HUMDROUGHT project meeting

12-05-2022

The dynamics of low flows and exposure to hydrological drought along the River Vistula and in its basin

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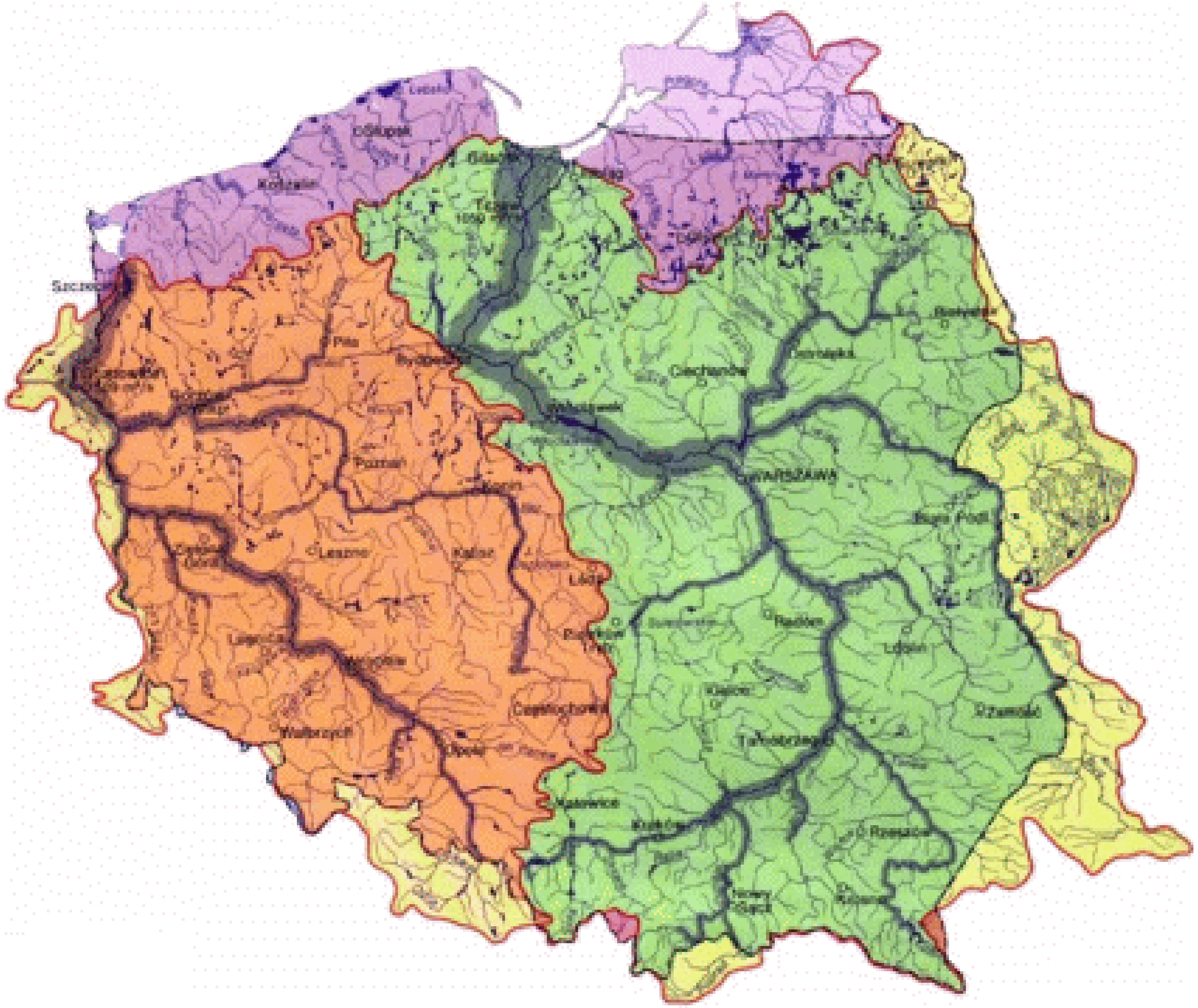
The River Vistula basin in Poland



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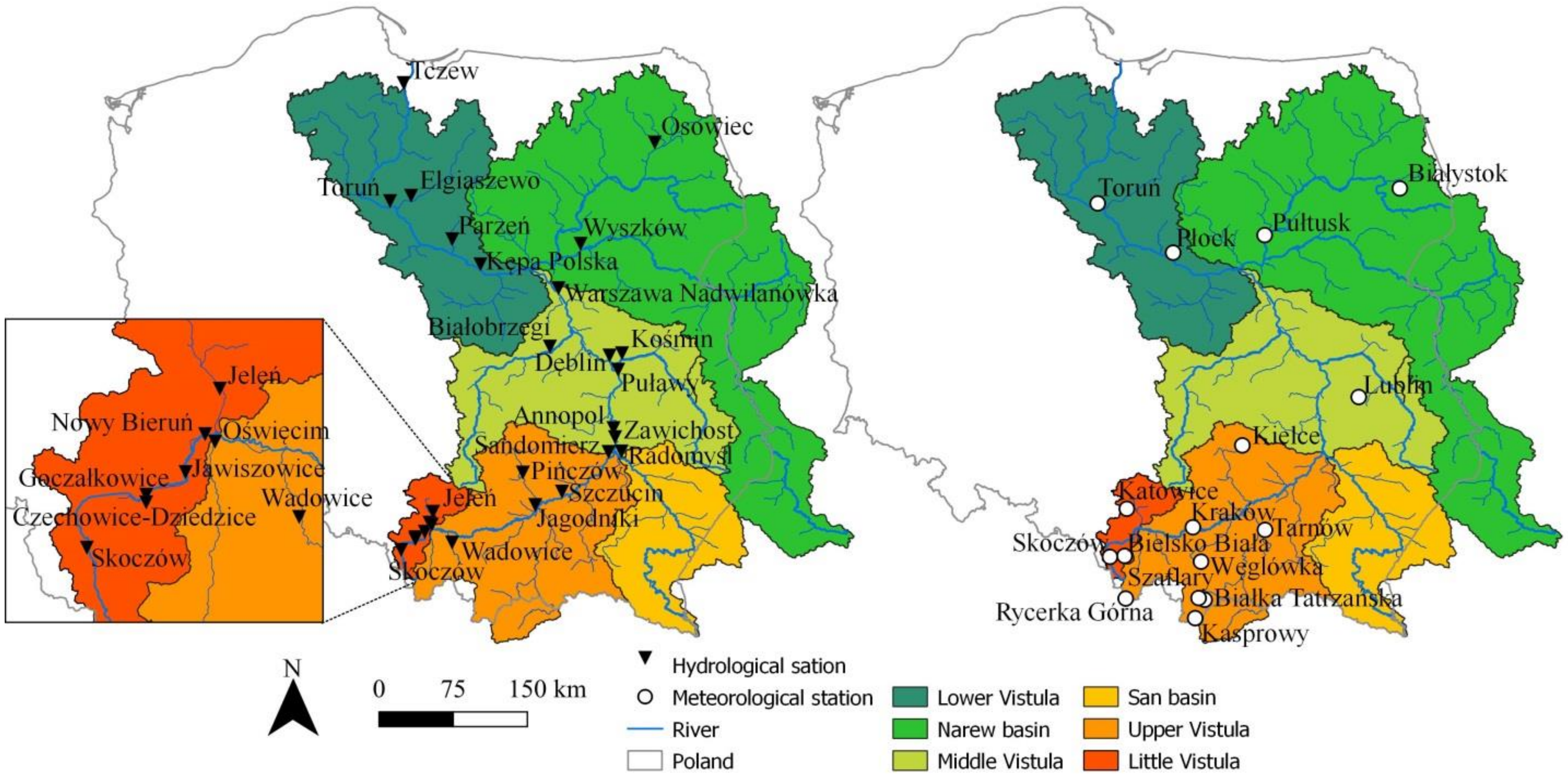
Stations used in the research

15 hydrological stations along the Vistula course and
12 hydrological stations on the main tributaries with the same observation period 1951-2018.
16 Meteorological stations (observations 1952-2018)



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The scope of the research

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1. The assesement of the dynamics of low flows along the River Vistula based on real hydrological data in 15 gauging stations.
2. Drought characteristics assessment by the means of flow-duration-probability (QdF) modelling.
3. Conclusions on climate change impact on low flows of the River Vistula and its basin and exposure to droughts (in progress).

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Timing of the minimum flow

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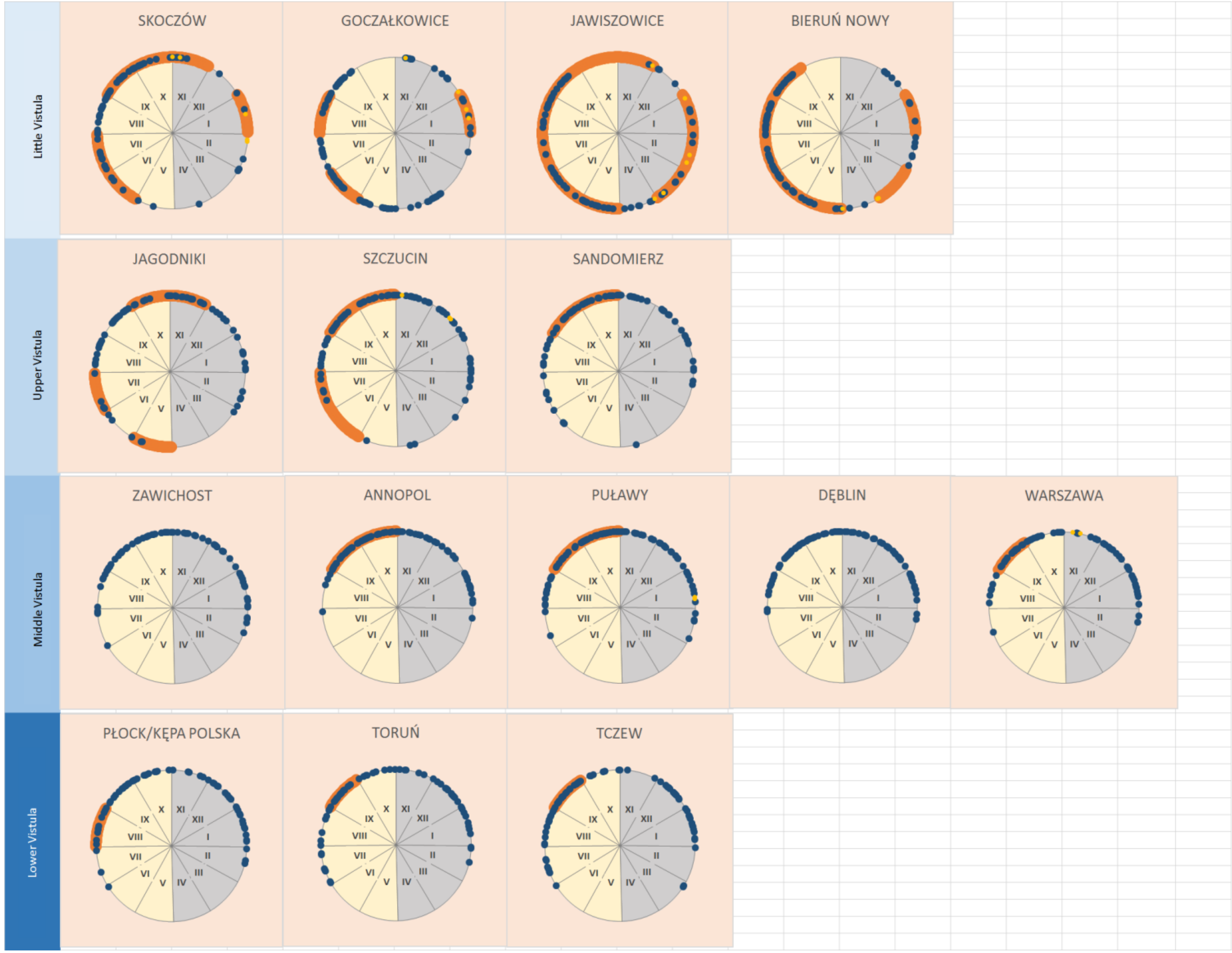

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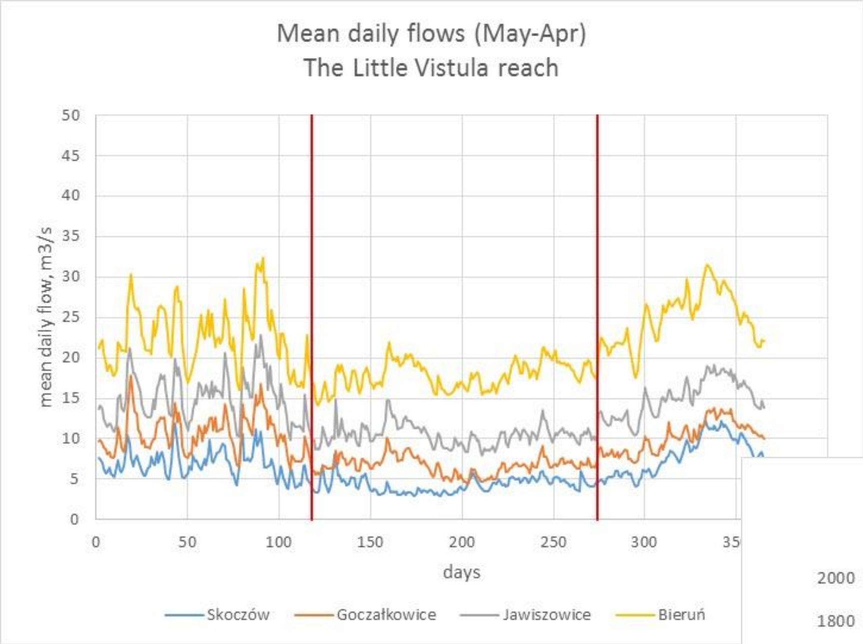
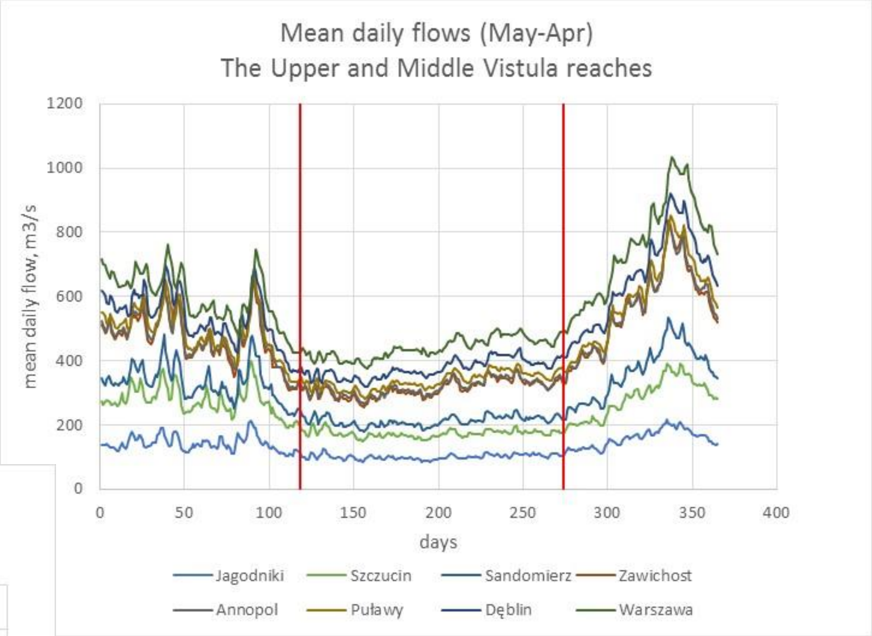
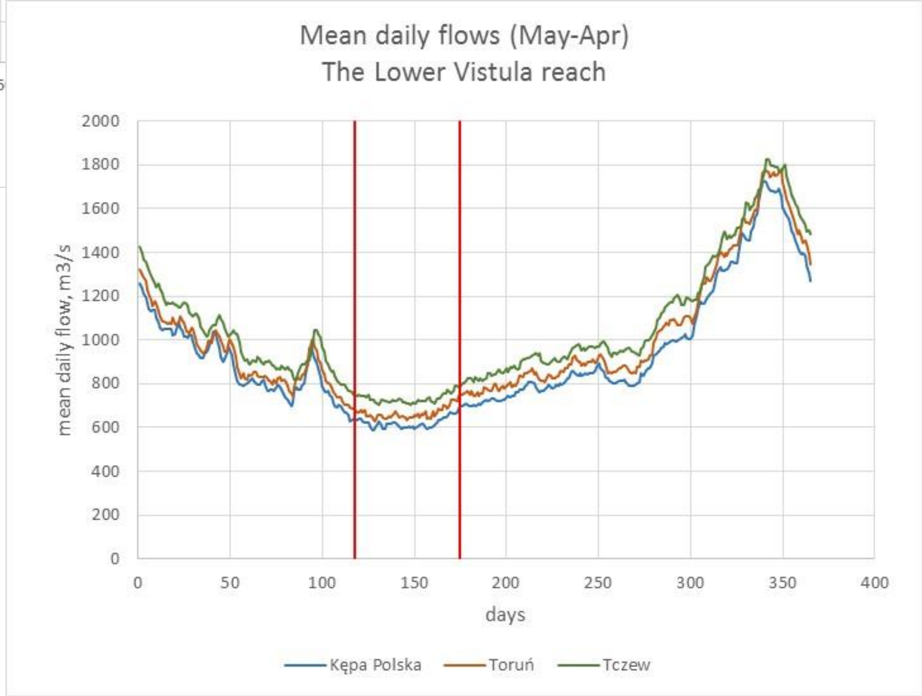
Timing of the minimum low flow.



Red vertical lines
End of August – end of January





End of August – end of October

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. The deepest low flows on the Vistula and on its reaches and the main tributaries..

Rank	Vistula		Little Vistula		Upper Vistula		Midlle Vistula		Lower Vistula	
	Year	Total	Year	Total	Year	Total	Year	Total	Year	Total
1	1959	83	1959	31	1953	4	1951	15	1961	8
2	1951	109	1957	34	1957	9	1963	16	1959	10
3	1961	134	1994	49	1954	10	1984	19	1992	12
4	1963	134	1951	53	1956	18	1959	21	1951	17
5	1954	154	1958	56	1959	21	1961	31	2015	18
6	1953	157	1993	57	1963	22	1952	36	1952	21
7	1952	167	1963	61	1951	24	1954	36	1954	21
8	2015	173	2003	61	1961	25	1993	41	1953	23

Rank	Przemsza	Soła	Skawa	San	Wieprz	Pilica	Bug
	Jeleń	Oświęcim	Wadowice	Radomyśl	Kośmin	Białobrzegi	Wyszków
1	1951	1959	1994	1959	1992	1992	1959
2	1953	1957	2015	1951	1952	1994	2015
3	1954	1983	2011	1961	1962	1954	1951
4	1952	1958	2012	1963	1963	1963	1952
5	2017	1963	1960	1962	1964	1995	1953
6	2015	1961	1955	1952	1961	2006	1963
7	2016	1953	1961	1967	1995	2015	1961
8	1962	2003	2003	1968	1994	2008	2016

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2. Drought design characteristic

Analysis of annual minima
and their frequency is not enough

↓

Duration of extreme events is needed

↓

Flow-duration-frequency

QdF

d – fixed value

Q – random variable

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2. Drought design characteristic

QdF model

Low flows

Quantile function :

$$Q(d,F) = Q(0,F) \cdot \left(1 + \frac{d}{D}\right)$$

Distribution of the flow non-exceeded in *d* days

Annual minima distribution

D - parameter of low flows dynamics

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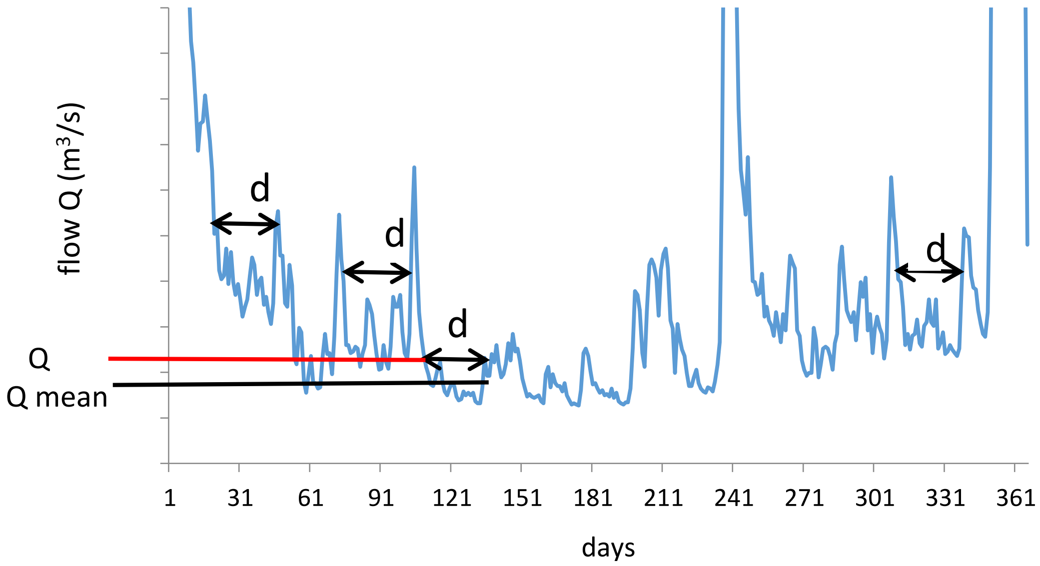
2. Drought design characteristic

Low flows

QdF approach



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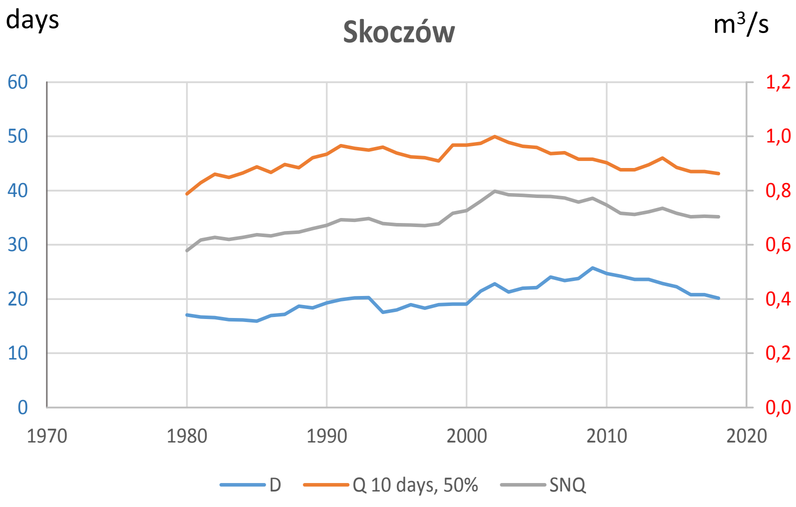
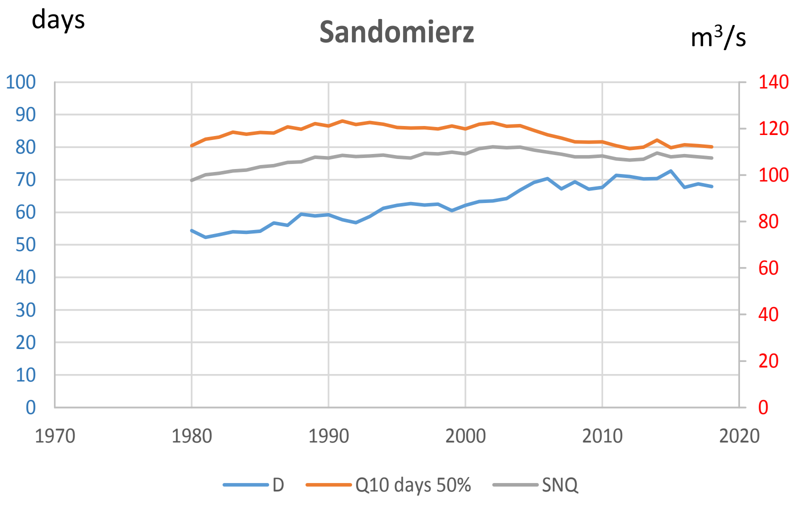
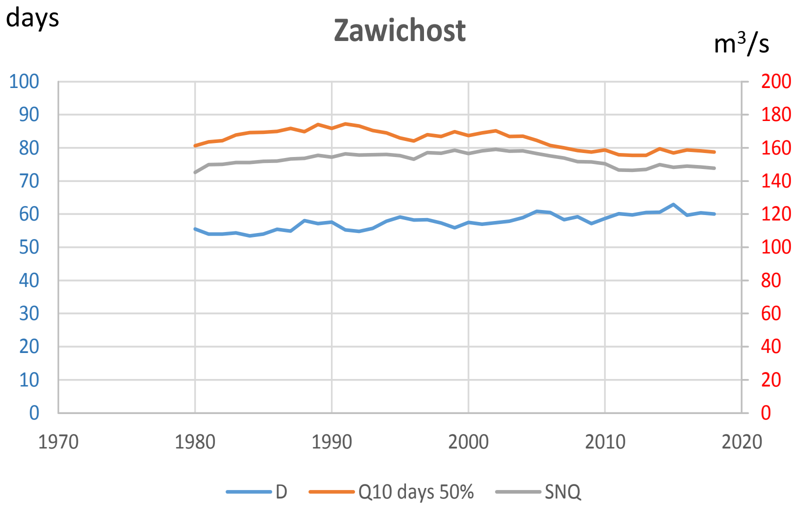
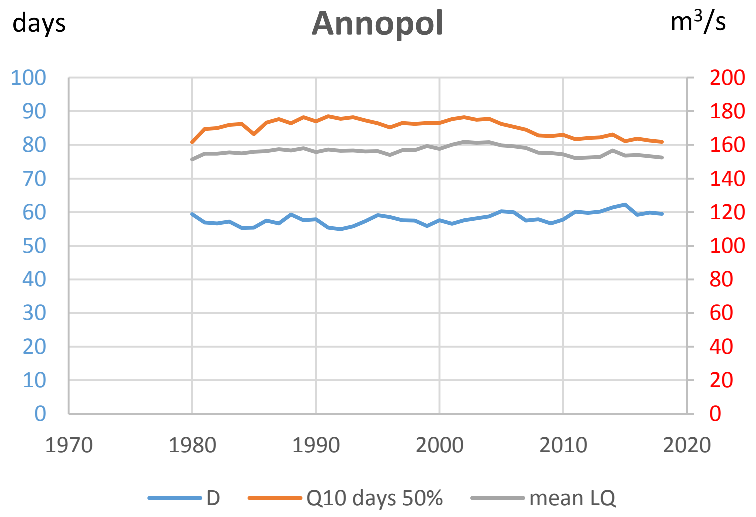
QDF model -results









SNQ-mean annual minimum low flow

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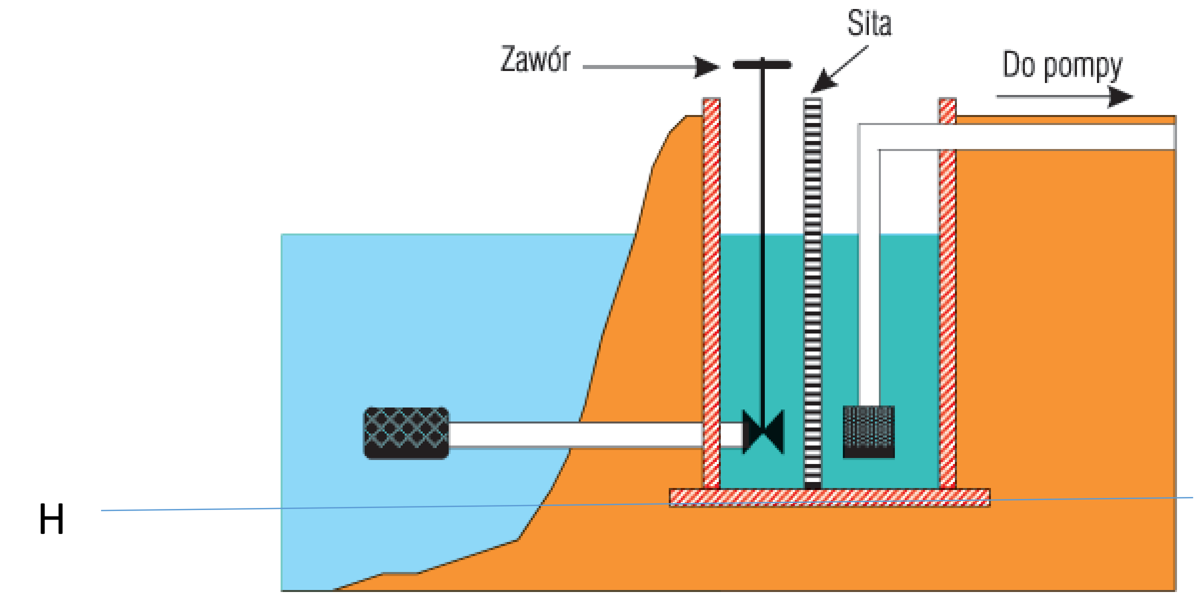
2. Drought (for who?)

- Potable water for population
- Water for industry
- Water for irrigation

The water level corresponding to Q d days p%



- Water for environment (ecological flow)

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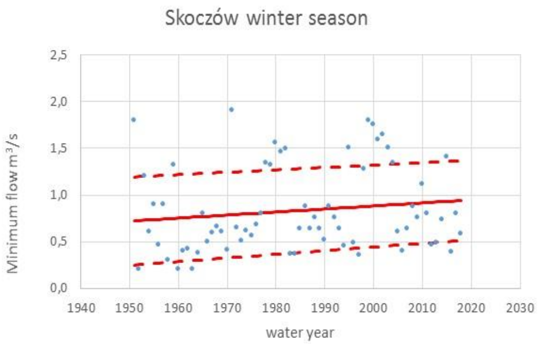
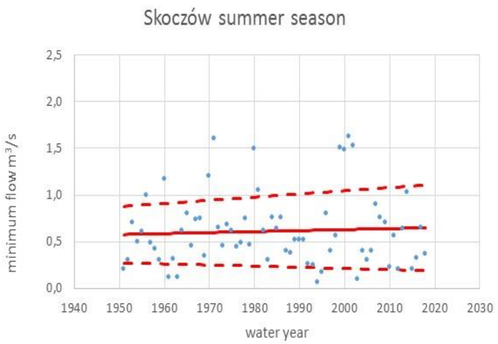
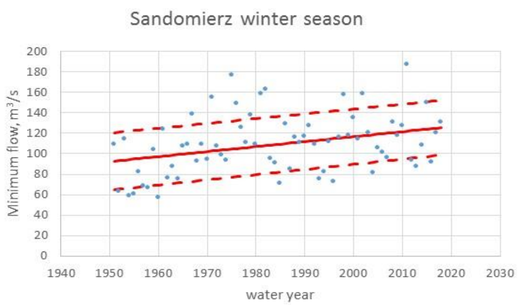
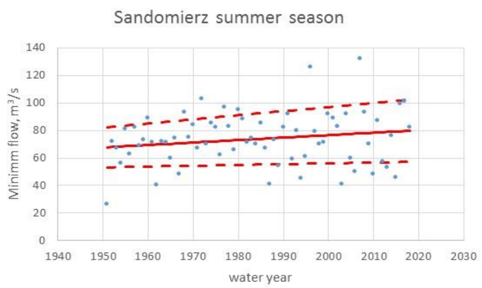
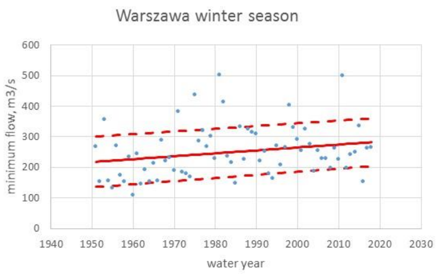
Conclusions

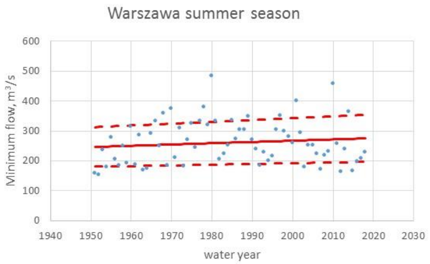


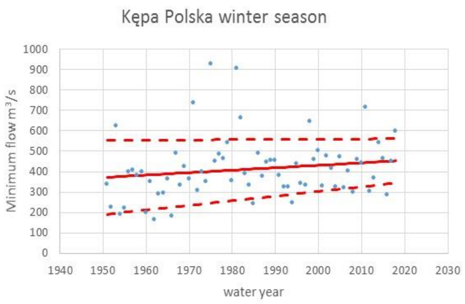


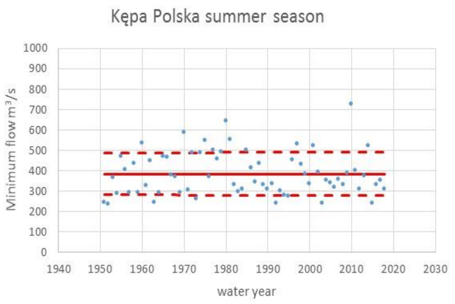


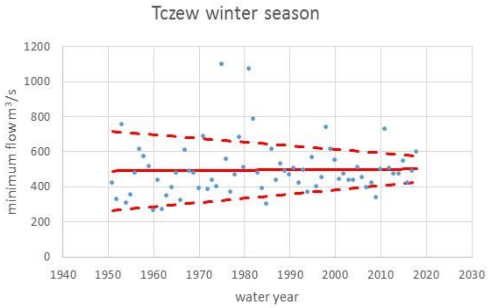


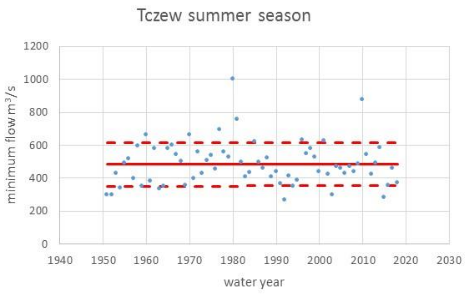












Analyzes of trends in many flow characteristics have shown, inter alia, that the minimum winter flows increased in the period 1951-2018.
In general, the summer minima do not show downward trends. Moreover, flow maxima reveal decreasing trends.

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Conclusions

However, in the social perception and media coverages droughts and floods become more sever due to the climate change.

One of the reasons of these contradictory opinions can be river regulation, in the form of engineering structures in the channel (mainly wing dikes), sediment retention in water reservoirs and bagging of navigable routes. Natural bottom erosion of the riverbed strongly accelerated and exploitation of sand and gravel which results in river cutting into deeper horizons of groundwater and their drainage. The lowering of the river channel causes a decrease in the water level, especially visible at low levels, but the flow does not change.

Straightening of natural river beds and sediment deposition in inter-dike spaces decrease in the rivers' capacity to convey flood flows what results in more frequent inundations.

However, it must be emphasized that this hypothesis applies to large regulated rivers. In small catchments (not explored here), the trends and their reasons may be different.

Thank you for your attention

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