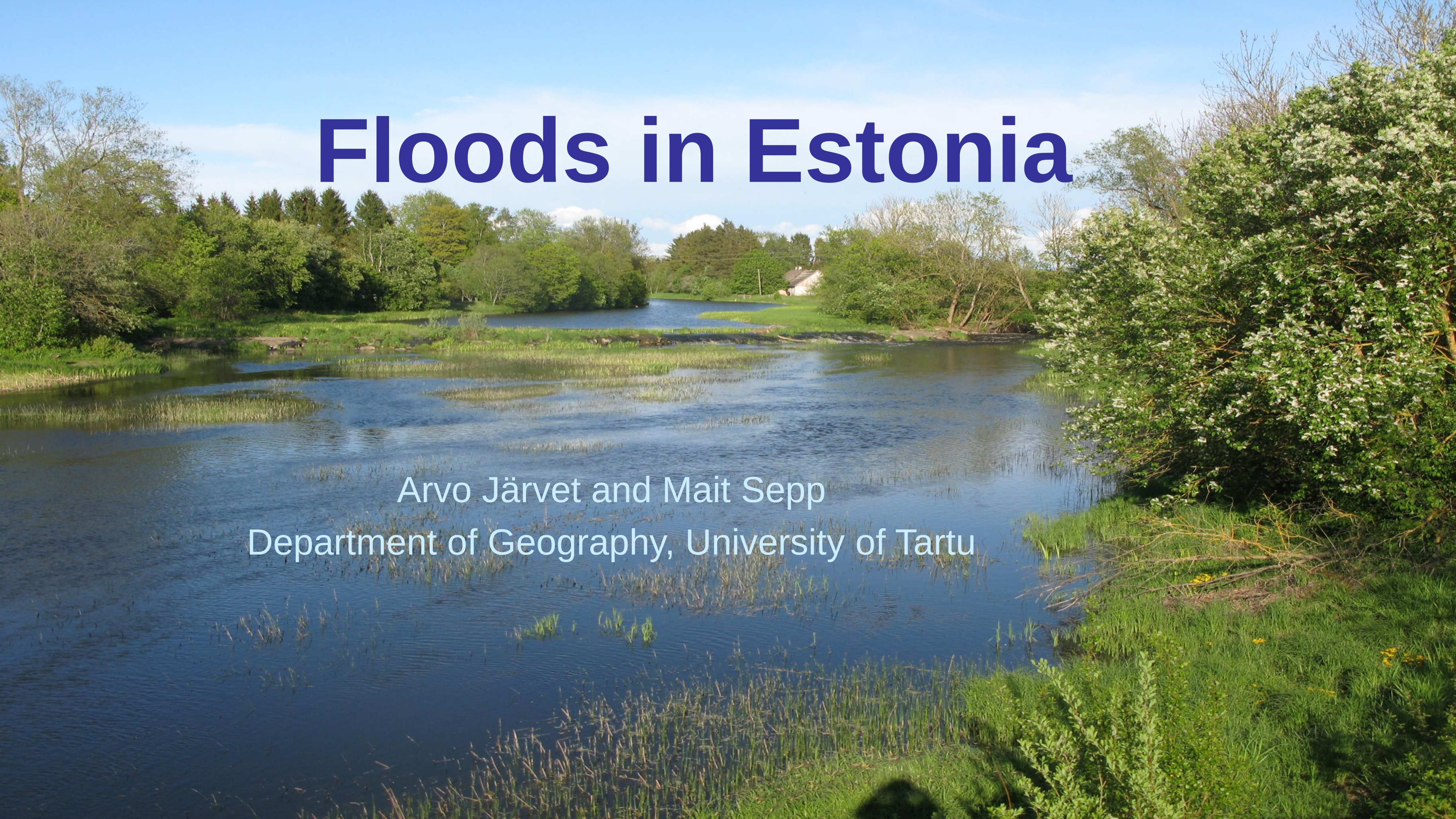
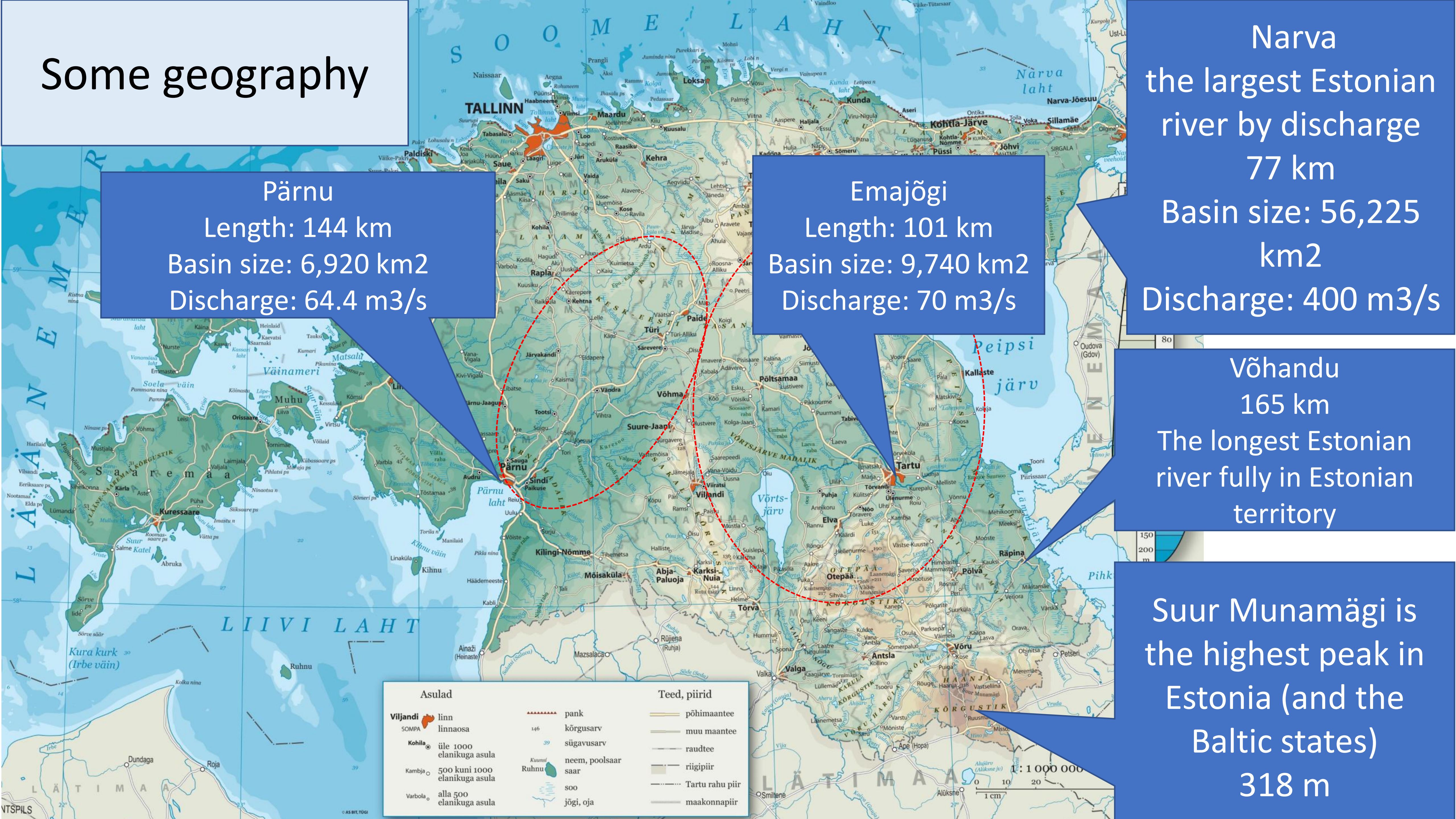


Floods in Estonia

Arvo Järvet and Mait Sepp
Department of Geography, University of Tartu

Some geography



Pärnu
Length: 144 km
Basin size: 6,920 km2
Discharge: 64.4 m3/s

Emajõgi
Length: 101 km
Basin size: 9,740 km2
Discharge: 70 m3/s

Narva
the largest Estonian river by discharge
77 km
Basin size: 56,225 km2
Discharge: 400 m3/s

Võhandu
165 km
The longest Estonian river fully in Estonian territory

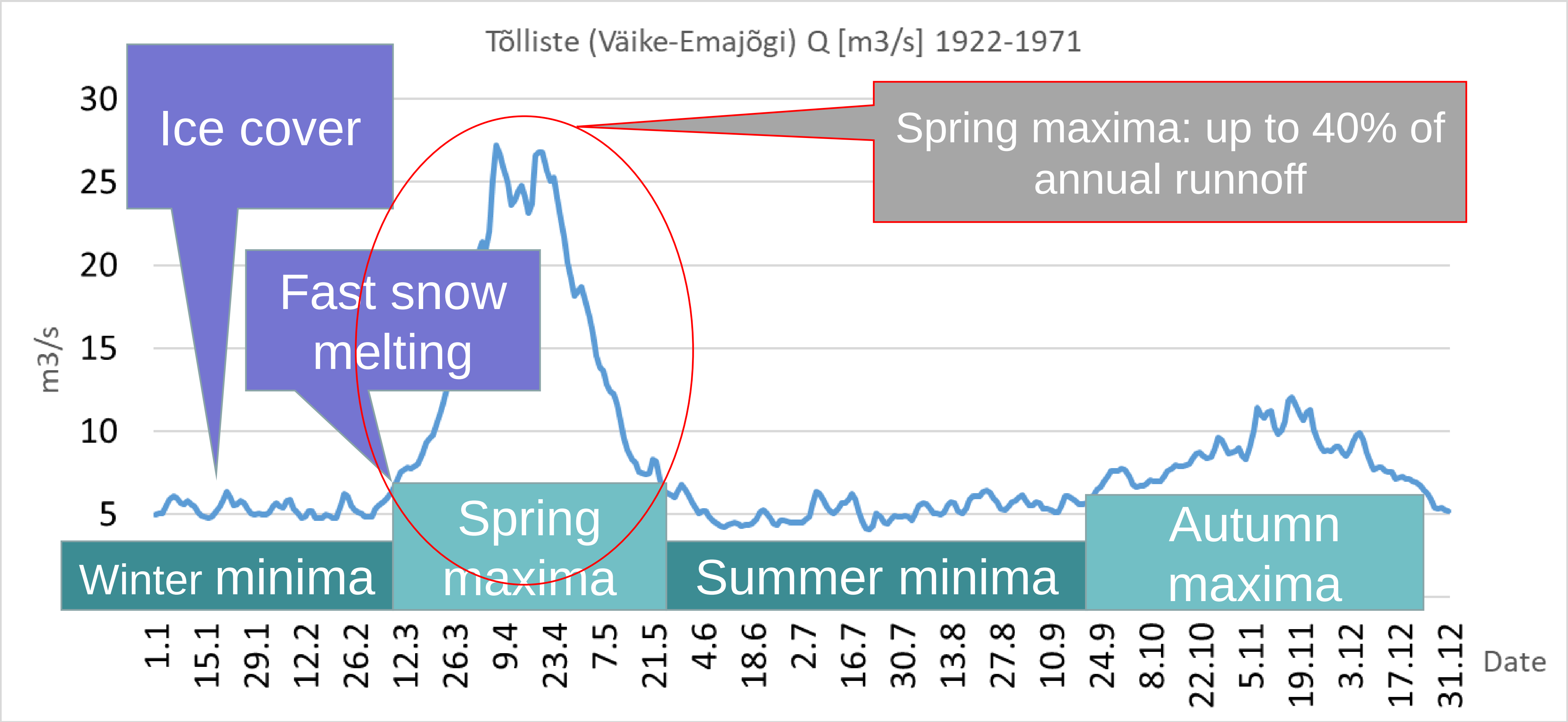
Suur Munamägi is the highest peak in Estonia (and the Baltic states)
318 m

Main river basins and mean annual runoff

In blue color – observed runoff area = 29,103 km^2 = 66 % of Estonian territory

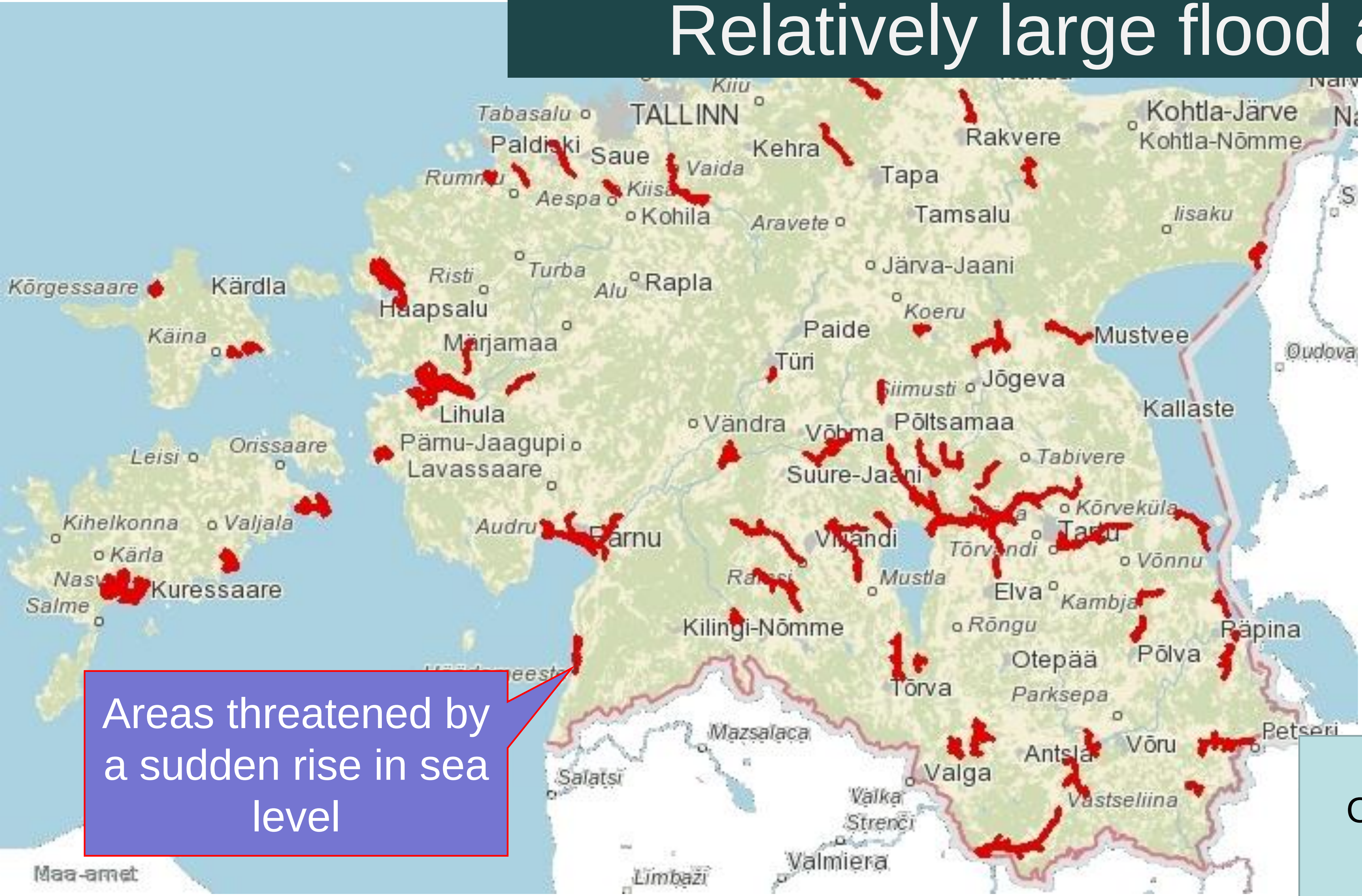
Järvet, A. Hydrography. – Estonian Atlas for Schools. Tallinn, 2004 (in Estonian)

Väike-Emajõgi



Catasrophic spring flood = a lot of rain in autumn + heavy cold at the beginning of winter + a lot of snow + sudden and warm spring (+ ice jam + spring rains)

Relatively large flood areas



Areas threatened by a sudden rise in sea level

Compiled by Kristjan Piirimäe (2021)

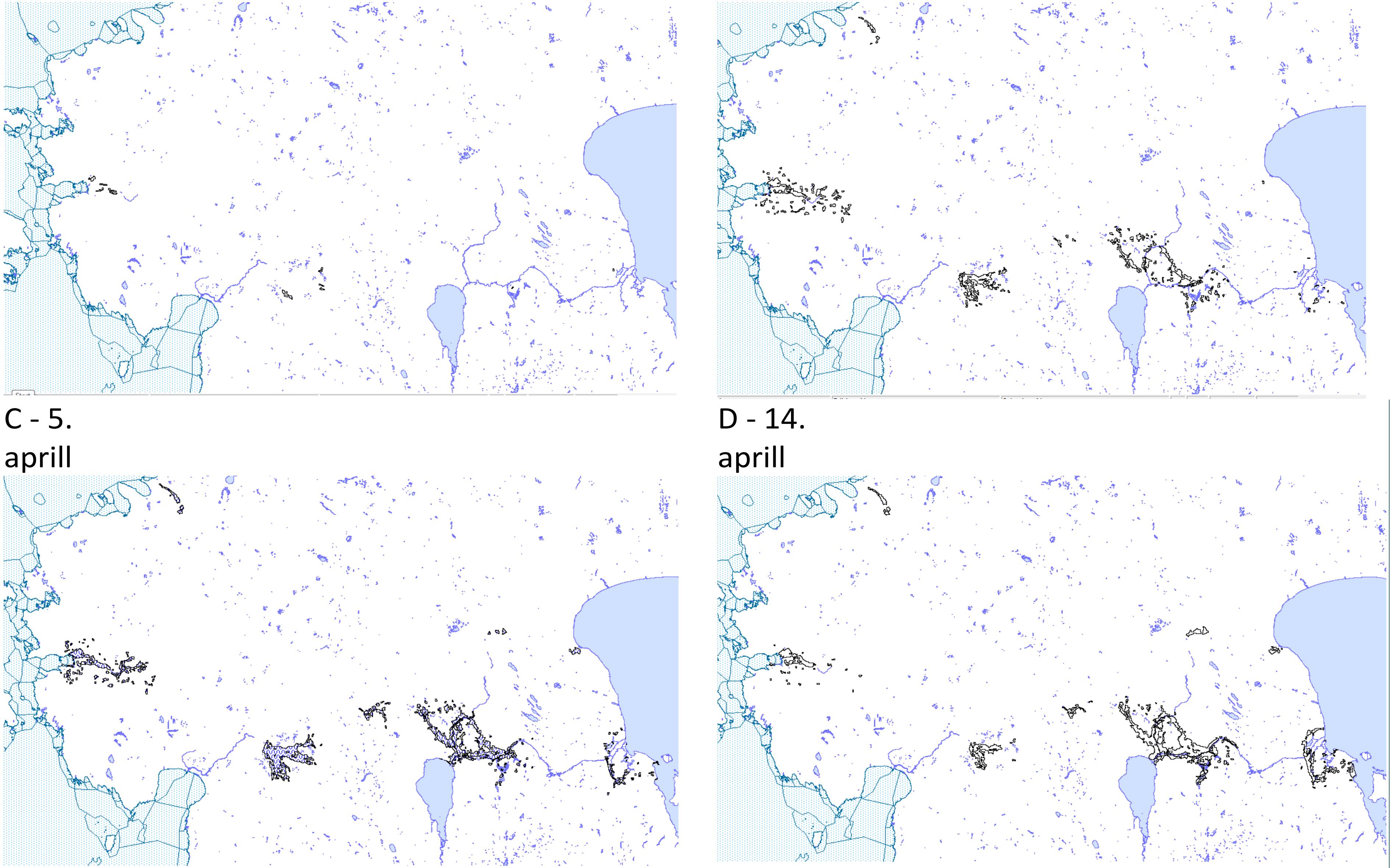
Changes in flood areas in the spring of 2010 as seen from satellite photos

A - 29. märts

B - 2. aprill

C - 5. aprill

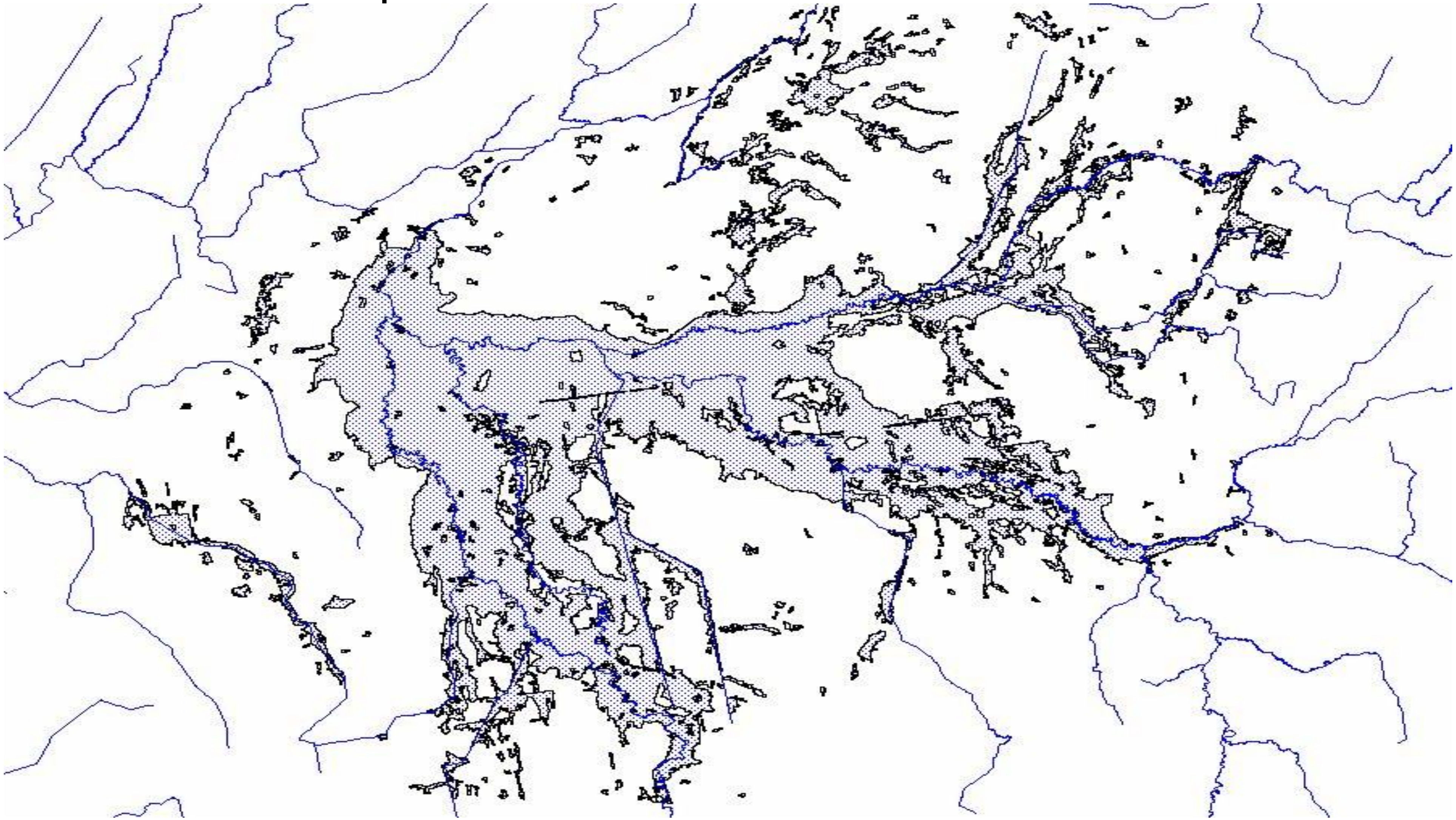
D - 14. aprill



Voormansik, K., Jagomägi, J., Järvet, A. 2011. Kõnekad satelliitpildid: suurvesi kevadel 2010. – Eesti Loodus, 3, 150-155 (In Estonian)

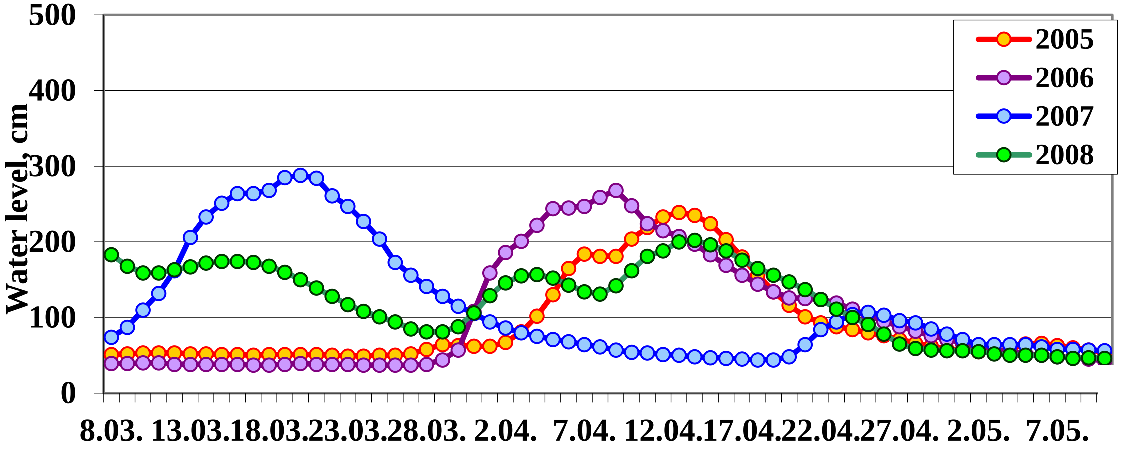
The flood area of Soomaa in the spring of 2010 based on satellite images.

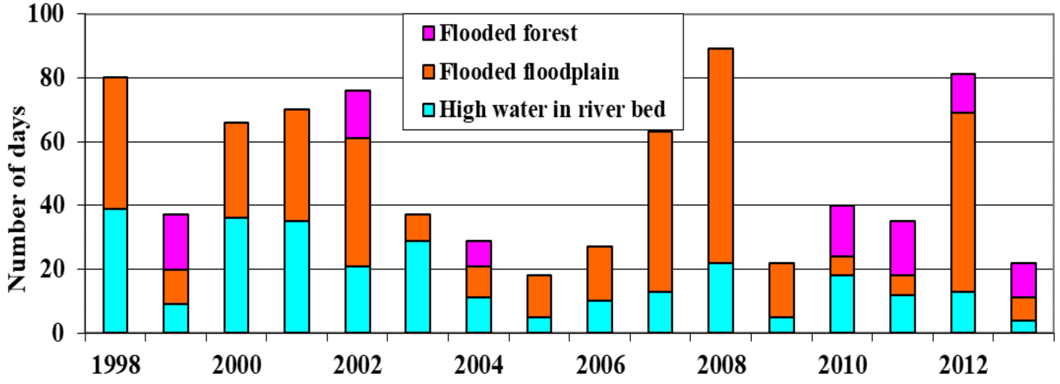
Riisa HP Hmax = 494 cm. The map shows all areas covered by water that were larger than 1 ha.
The total area of the floodplain is 142 km2

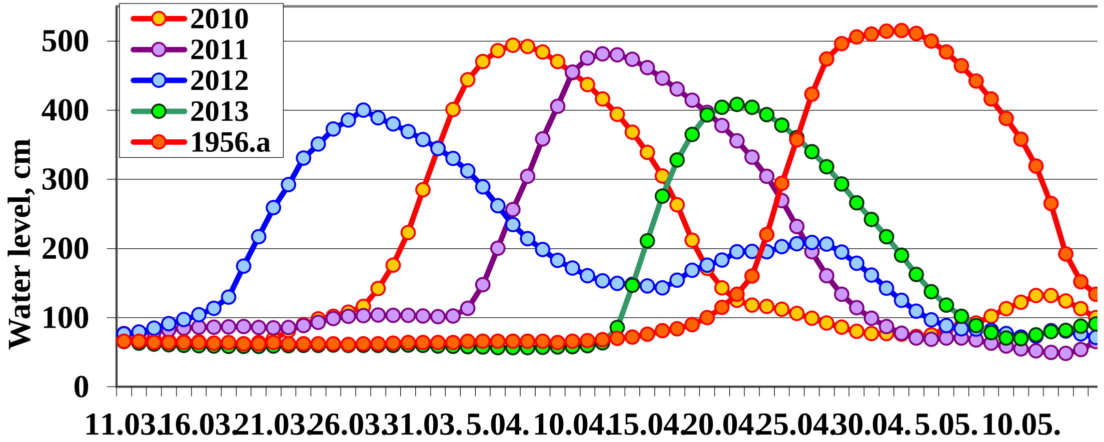


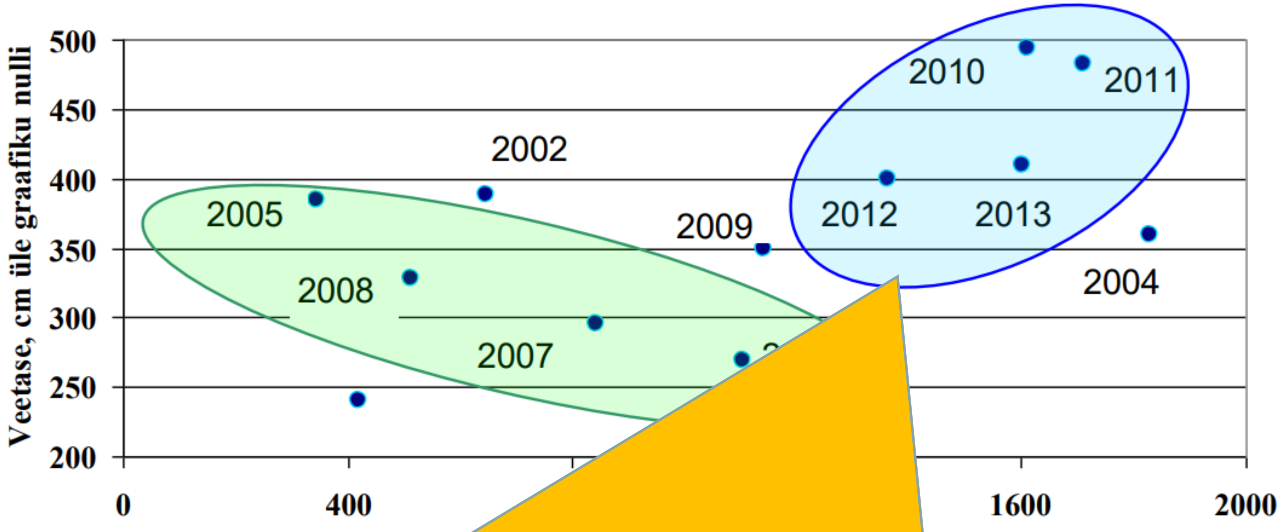
Floods in Soomaa and their importancy for tourism

(A. Järvet and A. Martsoo. 2014. Year-book of the Estonian Geographical Society, 39, 124-136; in Estonian)

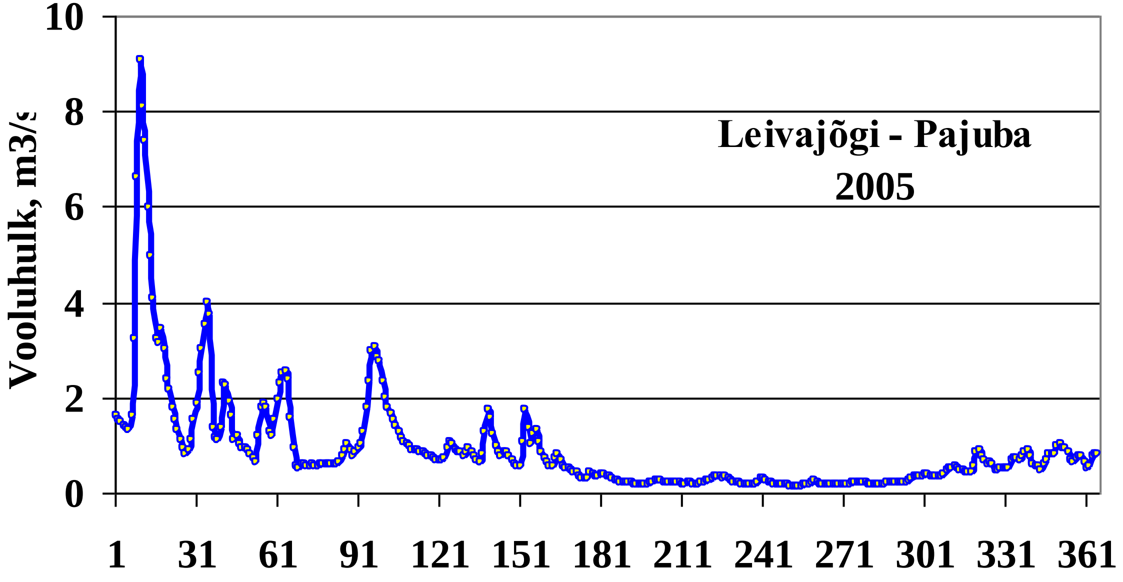








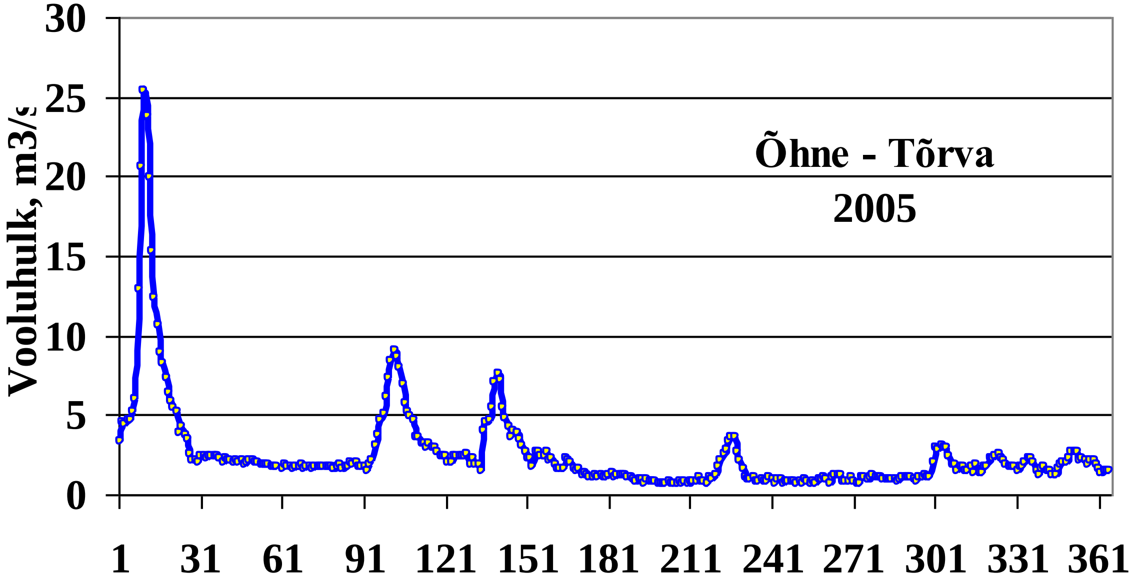
Quite a linear relationship: higher water level -> more fun -> more visitors -> more money

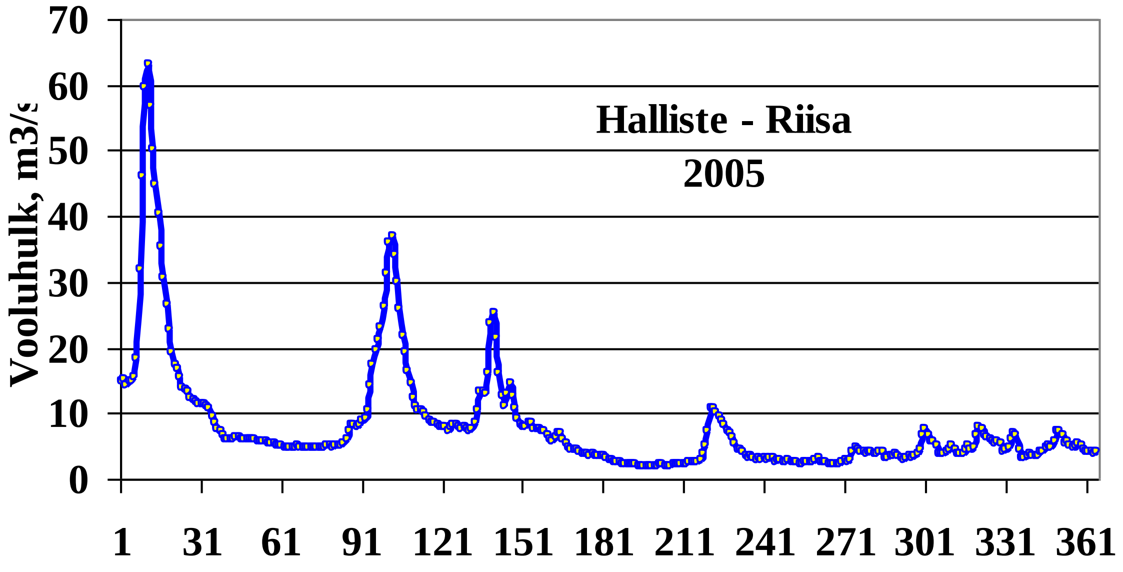


Years are not brothers

Extremely rare winter flood in 2005

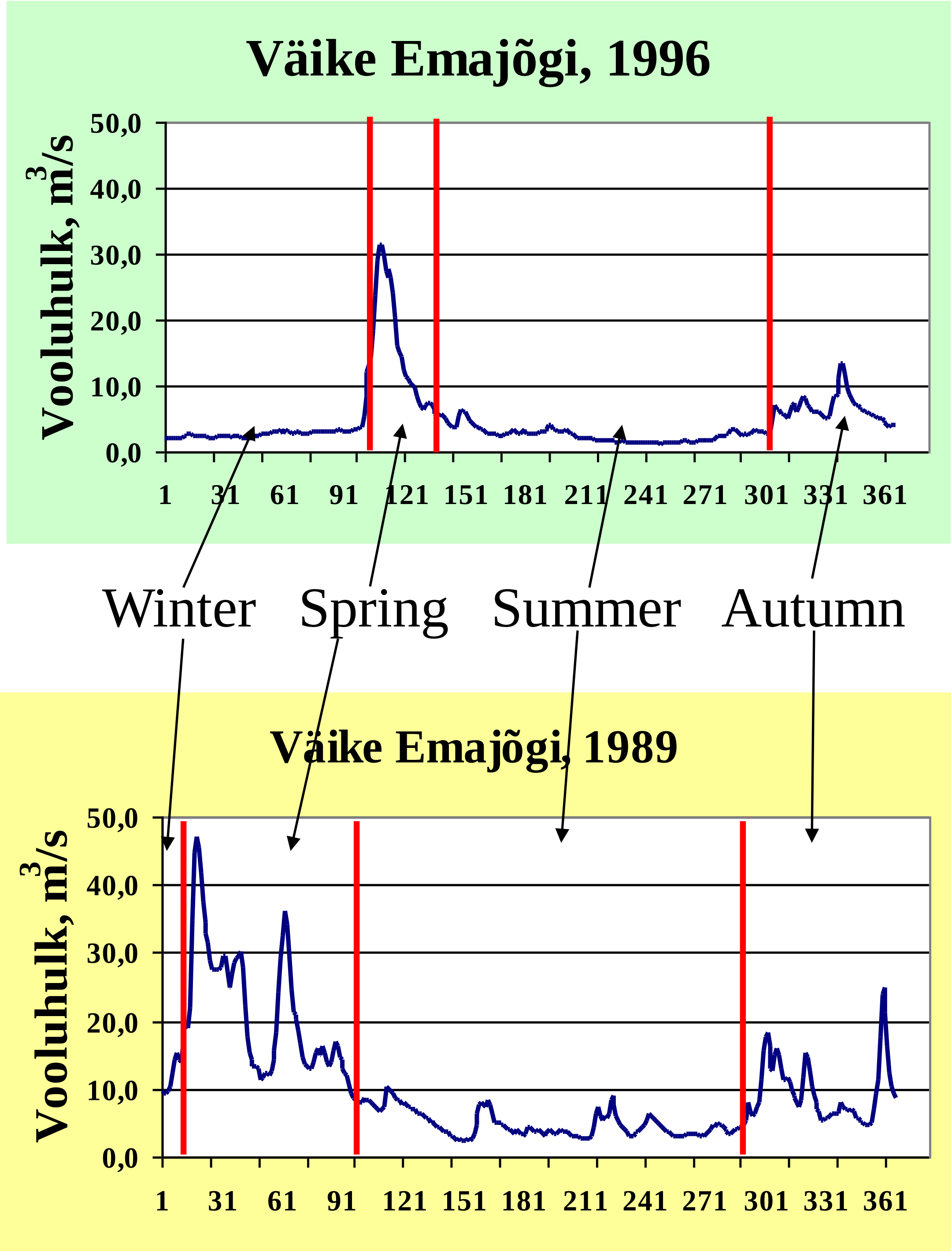
Unexpected winter thaw





Järvet, A. 2015. Winter floods in Estonia. – Estonian Nature, 66, 1, 26–29 (in Estonian)

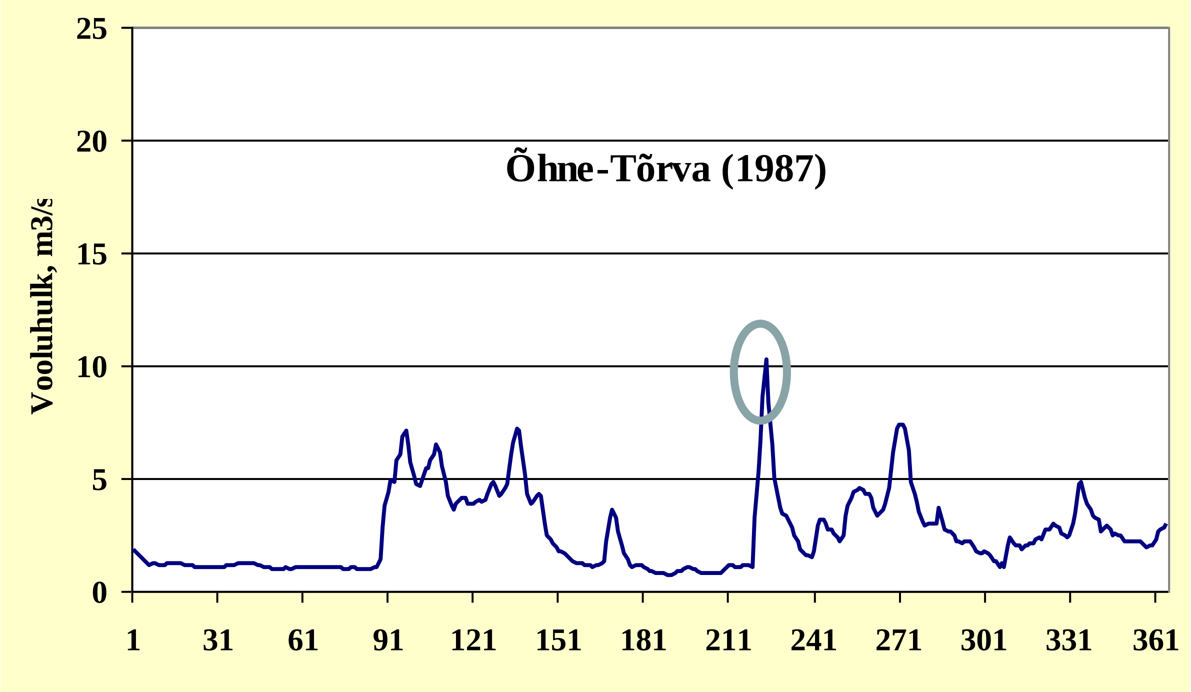
Runoff (m3/s) of Väike-Emajõgi River in hydrologically different years



Very dry year

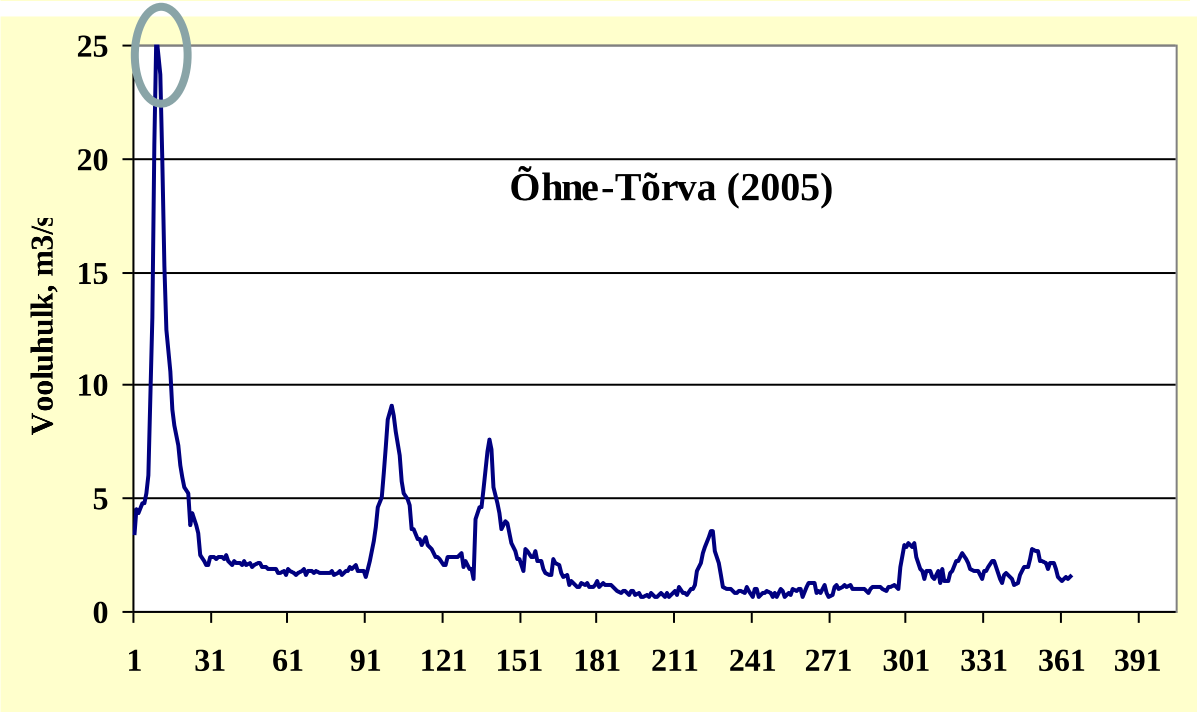
Statistically mean year, but nontypical seasonal distribution of runoff

Annual hydrographs



ÕHNE RIVER

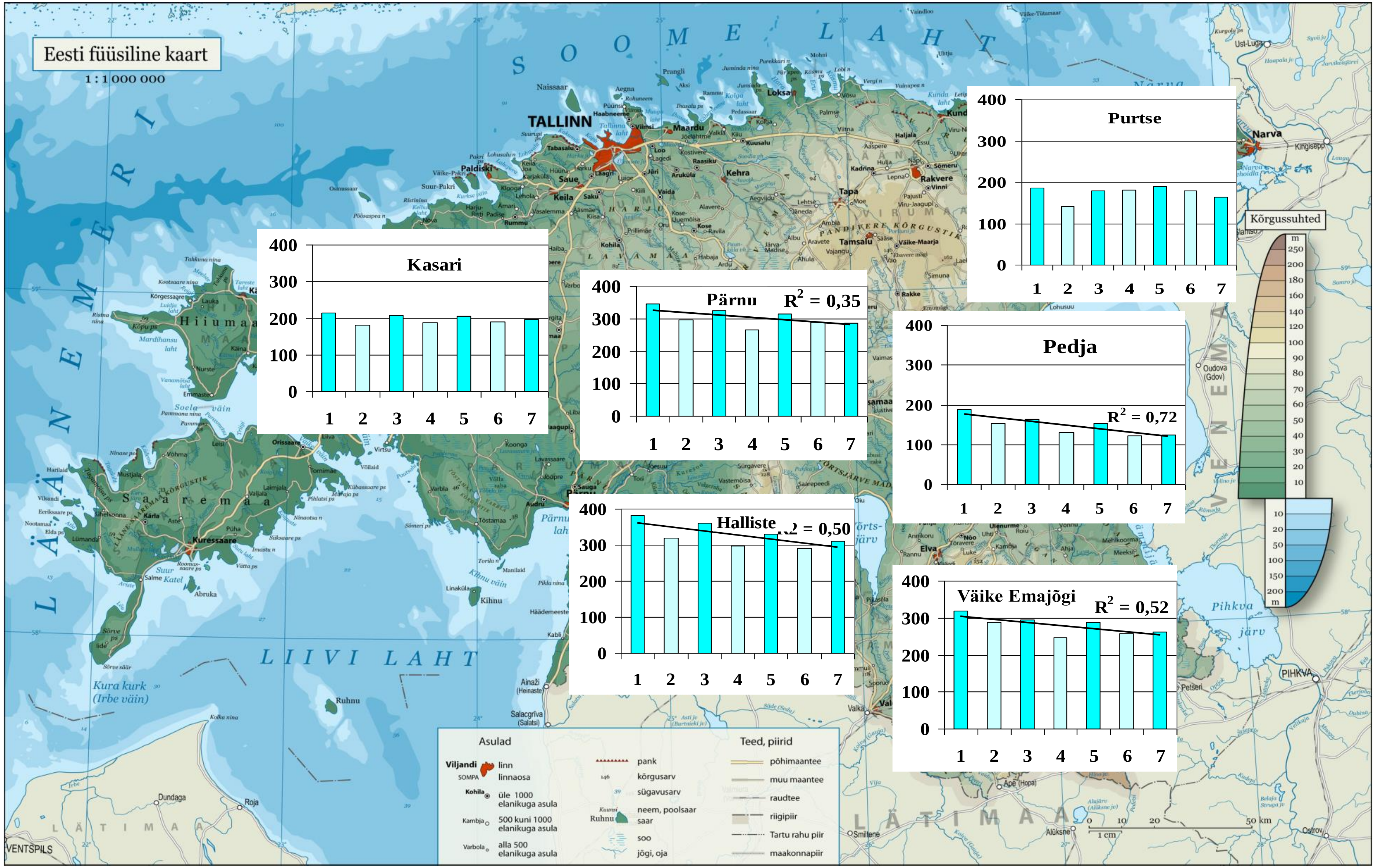
Low flood in summer 1987.



ÕHNE RIVER

High flood in winter 2005.

Change of spring maximum water level in 1923-2020

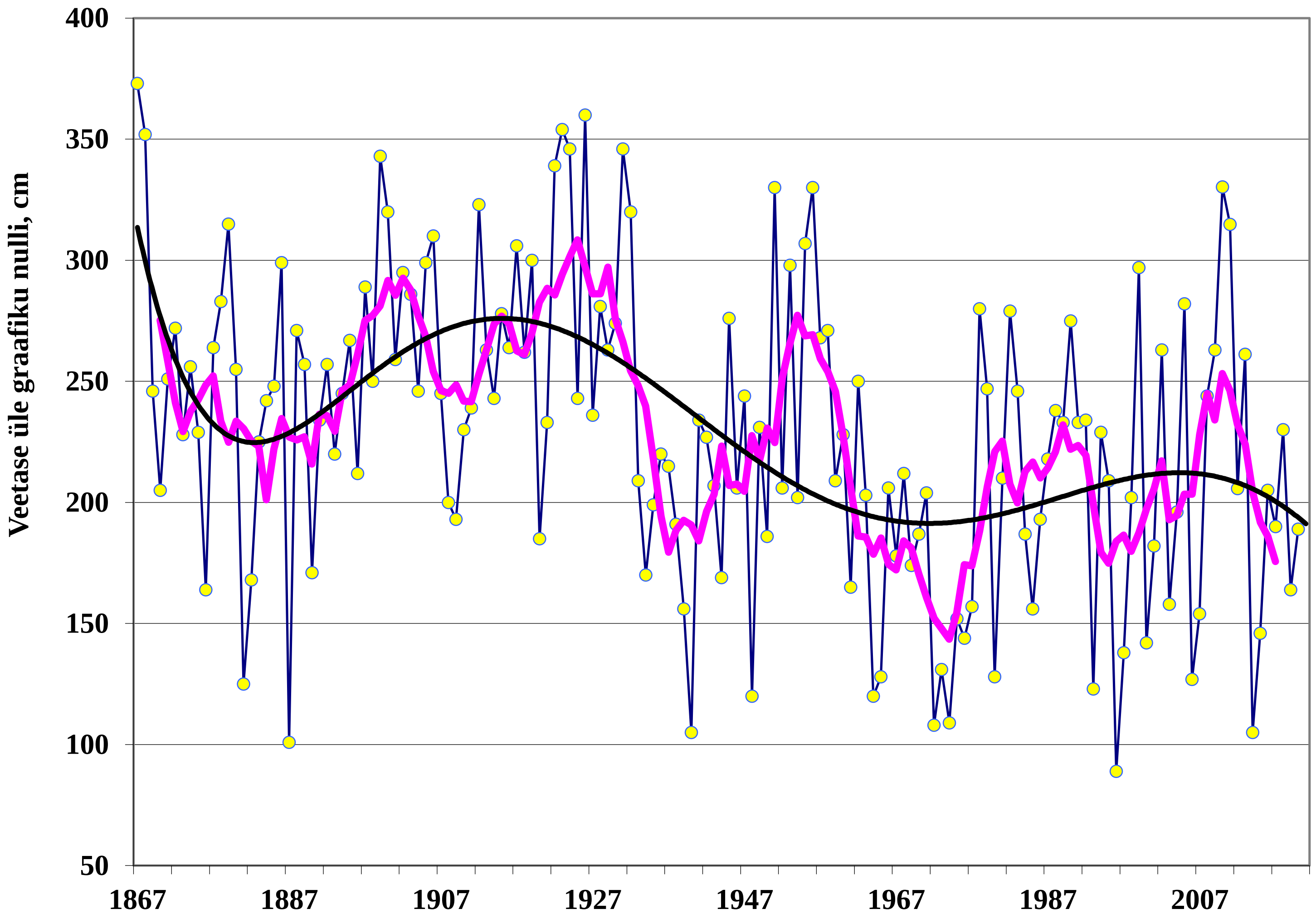


Periods: 1) 1923–1932, 2) 1933–1944, 3) 1945–1963, 4) 1964–1977, 5) 1978–1991, 6) 1992–2007, 7) since 2008–.

Light bars represent relatively water-poor periods, dark bars more water-rich periods

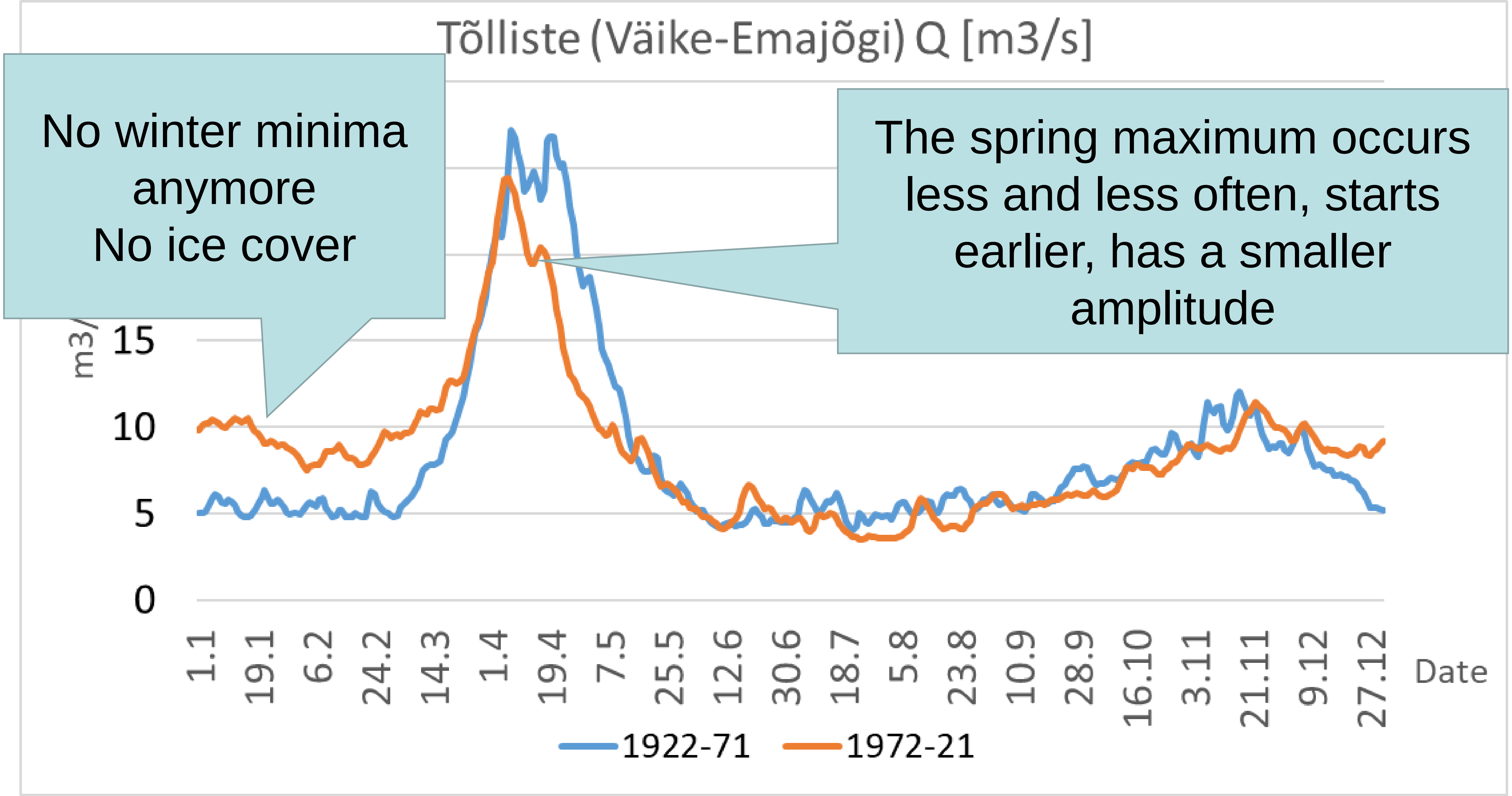
Maximum spring water level of Emajõgi River in Tartu in 1867-2020

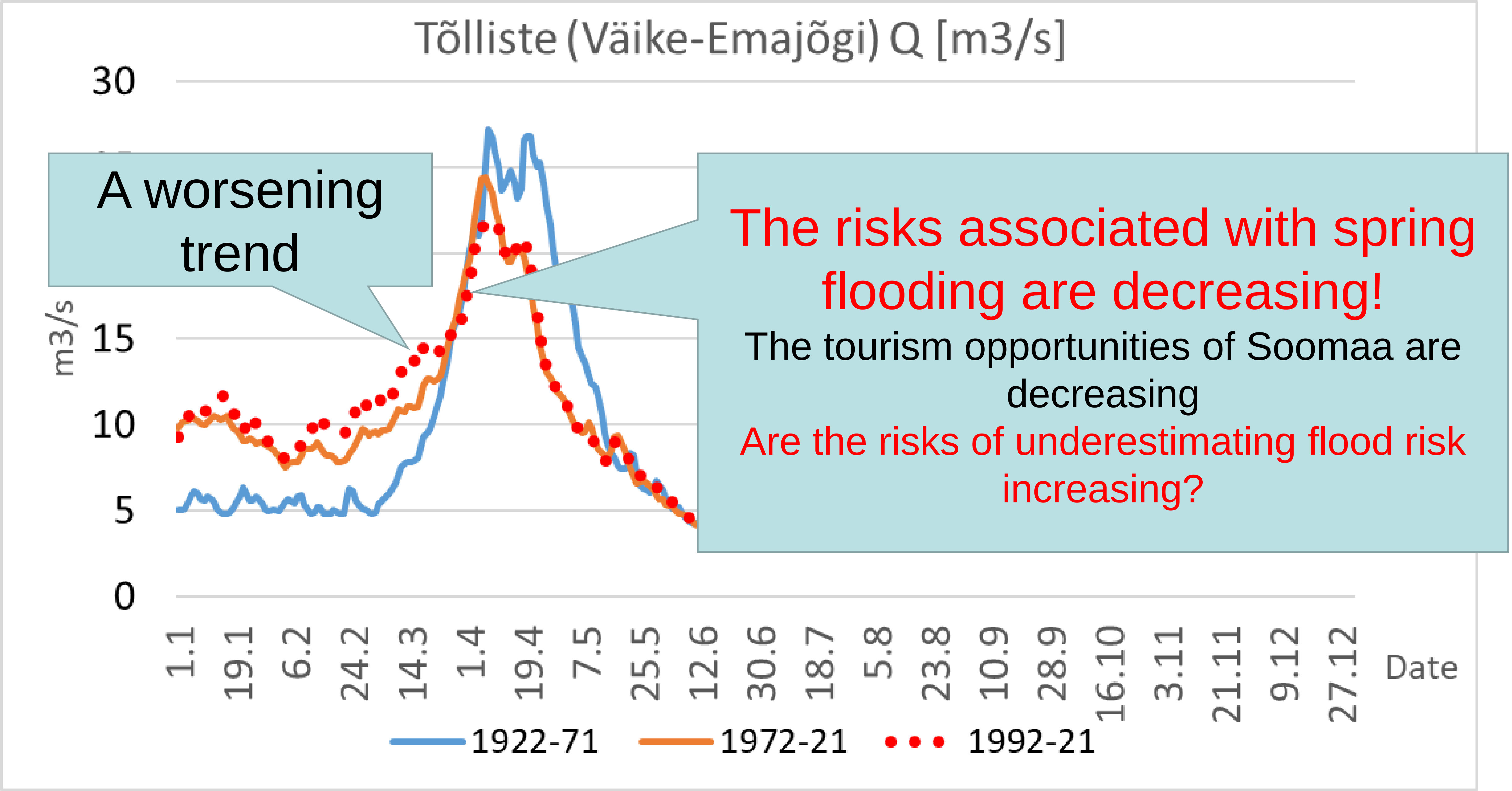
(F = 7840 km2)



Bold line - 7-year moving average

The wavy line is a 6th degree polynomial eqation line that generalizes the long-term dynamics of the water level


Tõlliste (Väike-Emajõgi) Q [m3/s]
No winter minima anymore
No ice cover
The spring maximum occurs less and less often, starts earlier, has a smaller amplitude
m3/
15
10
5
0
1.1
19.1
6.2
24.2
14.3
1.4
19.4
7.5
25.5
12.6
30.6
18.7
5.8
23.8
10.9
28.9
16.10
3.11
21.11
9.12
27.12
Date
1922-71
1972-21



Tõlliste (Väike-Emajõgi) Q [m3/s]
30
15
10
5
0
m3/s
1.1
19.1
6.2
24.2
14.3
1.4
19.4
7.5
25.5
12.6
30.6
18.7
5.8
23.8
10.9
28.9
16.10
3.11
21.11
9.12
27.12
Date
1922-71
1972-21
1992-21
A worsening trend
The risks associated with spring flooding are decreasing!
The tourism opportunities of Soomaa are decreasing
Are the risks of underestimating flood risk increasing?

Climate change: something happend in 1989

(…in addition to the fall of the Berlin Wall)

More water in the system. Mainly in winter

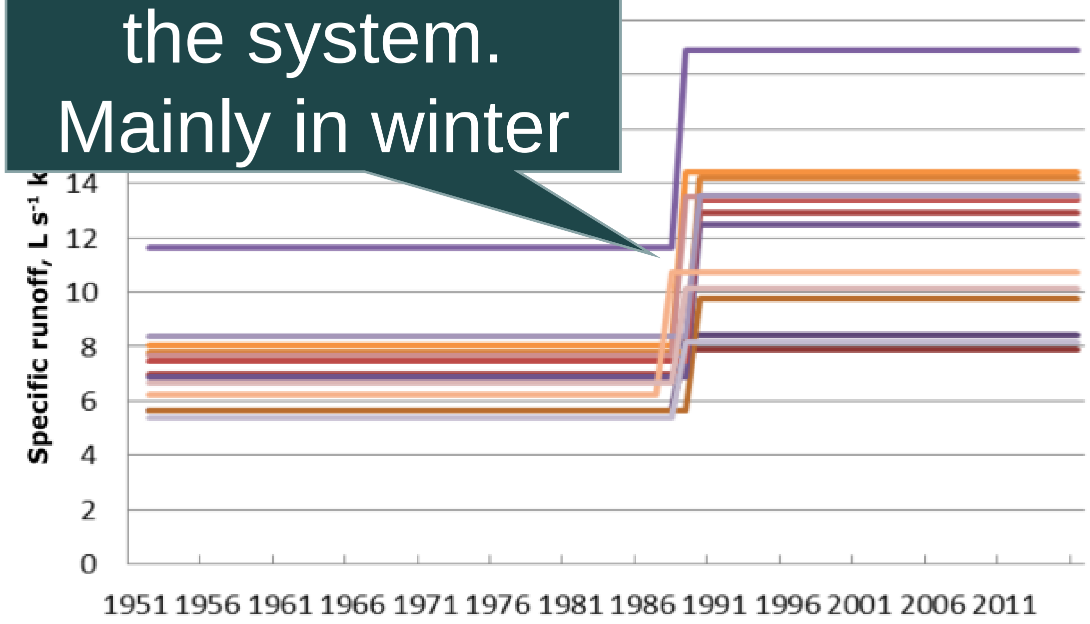


Figure 2. Regime shifts in winter (DJF) specific runoff of rivers in 14 stations where a statistically significant shift was detected in 1987/1988 or 1988/1989.

The start of spring high water has shifted from April to March

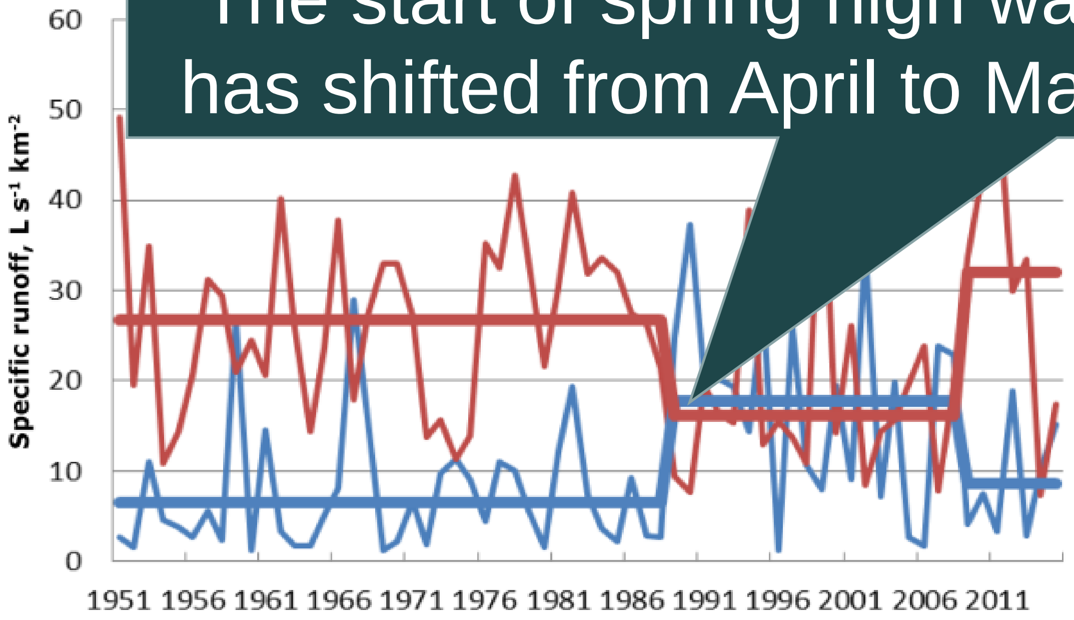
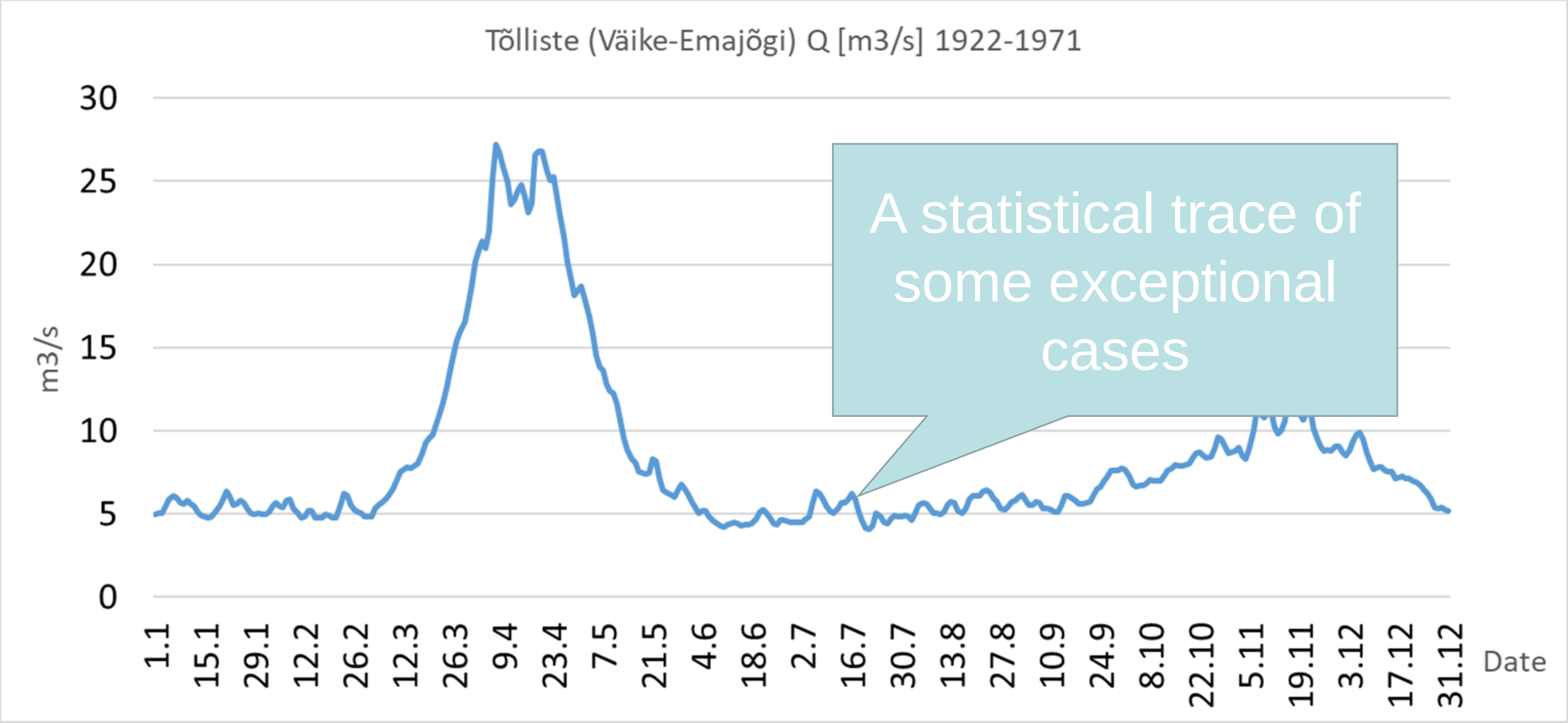


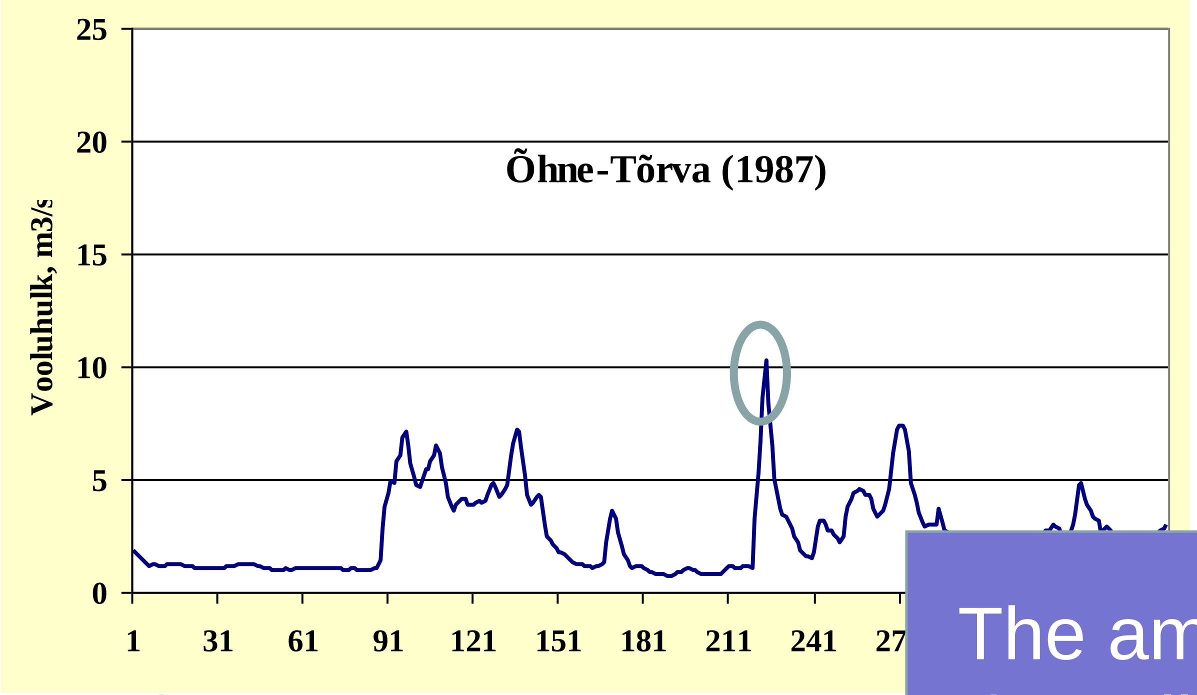
Figure 3. Time series of specific runoff (L s^{1} km^{-2}) in March (blue) and April (red) at Riisa station on the Halliste River during 1951–2015 and their regime shifts of opposite sign since 1989 and 2009 (wide lines).

Jaagus, et al. (2017). Trends and regime shifts in climatic conditions and river runoff in Estonia during 1951–2015. Earth System Dynamics, 8, 963–976.

What about flash floods?



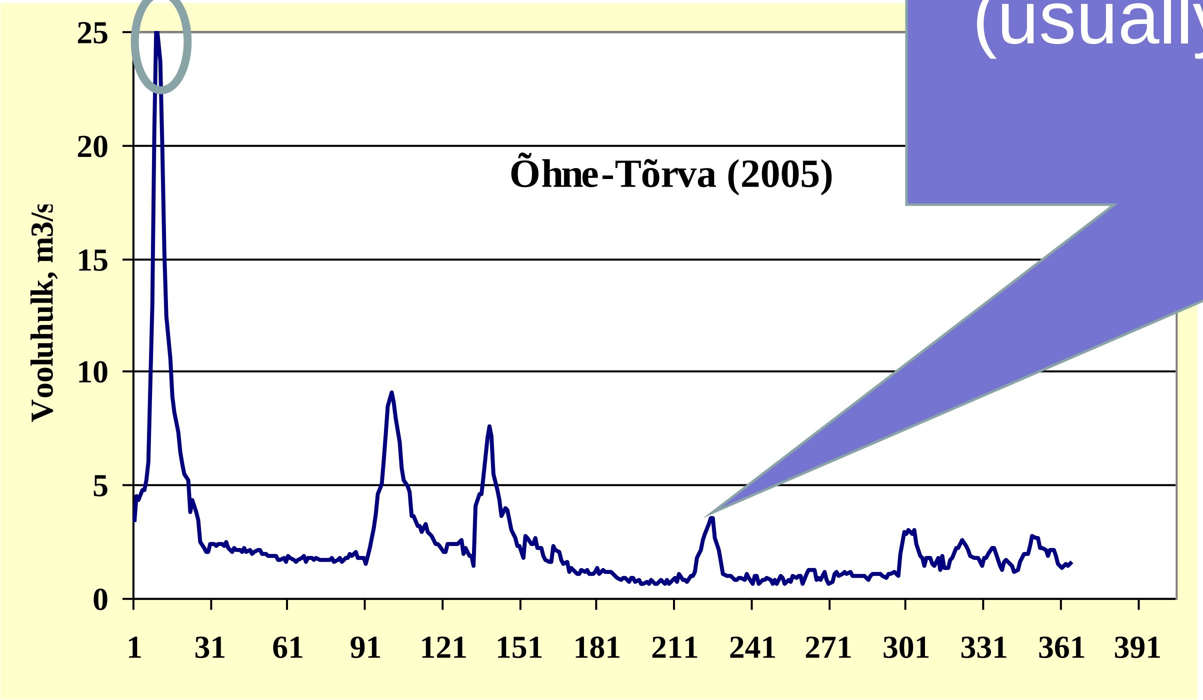
Annual hydrographs



ÕHNE RIVER

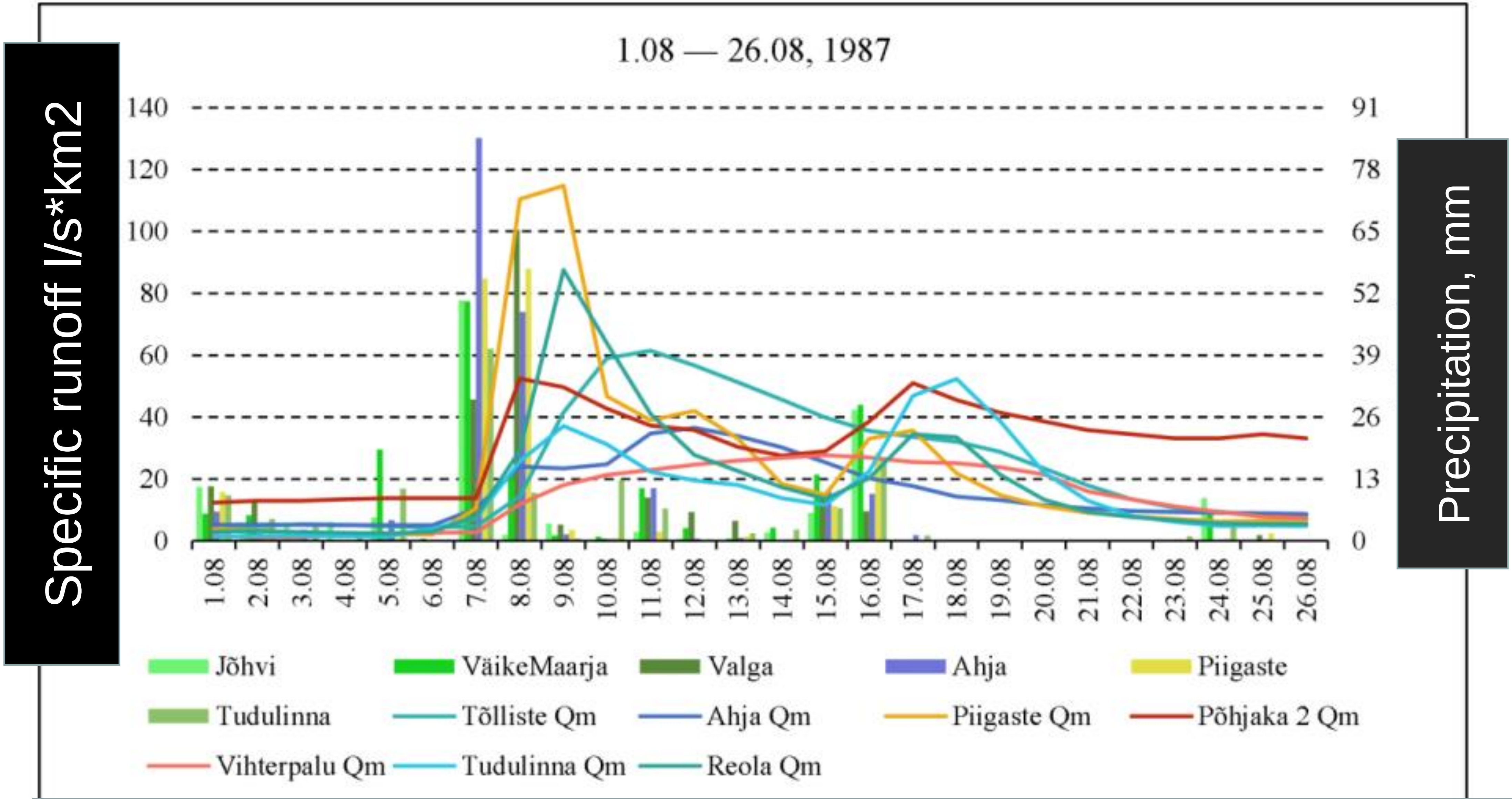
Low flood in

The amplitude of summer floods is (usually) many times smaller than spring floods



ÕHNE RIVER

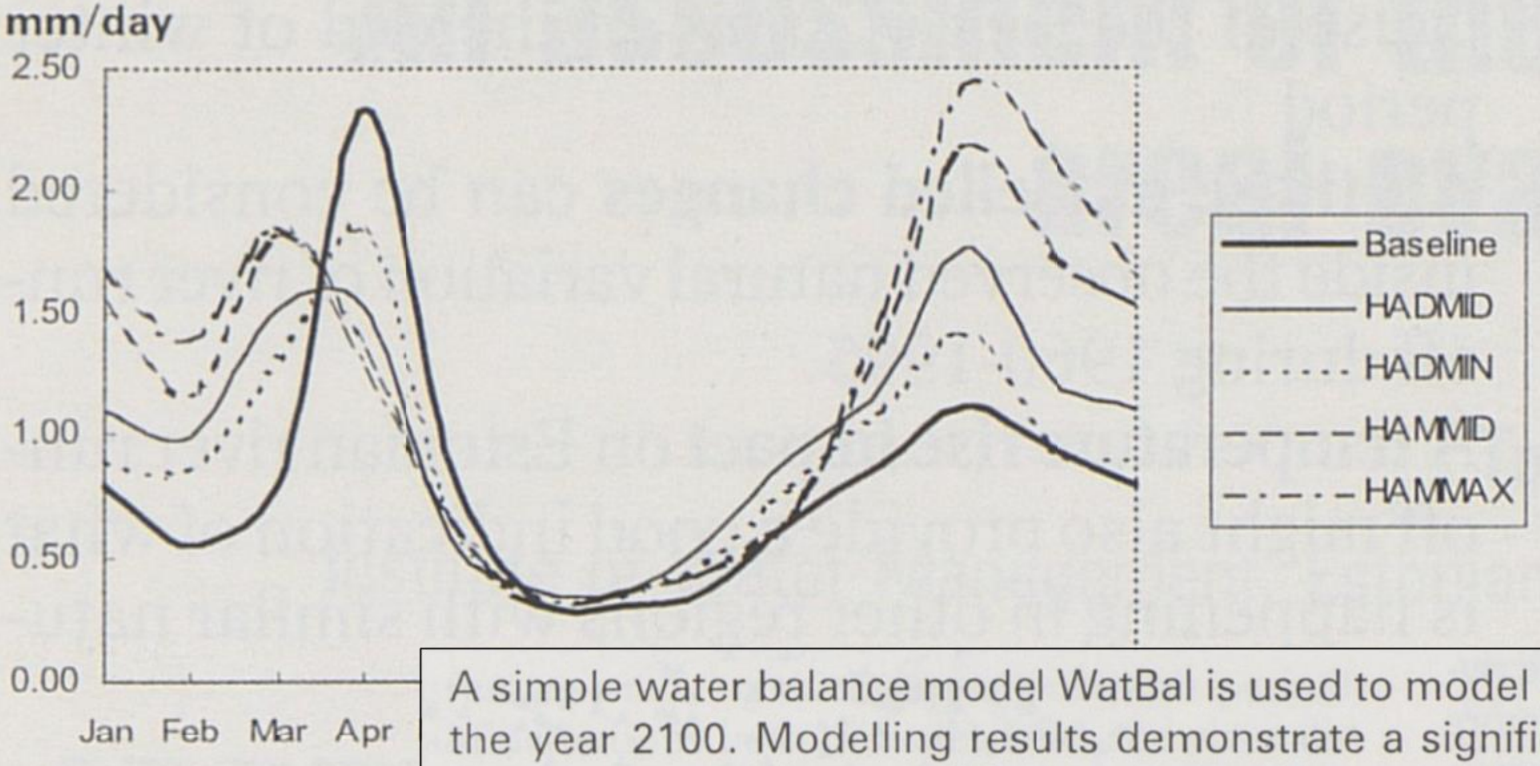
High flood in winter 2005.



Egert Indres, masters thesis 2021, Flash floods in Estonian rivers during summer months throughout 1935–2015. University of Tartu (in Estonian)

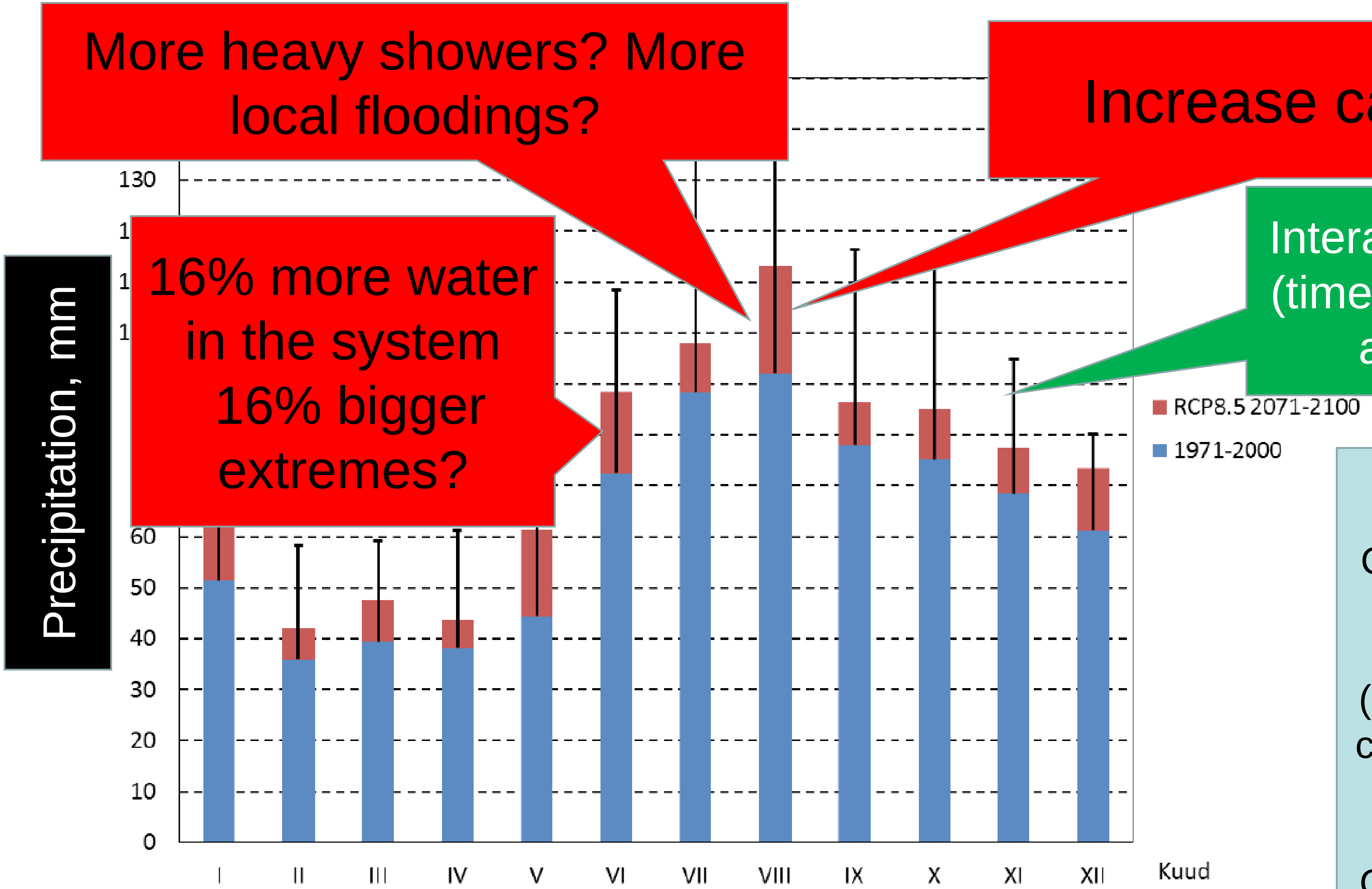
Future?

Figure 13. Changes in monthly runoff in the Pärnu River basin (Pärnu026)



Jaagus, J.; Järvet, A.; Roosaare, J. (1998). Modelling the climate change impact on river runoff in Estonia. In: Kallaste, T.; Kuldna, P. (Ed.). Climate Change Studies in Estonia (117−126)

A simple water balance model WatBal is used to model climate change impacts on river runoff in the year 2100. Modelling results demonstrate a significant change in the hydrological cycle in Estonia. Annual river runoff is expected to increase by 20-40% on the average. The increase will be remarkable during winter seasons due to shortening of the period with snow and ice cover. The spring runoff maximum will mostly decrease and shift earlier. Due to the increase of precipitation, autumn runoff should increase significantly. The period with minimum runoff in summer will probably become longer because of earlier springs.



Sepp, Mait (2015). Climatological aspects of adaptation to climate change. In: Antti Roose (Ed.). Adapting to climate change in Estonia - ready for force majeure? Publicationes Instituti Geographici Universitatis Tartuensis; 112

Spring floods:

A common phenomenon that becomes less of a risk year by year due to climate change

But this threat is not going away and underestimating it can have disastrous consequences

Flash floods:

More of a curiosity than a very serious threat

In the future climate, the threat becomes more serious

Floods in Estonia

Tallinn, Laagna street 10.07.2016
Photo: Kaarel Tooming/ERR