Climate change impact on recurrence and regime of runoff extremes: floods and droughts

An example of the Middle Daugava River

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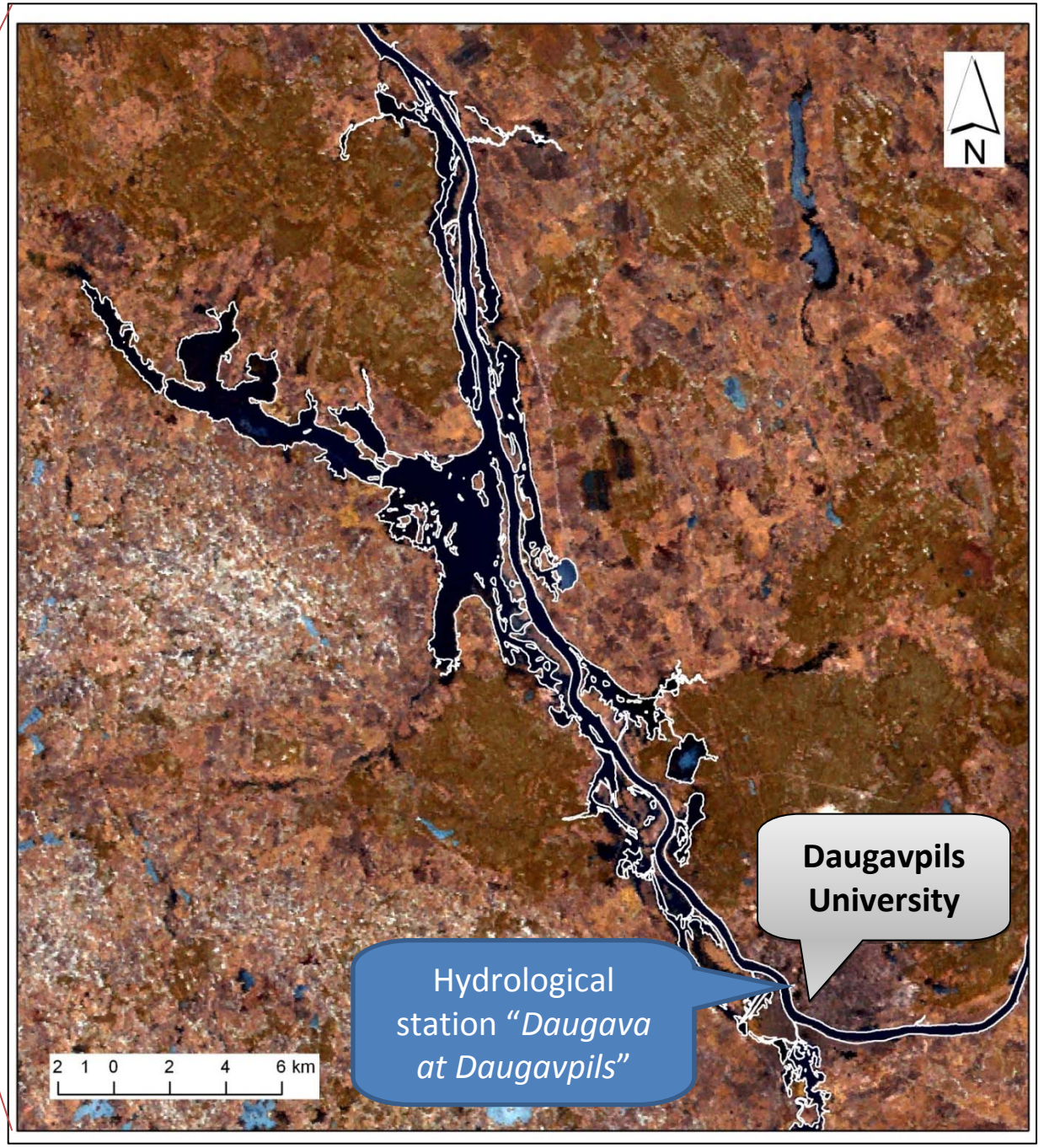
Introduction

Aim of the study:

- to evaluate long-term changes in the reoccurence (probability) and regime of the runoff extremes (floods and droughts) of the Middle Daugava River in context of climate change.

Study site

A false-colour image of the Middle Daugava and its floodplain from the *LANDSAT-2* satellite at the peak of the spring floods (April 10, 1979).



The Daugava River upstream from Daugavpils City during the summer low-flow period (photo by Ivars Druvietis, July 28, 2004)

The Daugava River downstream from Daugavpils (at Nīcgale) during the spring floods (obligue aerial photo by Dāvis Gruberts, April 25, 2009)

Floodplain meadows of the Daugava River at Dviete during the spring floods
(obligue aerial photo by Dāvis Gruberts, April 24, 2009)

Floodplain meadows of the Daugava River at Ilūkste during the spring floods
(obligue aerial photo by Kristīne Vēvere, April 24, 2009)

Data sources

1. **The Global Runoff Data Centre, Koblenz, Germany** (www.grdc.bafg.de) – daily mean discharges of the Daugava River at Daugavpils (GRDC No. 6973300, 1936-2007);
2. **The National Climatic Data Centre, Asheville, NC, USA** (ftp://ftp.ncdc.noaa.gov/pub/data/gsod): daily mean air temperature, amount of precipitation and thickness of snow cover at Riga, Daugavpils and Vitebsk weather stations (1964-2006).

Main characteristics of the hydrological station "*Daugava at Daugavpils*"

- latitude: 55,88°
- longitude: 26,53°
- altitude: 86,0 m a.s.l.
- catchment area: 64'500 km²
- object of observations: water level, discharge
- beginning of observations: since 1881
- frequency of observations: each day
- highest observed discharge: 6930 m^3/s (April, 1931)
- lowest observed discharge: 40,5 m^3/s (February, 1942)

Location of the weather stations

Statistical analysis of the hydrological drought reoccurence (probability distributions)

- **selected periods:** 1936-1977, 1966-2007 (summer and all-year droughts); 1936-1987, 1956-2007 (winter droughts);
- **threshold level** for the distinction of the hydrological drought periods: 70 %;
- **parameters:** all-year droughts; summer droughts (June 5 – November 9); winter droughts (November 10 – June 4);
- **estimated probability distributions:** relative runoff deficit; real low-flow duration; full low-flow duration;
- **the program:** *Nizowka 2003* (*Distributions of Low Flow Extremes*)*.

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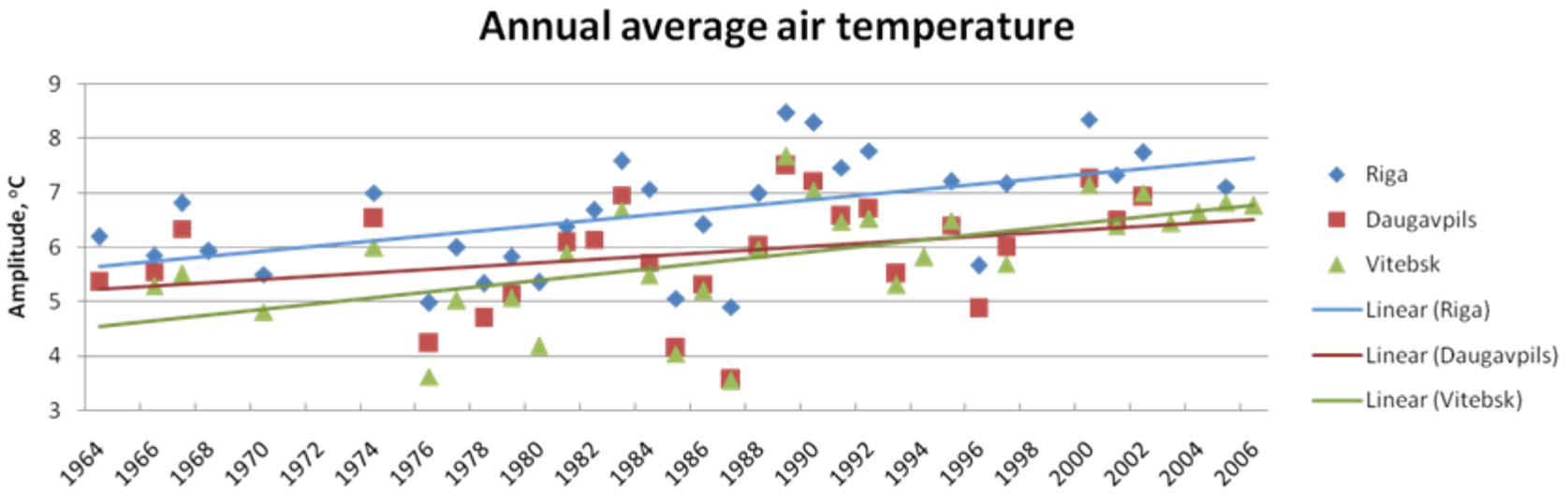
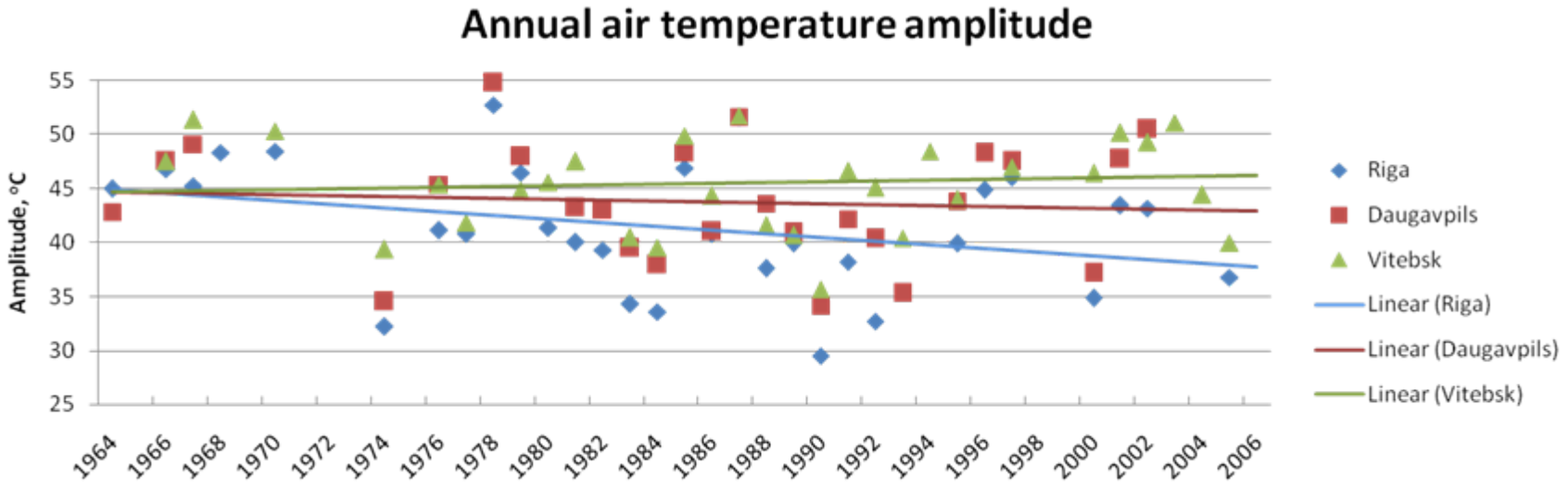
* - Dr. Wojciech Jakubowski, prof. Laura Radczuk, Agricultural University of Wrocław, Poland

The long-term changes





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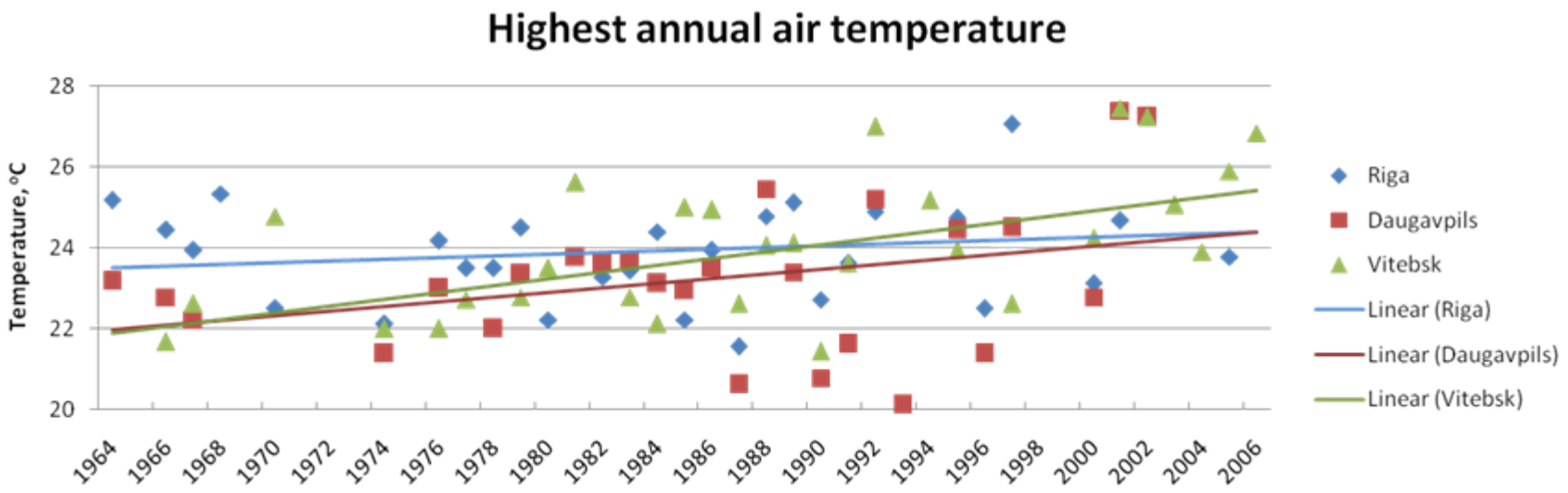
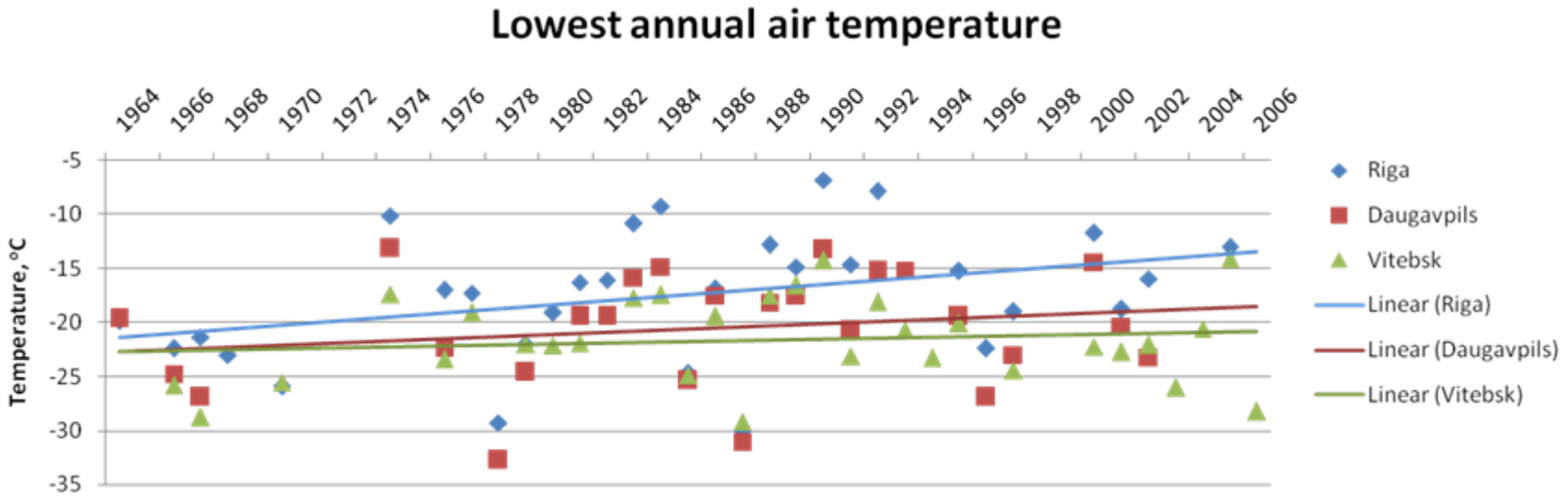
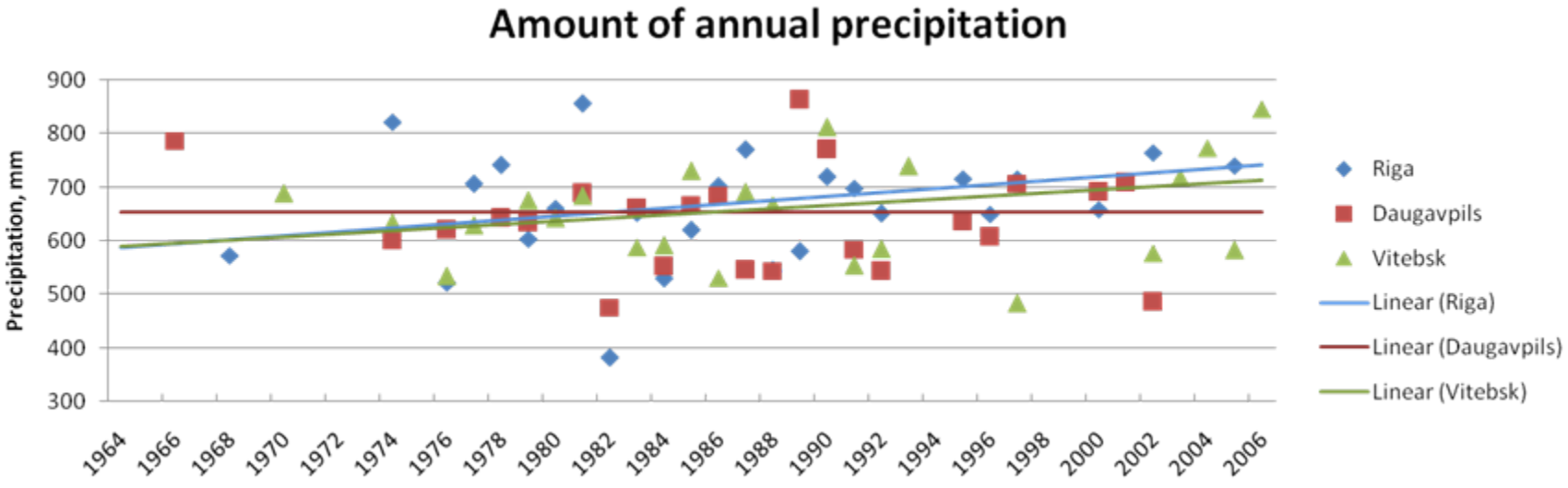
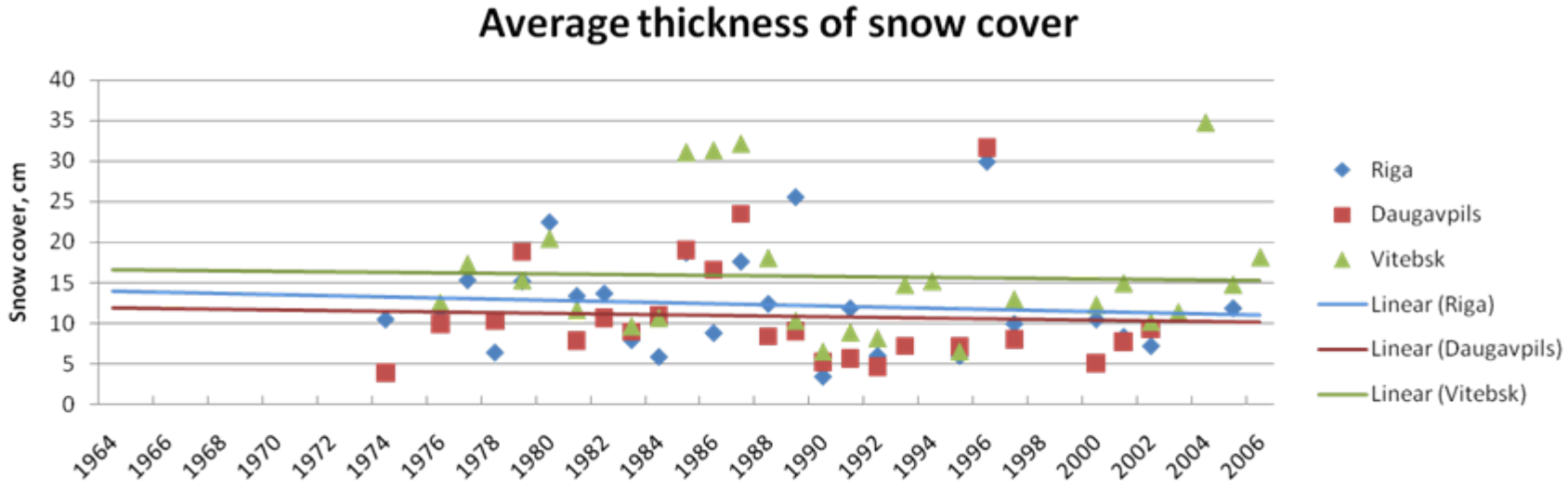




The long-term changes





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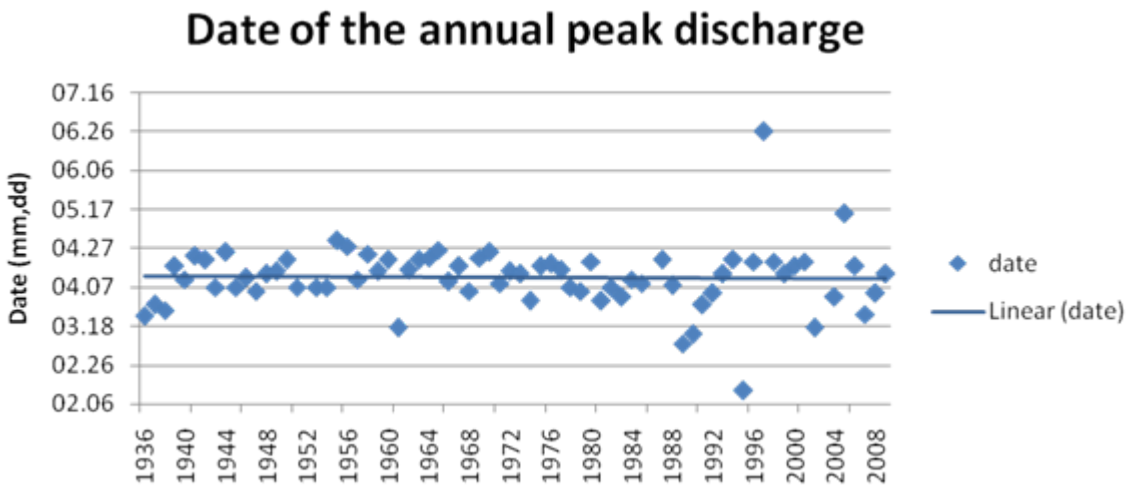

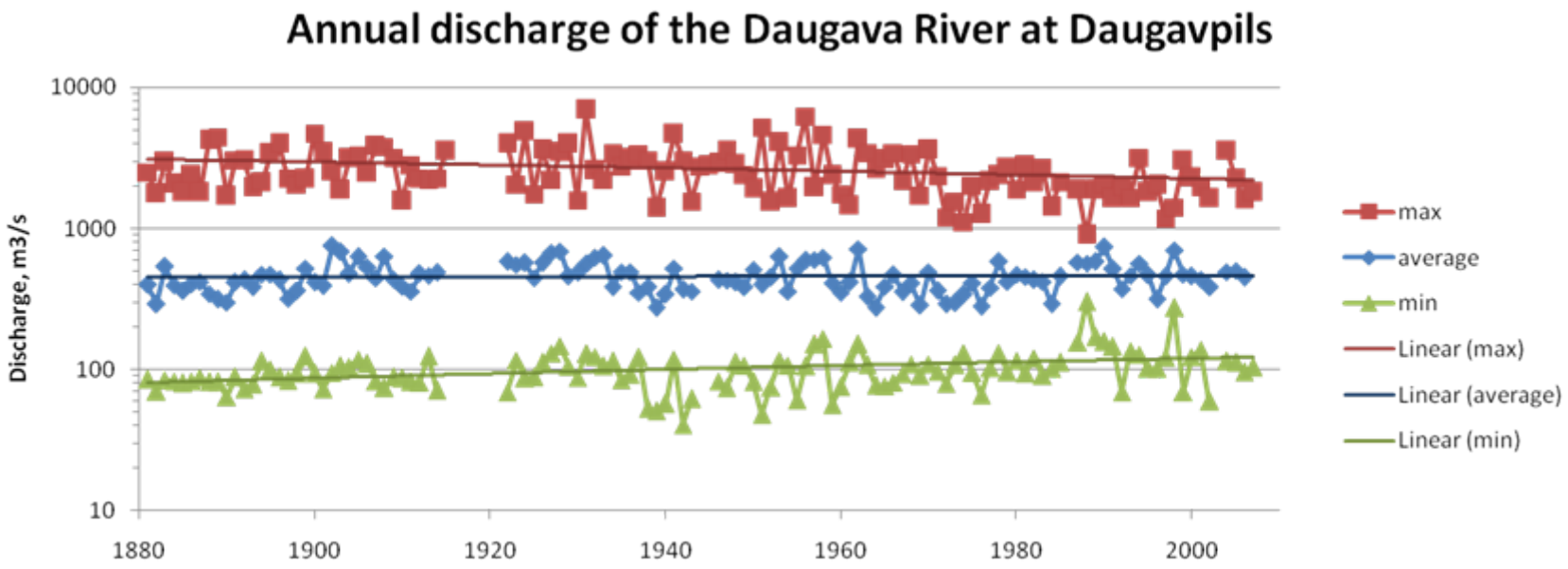

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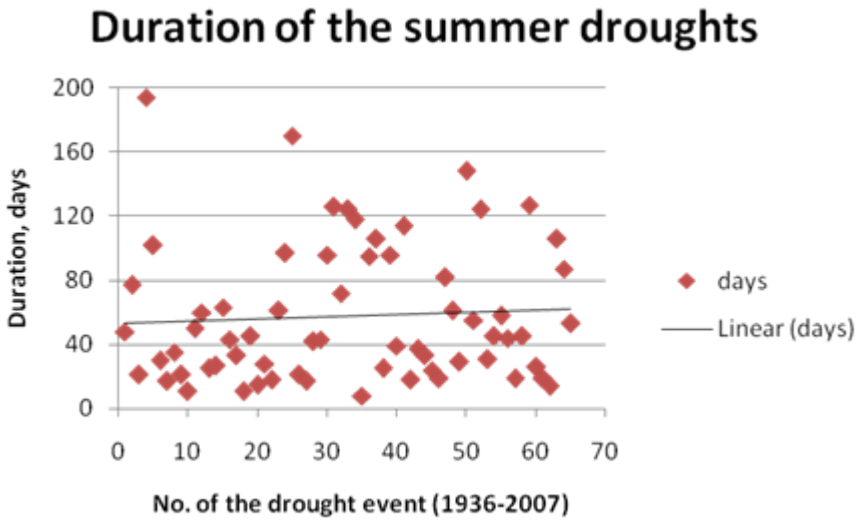
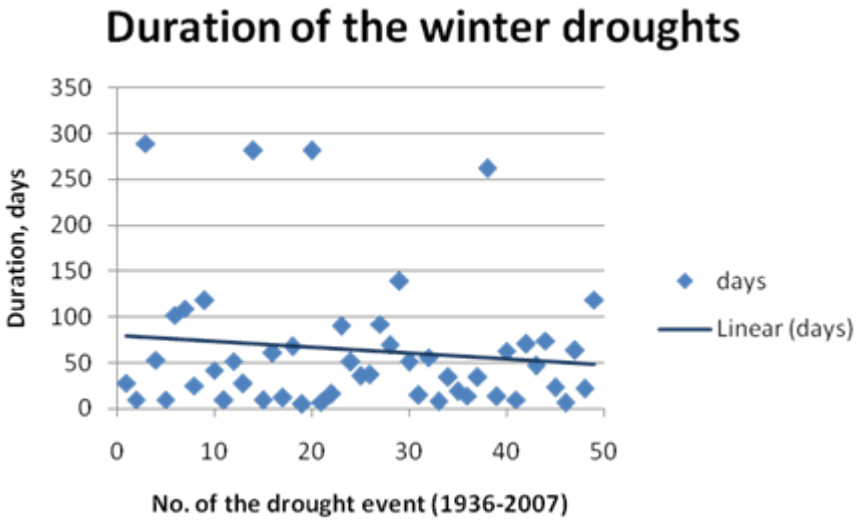
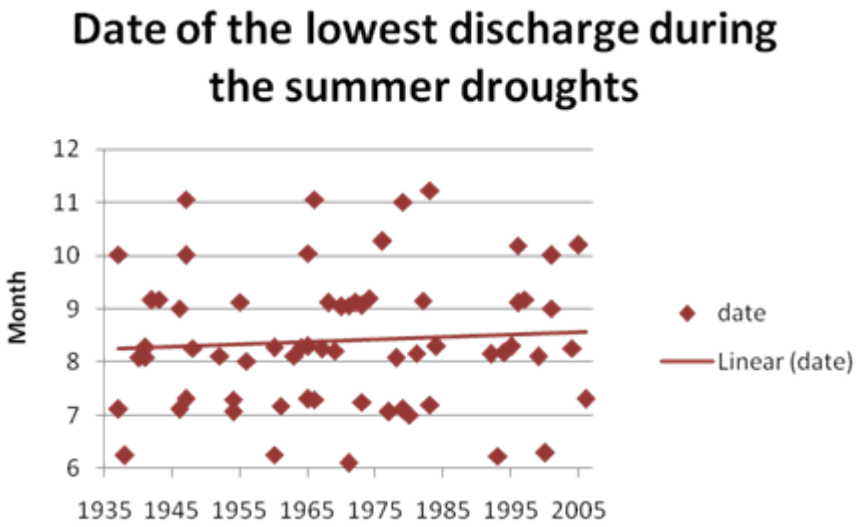
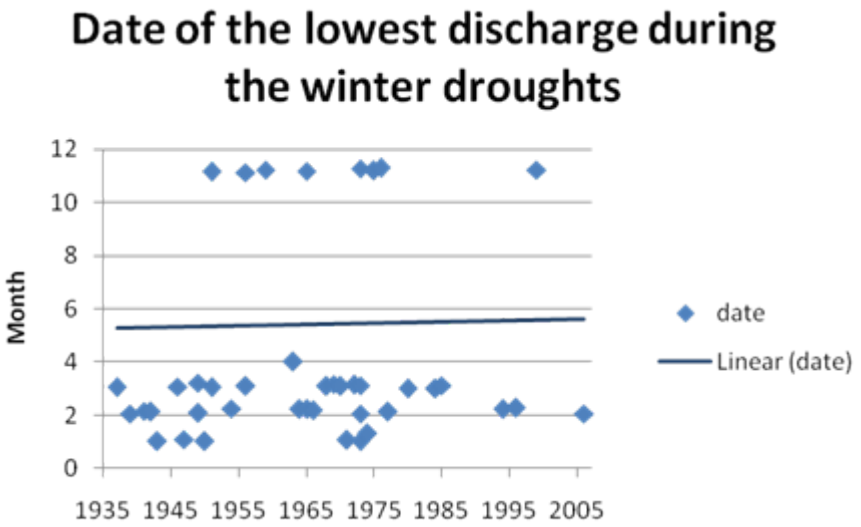


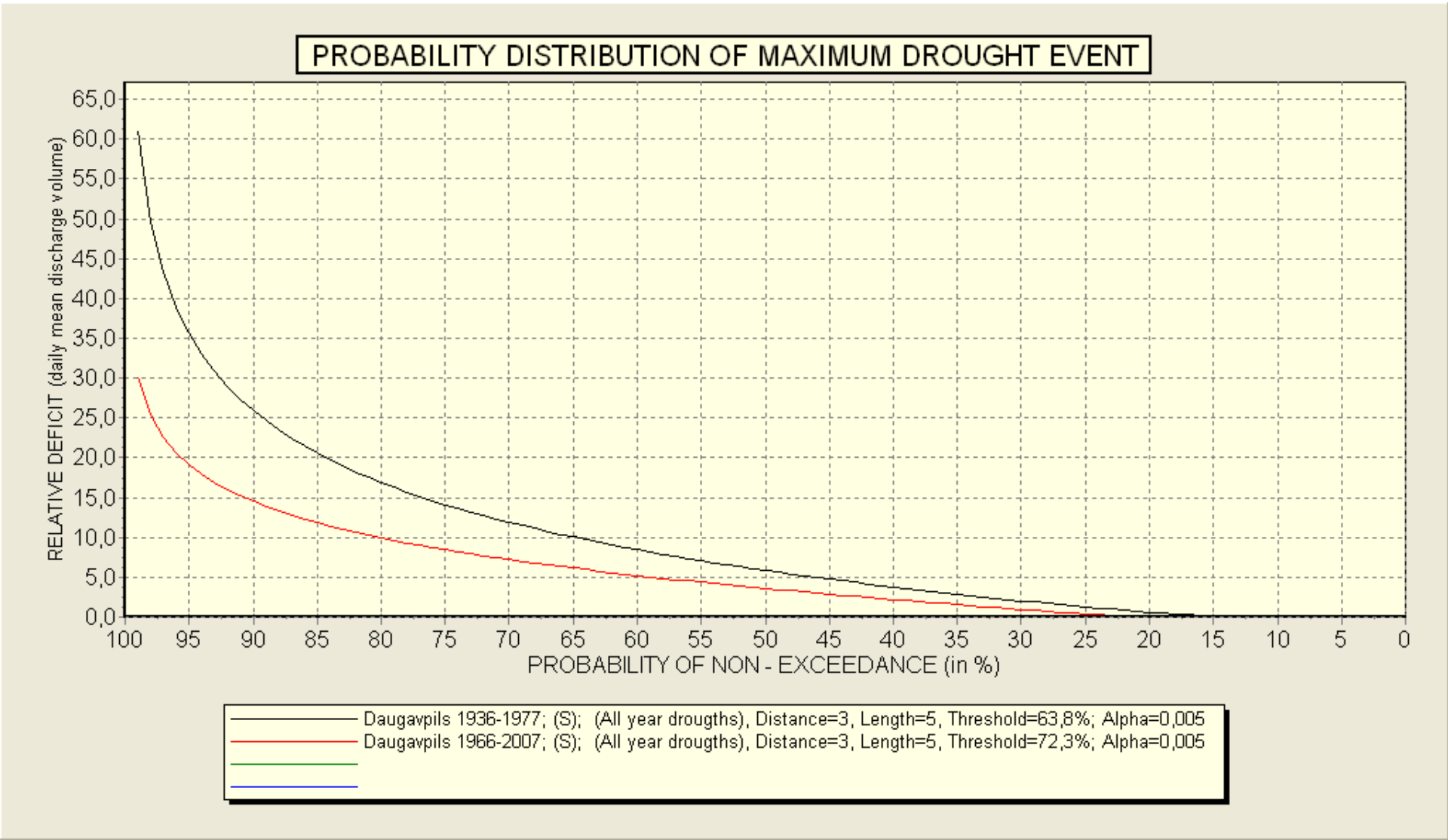






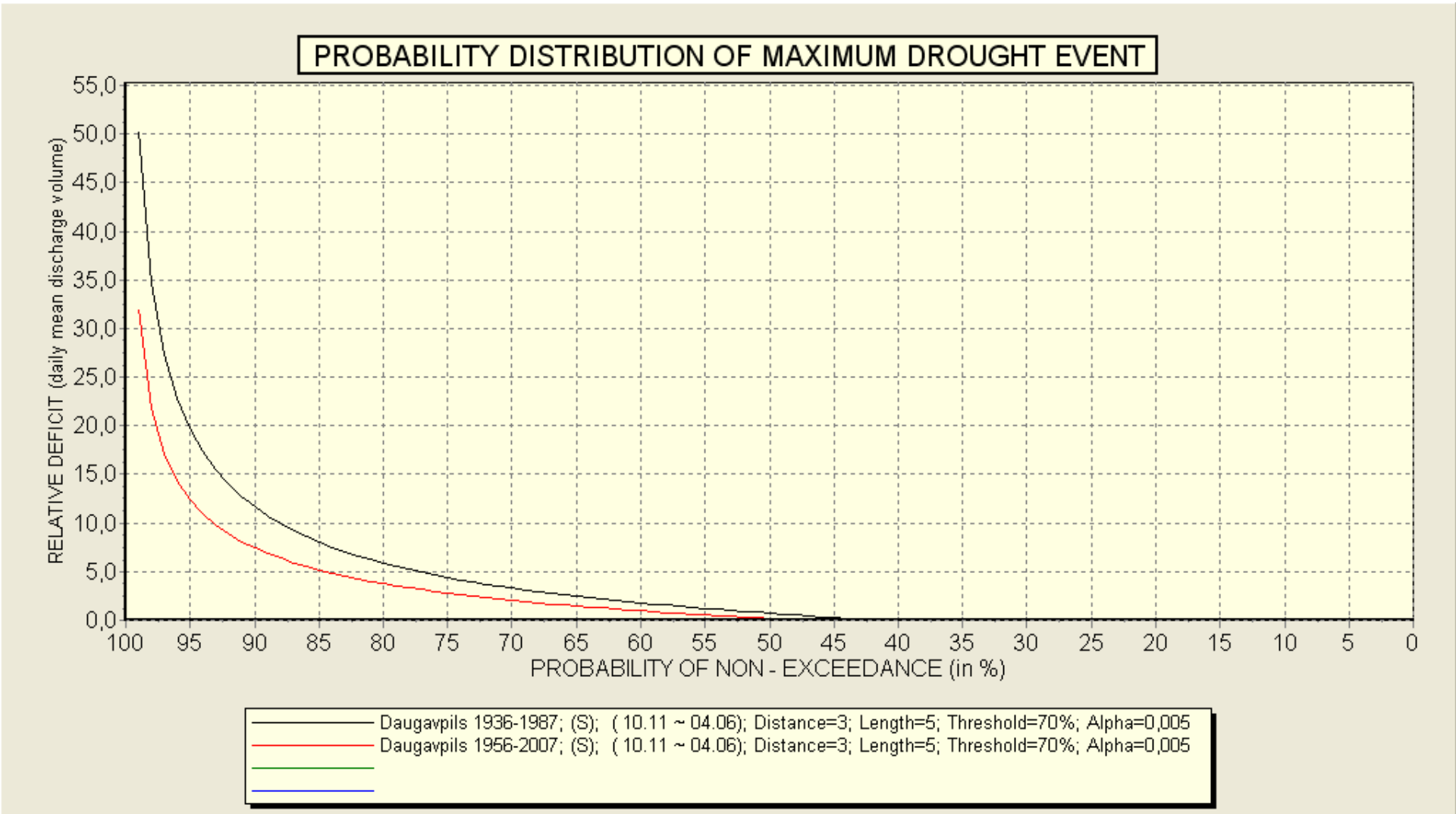
The probability of hydrological droughts

Relative deficit of the all-year droughts



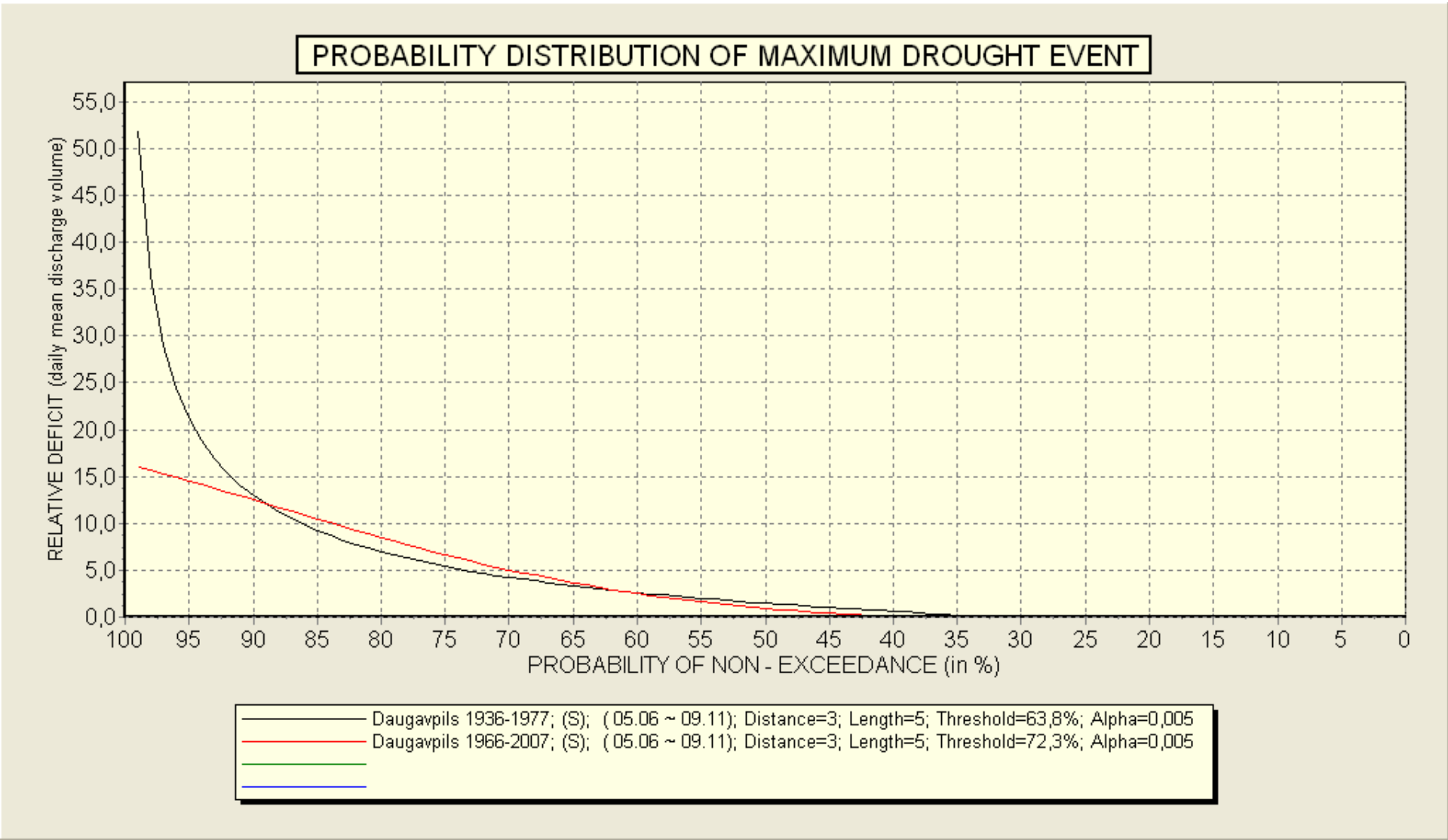
The probability of hydrological droughts

Relative deficit of the winter droughts



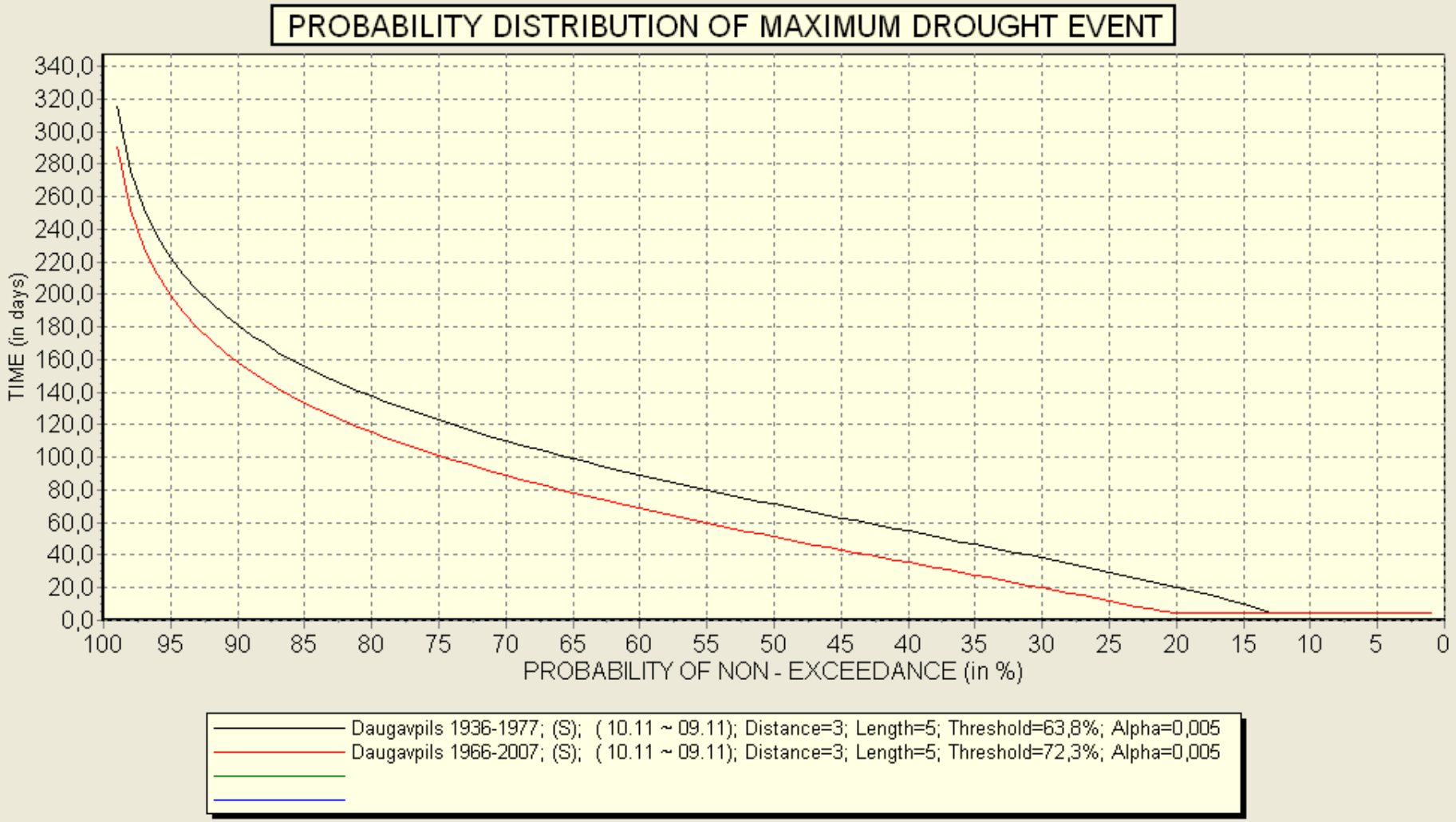
The probability of hydrological droughts

Relative deficit of the summer droughts



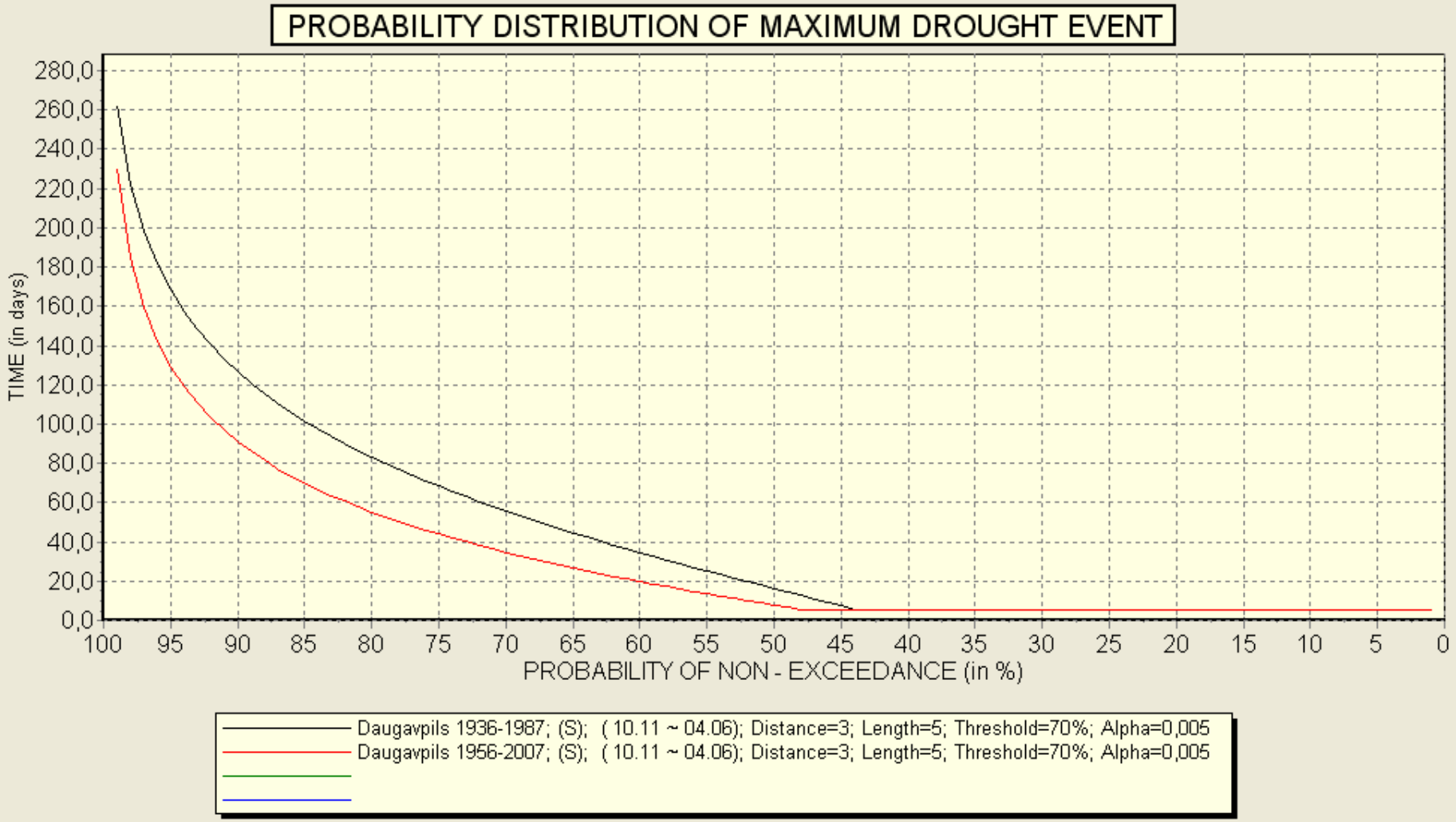
The probability of hydrological droughts

Full duration of the all-year droughts



The probability of hydrological droughts

Full duration of the winter droughts



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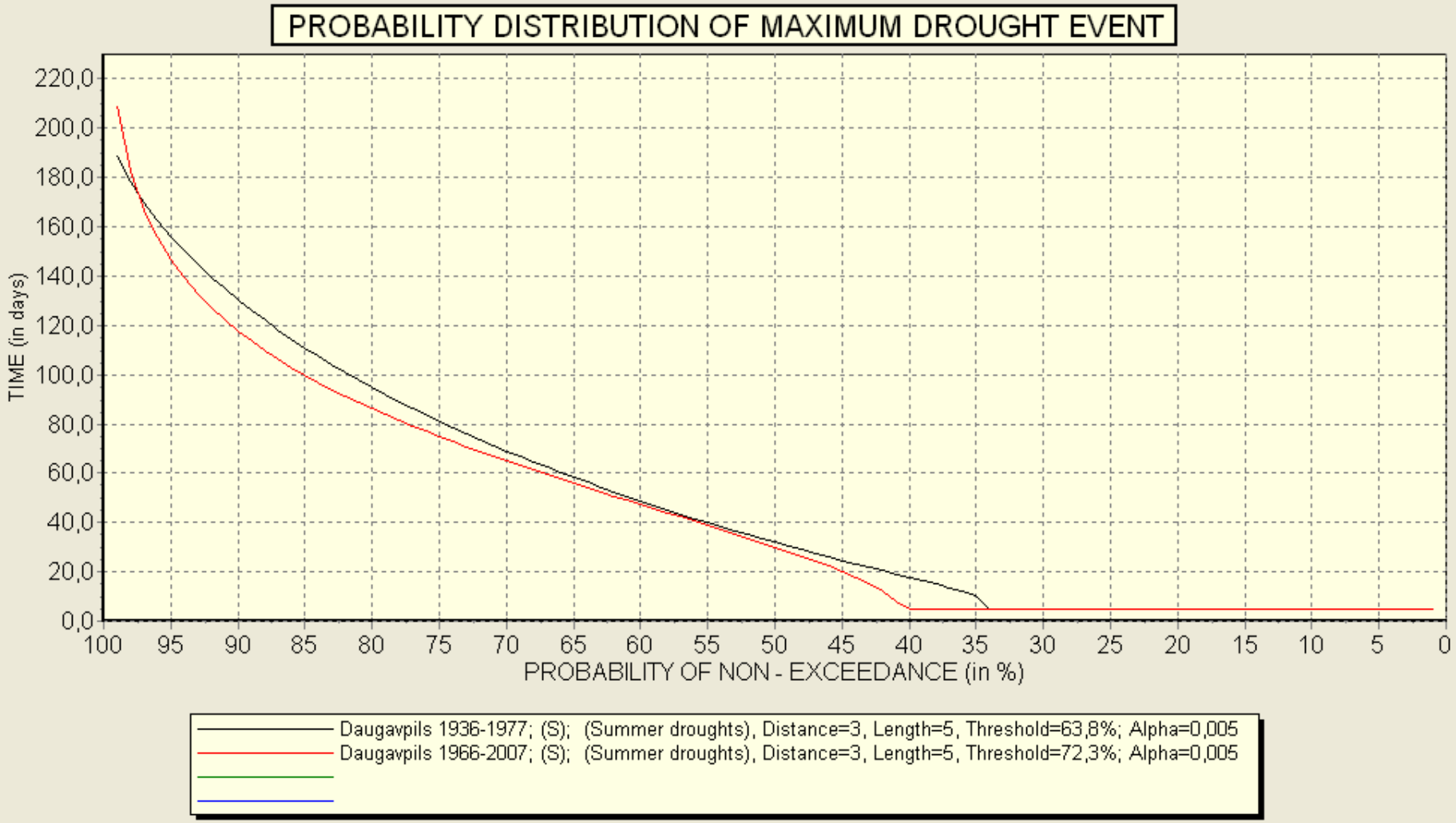
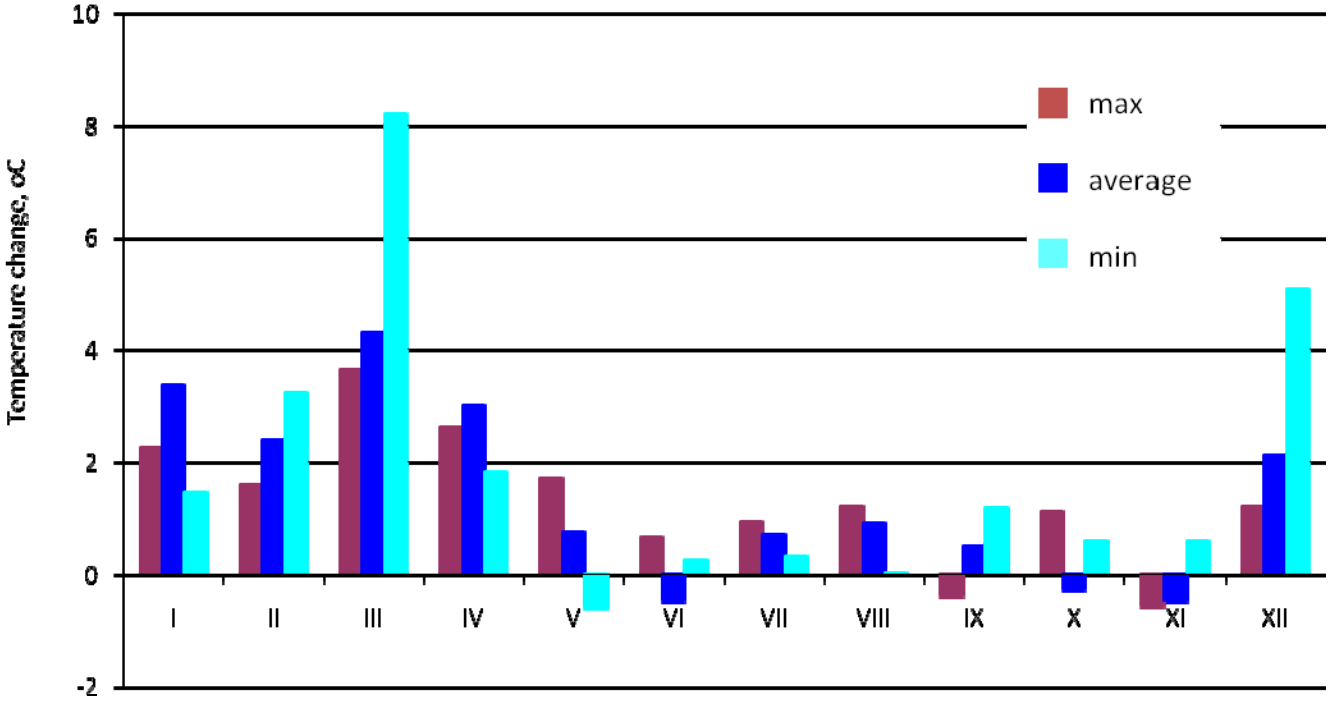


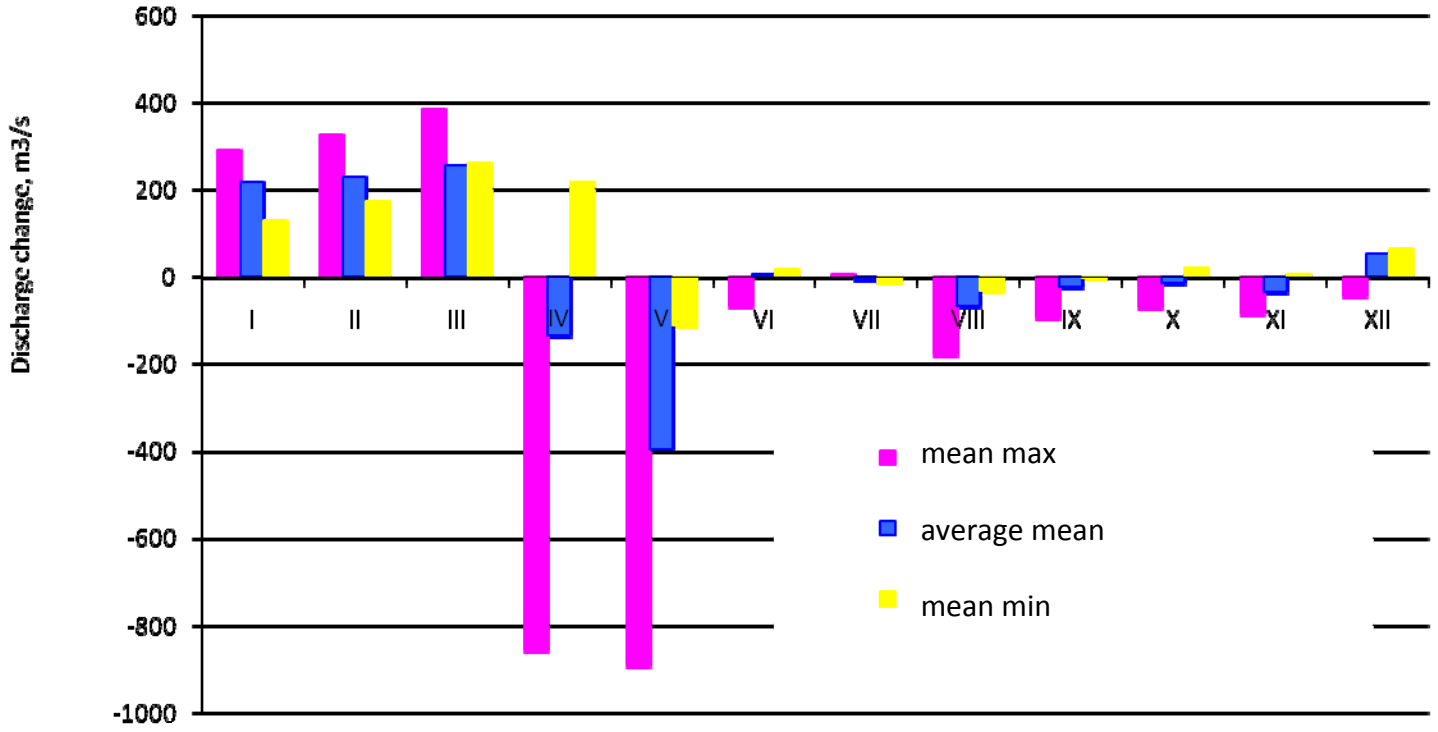
Long-term changes on the monthly scale

Example 1: the monthly highest, averare and lowest air temperature at Daugavpils (1973-2007)



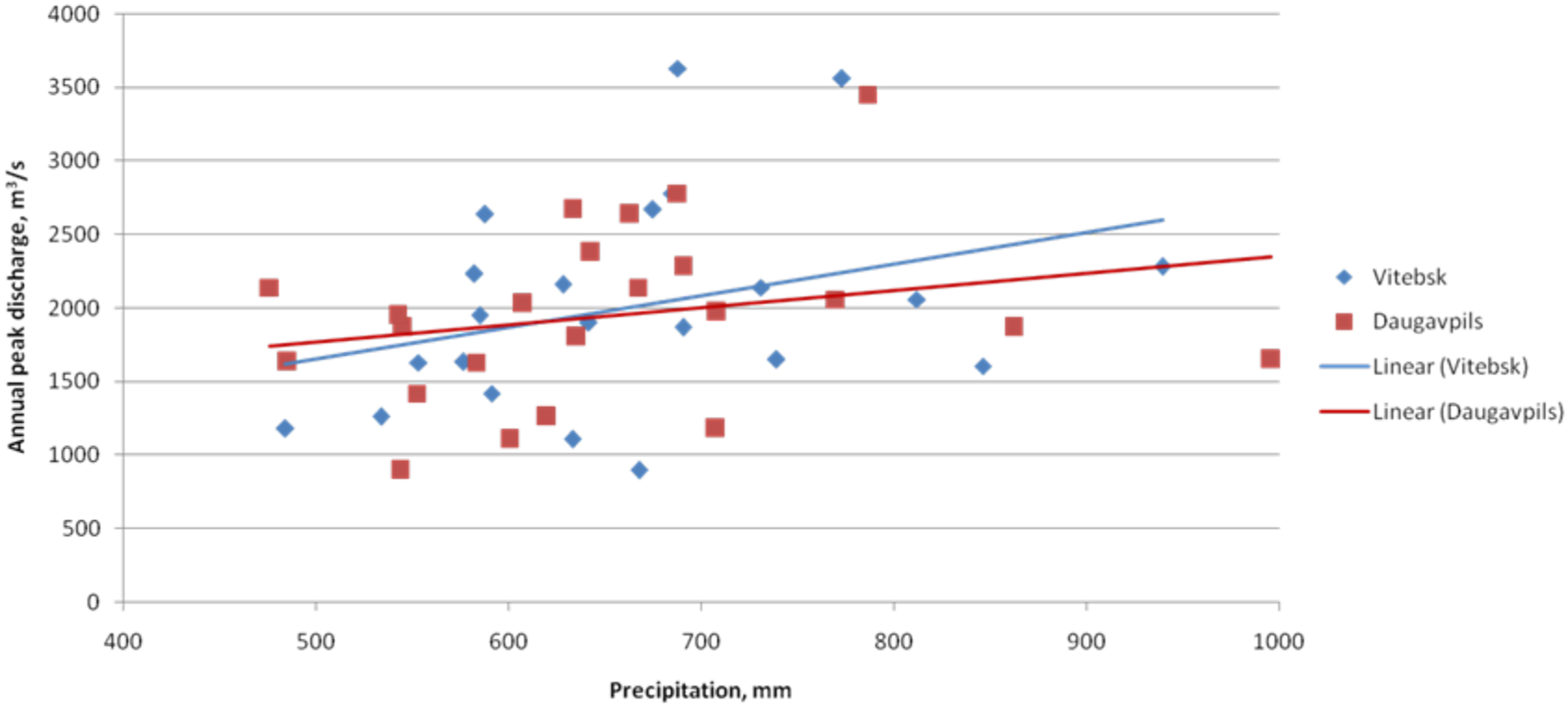
Long-term changes on the monthly scale

Example 2: the monthly mean max, average and min discharge of the Daugava at Daugavpils (1881-2007)

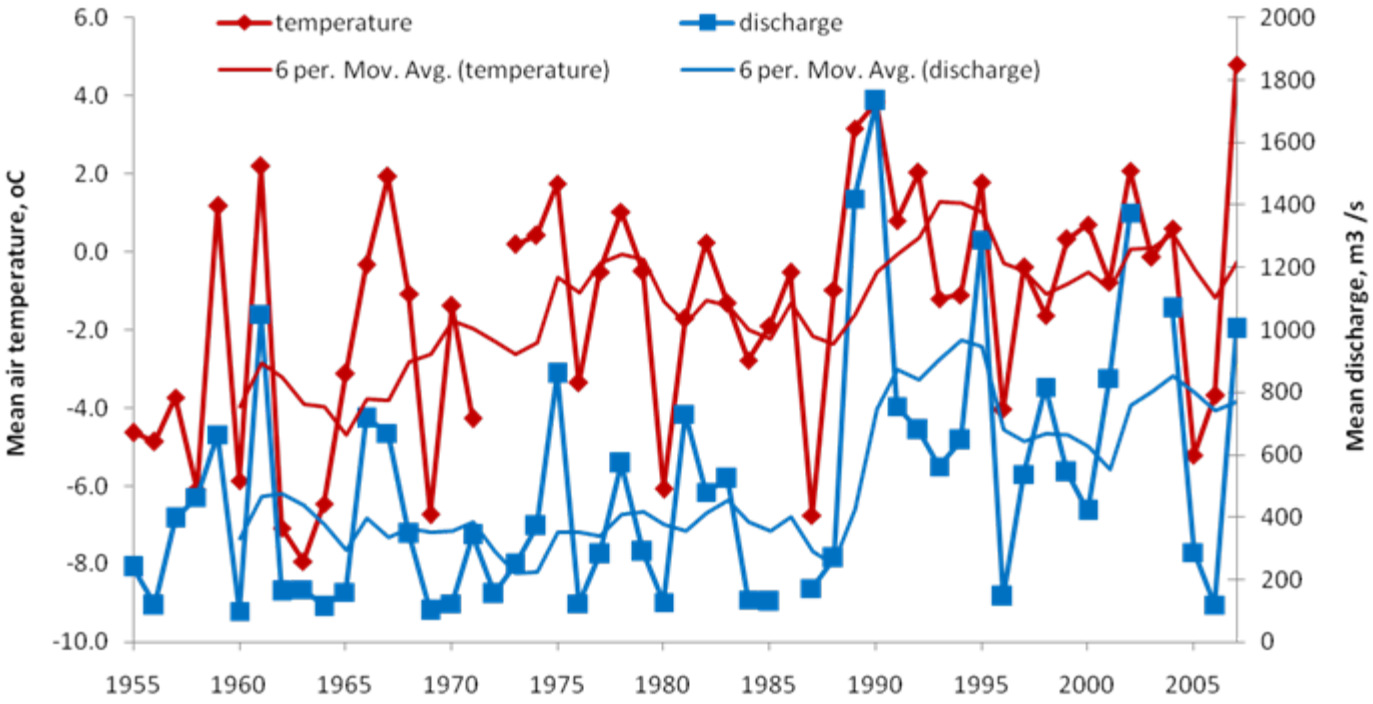


Climate change impact

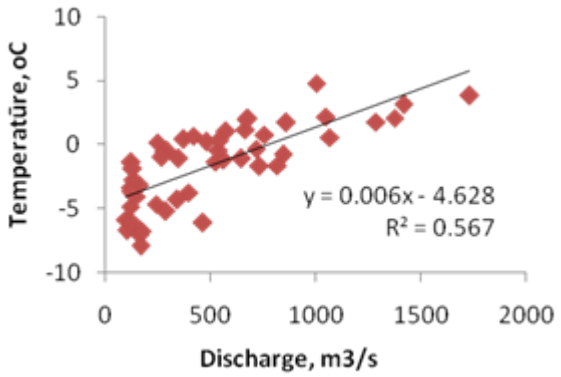
Example 1: Correlation between the peak discharge of the Daugava at Daugavpils and the amount of annual precipitation



Climate change impact



Example 2: Correlation between the mean monthly discharge of the Daugava River and the mean air temperature at Daugavpils in March



Main conclusions

1. In general, the climate of the Daugava River drainage basin becomes more warm and wet, with less snow in winter.
2. The climate becomes also more diverse on the regional scale.
3. The annual discharge of the Middle Daugava correlates better to the climatic characteristics of the Vitebsk weather station.
4. Peculiaries of the climate change and the Daugava's runoff regime are better seen on the monthly scale.
5. The probability of reoccurence and the magnitude of typical runoff extremes of the Daugava River are decreasing.
6. The possibility to predict the date of the annual floods' peak is also decreasing.
7. Predictions of the future climate related changes in the runoff regime of the Middle Daugava should be based on the weather stations located outside Latvia.

Paldies par uzmanību!

The Daugava River upstream from Daugavpils City during the spring floods
(photo by Dainis Lazdāns, March 26, 2007)