Hydrological Drought in Headwater Areas of Šumava Mt. (Bohemian Forest) and Krušné hory Mt. (Ore Mt.)

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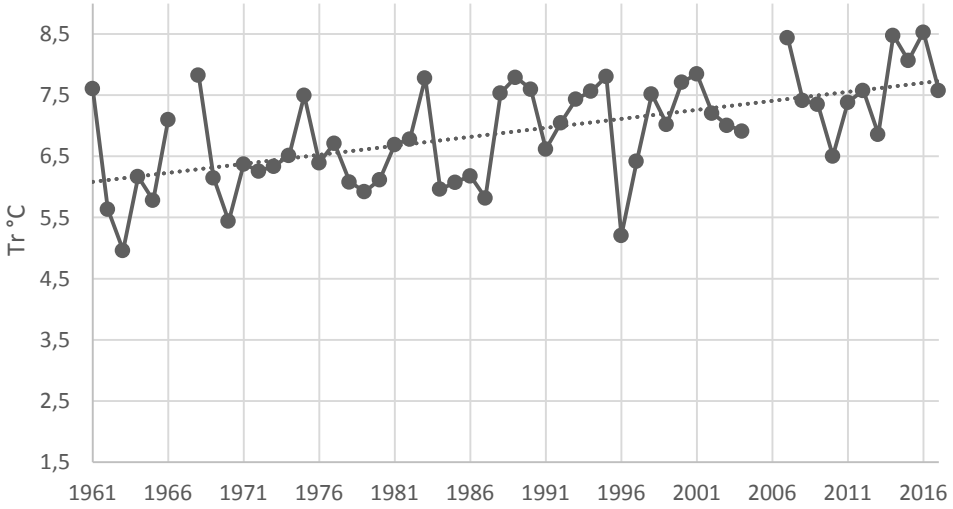
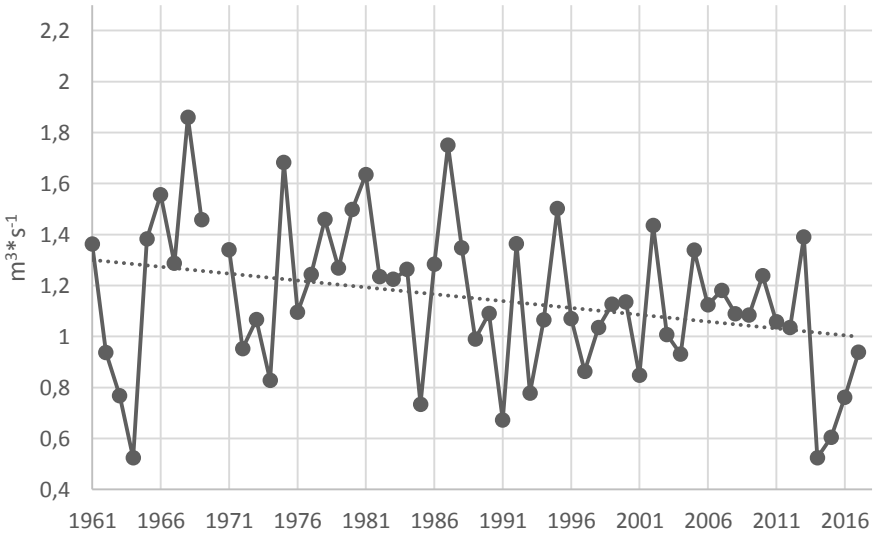
Introduction & Aims

- The presented study is an attempt to evaluate trends in runoff regime and hydrologic drought in headwater areas of the Elbe and Danube Rivers catchments; focused on the Šumava (Bohemian Forest) and Krušné hory Mt. (Ore Mt.) regions.



Elster Bad-Sohl, Tr 1961–2017, Data Source: DWD



Qr profilu Klingenthal, 1961–2017, Data Source: DWD

Data sources and applied methods

- **Input data:** CHMI, DWD, Bavarian and Saxon Institutes for Environment and Department of Physical Geography and Geoecology, Faculty of Science, Charles University
- **Studied period: 1930/67–2014/2017**
- Values of Qd (mean daily discharge), Qm (mean monthly discharge), Qmin and Q355
- **Methods:**
  - the threshold value method of Q355
  - Gumbel 63
  - the Indicators of Hydrological Alteration (IHA 7.1 statistics software)
    - base flow index and 7-day minimums.
  - Low-flow index (LFI)
  - non-parametric statistical Mann-Kendall test
    - first form time series of Qm, QmMIN and monthly sums of drought days according to the threshold concept
    - second form Zhang method (vector calculation)

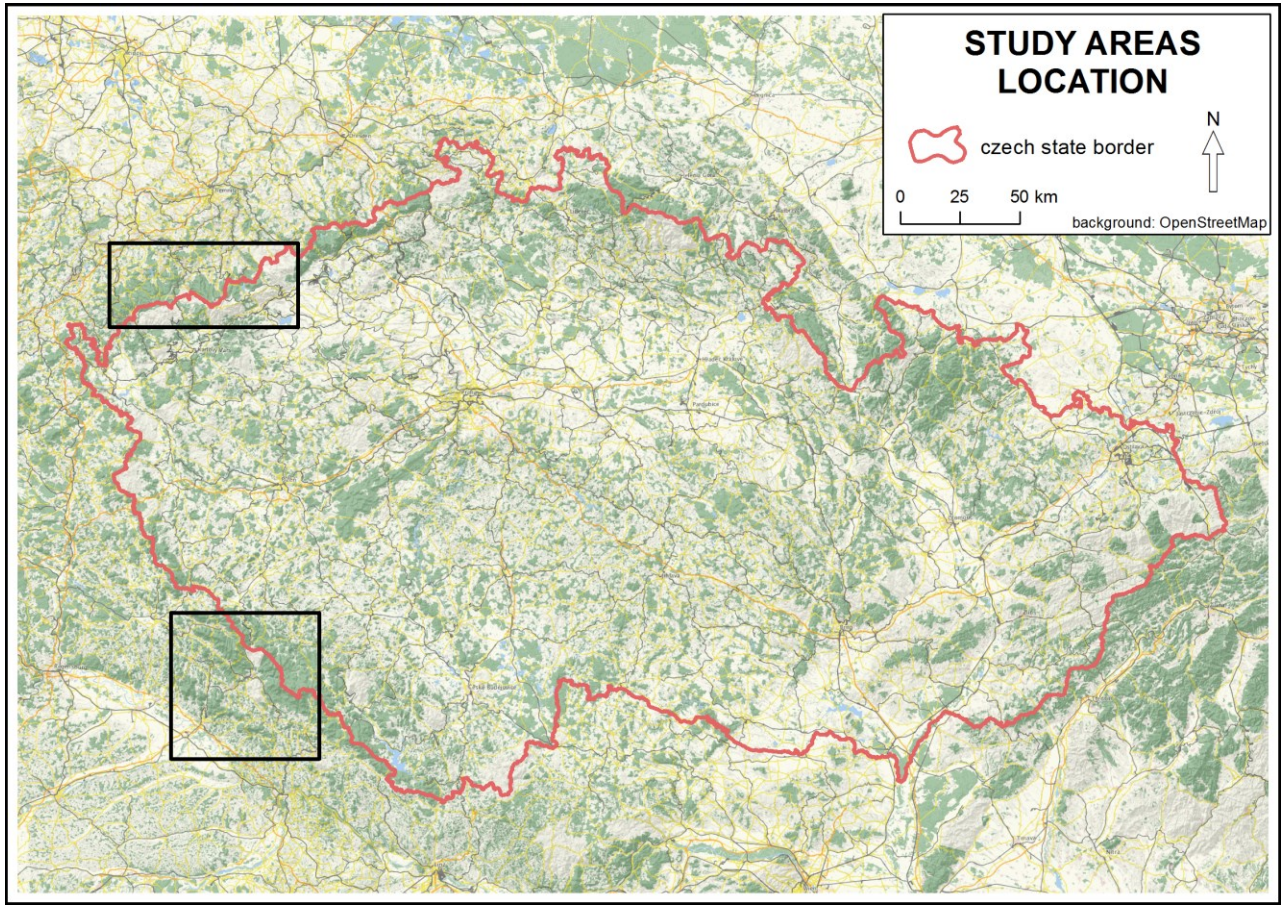
Model study basins

Šumava (Bohemian Forest Mt.)

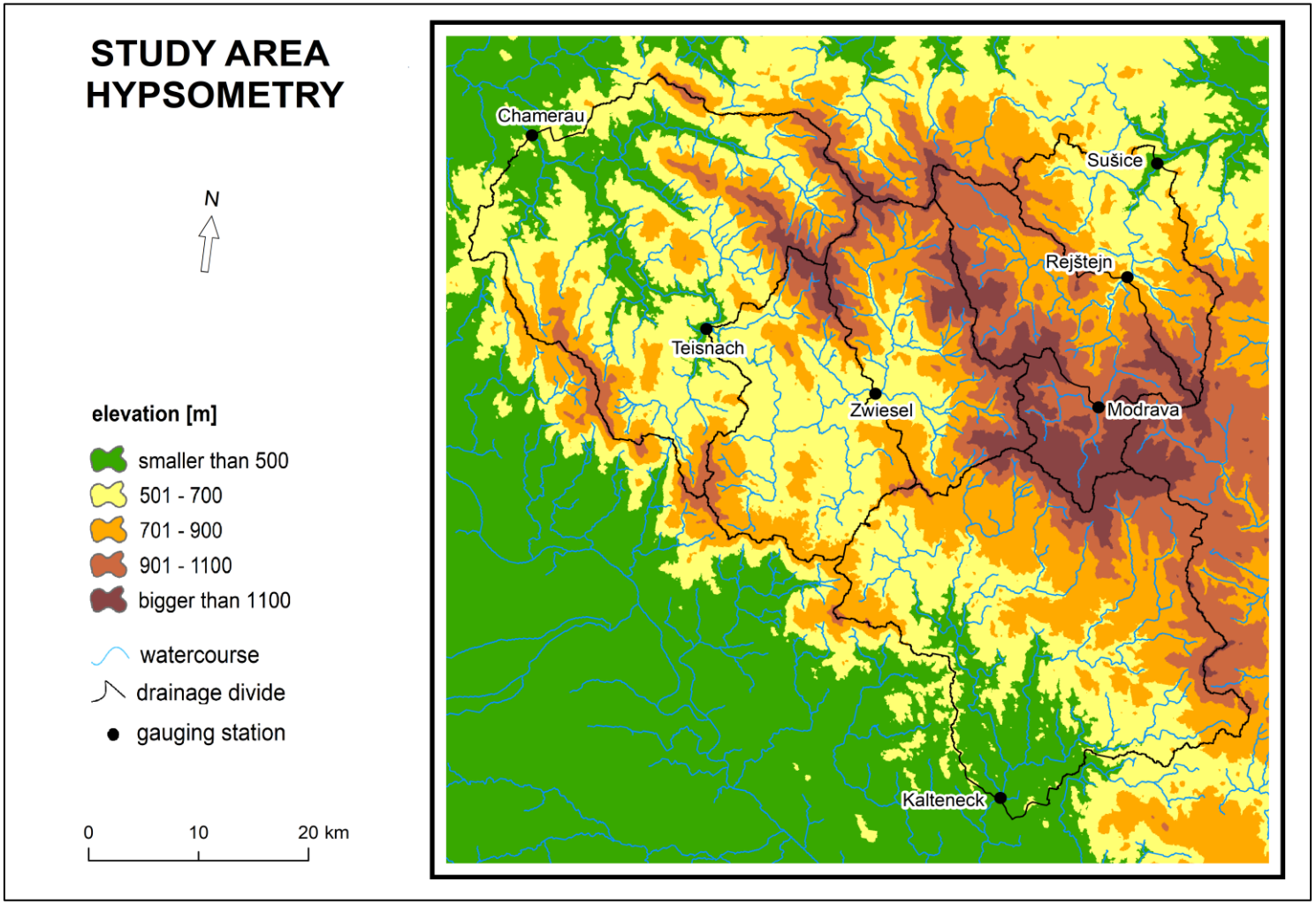
- *Vydra (Modrava)*
- *Upper Otava (Rejštejn)*
- *Otava (Sušice)*
- *Schwarzer Regen (Teisnach)*
- *Großer Regen (Zwiesel)*
- *Ilz (Kalteneck)*
- *Regen (Chamerau)*

Krušné hory (Ore Mt.)

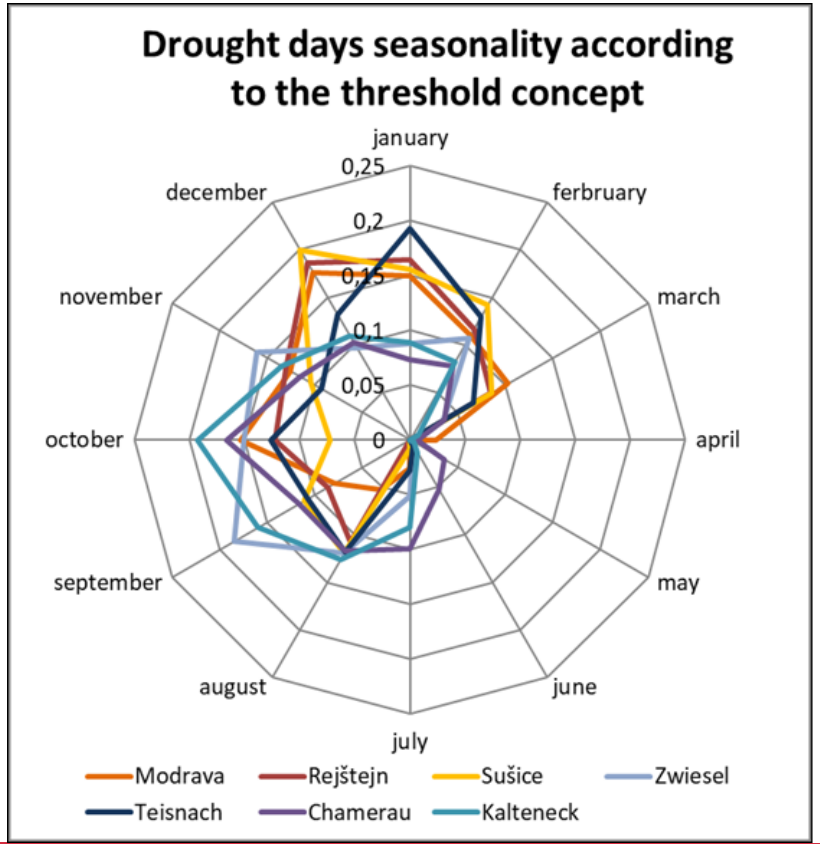
- *Upper Rolava River (Chaloupky) and Slatinný Brook (KH)*
- *Upper Svatava/Zwota River (Klingenthal)*
- *Načetínský Brook/Natschung (Rothenthal)*

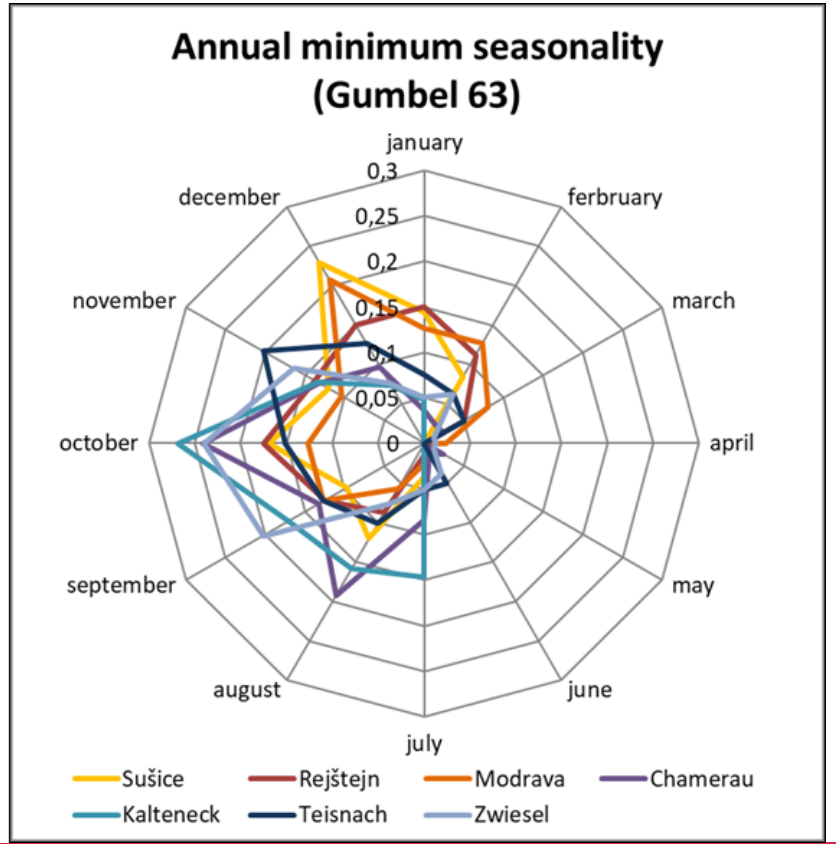


Model study basins in Šumava (Bohemian Forest Mt.)

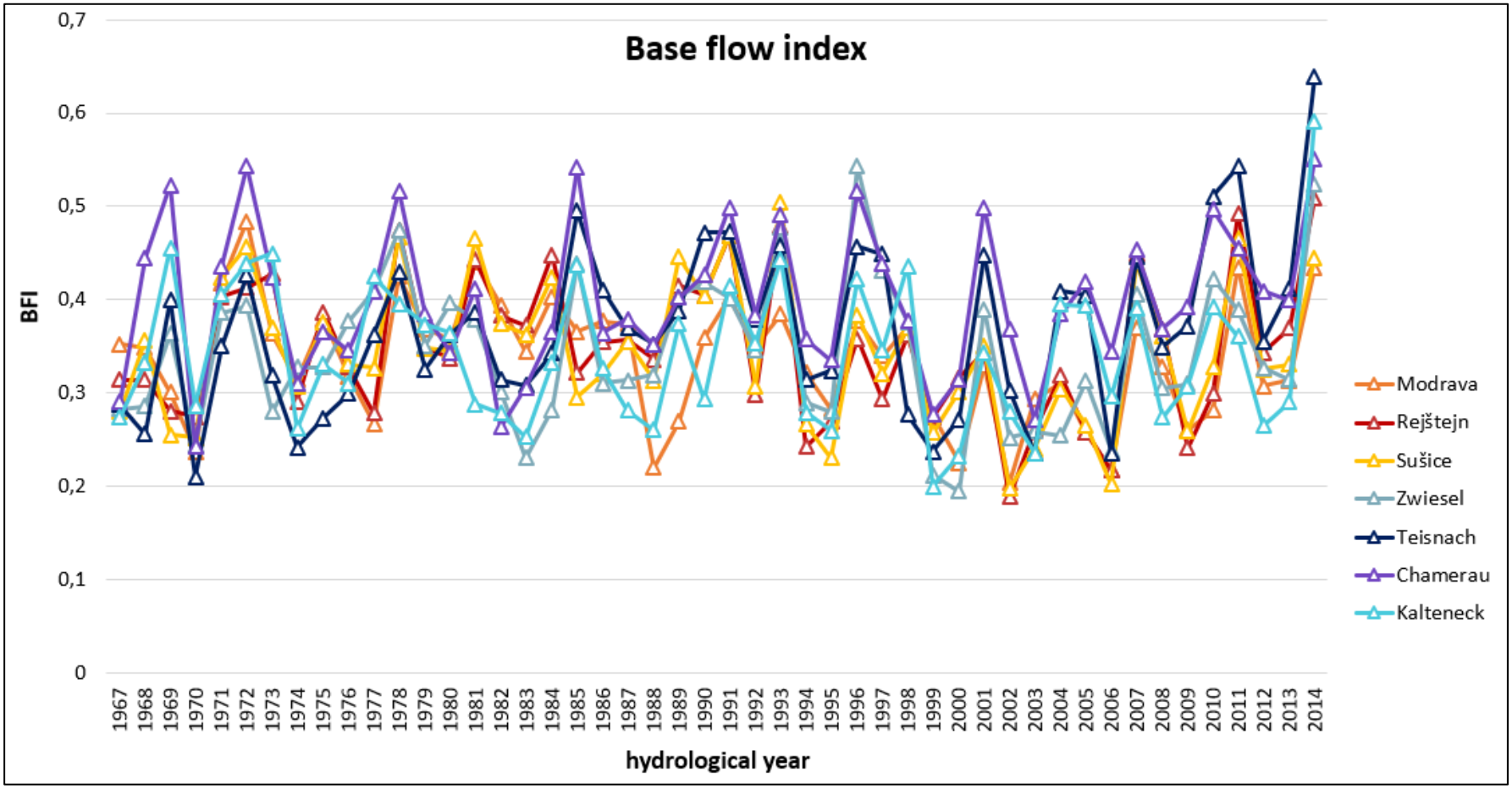


Seasonality of drought Šumava Mt.

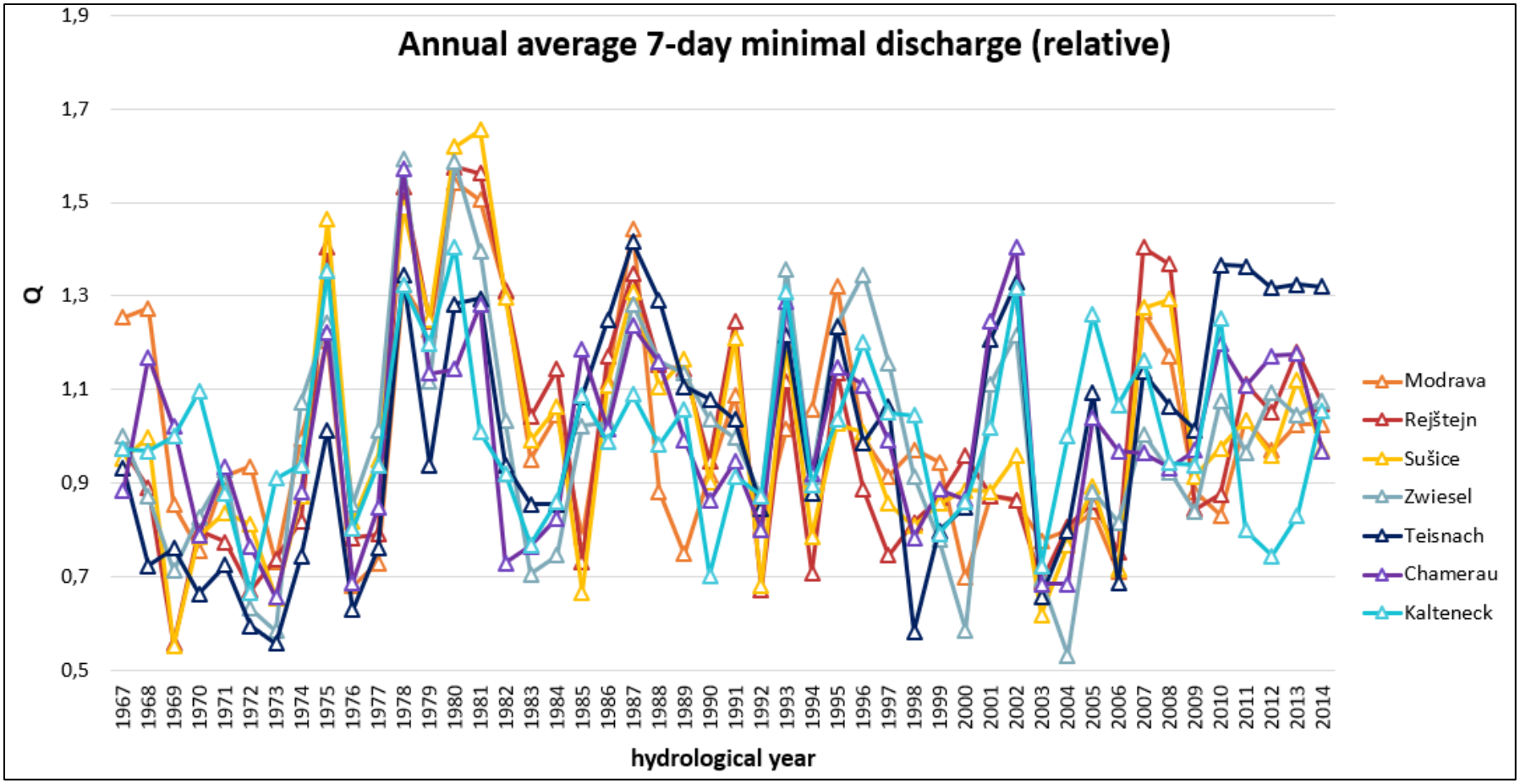




Šumava Mt.


Base flow index
BFI
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
hydrological year
Modrava
Rejštejn
Sušice
Zwiesel
Teisnach
Chamerau
Kalteneck

Šumava Mt.

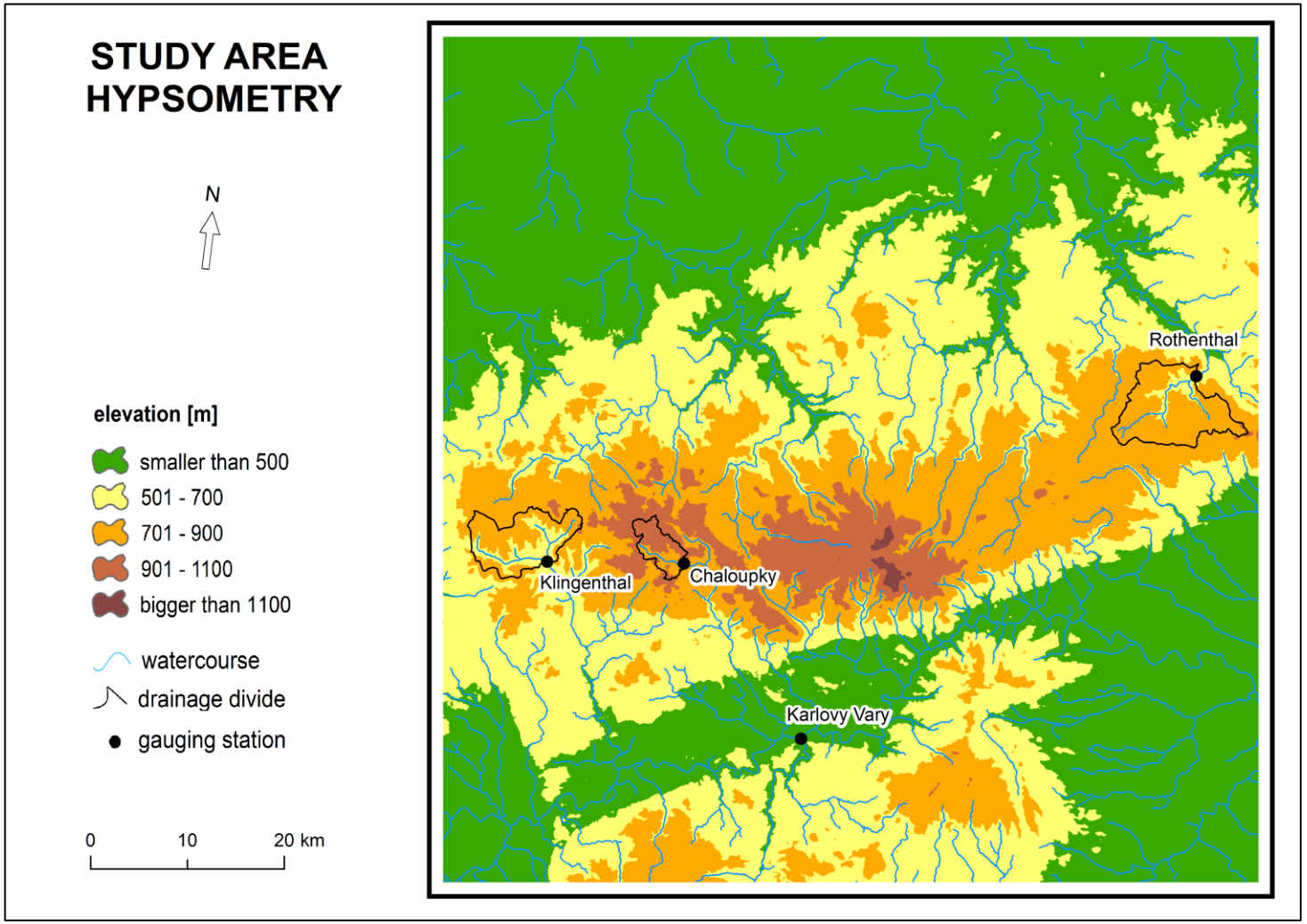

Annual average 7-day minimal discharge (relative)
Q
1,9
1,7
1,5
1,3
1,1
0,9
0,7
0,5
1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
hydrological year
Modrava
Rejštejn
Sušice
Zwiesel
Teisnach
Chamerau
Kalteneck

Mann-Kendall trend test results Šumava Mt.

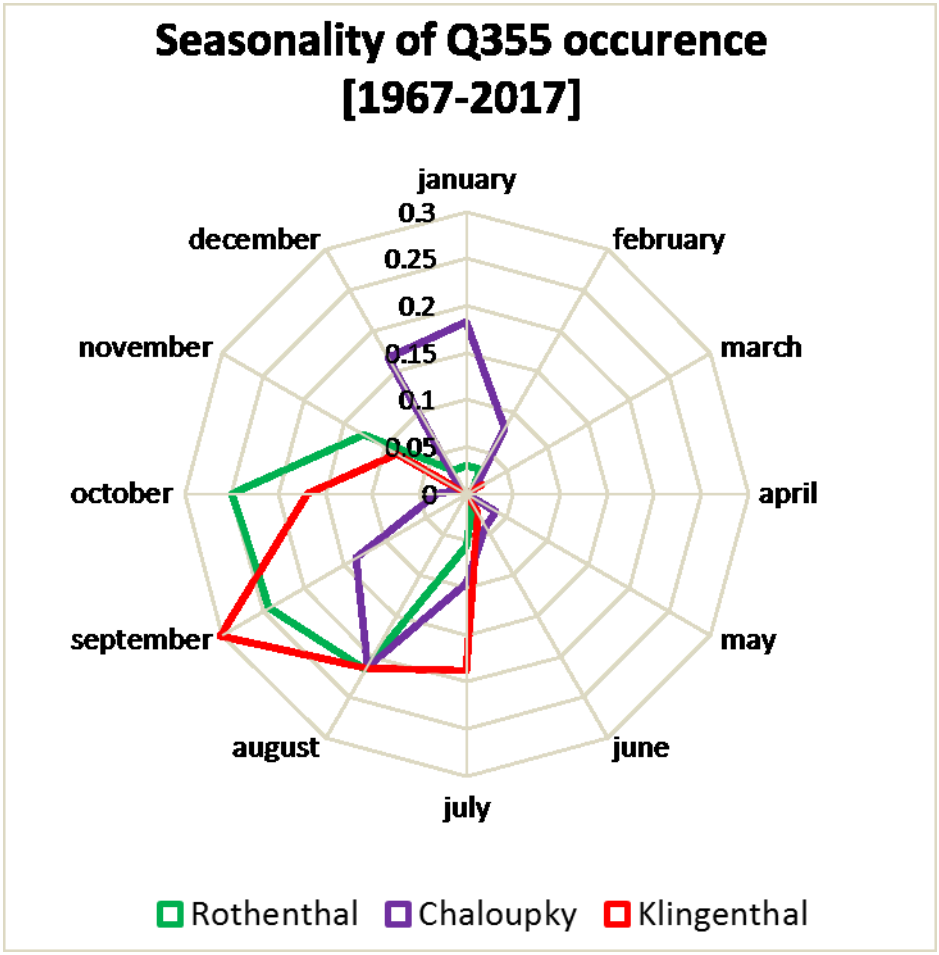
Mann-Kendall trend test results for deficit volume time series							
Profile	Modrava	Rejštejn	Sušice	Zwiesel	Teisnach	Chamerau	Kalteneck
p-value	**0,00000**	**0,000003**	**0,000002**	**0,011259**	**0,000001**	0,598408	**0,000021**
Mann-Kendall trend test results for monthly sums of drought days time series							
p-value	**0,00000**	**0,00000**	**0,000048**	**0,000207**	**0,000006**	**0,000000**	**0,000006**

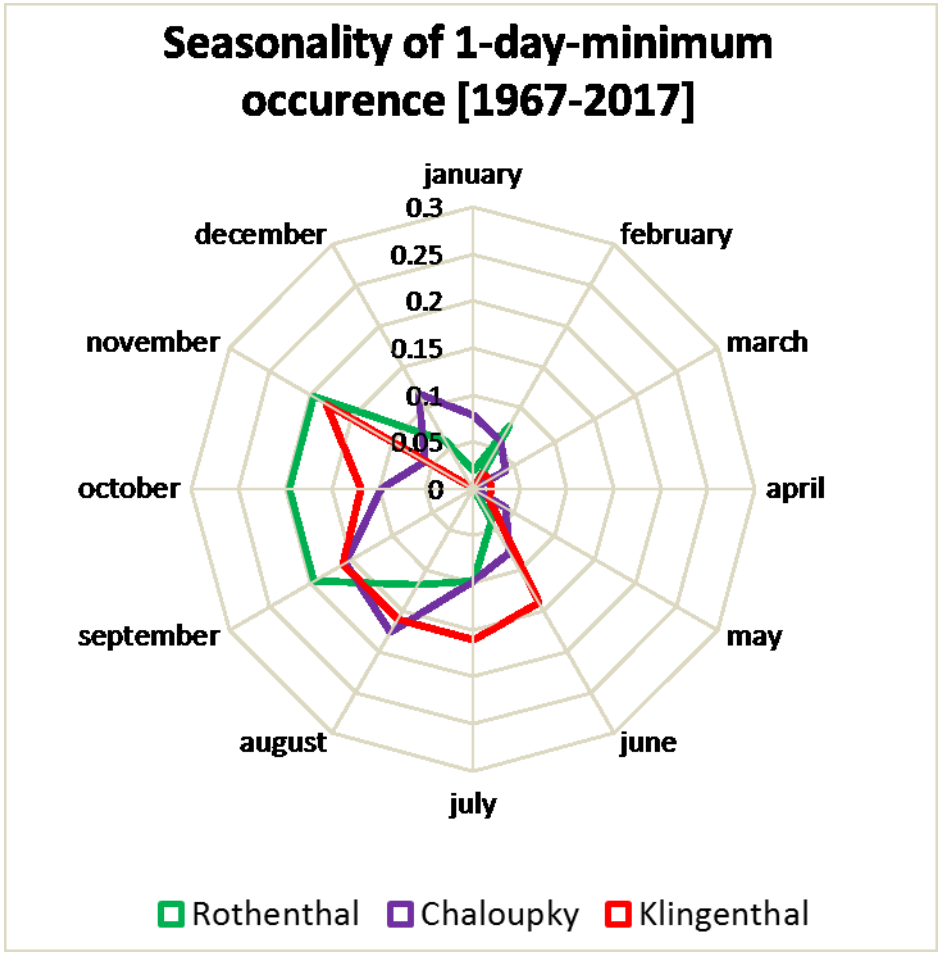
Mann-Kendall seasonality trend test results for sums of drought days time series for each month								
	month	Modrava	Rejštejn	Sušice	Zwiesel	Teisnach	Chamerau	Kalteneck
p-value	january	**0,013**	**0,003**	**0,008**	0,121	**0,011**	**0,000**	0,237
	february	**0,026**	0,198	0,168	0,118	0,069	**0,001**	NaN
	march	0,284	0,211	0,071	0,308	0,344	**0,003**	NaN
	april	0,094	NaN	NaN	NaN	NaN	**0,010**	0,081
	may	NaN	NaN	NaN	NaN	NaN	**0,001**	**0,032**
	june	NaN	NaN	NaN	0,441	0,864	**0,000**	0,768
	july	0,064	NaN	0,706	0,274	0,254	**0,000**	0,170
	august	**0,047**	0,184	0,879	0,450	0,248	**0,000**	0,068
	september	**0,003**	0,669	0,611	0,244	0,671	**0,001**	**0,018**
	october	**0,001**	**0,014**	0,221	0,065	0,100	**0,000**	0,148
	november	**0,002**	**0,004**	**0,044**	0,090	**0,013**	**0,000**	**0,036**
	december	**0,000**	**0,019**	**0,044**	0,721	0,102	**0,001**	0,057

Model study basins in Krušné hory Mt.

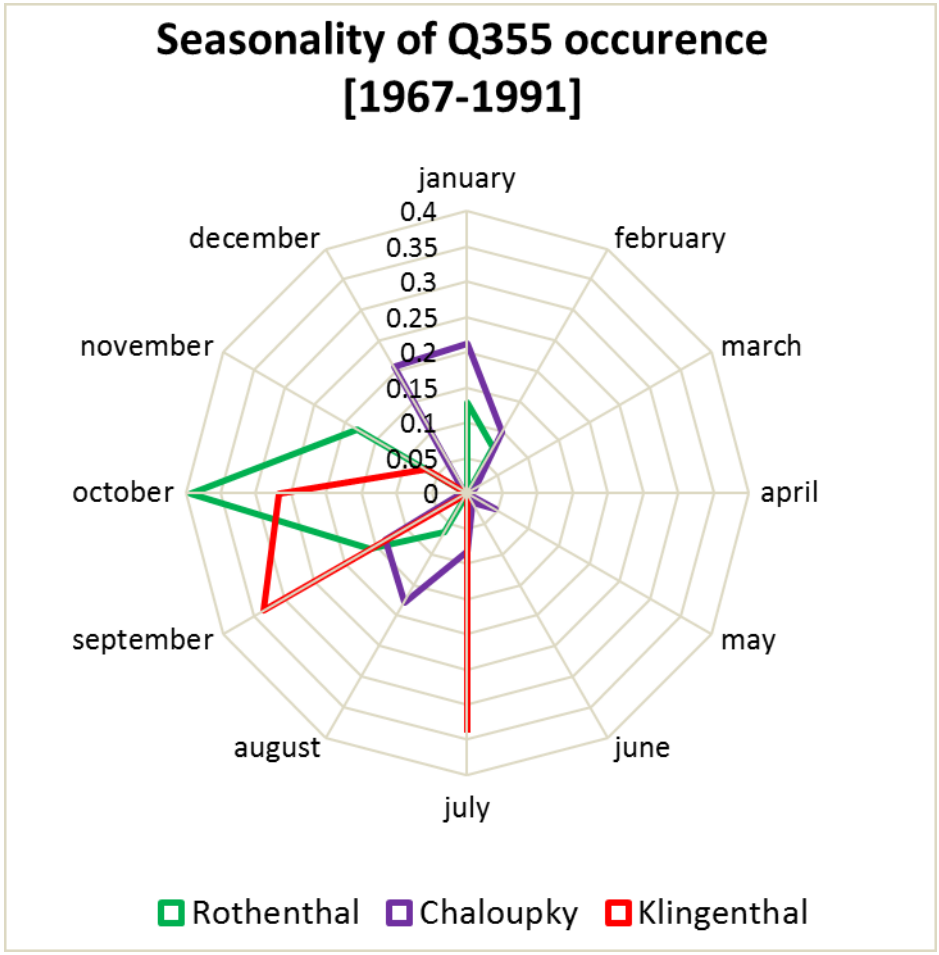


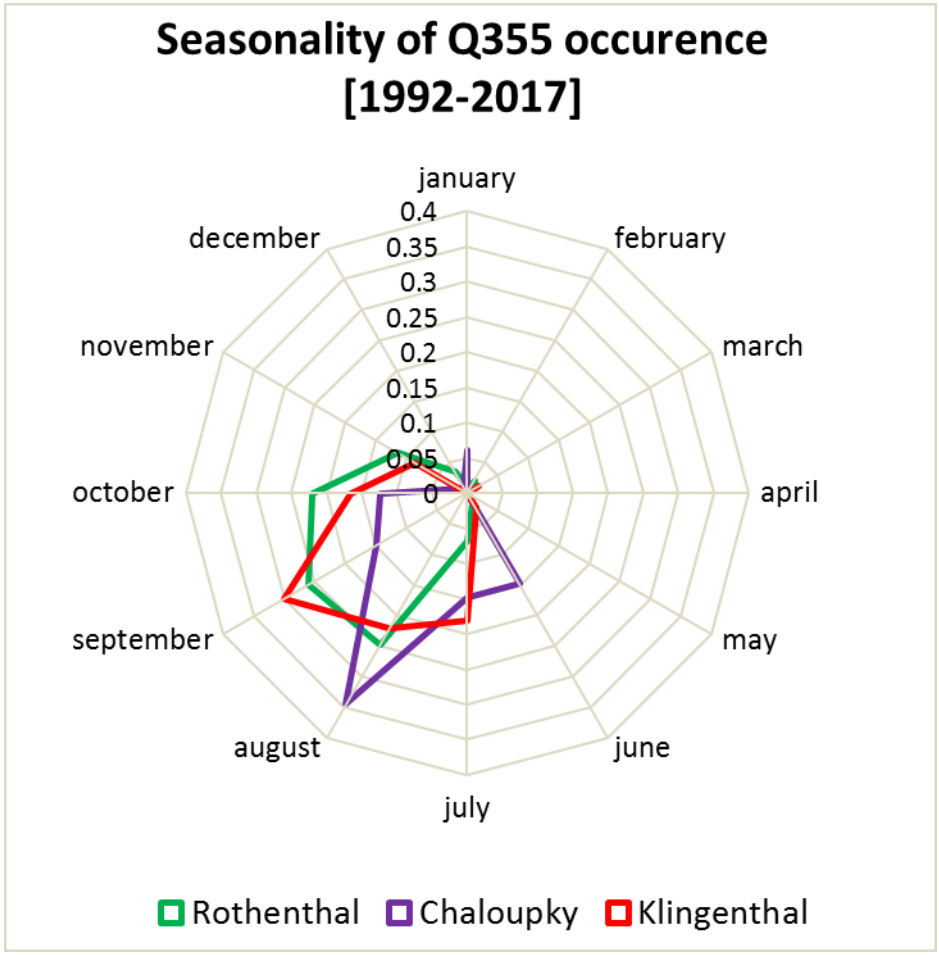
Seasonality of drought
Krušné hory Mt.

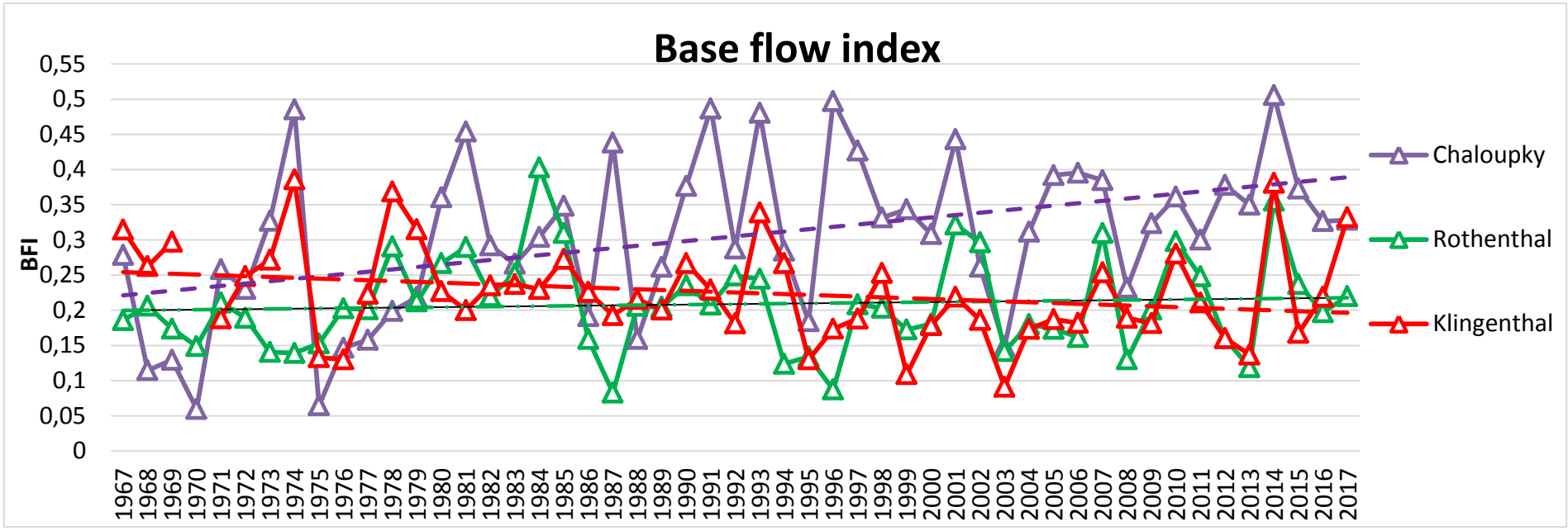


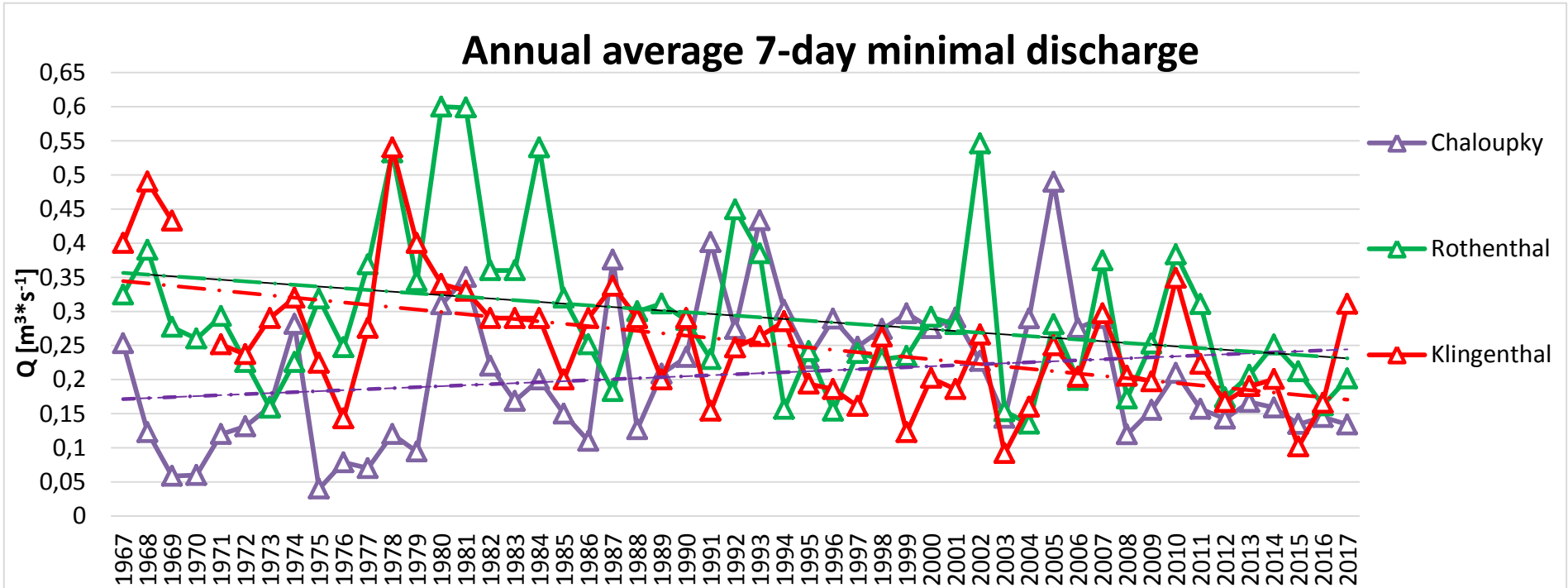


Seasonality of drought
Krušné hory Mt.

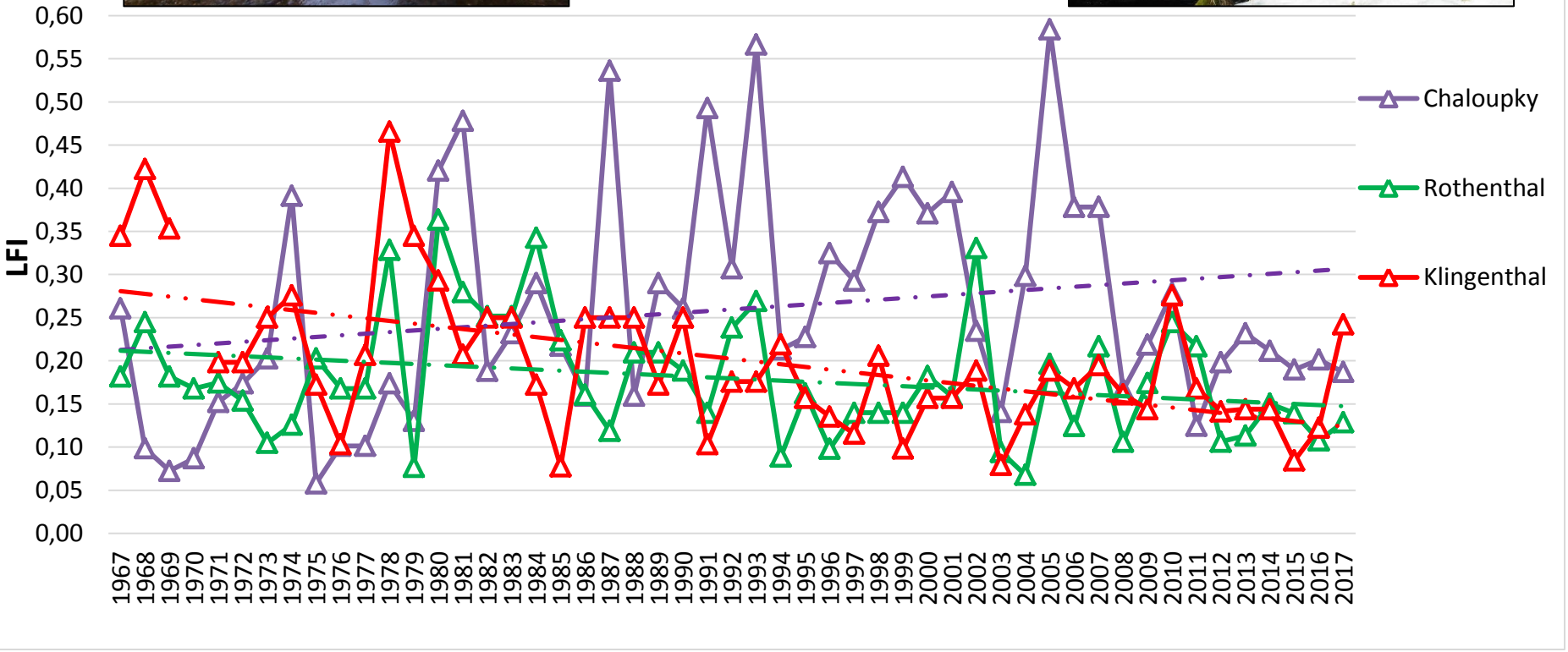





Base flow index
BFI
0,55
0,5
0,45
0,4
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Chaloupky
Rothenthal
Klingenthal


Annual average 7-day minimal discharge
Q [m³*s⁻¹]
0,65
0,6
0,55
0,5
0,45
0,4
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Chaloupky
Rothenthal
Klingenthal

Low Flow index

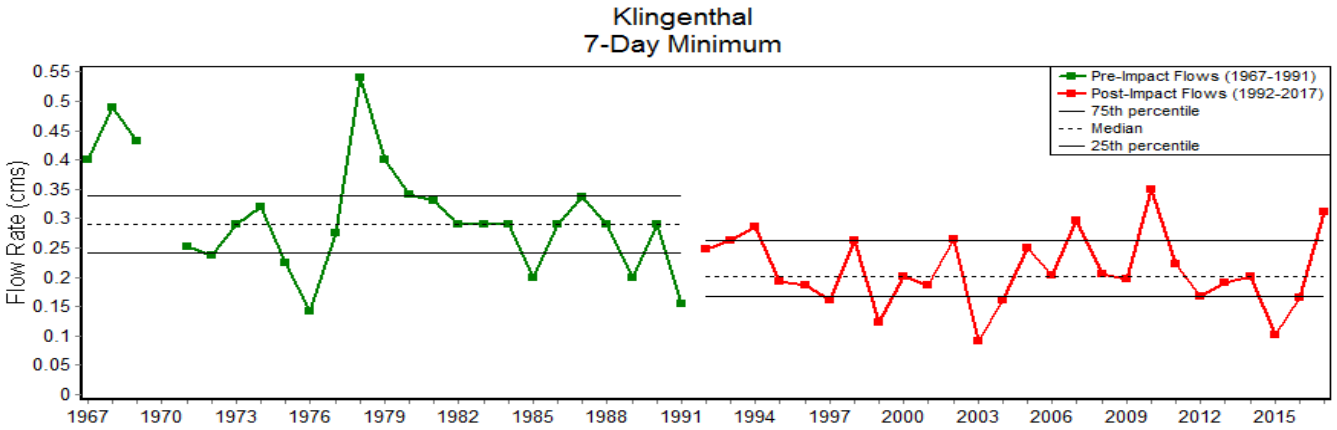


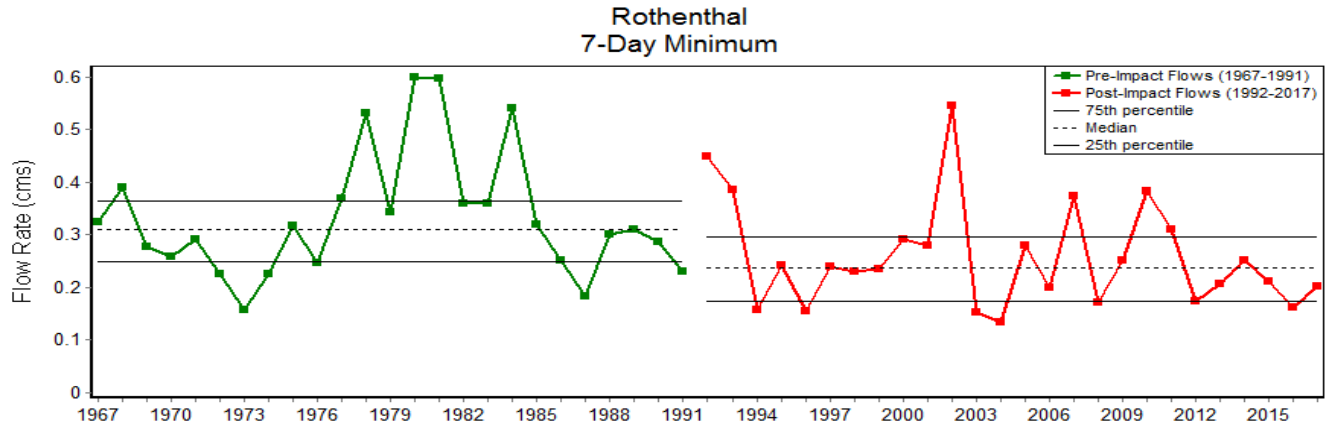
Mann-Kendall trend test results (Krušné hory Mt.)

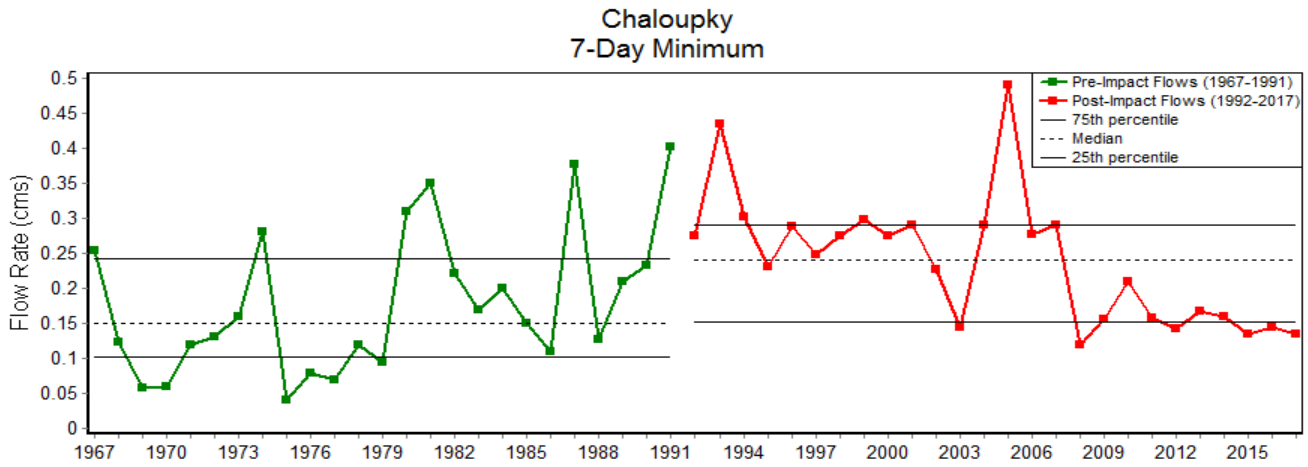
Qm	Chaloupky	Rothenthal	Klingenthal
November			
December			
January			
February			
March			
April	↓	↓	↓
May	↓	↓	↓
June		↓	↓
July		↓	↓
August		↓	↓
September		↓	
October			

Qm_min	Chaloupky	Rothenthal	Klingenthal
November			
December			
January			
February			
March			
April		↓	↓
May		↓	↓
June		↓	↓
July		↓	↓
August		↓	↓
September		↓	↓
October		↓	

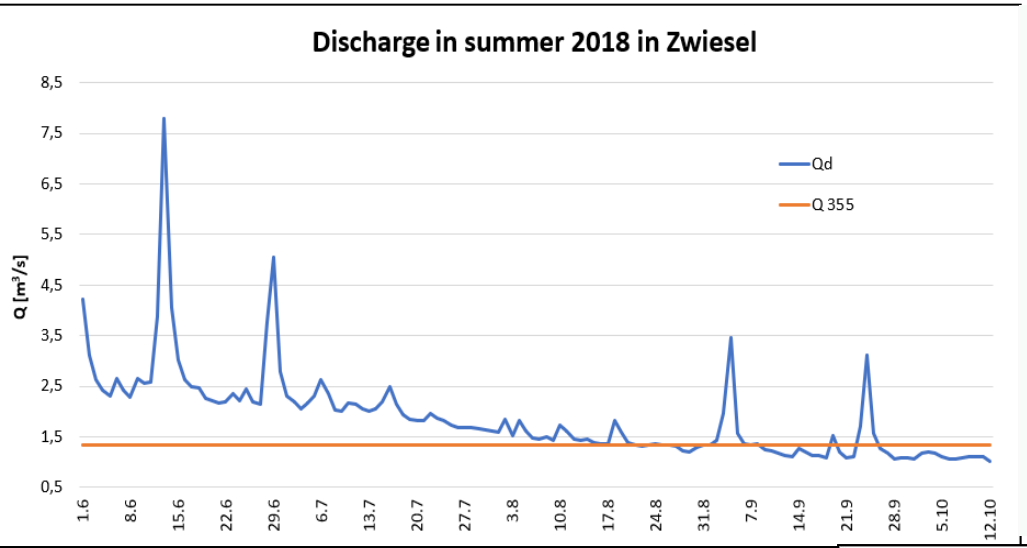
Qm355_sum	Sign. code	Sign. code	Sign. code
November			
December	↓		
January			
February	↓		
March			
April			
May			
June			↑
July		↑	↑
August		↑	↑
September		↑	↑
October			↑

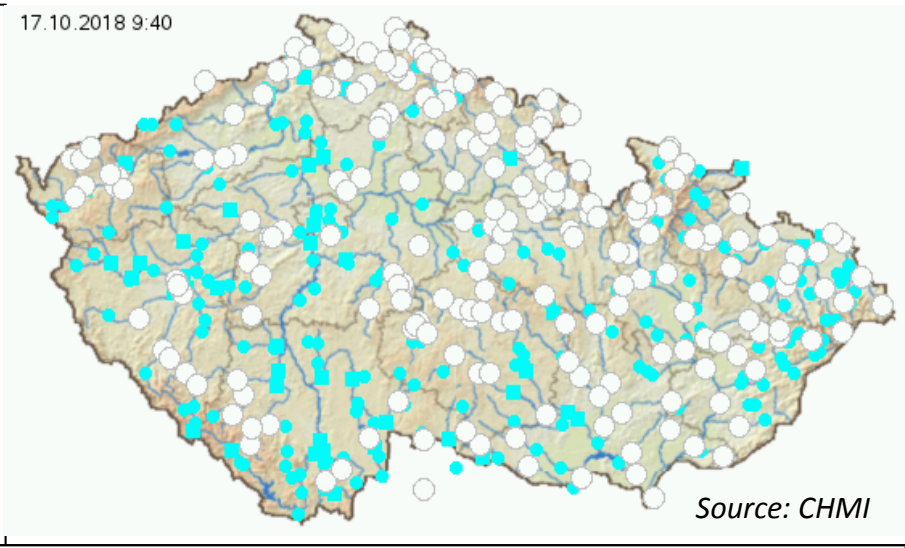

Klingenthal
7-Day Minimum
Flow Rate (cms)
Pre-Impact Flows (1967-1991)
Post-Impact Flows (1992-2017)
75th percentile
Median
25th percentile

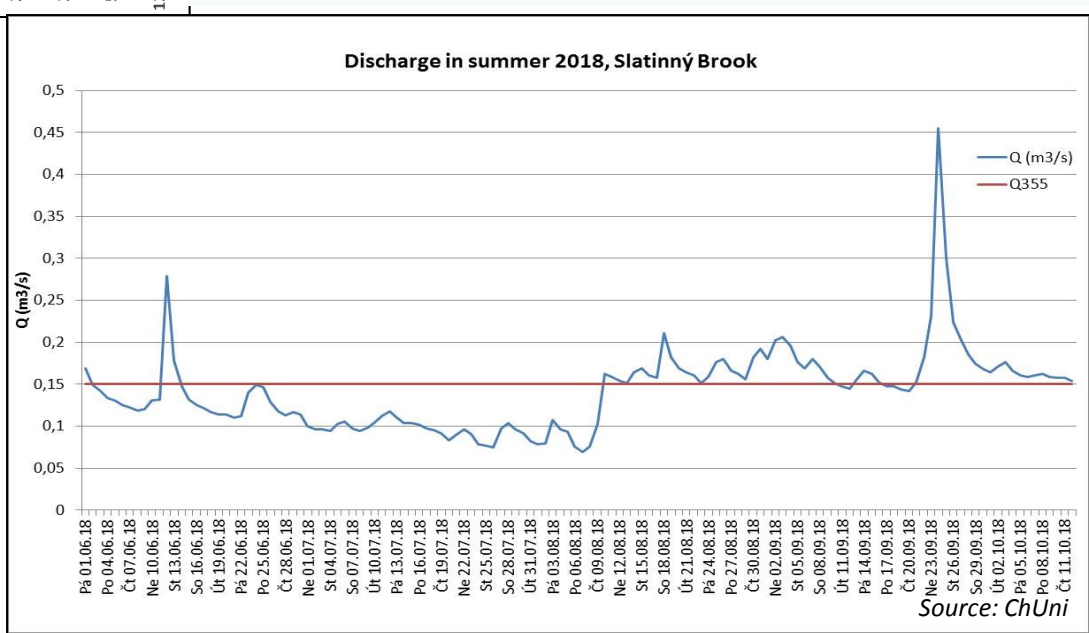

Rothenthal
7-Day Minimum
Flow Rate (cms)
Pre-Impact Flows (1967-1991)
Post-Impact Flows (1992-2017)
75th percentile
Median
25th percentile


Chaloupky
7-Day Minimum
Flow Rate (cms)
Pre-Impact Flows (1967-1991)
Post-Impact Flows (1992-2017)
75th percentile
Median
25th percentile

Hydrological drought in 2018







Discussion and Conclusion

Šumava Mt.: decreasing trend of hydrological drought occurrence

- No trends in BFI, 7-day minimal discharges and LFI (different from the Krušné hory Mt.)
- Seasonality of drought is different from the most of CZ
- Clearly visible difference in drought seasonality on the windward and lee sides in Šumava Mt.
- Spatial distribution of trends isn´t clear: stronger decrease in higher elevation

Krušné hory Mt: increasing trend of hydrological drought in upper Svatava and Načetínský B. catchments **x** decreasing trend in Rolava R. catchment

- Decreasing trend in BFI, 7-day minimums and LFI
- Reduction in runoff from 1990s, during periods of growth, and particularly in connection with air temperature increases in the summer months
- Influence of human impact?

References

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Thank you for your attention