BALTEX workshop
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Effect of climate change on river discharges

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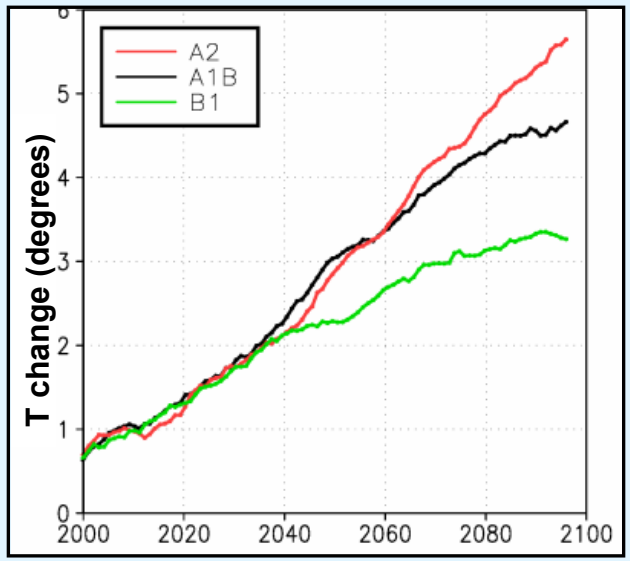
Introduction

- **Finnish Environment Institute's Watershed Simulation and Forecasting System (WSFS) is used to simulate changes in hydrology and flood**
  - **Conceptual watershed model (HBV-type)**
  - **Includes water quality model**
- **Research had been done part of several national and international projects**
  - **CES, WaterAdapt, TULeVAT, TOLERATE**
- **Outline of presentation**
  - **Methods, models, scenarios**
  - **Results**

Methods

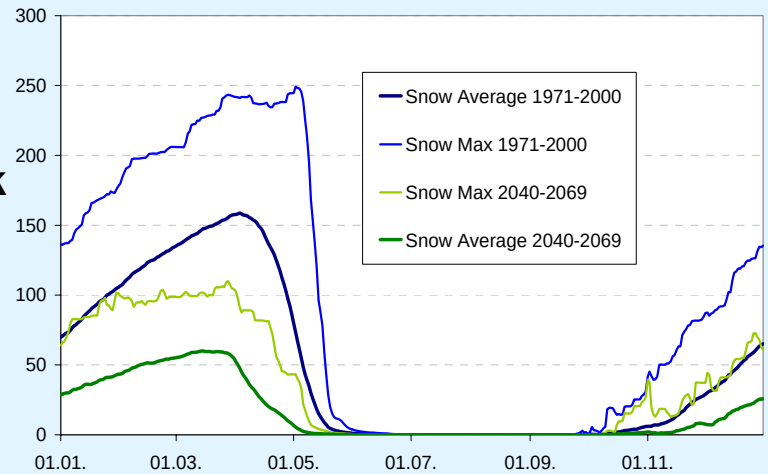
- **The climate scenarios from the Finnish Meteorological Institute (FMI)**
  - **Three time periods: 2010-39, 2040-69 and 2070-99**
  - **Three SRES-emission scenarios: A2, B1 and A1B**
  - **Three global climate models**
  - **Average from 19 global models**
    - **Average scenario: Average with A1B**

    → results shown from this scenario
  - **3 regional scenarios (RCA3)**
- **Delta change method**
- **30 years of dicharges and water levels were simulated**
  - **Baseline 1971-2000**



Snow simulation

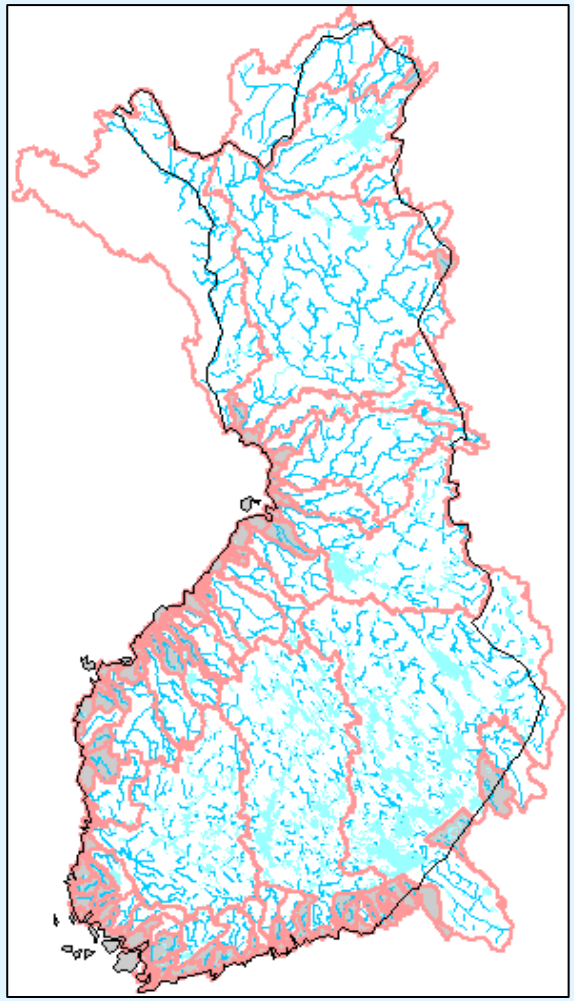
- **The WSFS has a snow model that simulates snow accumulation and melt**
  - **Input is areal precipitation and temperature**
  - **Snowmelt is simulated by degree-day model with increasing degree-day value during the melt period**
  - **Open and forest snowmelts are simulated separately**
  - **Parameters for each sub basin**
  - **Other important processes**
    - **Liquid water retention in snow pack**
    - **Refreezing of melted water**
    - **Simulation of snow-covered area**
    - **Temporary surface storage**



SYKE

Different hydrological areas in Finland

- **Northern Finland**
  - Large runoffs during spring caused by snow melt
- **Lake District in Central Finland**
  - Storage of water in the lakes
  - Central lakes and upstream lakes
- **Small watersheds in the cost**
  - Fast fluctuations of discharge



Hydrological changes in Finland 1/2

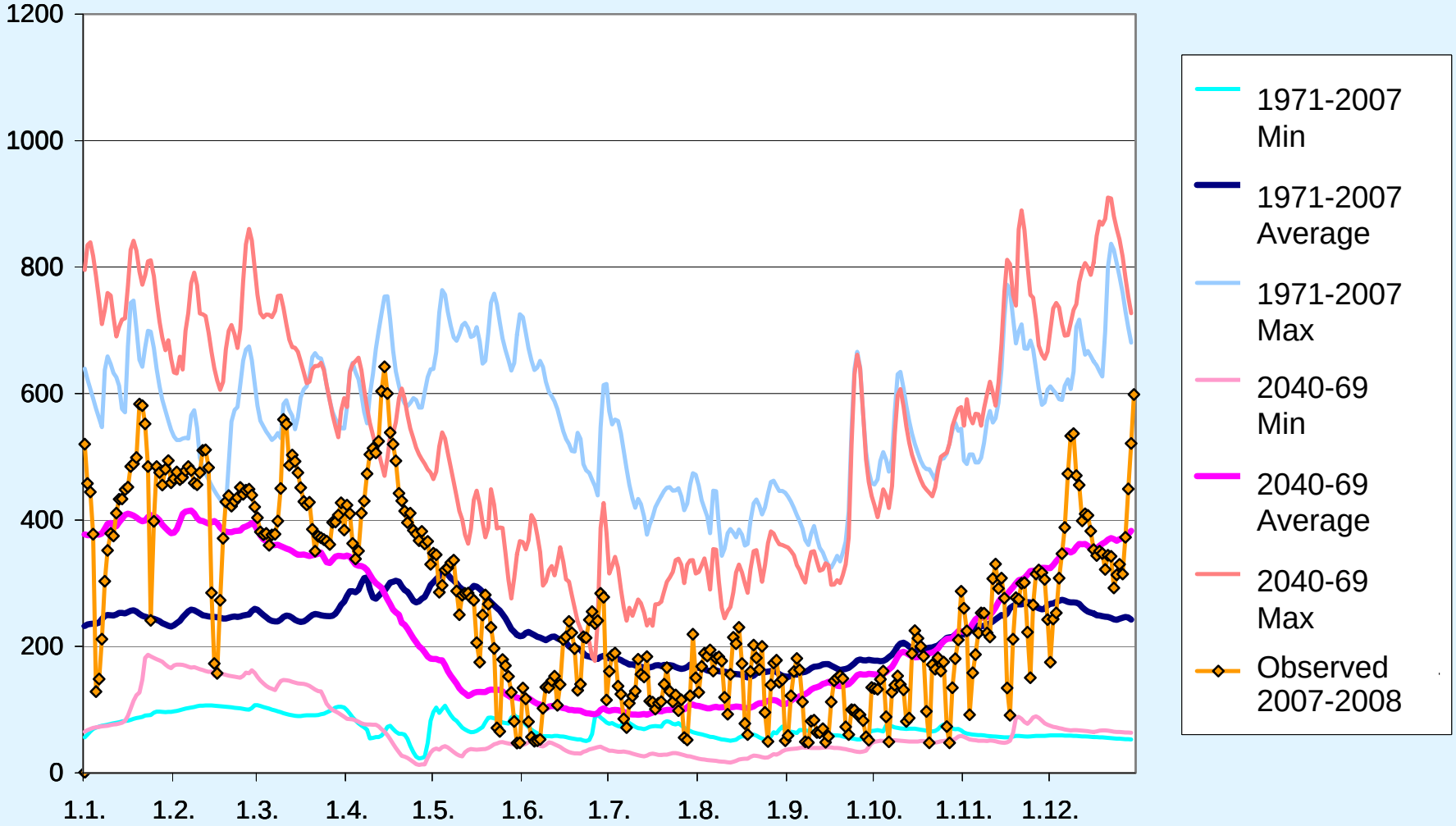
- **Summer and early autumn**
  - **Evaporation increases→ runoff and ground water decrease, drought risk increases**
  - **Extreme precipitation events increase**
    - **Risk for summer floods and urban flooding increases**
- **Winter (and late autumn)**
  - **Snow melt and precipitation as rain increase**
    - **Especially in Southern and Central Finland**
  - **Runoff increases, river floods and frazil ice floods increase**
  - **Large central lakes flood more frequently**

Hydrological changes in Finland 2/2

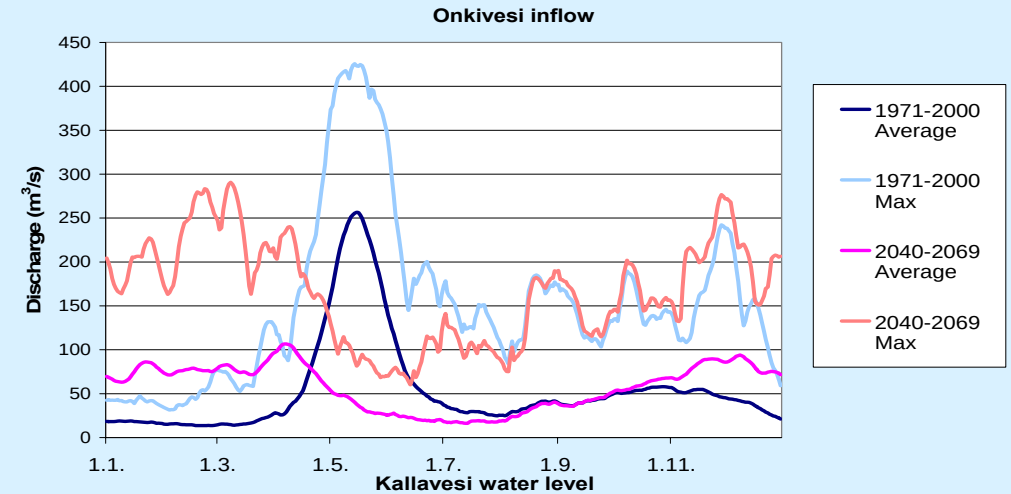
- **Spring**
  - **Southern and Central Finland**
    - **Less snow → snow melt floods decrease**
  - **Northern Finland**
    - **In the near term future snow and spring floods don't decrease and may even increase**
    - **When the temperatures continue to increase, snow and spring floods begin to decrease**
- **Total: Runoff increases ~0-10 %**

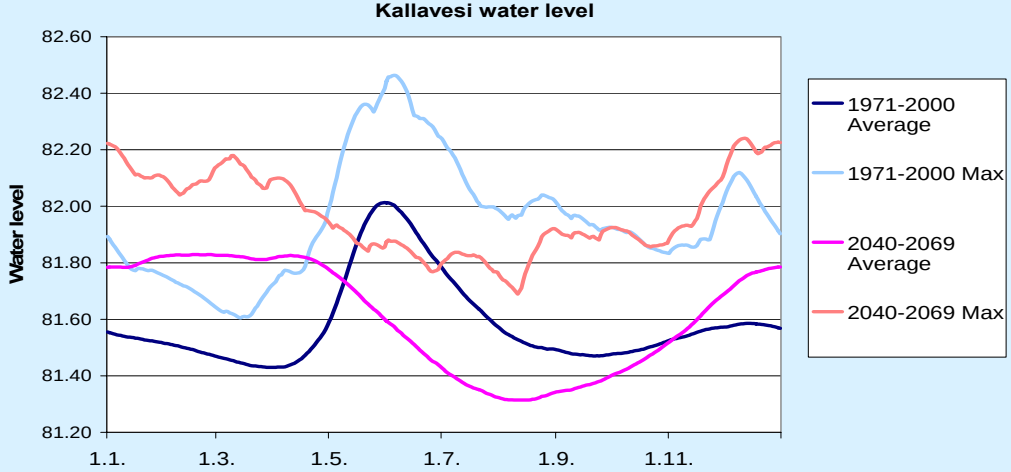
Southern/central Finland: Kokemäenjoki

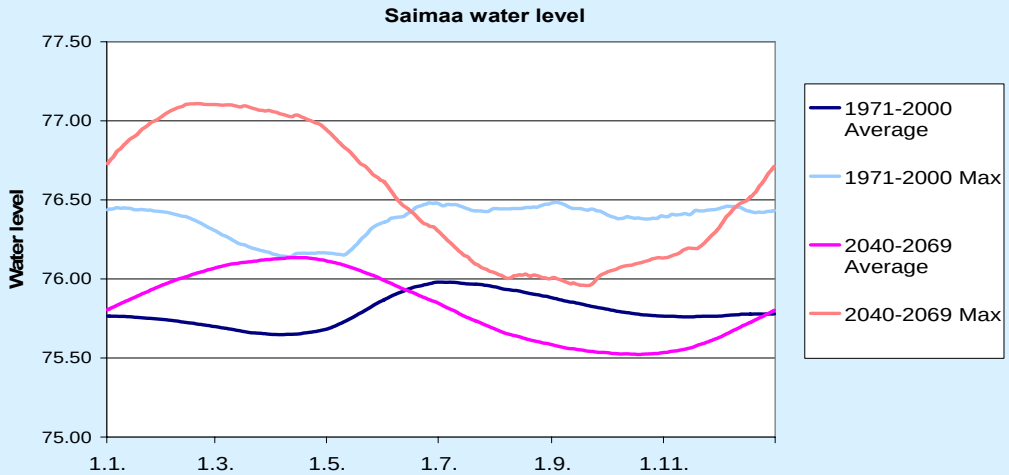
Discharge 2040-69

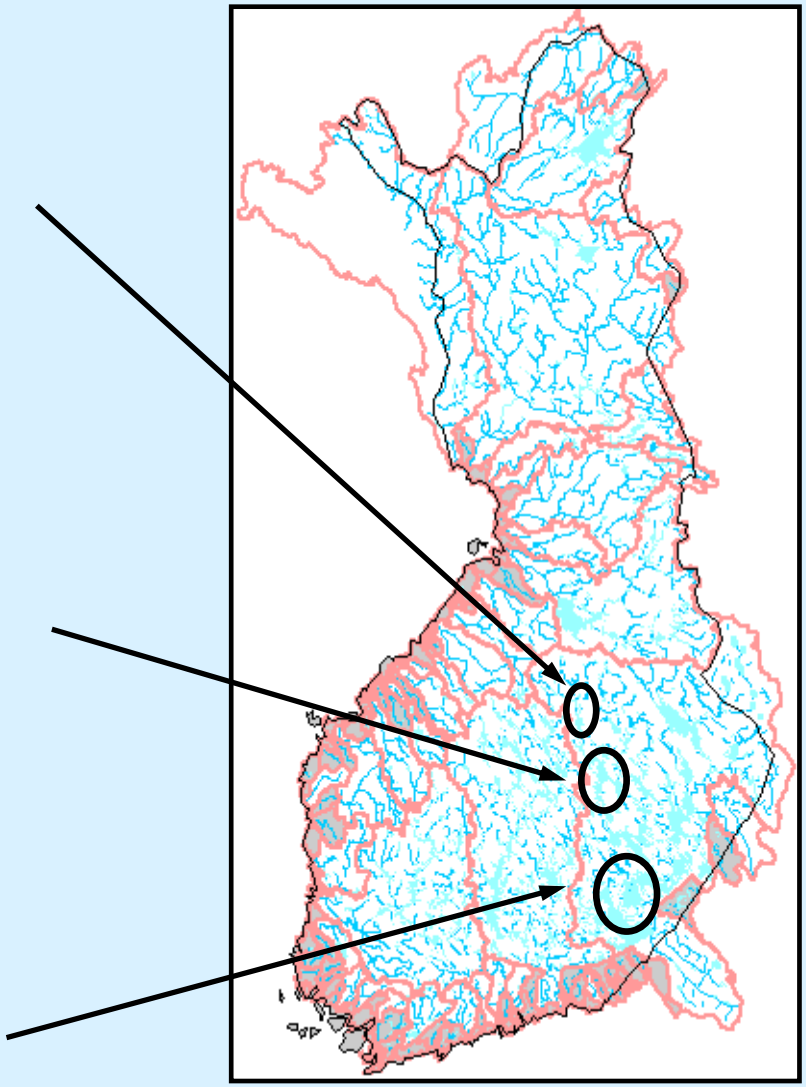


SYKE

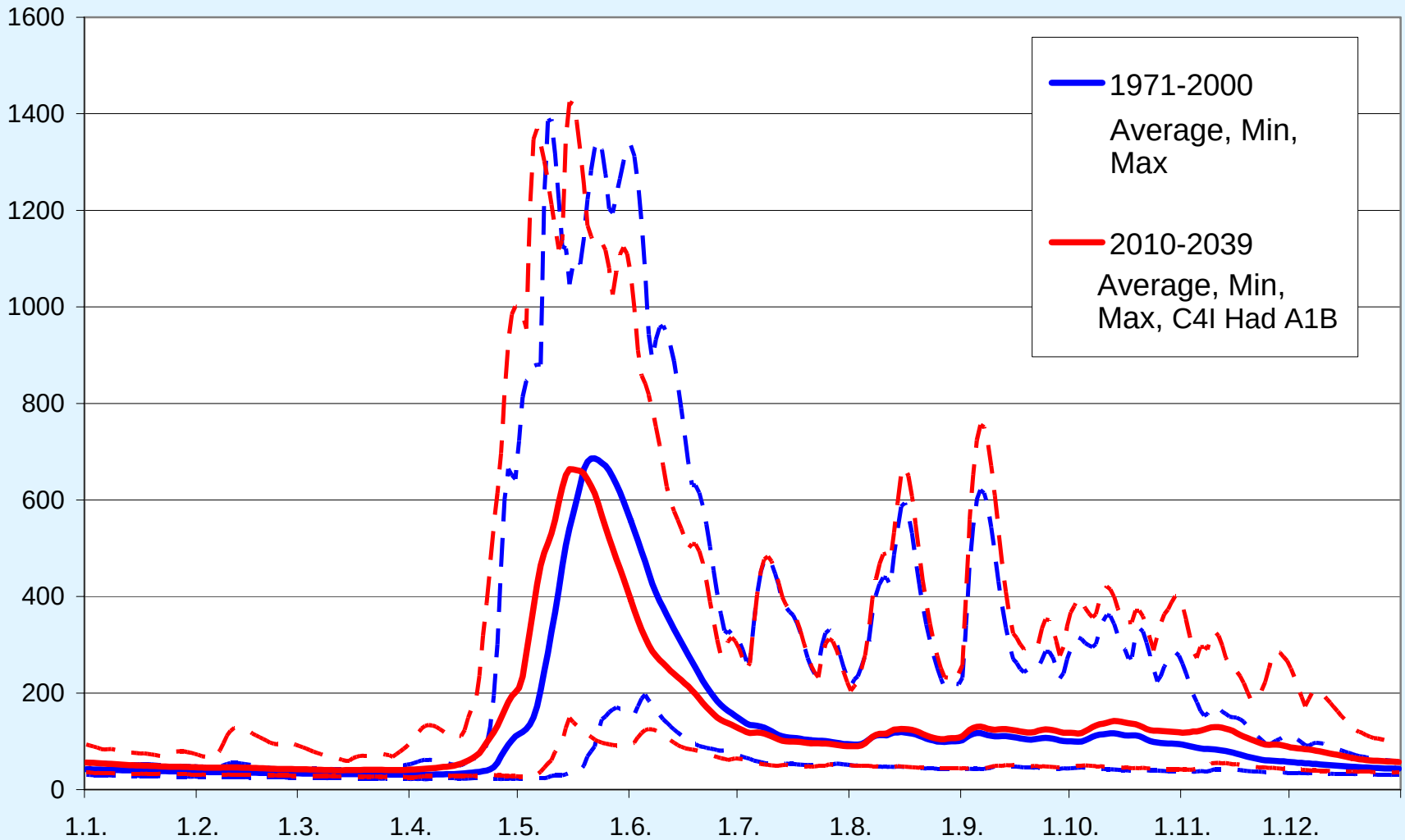

Onkivesi inflow
Discharge (m3/s)
450
400
350
300
250
200
150
100
50
0
1.1.
1.3.
1.5.
1.7.
1.9.
1.11.
1971-2000 Average
1971-2000 Max
2040-2069 Average
2040-2069 Max


Kallavesi water level
Water level
82.60
82.40
82.20
82.00
81.80
81.60
81.40
81.20
1.1.
1.3.
1.5.
1.7.
1.9.
1.11.
1971-2000 Average
1971-2000 Max
2040-2069 Average
2040-2069 Max


Saimaa water level
Water level
77.50
77.00
76.50
76.00
75.50
75.00
1.1.
1.3.
1.5.
1.7.
1.9.
1.11.
1971-2000 Average
1971-2000 Max
2040-2069 Average
2040-2069 Max

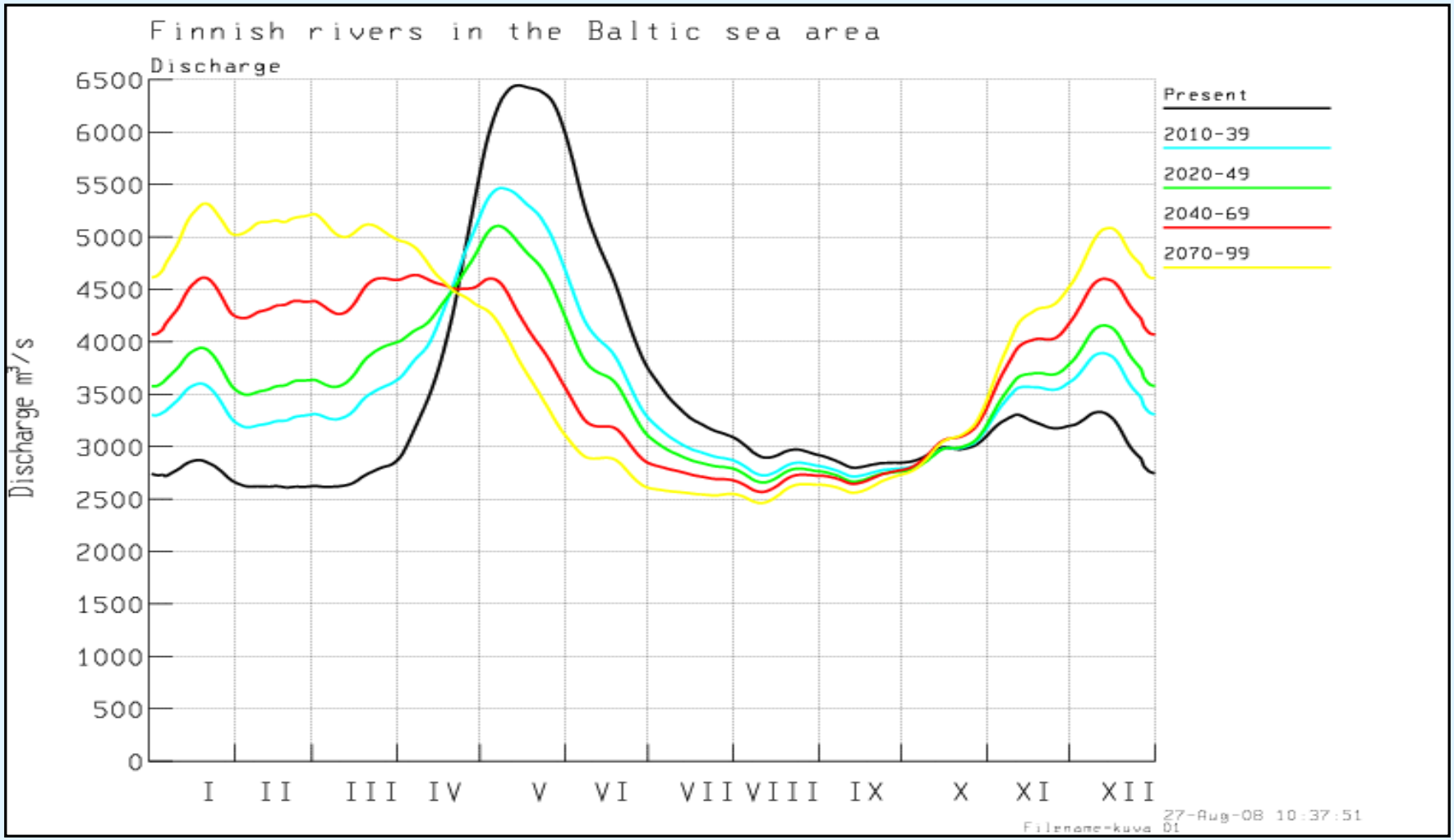


Northern Finland: Ounasjoki discharge 2010-39 compared to 1971-2000: Clim-ATIC-project



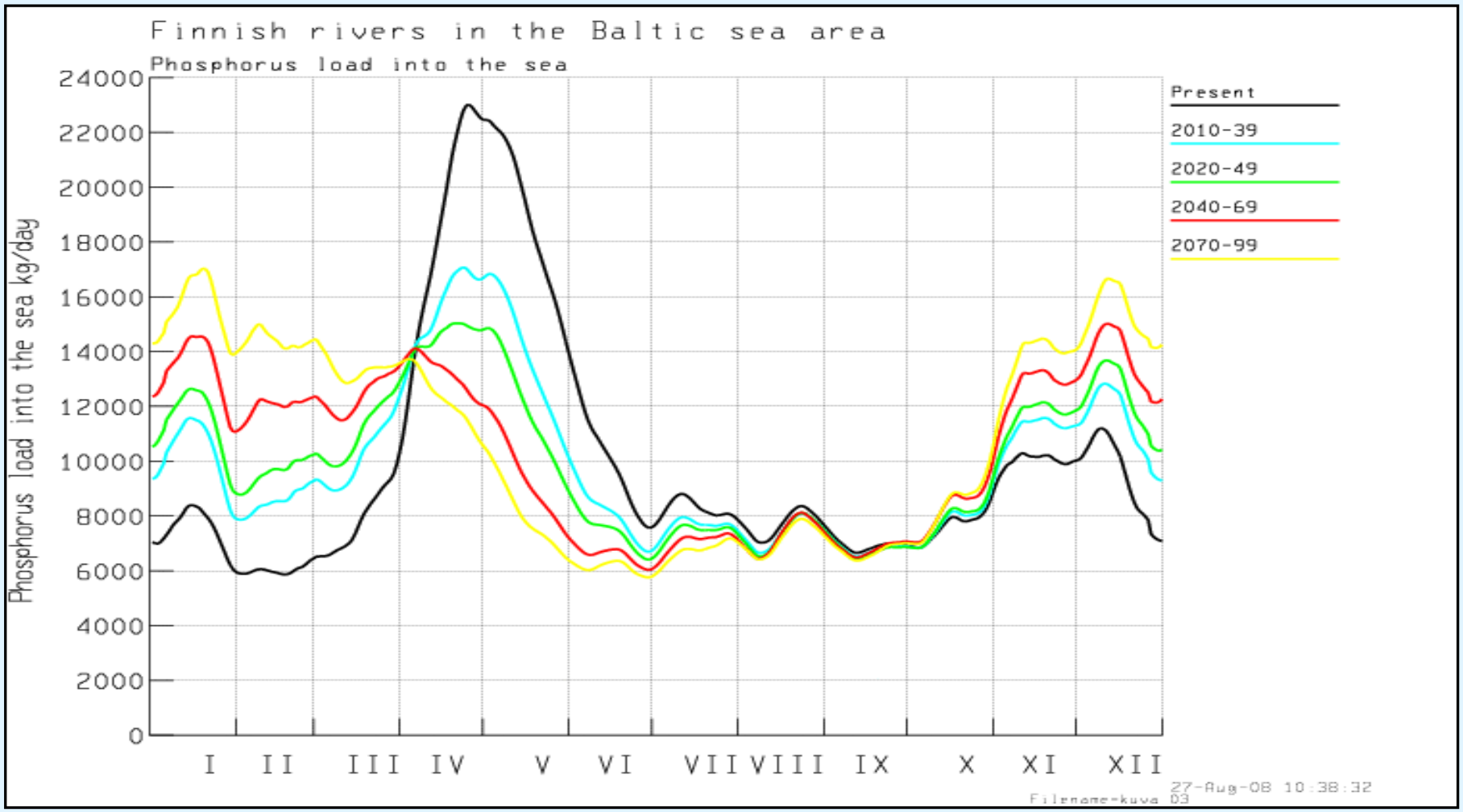
SYKE

Discharge from Finland to the Baltic Sea



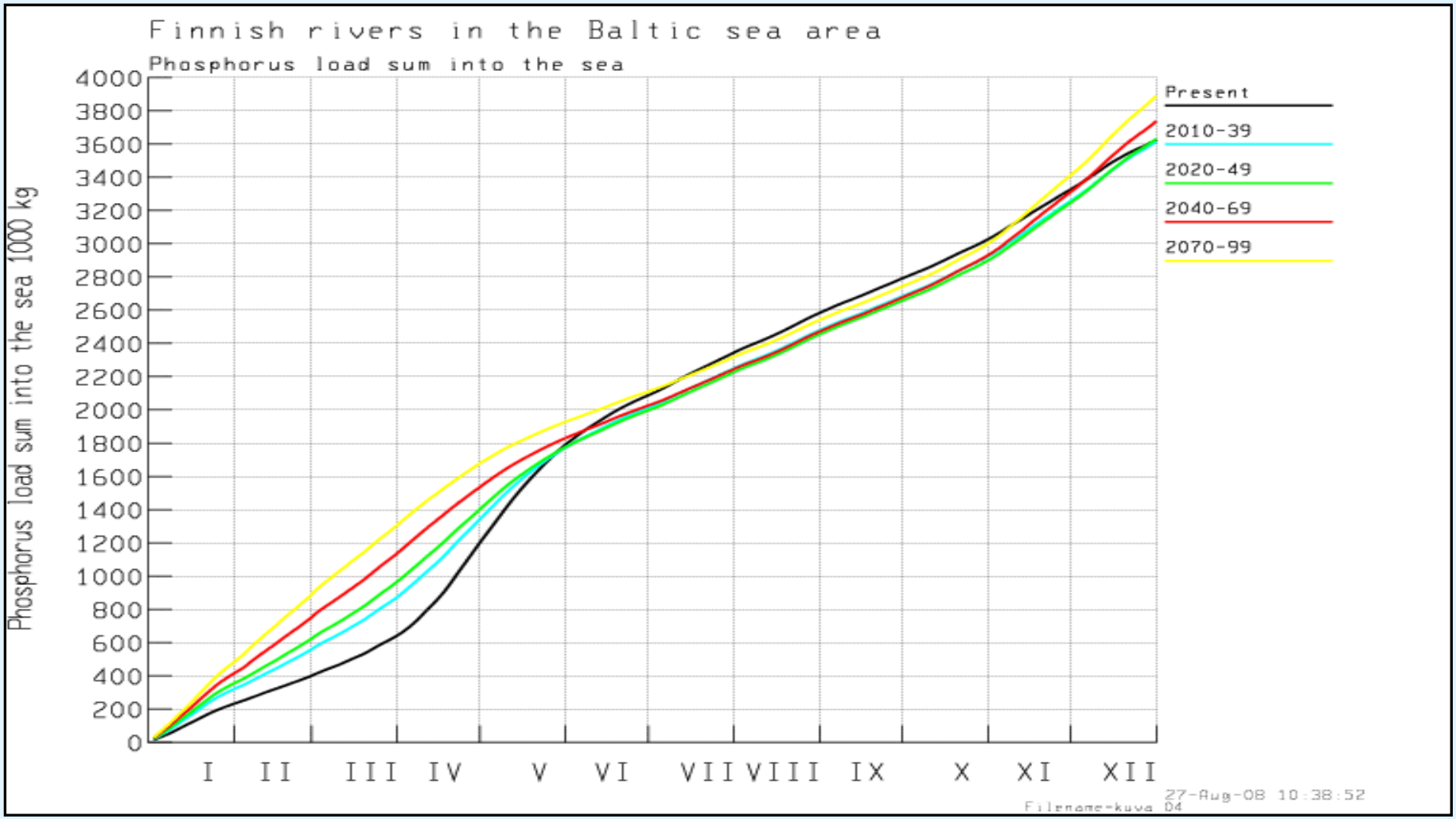
SYKE

Phosphorus loading from Finland



SYKE

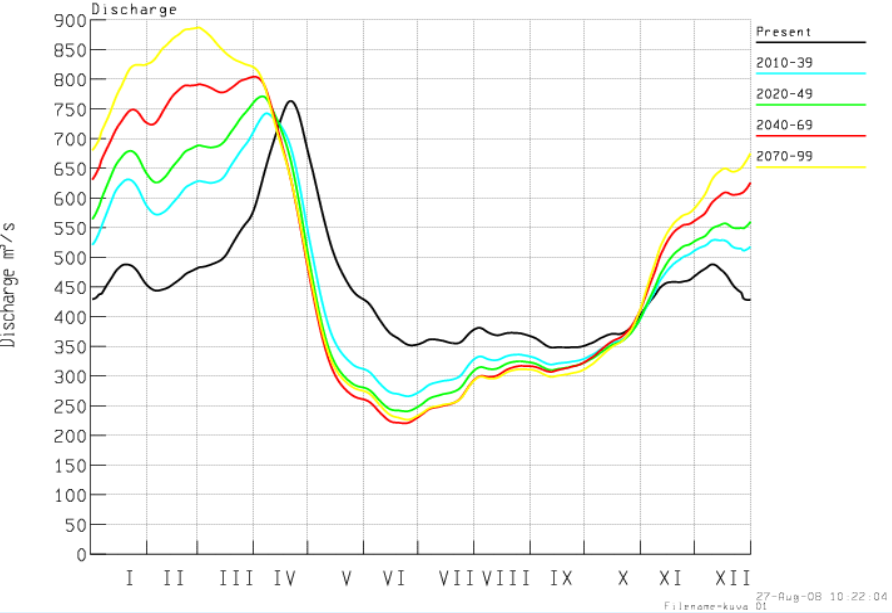
Yearly phosphorus loading increases ~10 %



SYKE

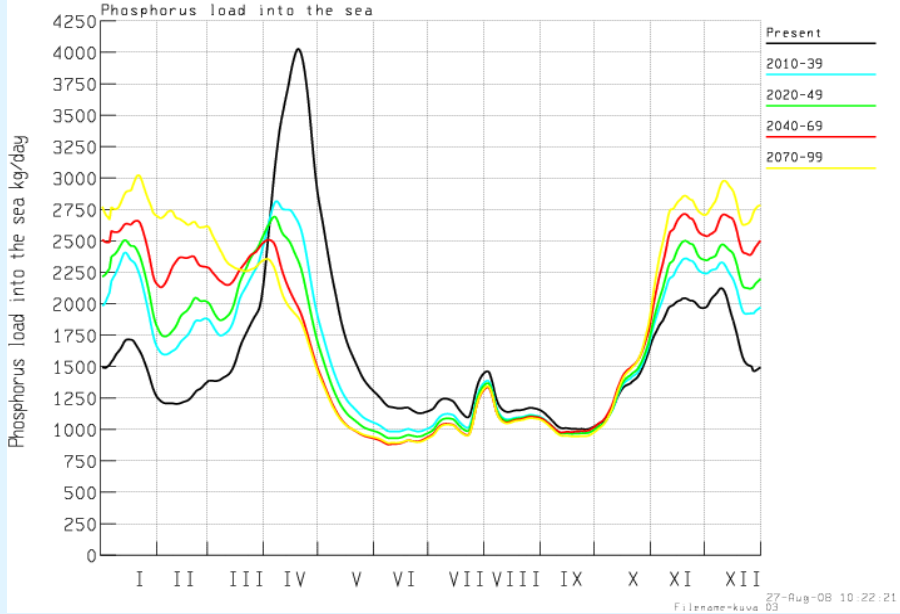
Finnish rivers on the Gulf of Finland area

Discharge



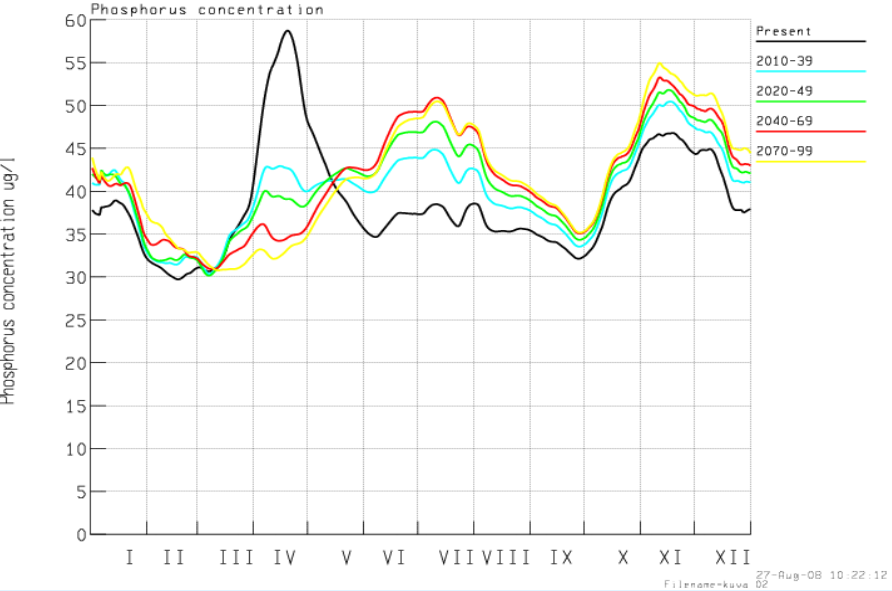
Finnish rivers on the Gulf of Finland area

Phosphorus load into the sea



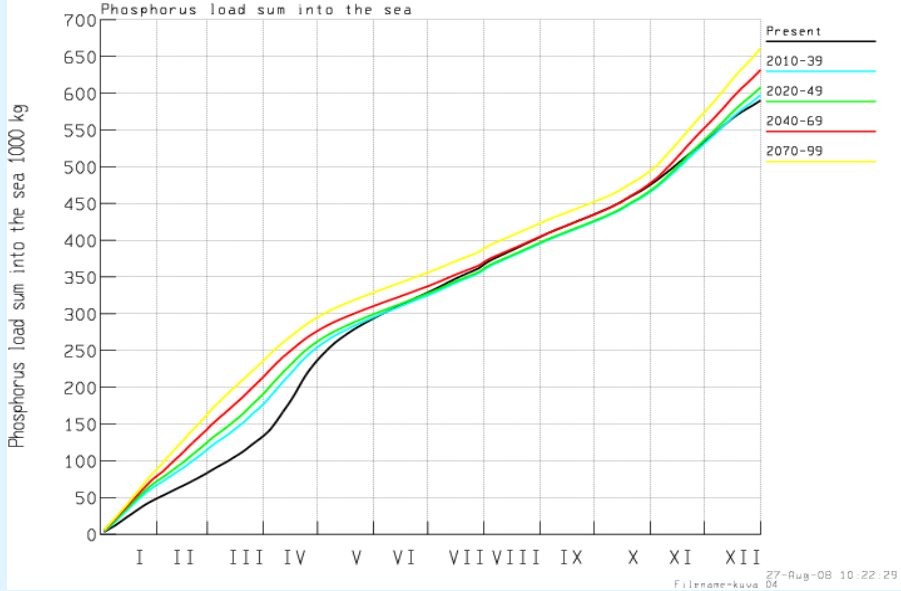
Finnish rivers on the Gulf of Finland area

Phosphorus concentration



Finnish rivers on the Gulf of Finland area

Phosphorus load sum into the sea



SYKE

Conclusions

- **Hydrological regime and floods will change dramatically**
  - **Spring floods will decrease**
  - **Winter runoff and floods will increase**
  - **Frazil ice floods will become more common**
  - **Summer runoff will on average decrease**
- **Adaptation to climate change**
  - **Changing lake regulations**
  - **More use of the improving hydrological forecasts**
  - **Flood protection measures**


Thank You !


1899
1900