Changes in the Extreme Discharge of the Meuse River over the Past Century

Tu Min

(IHE, The Netherlands)

M.J.M. de Wit

(RIZA, The Netherlands)

(CHR-Workshop, 24-25 June 2003)

Introduction

Background

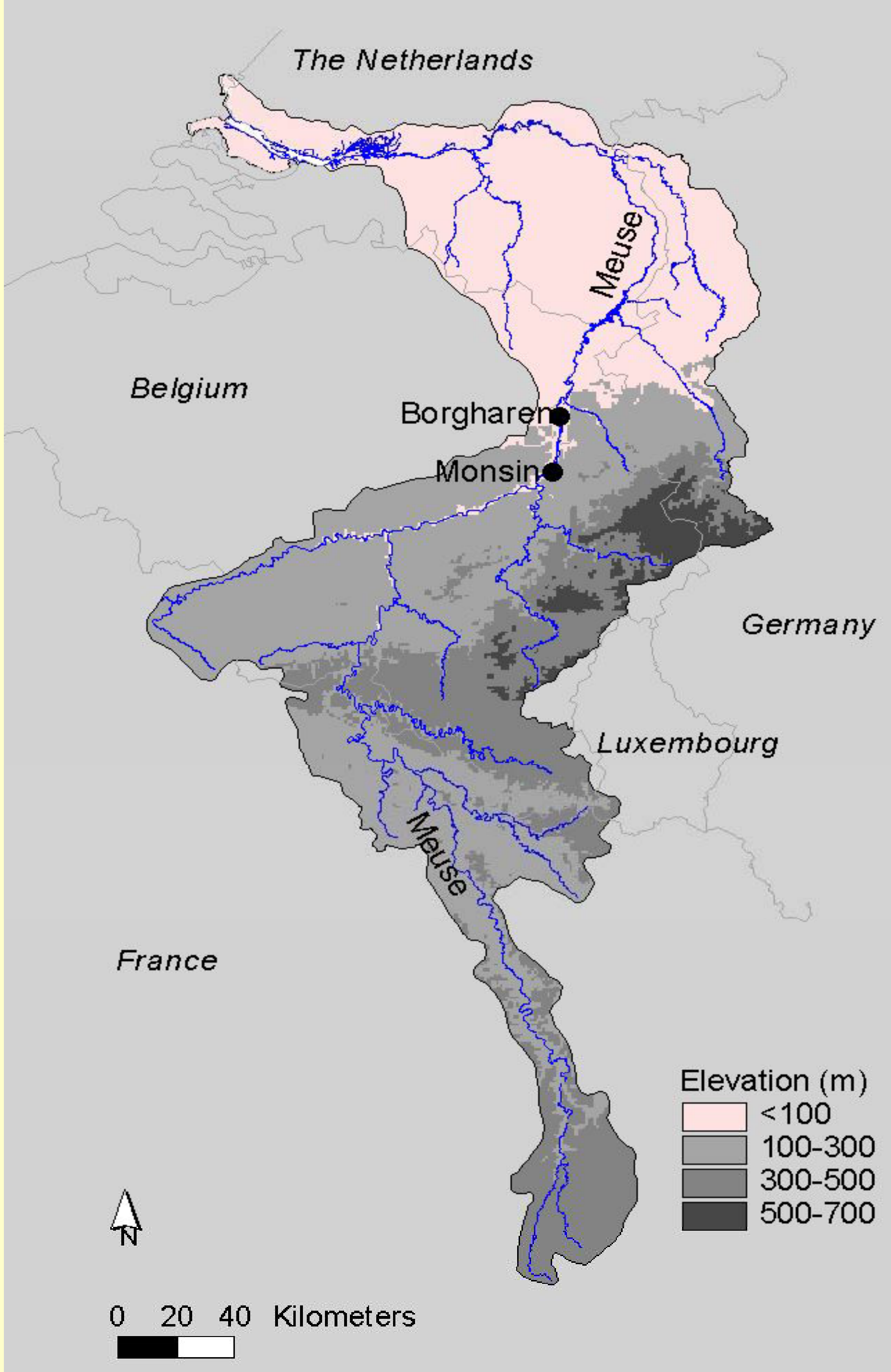
Data & Methods

Results & Discussion

Conclusions

The Meuse river

- Scope
  - 33,000 km²
  - 875 km
  - international
- Borgharen (NL)
  - 21,000 km²
  - 3,000 m³/s (1926)
- Recent floods
  - 1993, 1995, 2002 & 2003



Flooding of the Meuse river

Climate variability?

1995 in The Netherlands

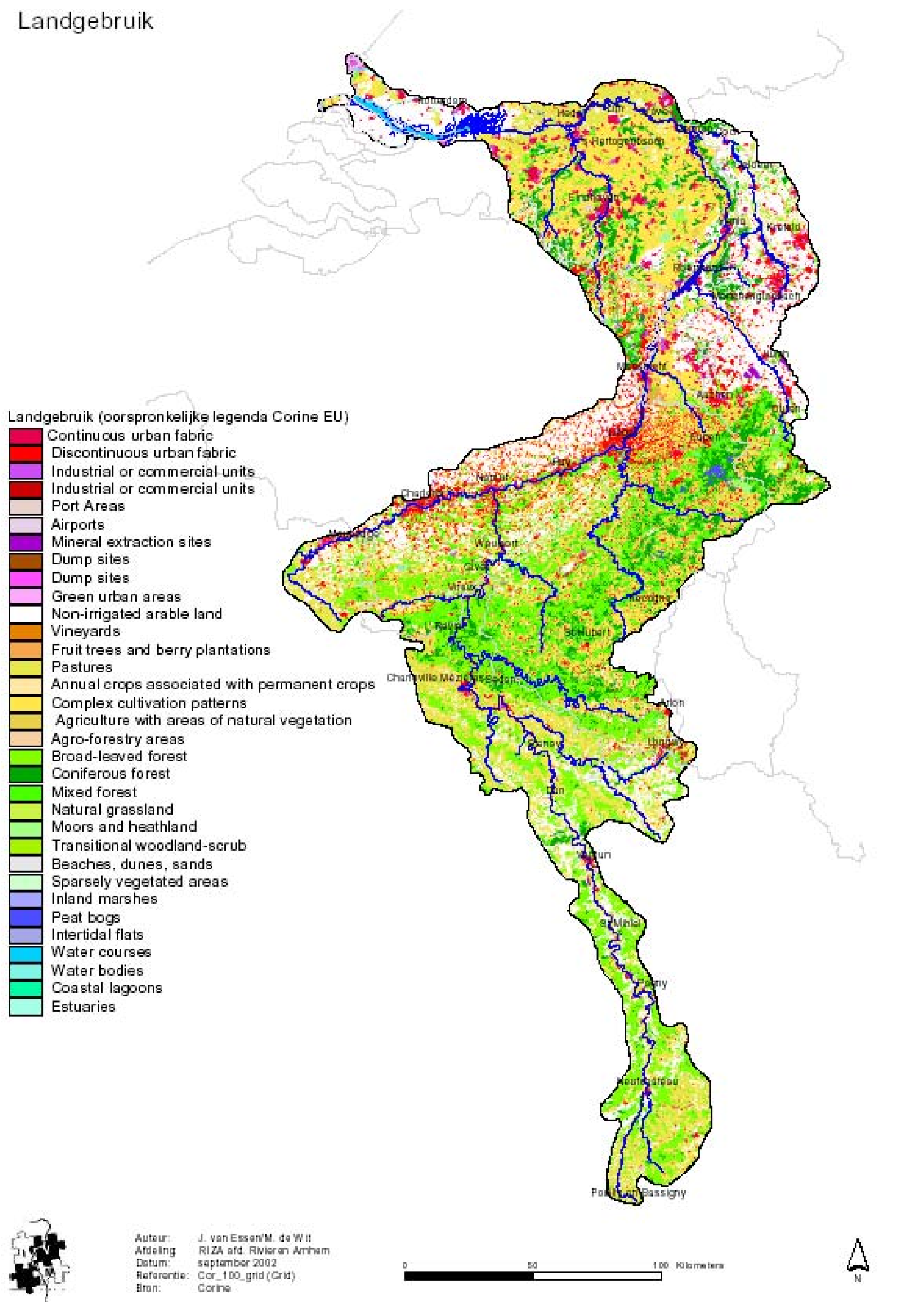
1993 in Belgium

Land-use changes?

Land use/cover

Upstream of BL/NL

Agricultural land	**34%**
Pasture	**20%**
Forest	**35%**
Built-up area	**9%**



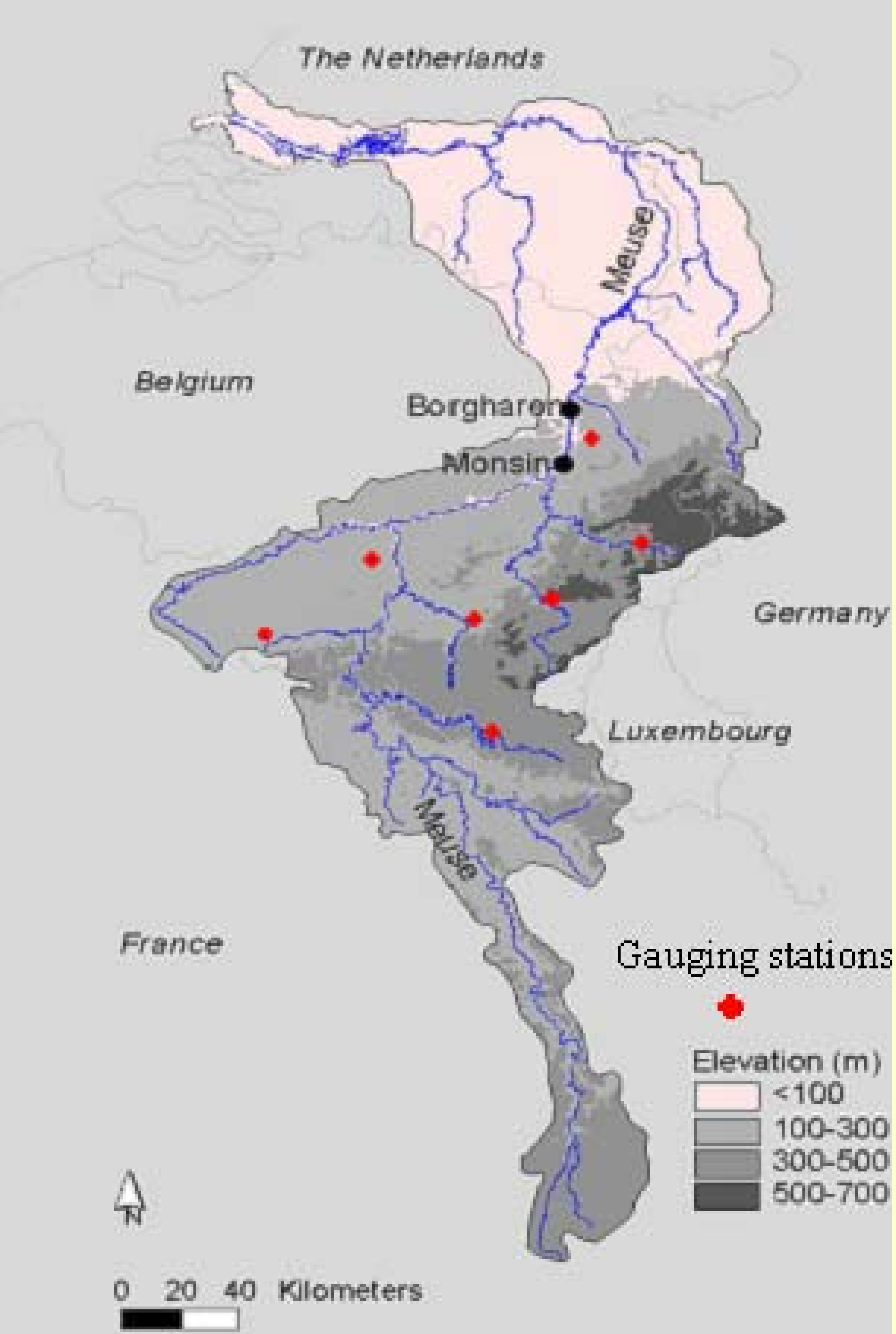
Objectives

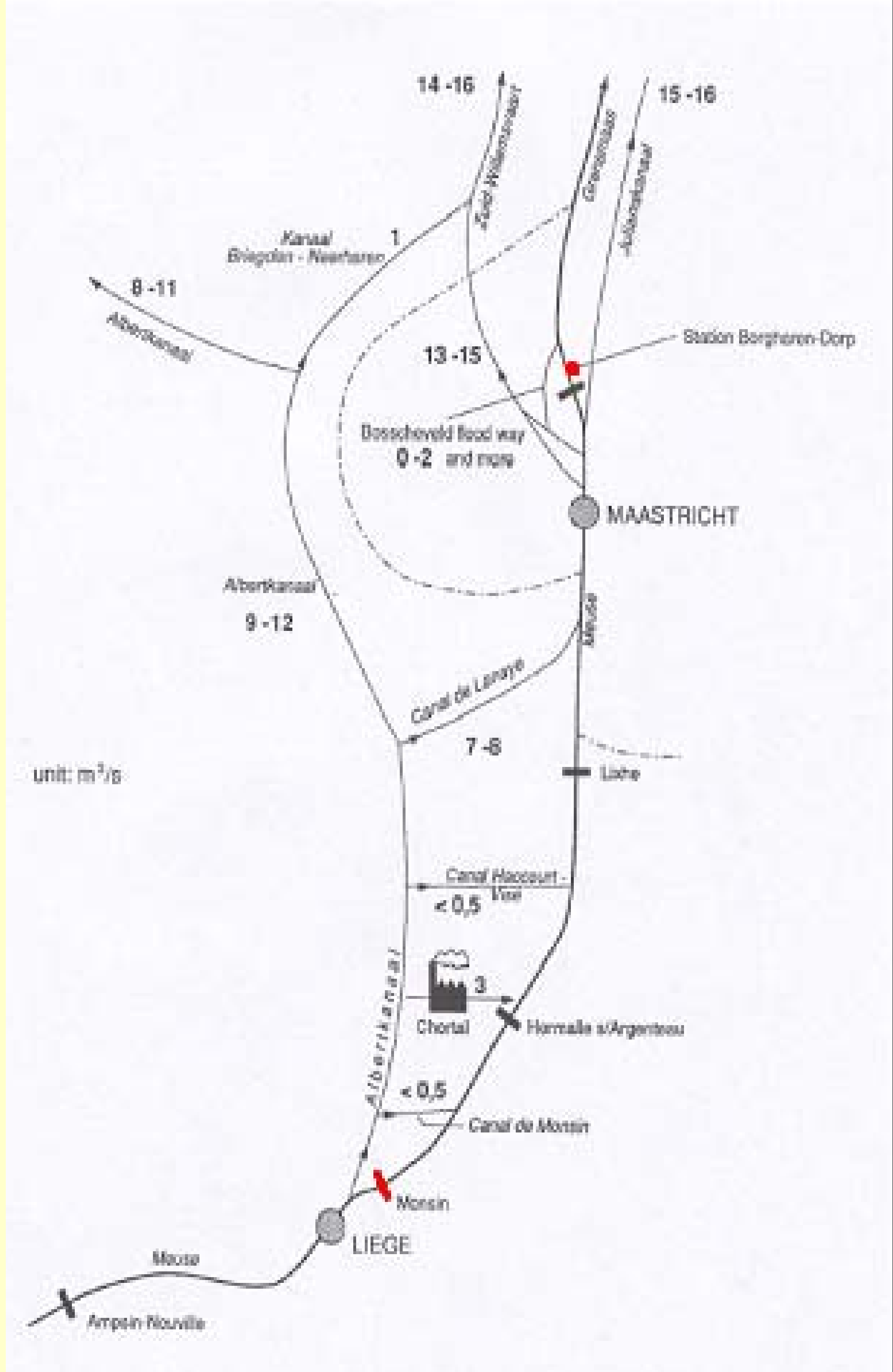
- To investigate long-term changes in the flood regime of the Meuse river

  - Flood peak discharge
  - Antecedent precipitation
  - Flood runoff generation
  - Flood frequency curve

Data and methods (2-1)

- Daily records (> 1911)
  - Discharge at Borgharen & Monsin stations
  - Belgian 7 precipitation stations
- Hydro-meteorological variables
  - k-day extreme discharge
  - k-day antecedent precipitation
  - Runoff coefficient (q=FCiA)


The Netherlands
Belgium
Borgharen
Monsin
Meuse
Germany
Luxembourg
France
Meuse
Gauging stations
Elevation (m)
<100
100-300
300-500
500-700
N
0 20 40 Kilometers


14 -16
15 -16
Zuid-Willemsvaart
Grensmaas
Julianakanaal
Kanaal Briegden - Neerharen
1
8 -11
Albertkanaal
13 -15
Station Borgharen-Dorp
Bosscheveld flood way
0 -2 and more
MAASTRICHT
Albertkanaal
9 -12
Meuse
Canal de Lanaye
7 -8
unit: m³/s
Lixhe
Canal Haccourt - Visé
< 0,5
Albertkanaal
3
Chertal
Hermalle s/Argenteau
< 0,5
Canal de Monsin
Monsin
LIEGE
Meuse
Ampsin-Neuville

Data and methods (2-2)

- Statistical tests

  - Linear trend — Spearman's rank correlation

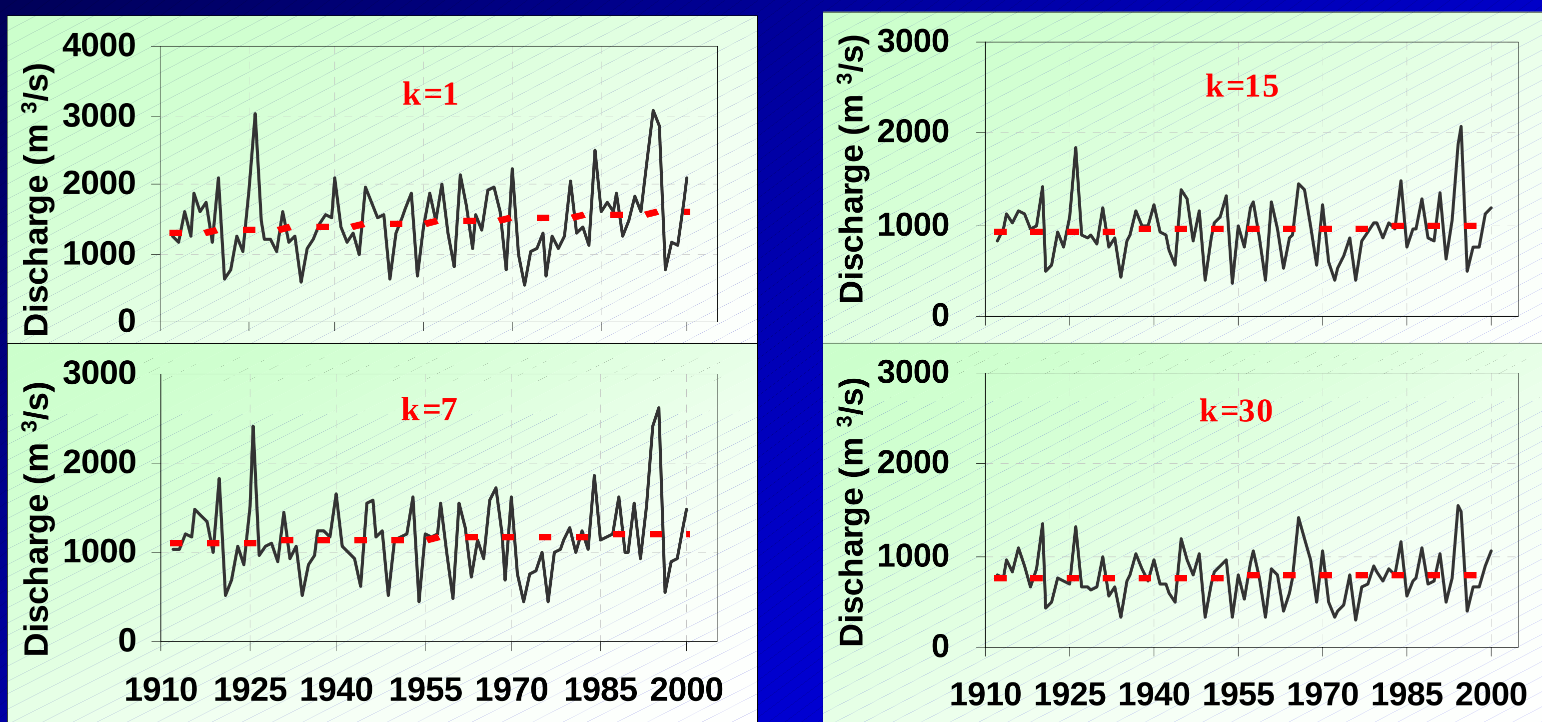
  - Change-point — Pettitt test (non-parametric)

    SNHT test (parametric)

  - Split-record tests (t-test & F-test)

Results and discussion (5-1)

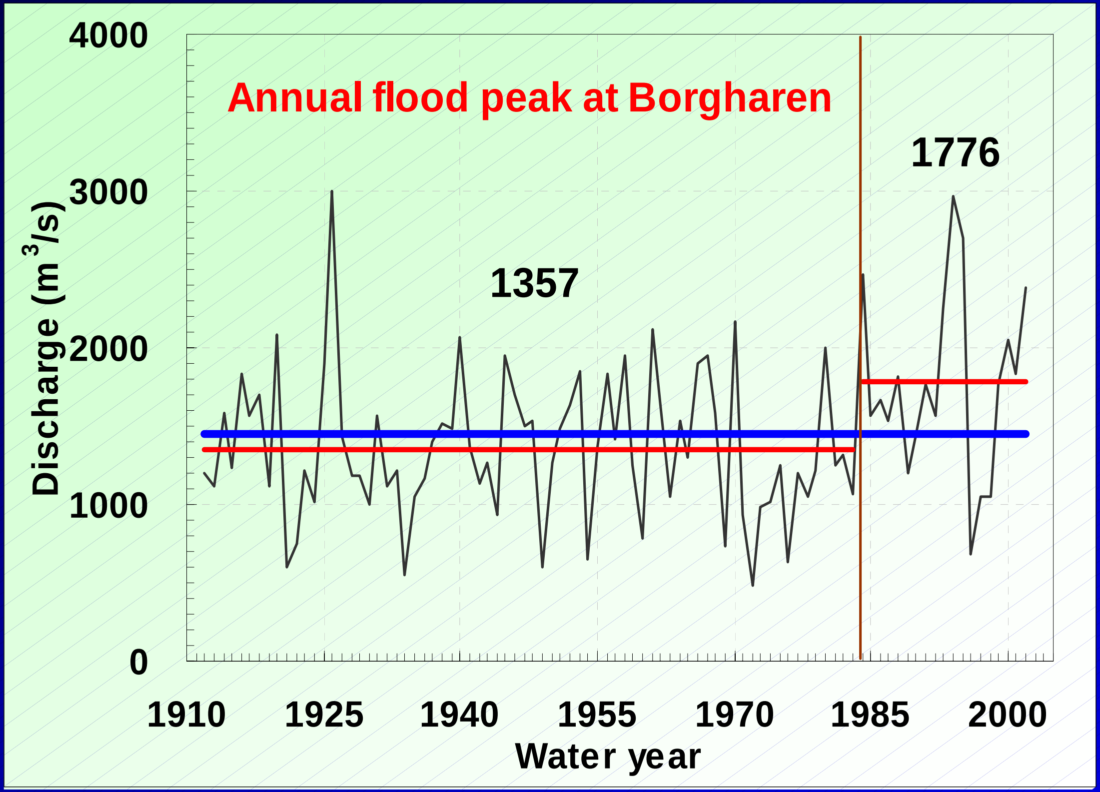
- No significant trend for both the annual and seasonal k-day extreme discharge (k=1, 3, 5, 7, 10, 15, 30)

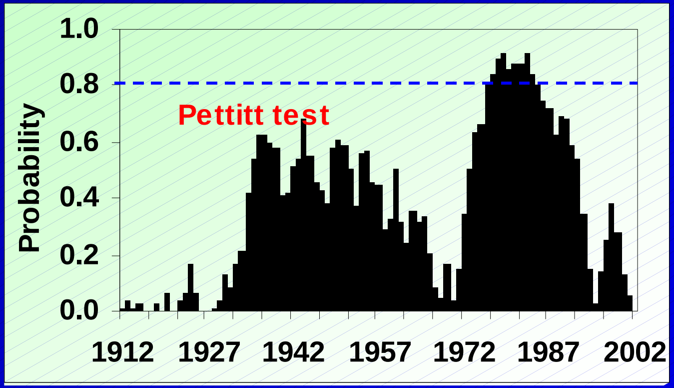


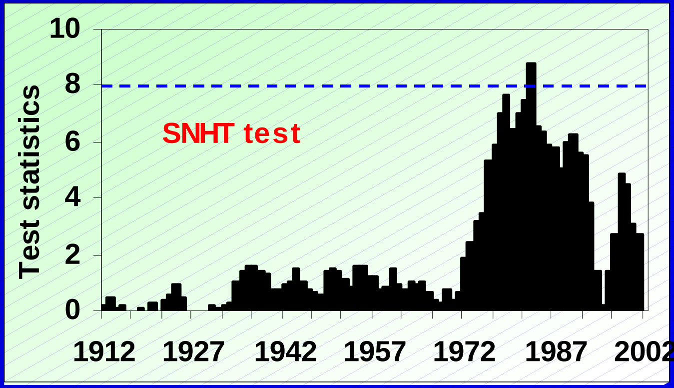
Annual k-day extreme discharge at Monsin

Results and discussion (5-2)

- Significant change-point in 1983 for the annual and winter k-day extreme discharges (k=1, 3)

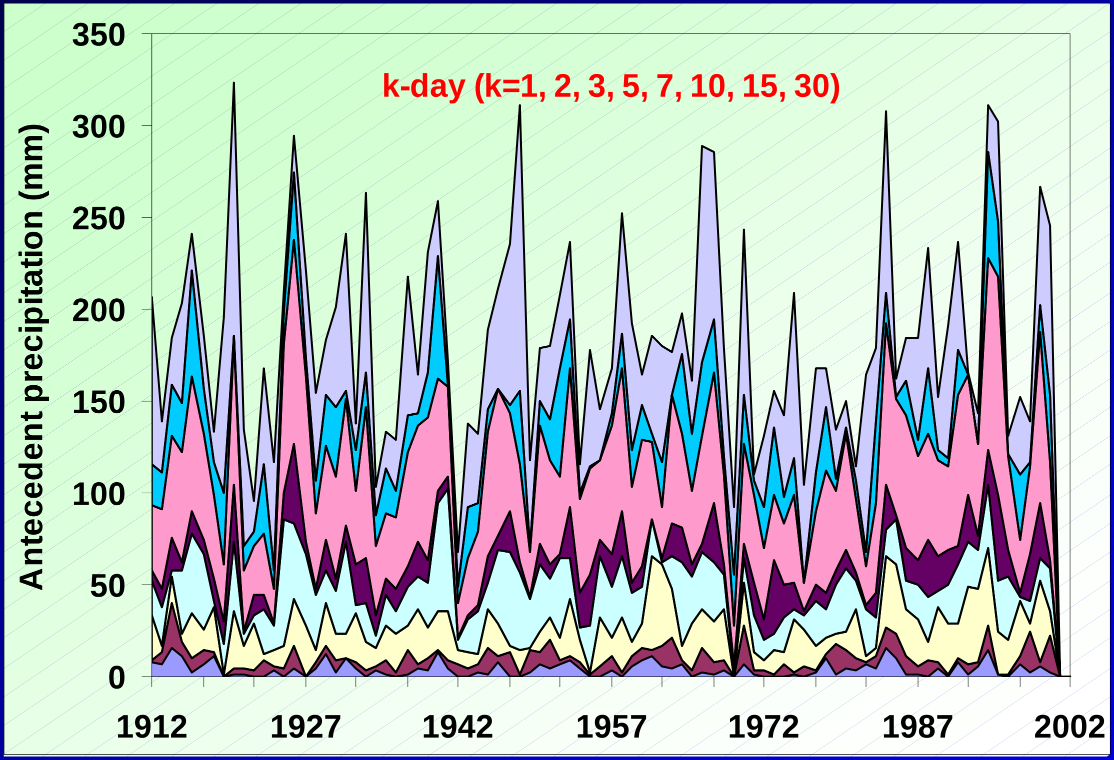


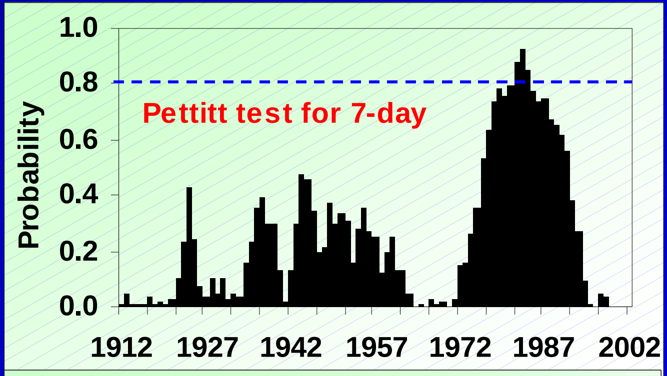


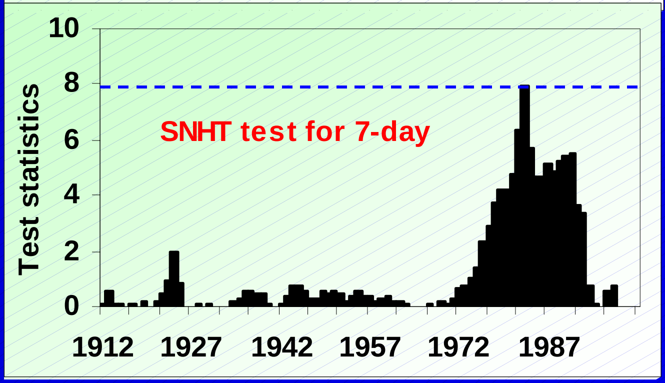


Results and discussion (5-3)

- Significant change-point in 1983 for the antecedent k-day precipitation depths for the winter peak at Monsin (k=3, 5, 7, 10)

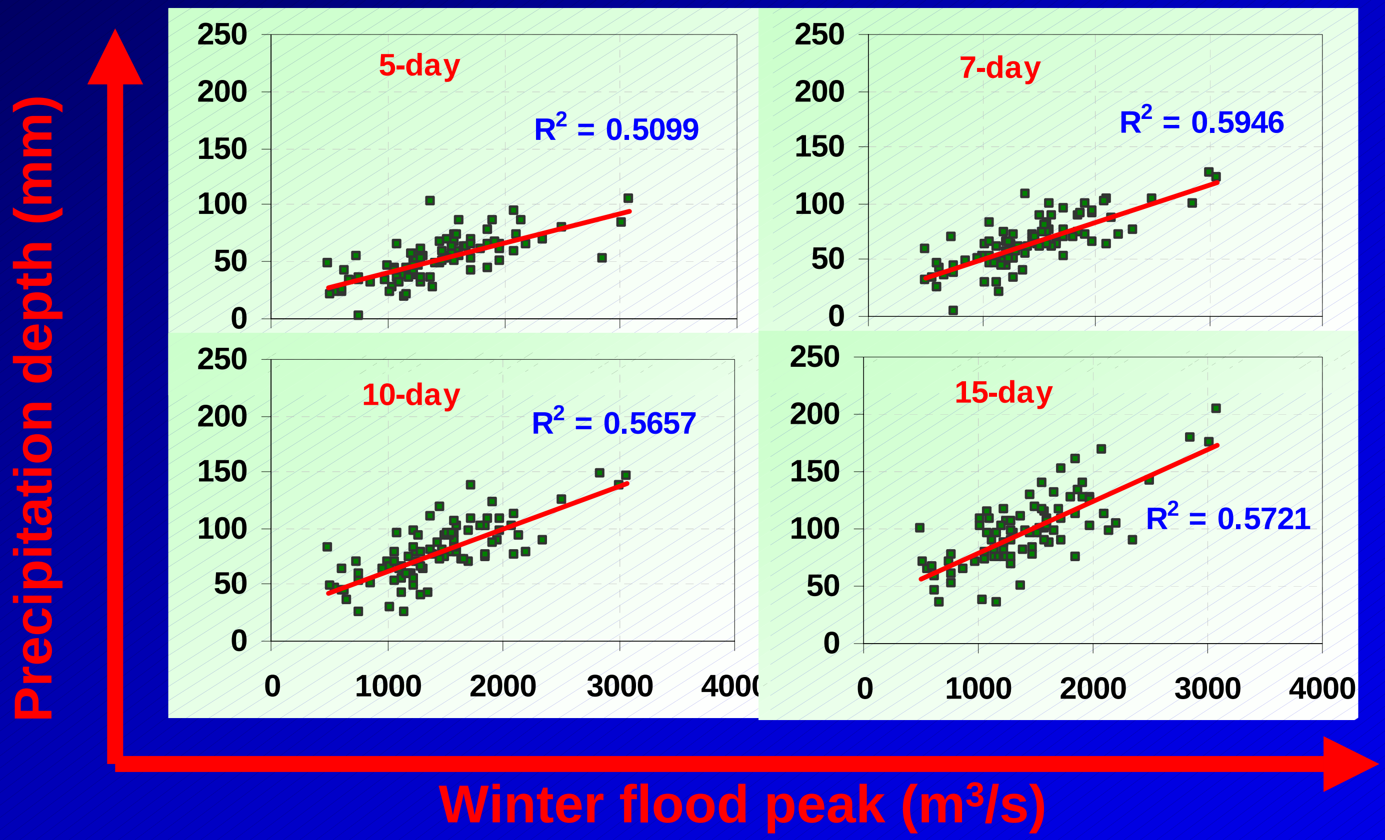






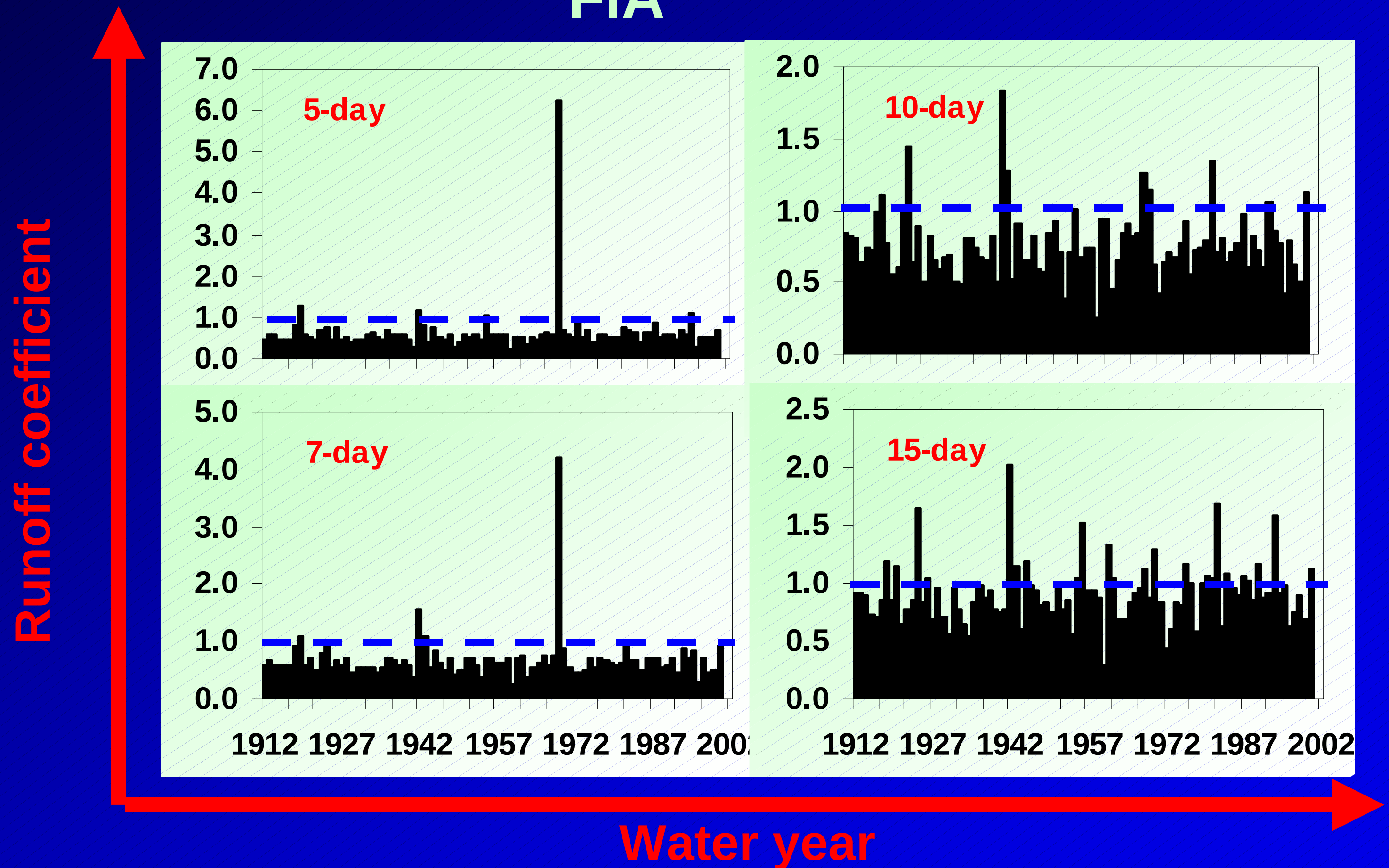
Results and discussion (5-4)

- Strong correlation for the antecedent 5-day to 15-day precipitation depth and the winter peak at Monsin



Results and discussion (5-5)

- No significant change-point for the runoff coefficient ($C = \frac{q}{FiA}$) at Monsin

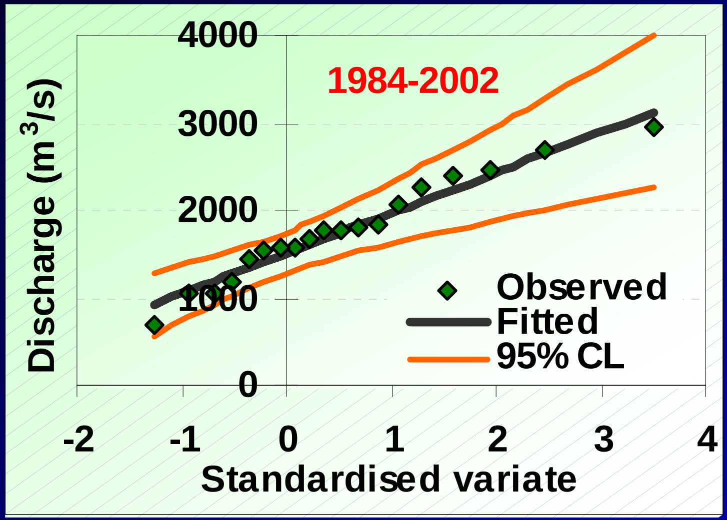


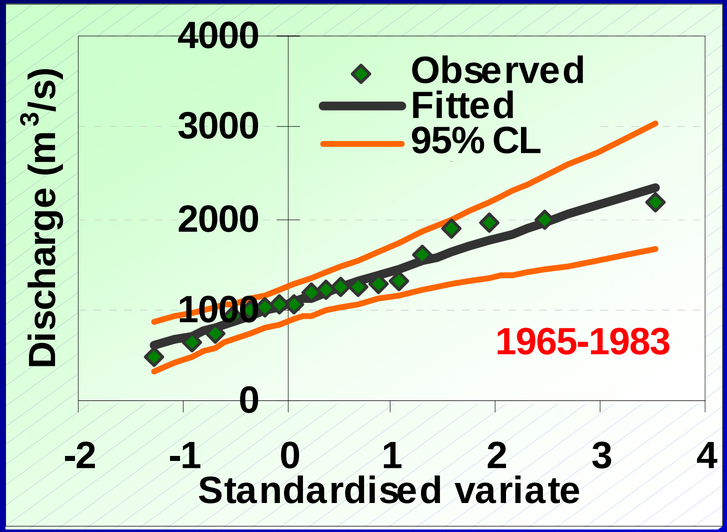
Conclusions (2-1)

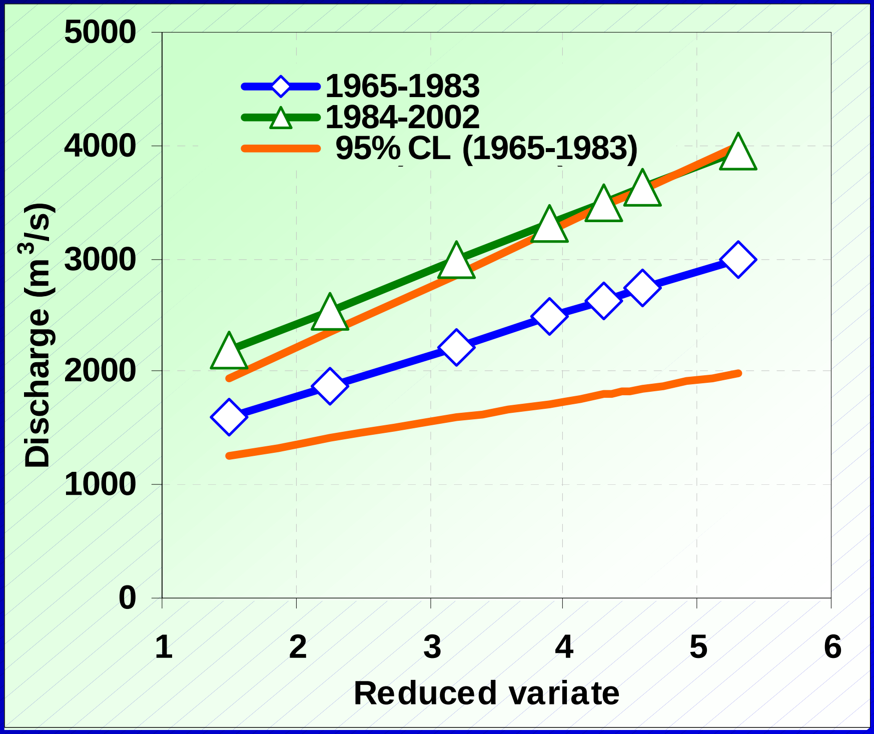
- The increase of the annual and winter flood peaks after 1983 can be explained by an increase of the antecedent precipitation depth.

- The relative large frequency and magnitude of floods in the Meuse river over the last two decades can largely be addressed to climatic variability.

Conclusions (2-2)



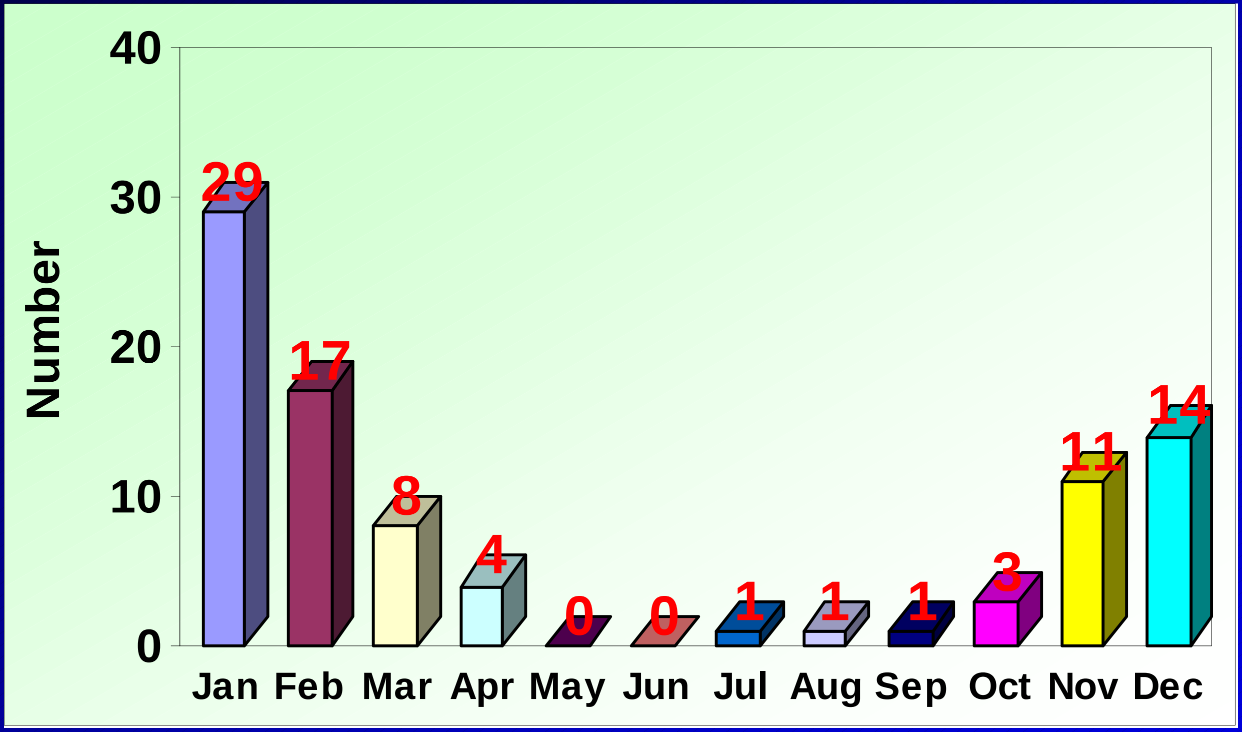




Magnitude of T-year flood at Borgharen (estimated using Gumbel distribution)

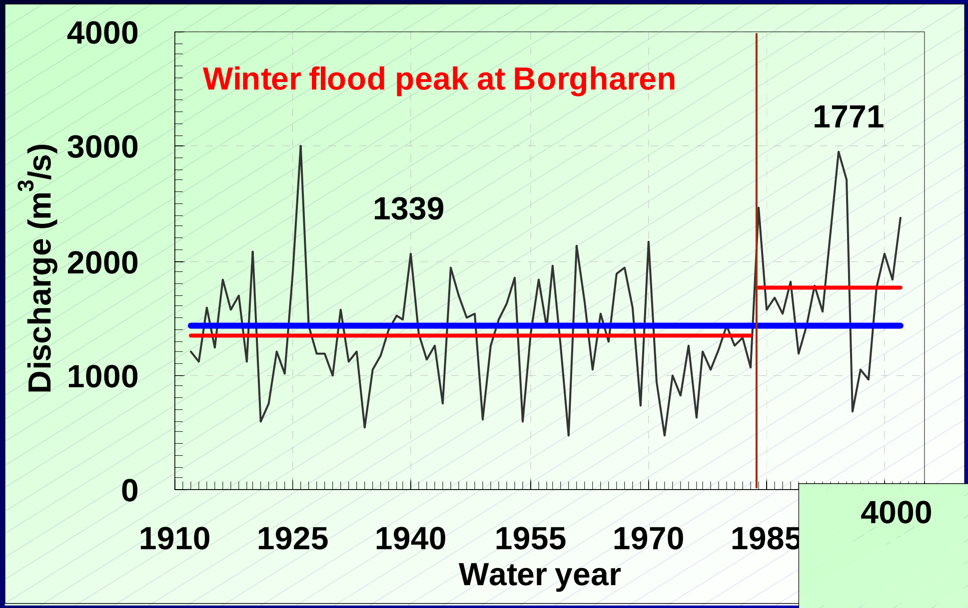
Thank you!

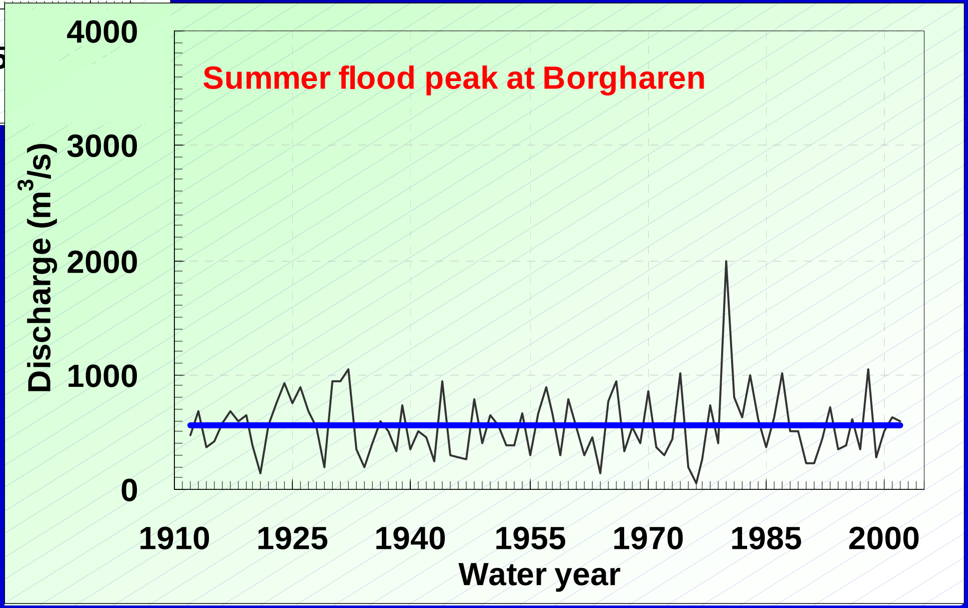
Distribution of annual flood peaks



at Monsin (1912-2000, in water years)

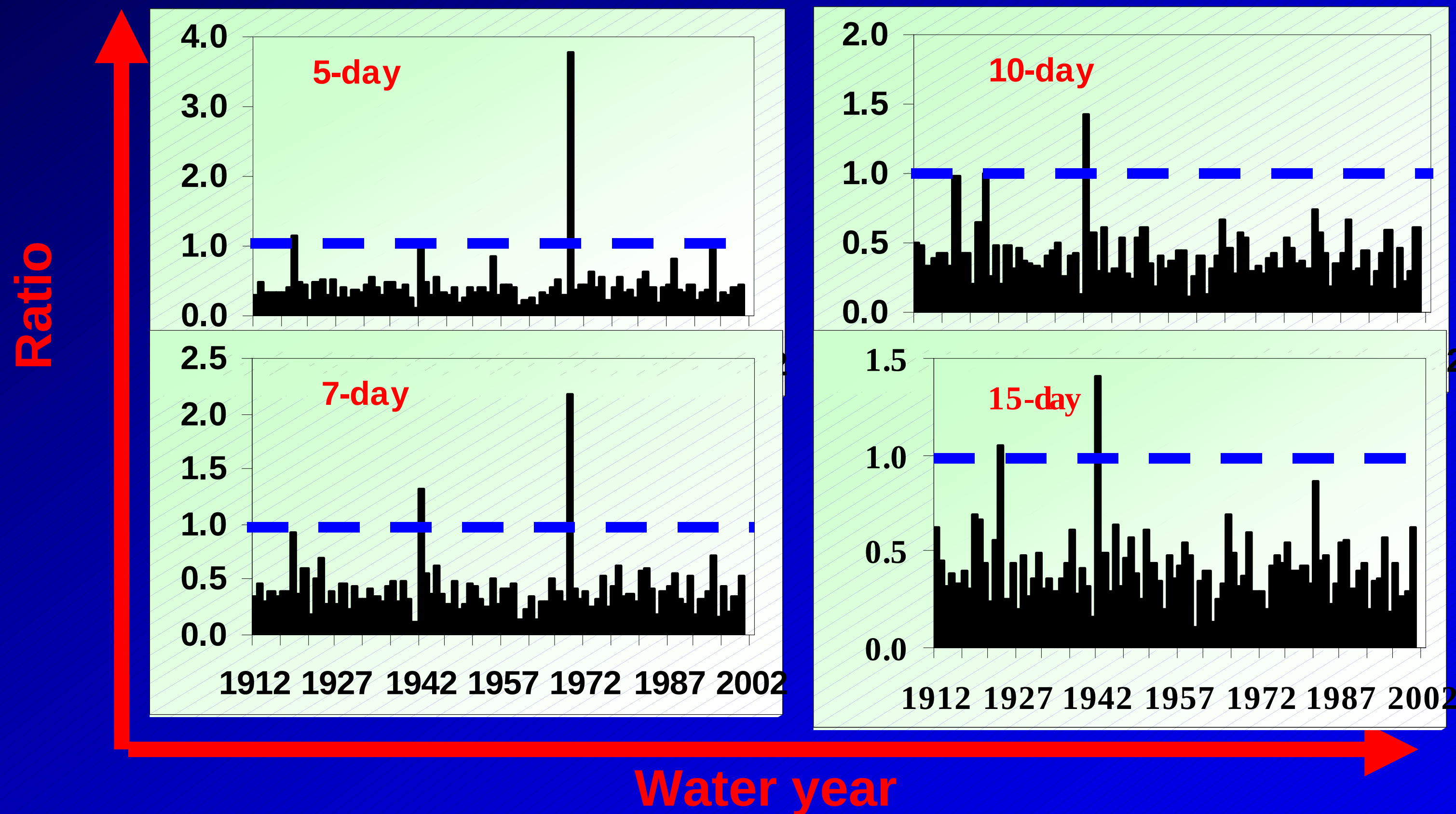
Change-point analyses



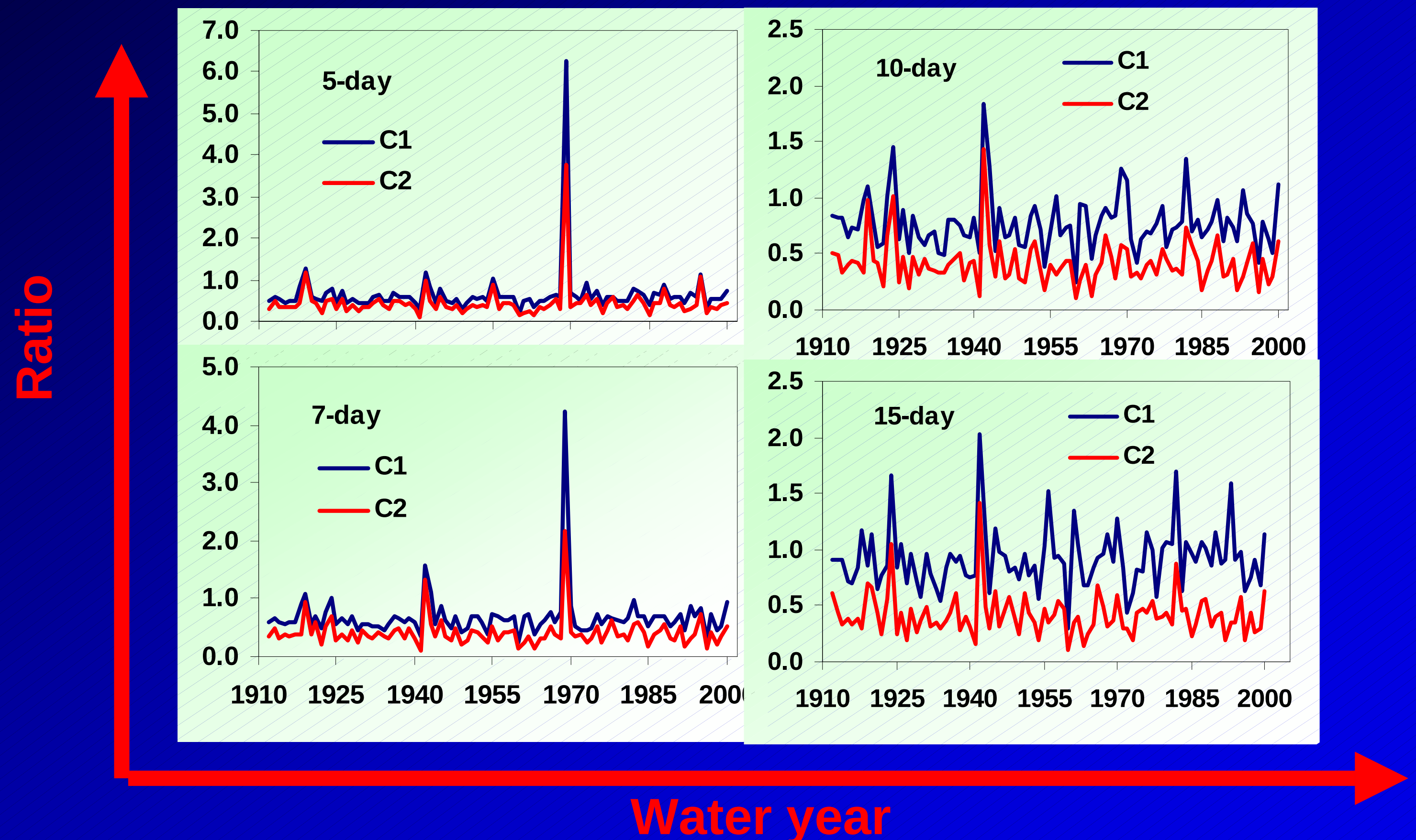


Ratio of runoff and precipitation

- No significant change-point for the ratio of runoff and precipitation during k-day at Monsin (k=1, 3, 5, 7, 10, 15, 30)



Runoff coefficient (C1) vs. ratio of runoff and precipitation (C2)



Gumbel distribution fitting