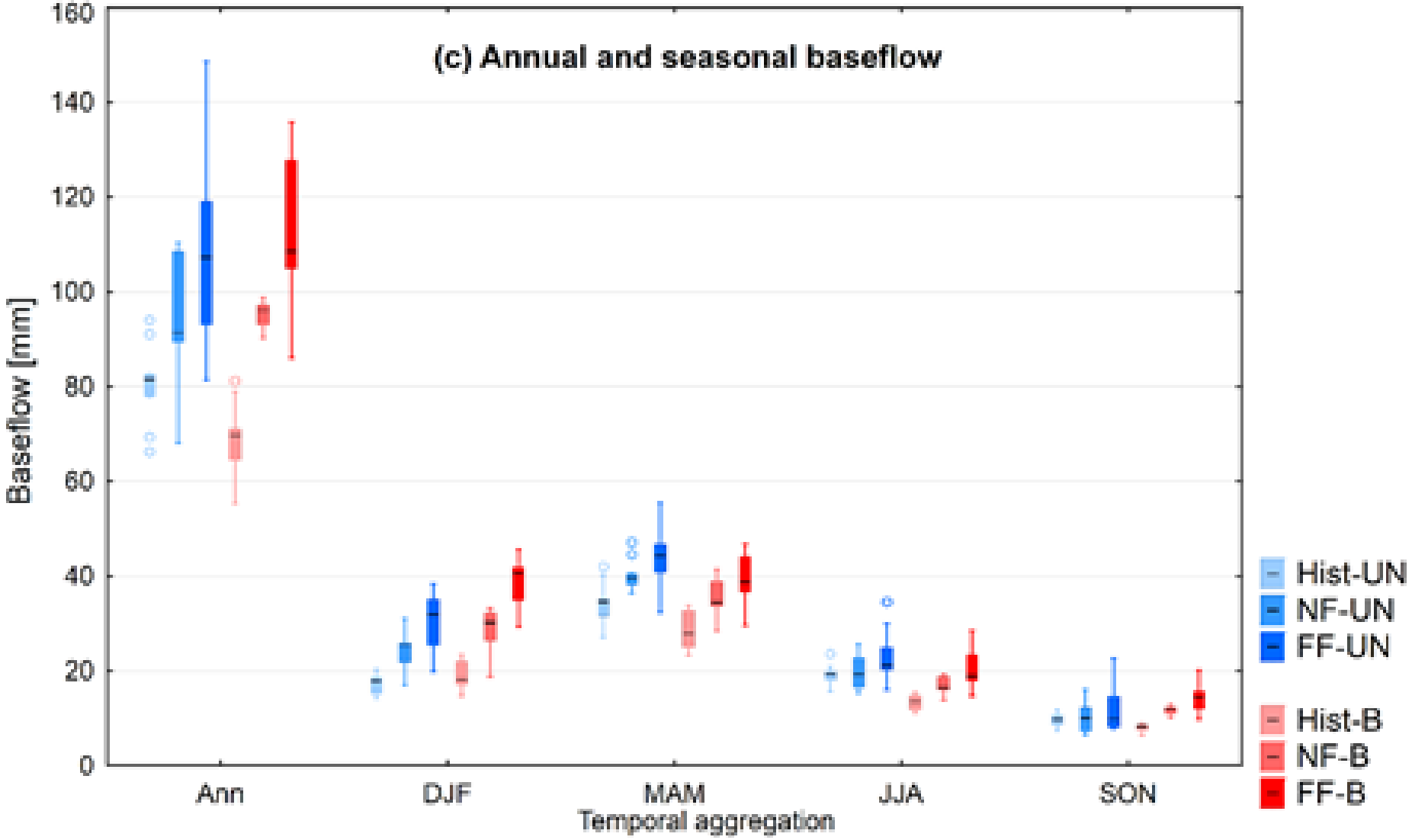
Water yield response



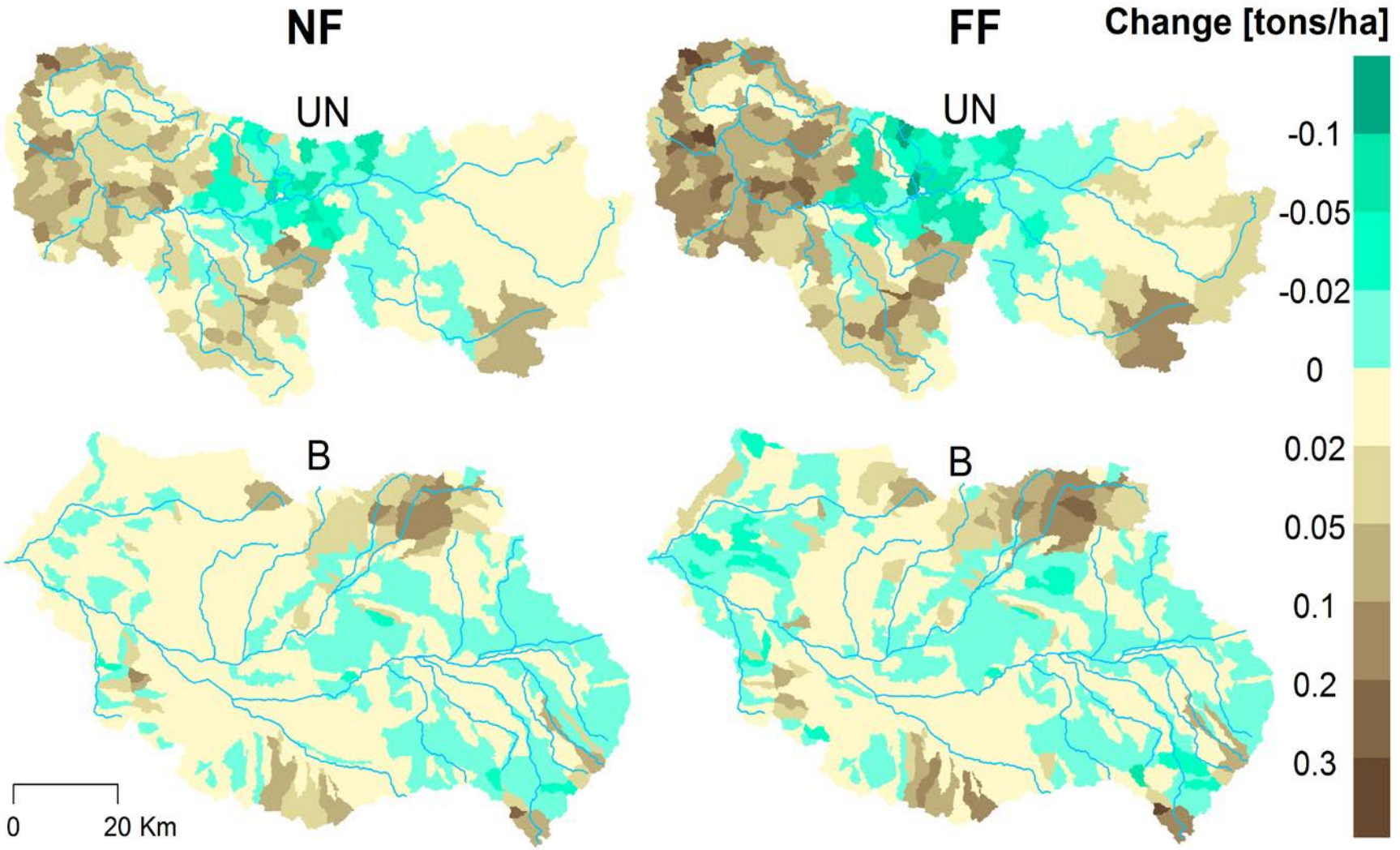
Surface runoff response



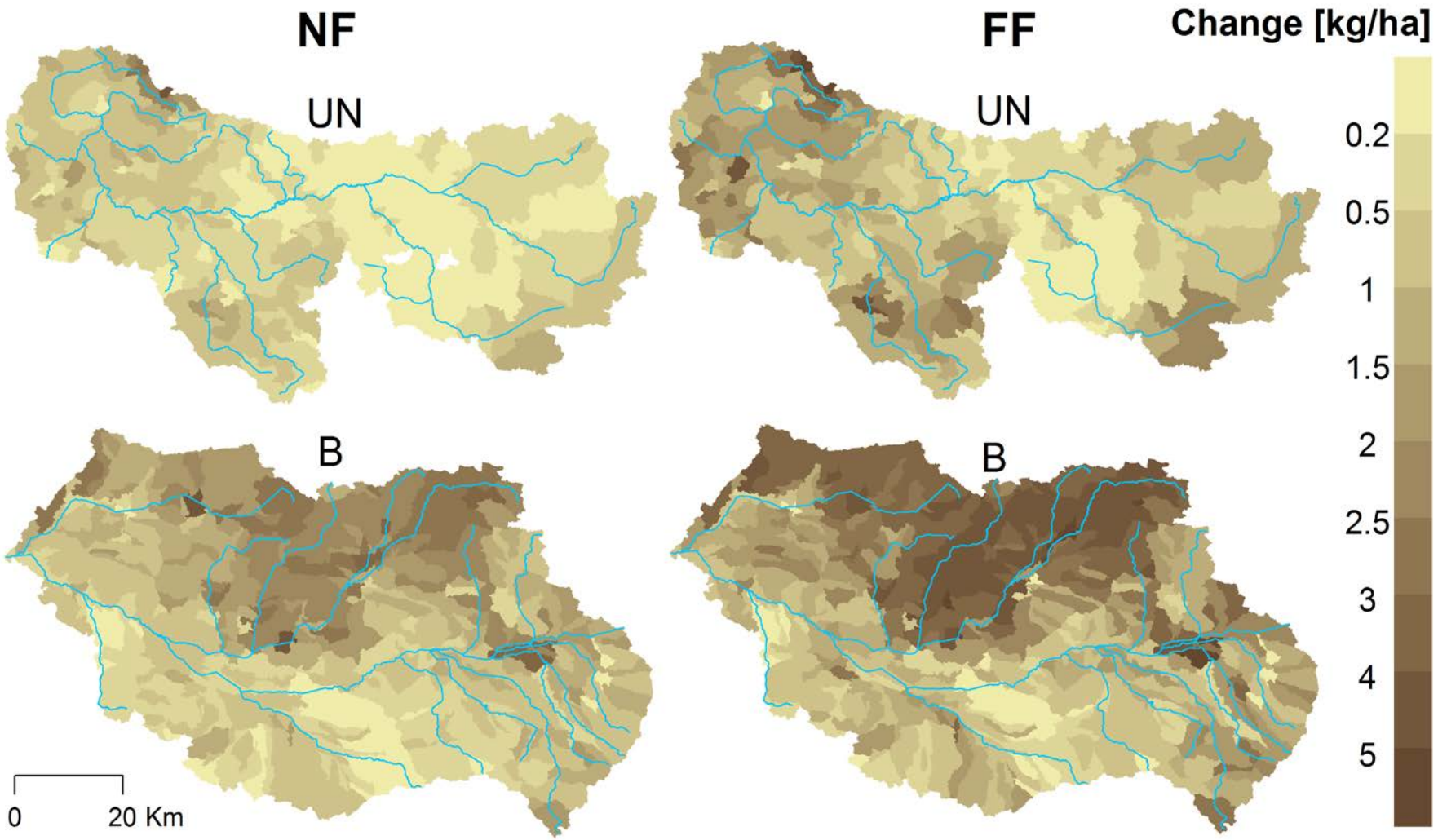
Baseflow response



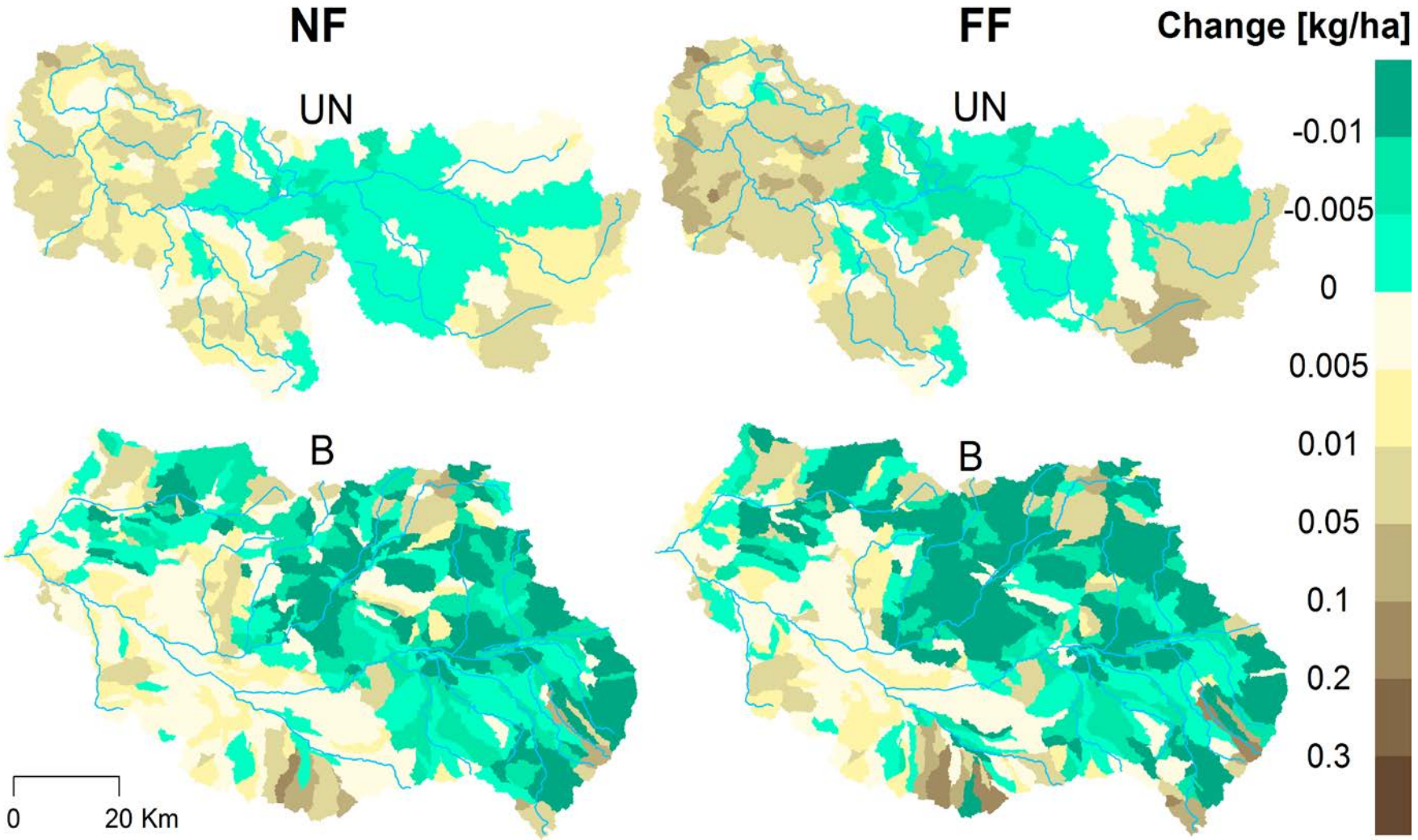
Water quality changes - sediment



Water quality changes - TN



Water quality changes - TP



DOI: 10.1515/jwld-2016-0040

JOURNAL OF WATER AND LAND DEVELOPMENT
2016, No. 31 (X–XII): 97–111
PL ISSN 1429–7426
Available (PDF): http://www.itp.edu.pl/wydawnictwo/journal; http://www.degruyter.com/view/j/jwld

Received 03.08.2016
Reviewed 30.09.2016
Accepted 29.11.2016

A – study design
B – data collection
C – statistical analysis
D – data interpretation
E – manuscript preparation
F – literature search

Challenges in modelling of water quantity and quality in two contrasting meso-scale catchments in Poland

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water

MDPI

Article

Effect of Climate Change on Hydrology, Sediment and Nutrient Losses in Two Lowland Catchments in Poland

Paweł Marcinkowski [1,*], Mikołaj Piniewski [1,2], Ignacy Kardel [1], Mateusz Szcześniak [1], Rasmus Benestad [3], Raghavan Srinivasan [4], Stefan Ignar [1] and Tomasz Okruszko [1]

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Acknowledgments

Support of the project CHASE-PL (Climate Change Impact Assessment for Selected Sectors in Poland) of the Polish-Norwegian Research Programme is gratefully acknowledged