Turun yliopisto
University of Turku

BACC II
Chapter 3.3.1 LAND: Hydrology

Jukka Käyhkö
Division of Geography
Department of Geography and Geology

3rd BACC II Lead Author Meeting, Copenhagen
9-10 February 2011

Summary

- Trends and tendencies outlined in BACC I get support from the new literature
- No particular break-through discoveries; science in agreement with BACC I
- BACC I had some regional bias -> a serious attempt has been made to include data/information from all countries
- Quite successful so far; still missing: Germany, Denmark, (Belarus)
- Late arrival: Russian data
- No. of valid new references in the field > 40

Key findings

- No statistically significant trends in **annual** river discharges; we have regional variation in climate response, and cyclicity
- **Temperature change** explains more about runoff change than precipitation
- **Winter** discharges **increase** (snow melt)

-> **Spring** discharges **decrease**

- Ice regime; shorter duration, earlier breakup
- Floods; no coherent picture – rather few studies found, need more

Turun yliopisto
University of Turku

Contributing authors

- **Elga Apsite**, Faculty of Geography and Earth Sciences, University of Latvia, Latvia elga.apsite@lu.lv
- **Anna Bolek**, Institute of Meteorology and Water Management, Warsaw, Poland anna.bolek@imgw.pl
- **Johannes Cullmann**, Federal Institute of Hydrology, Koblenz, Germany cullmann@bafg.de
- **Nikolai Filatov**, Northern Water Problems Institute KRC RAS, Russia nfilatov@rambler.ru
- **Sergey Kondratyev**, Institute of Limnology RAS, St.Petersburg, Russia kondratyev@limno.org.ru
- **Johanna Korhonen**, Finnish Environment Institute, Helsinki johanna.korhonen@ymparisto.fi
- **Jurate Kriauciuniene**, Lithuanian Energy Institute, Lithuania hydro@mail.lei.lt
- **Göran Lindström**, Swedish Meteorological and Hydrological Institute, Sweden goran.lindstrom@smhi.se
- **Niels Bering Ovesen**, Institute for Bioscience, National Environmental Research Institute, Aarhus University, Denmark, nbo@dmu.dk
- **Anna Pyrh**, Hydrology Department, Estonian Meteorological and Hydrological Institute, Tallinn, Estonia anna.pyrh@emhi.ee
- **Marzenna Sztobryn**, Institute of Meteorology and Water Management, Warsaw, Poland marzenna.sztobryn@imgw.pl

Turun yliopisto
University of Turku

Chapter structure (to be discussed)

1 Introduction

2 Basin-scale broad changes in discharge patterns

3 Regional and seasonal variations, and trends

- 3.1. Sub-basin scale changes
- 3.2 Recent and present changes in regional discharge patterns by country
  - 3.1.1 Belarus
  - 3.1.2 Denmark
  - 3.1.3 Estonia
  - 3.1.4 Finland
  - 3.1.5 Germany
  - 3.1.6 Latvia
  - 3.1.7 Lithuania
  - 3.1.8 Poland
  - 3.1.9 Russia
  - 3.1.10 Sweden
- 3.2 Recent and present changes in seasonal discharge patterns

4 Extreme events; floods and droughts

5 Ice regime

6 Conclusions plus synthesis of the findings

- 6.1 Discussion on the reasons for changes (climatic and non-climatic)
- 6.2 Discussion on the effects on and interactions with biotic and other abiotic systems (with reference to other relevant sections)

References

ANNEX: A summary of BACC I findings

- Annual and seasonal variation of total runoff
- Regional variations and trends
- Floods
- Lakes
- Ice regime

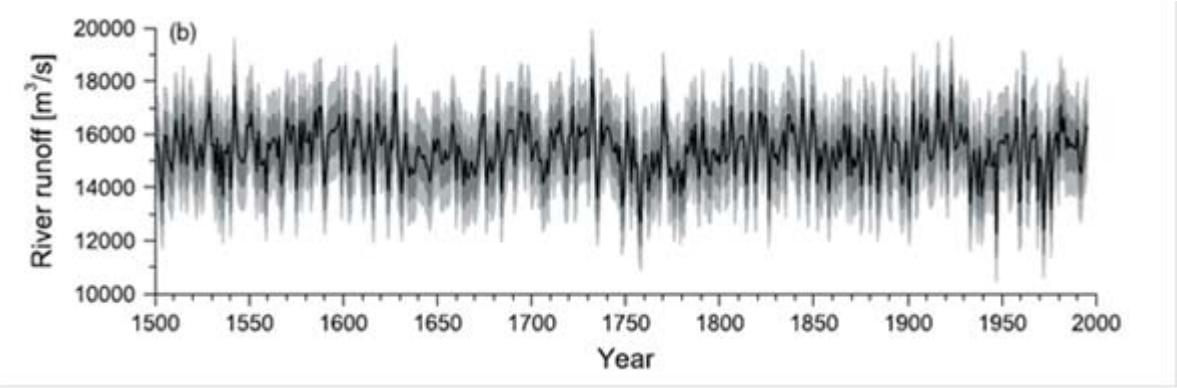
European-wide example

- A broad European study (15 countries) with 411 streamflow trends **1962–2004** in small near-natural catchments
  - negative trends in southern and eastern regions of Europe
  - generally positive trends elsewhere
  - positive trends in the winter months in most catchments

Stahl K, Hisdal H, Hannaford J, Tallaksen LM, van Lanen HAJ, Sauquet E, Demuth S, Fendekova M, & Jódar J 2010. Streamflow trends in Europe: evidence from a dataset of near-natural catchments. *Hydrology and Earth System Sciences* 14, 2367–2382.

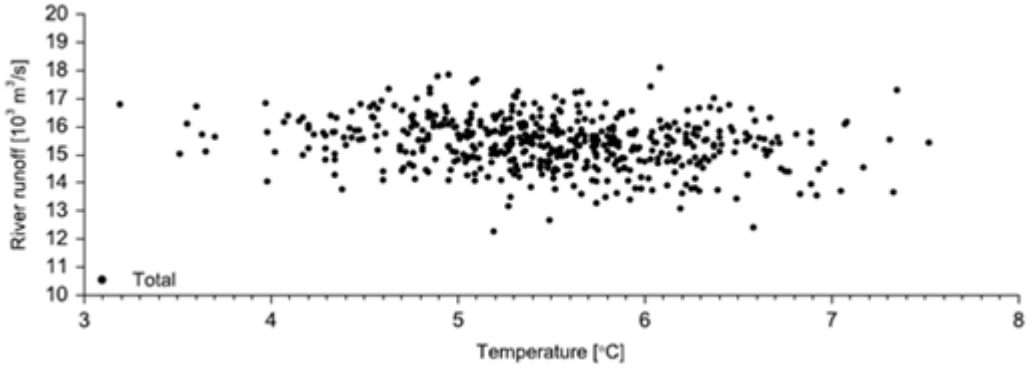
Turun yliopisto
University of Turku

Basin-scale broad changes in discharge patterns



The full reconstructed annual river runoff to the Baltic Sea over the 1500–1995 period

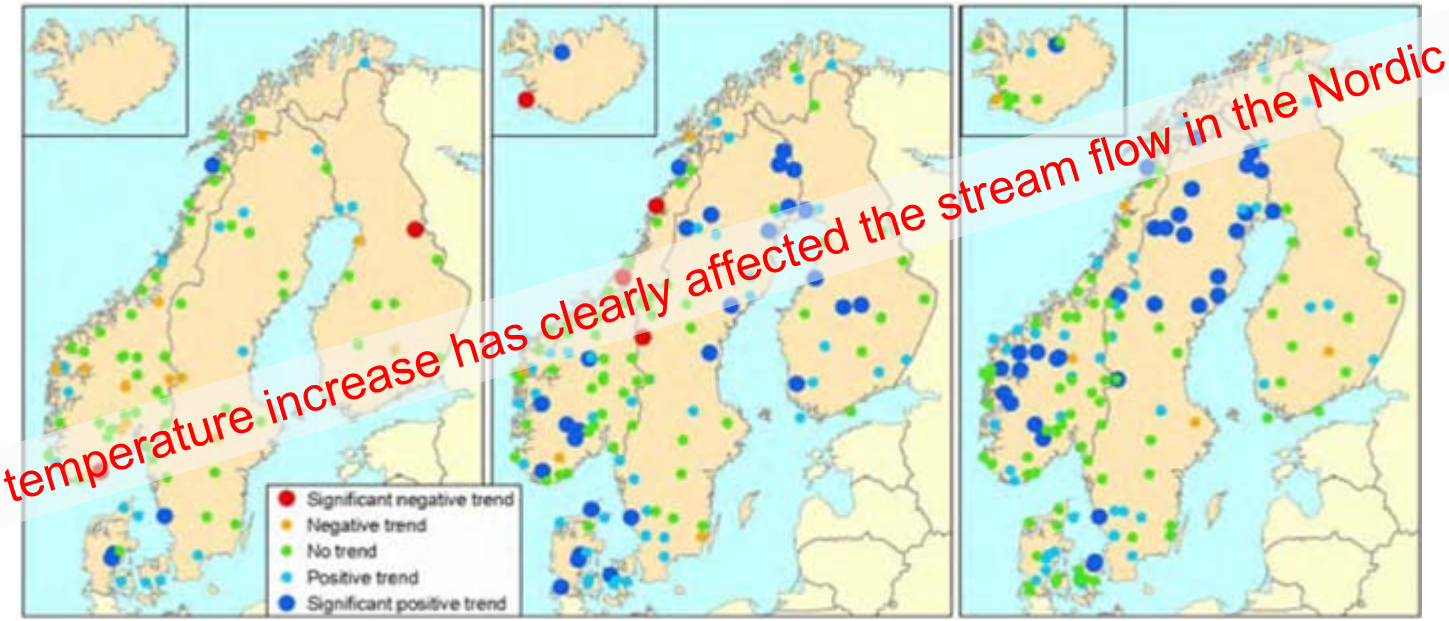
Reconstructed total river runoff as a function of temperature in the Baltic Sea. An increase of 1 °C results in a decrease of 3% (450 m^3/s)



- **Although decadal and regional variability is large, <u>no significant long-term change</u> detected in total river runoff to the Baltic Sea during 500 years**

Hansson D, Eriksson C, Omstedt A & Chen D 2010. Reconstruction of river runoff to the Baltic Sea, AD 1500–1995. *International Journal of Climatology.* DOI: 10.1002/joc.2097

Basin-scale broad changes in discharge patterns



observed temperature increase has clearly affected the stream flow in the Nordic countries

Trends in annual stream flow for the periods 1920-2002 (left), 1941-2002 (middle) and 1961-2000 (right)

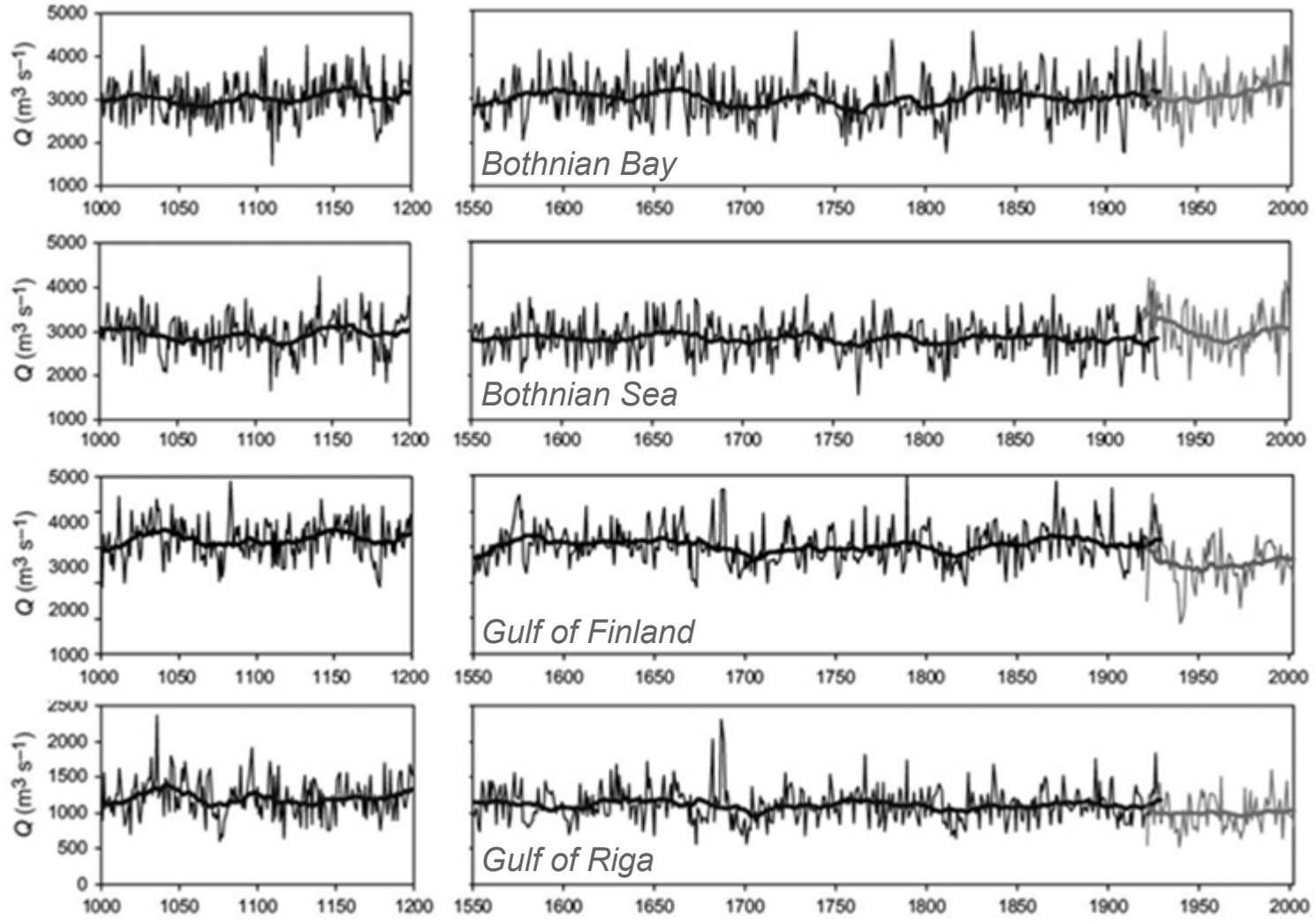
- Hisdal et al. (2010) have revised and extended their earlier analysis (2003) included in BACC I to more than **160 stream flow records**
- Trends towards increased stream flow dominated annual values plus winter and spring seasons. Trends in summer flow were highly depended on the analysed period whereas no trend was found for the autumn season. A signal towards earlier snowmelt floods was clear

Turun yliopisto
University of Turku

Sub-basin scale changes

Annual river flow 1000-1199 and 1551-1929 to four sub-basins of the Baltic Sea according to HBV-Baltic simulation, plus 1921-2002 (grey) as a reference

-> No apparent trends in river flow during the study period

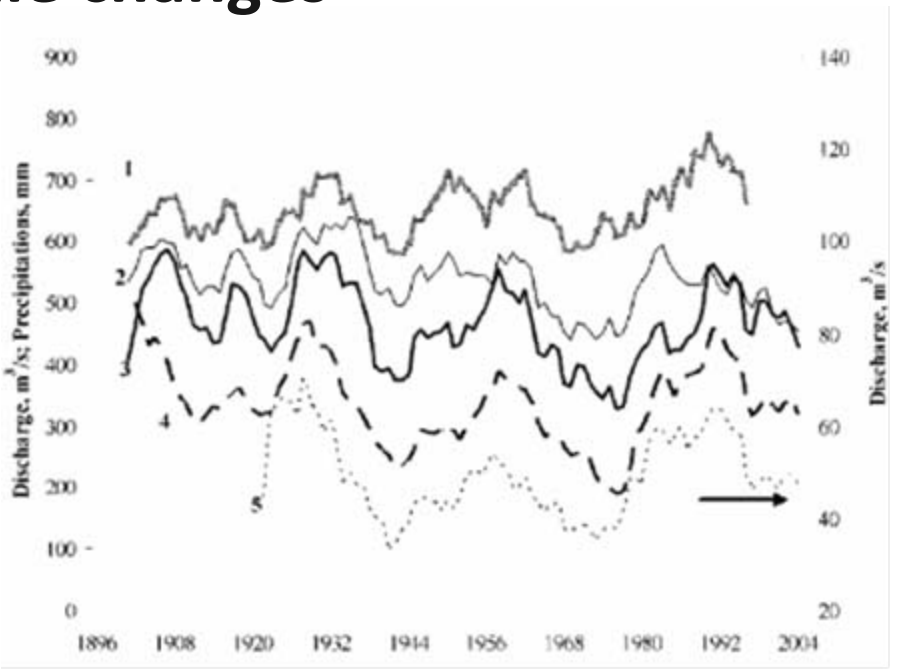


Hansson D, Eriksson C, Omstedt A & Chen D 2010. Reconstruction of river runoff to the Baltic Sea, AD 1500–1995. *International Journal of Climatology.* DOI: 10.1002/joc.2097

Turun yliopisto
University of Turku

Sub-basin scale changes

- A particularly significant increase in winter discharge could be observed during the recent two decades
- Spectral analysis identified statistically significant periods of 38, 28, 14, 19, 5, 4, 3 yr in the annual Q
- The average period of the wet and dry phases is 27–30 years, including average wet period of 15 years and dry period of 14 years



Long term changes of precipitations and mean annual discharge of the rivers in Baltic region (six-year moving average; Kļaviņš et al. 2008):
1 – precipitations (Station Rīga-University);
2 – Nemunas; 3 – Daugava; 4 – Narva; 5 – Pärnu.

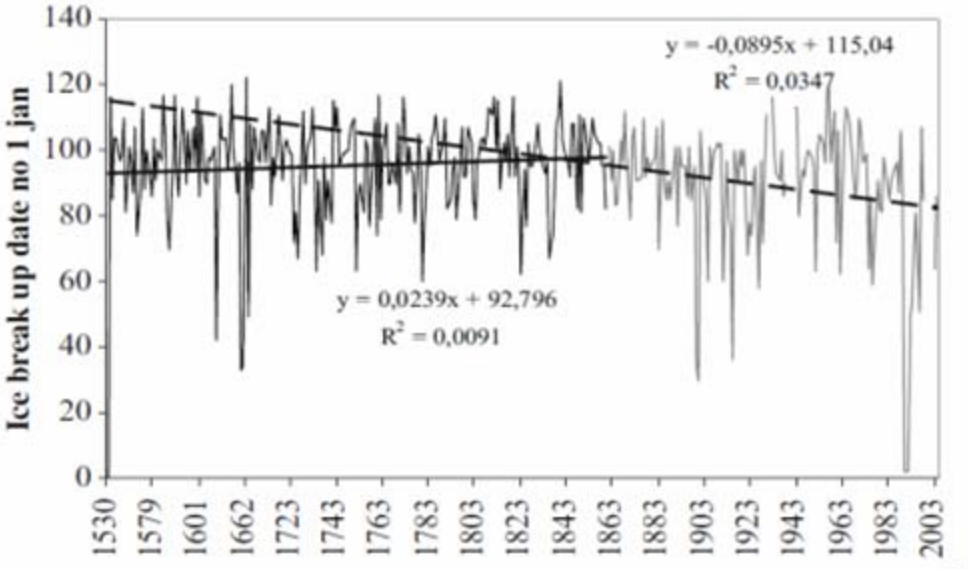
Kļaviņš M, Rodinov V, Timukhin A, Kokorīte I 2008. Patterns of river discharge: long-term changes in Latvia and the Baltic region. *Baltica* 21 (1-2), 41-49.

Kriauciuniene, J., Meilutyte-Barauskiene, D., Reihan, A., Koltsova, T., Lizuma, L. & Sarauskiene, D. 2012: Variability in temperature, precipitation and river discharge in the Baltic States. *Boreal Env. Res.* 17. In press. (online)

Turun yliopisto
University of Turku

Ice regime

- A pronounced downward trend in ice break up date and duration of ice cover was observed over the last 150 years and even more clearly evident during the recent 30 years -> Daugava 2.8 to 6.3 days per 10 years

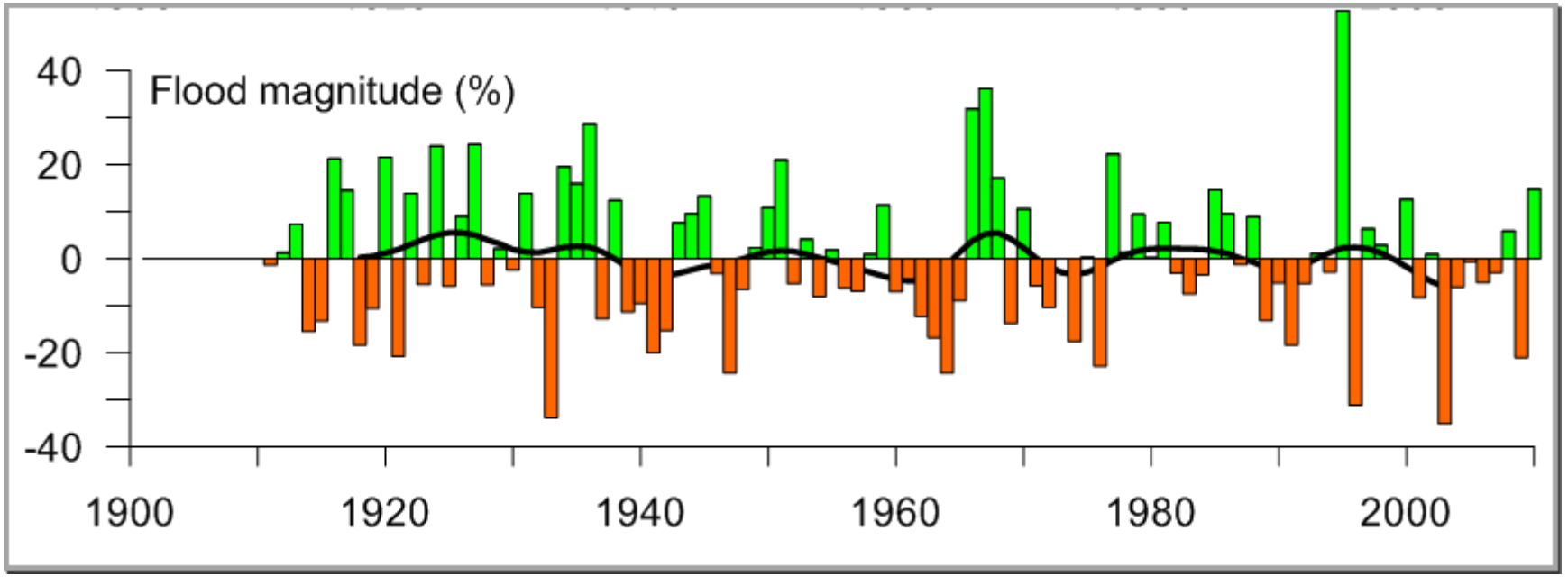


Time series of ice break-up dates in River Daugava (dashed line shows trend from 1860 to 2003 and continuous line from 1530 to 1859) (Kļaviņš et al. 2008)

Kļaviņš M, Rodinov V, Timukhin A, Kokorīte I 2008. Patterns of river discharge: long-term changes in Latvia and the Baltic region. *Baltica* 21 (1-2), 41-49.

Turun yliopisto
University of Turku

Floods



- In Sweden, the magnitude of the annual maximum floods in natural rivers rather stable over the last century. 1995 was the year with highest floods on average, and 2003 was the year with lowest flood peaks

Lindström G 2011. Klimat, vattentillgång och höga flöden i Sverige 1860-2010. *Elforsk rapport* nr ?

Turun yliopisto
University of Turku

Internal review comments

- Too little material on **lakes** -> agree; more emphasis (although regulation complicates interpretations), also on ice regime
- It would be good to systematically collect available information on the **effects of regulation** -> agree, although my prove difficult
- Is it necessary to include a brief **BACC I summary** of as an Annex? -> opinions?
- **Terminology** mismatch (runoff, streamflow, river flow, river discharge,…) -> harmonisation
- **Structure**:
  - is it necessary to separately deal with countries and sub-regions -> agree, perhaps confusing
  - floods and droughts; separate sub-chapter or not?

An idea & a question for discussion

- So far, many BACC illustrations are directly copied independent results from original journal papers; to get real added value, we could see the trouble of making compilation tables/diagrams etc. where possible/ applicable (like IPCC)
  - e.g. regional syntheses/homogeneous regions
- How to deal with occasional sparse/non-existing data/information (during the given time frame)?
  - give the little that is available?
  - highlight the fact that not much new information available?
  - ignore the topic altogether?


Thank you, kiitos!
C3
C3
Johnson
V-750 LP