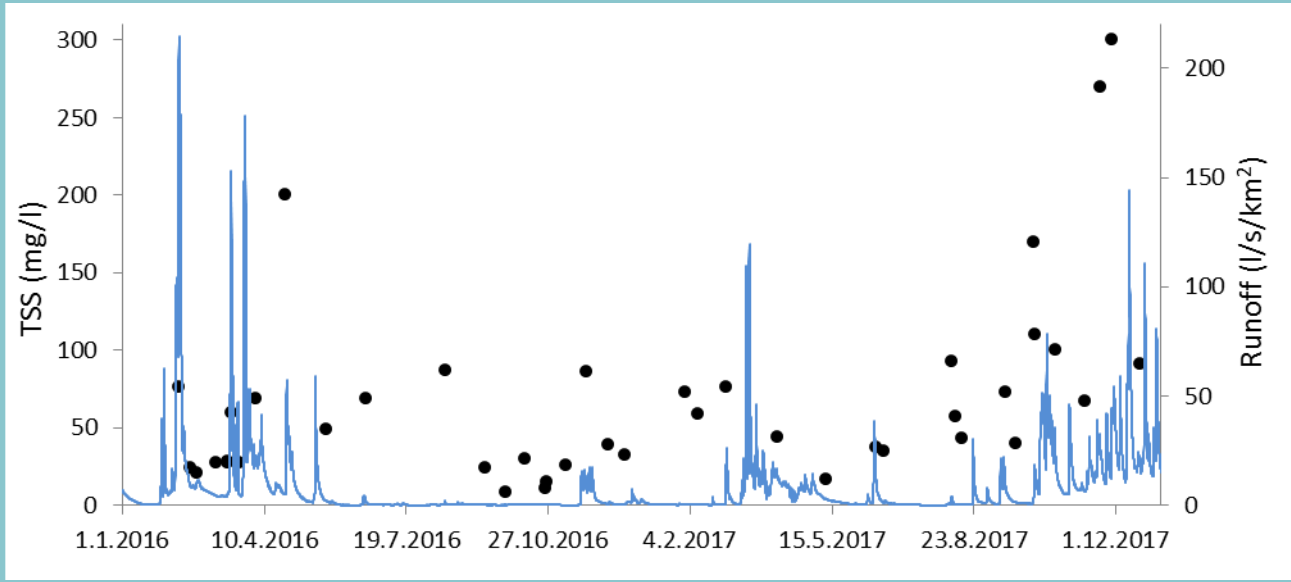
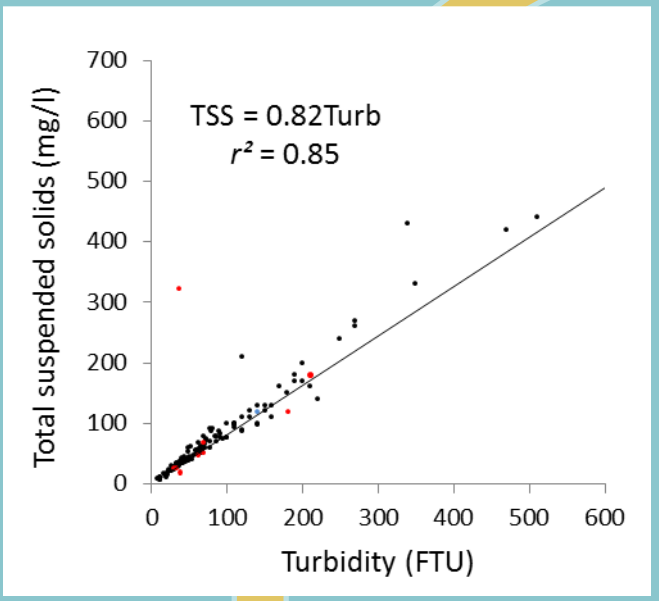
6. ESTIMATING NUTRIENT FLUXES

Common situation: Runoff/discharge data available, concentrations determined much less frequently



The Savijoki with hourly runoff measurements and about 20 water quality samples

Estimating the losses of total suspended solids using automatic sensors



Estimation of the concentrations of TSS

C_{TSS} (mg l^{-1}) = 0.82 Turbidity

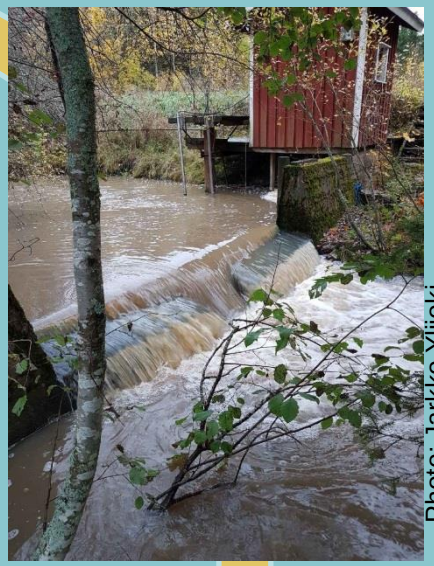


Photo: Jarkko Yljoki

Hourly runoff measurements q, (l s^{-1} km^{-2})

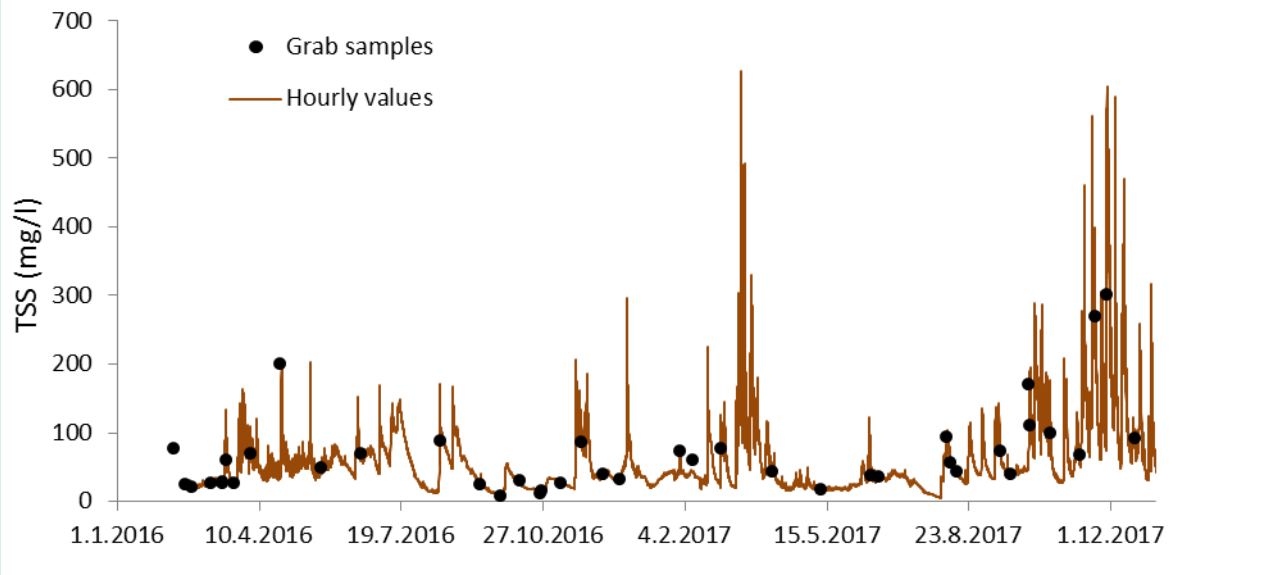
Mikko Kiirikki

Calculation of hourly losses of TSS

L_{PP} (g km^{-2} h^{-1}) = $q \cdot C_{PP} \cdot 3600/1000000$

Summing up for daily and annual losses

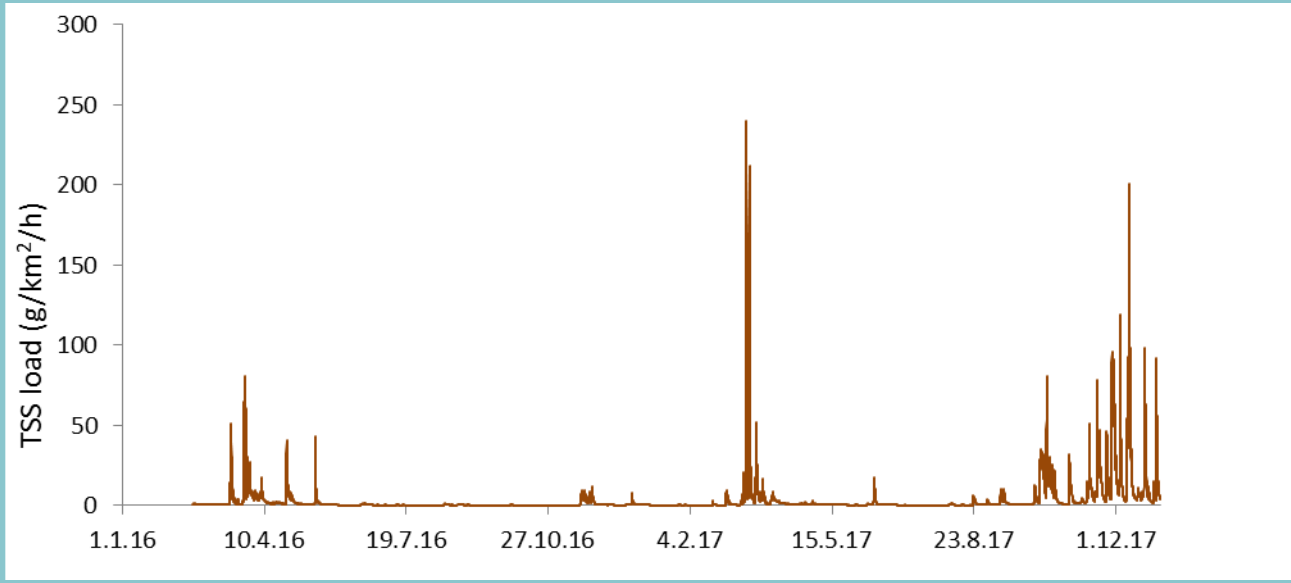
Measured and estimated concentrations of total suspended solids



TSS load in 2016–2017: 21 300 kg km^{-2} y^{-1}
Assuming that TSS originates only from fields:

- **Total area 15 km^2, fields 6 km^2**
- **68 000 kg field-km^{-2} y^{-1}**

Most of the material flux occurs on a few days, but which?



Calculating nutrient fluxes

- $L_t = C_t \cdot Q_t \cdot c$
  - L = Load (Flux) (kg y^{-1}) or Loss (kg $km^{-2}\,y^{-1}$)
  - C = Concentration (e.g. µg l^{-1})
  - Q = Flow/Discharge ($m^3\,s^{-1}$) or Runoff (mm, $l\,s^{-1}\,km^{-2}$)
  - c = conversion factor for units
- Flow is usually measured daily, concentrations much less frequently
  - How to estimate the concentrations of missing days?
- Reliability of nutrient flux estimates depends on
  - The frequency and timing of sampling
  - Frequency of flow measurements
  - Quality of chemical analysis and flow measurements
  - Load calculation method

$$\overline{Q} = \frac{\sum_{d=1}^{n} Q_d}{n}$$

$$\overline{c} = \frac{\sum_{d=1}^{n} c_d}{n}$$

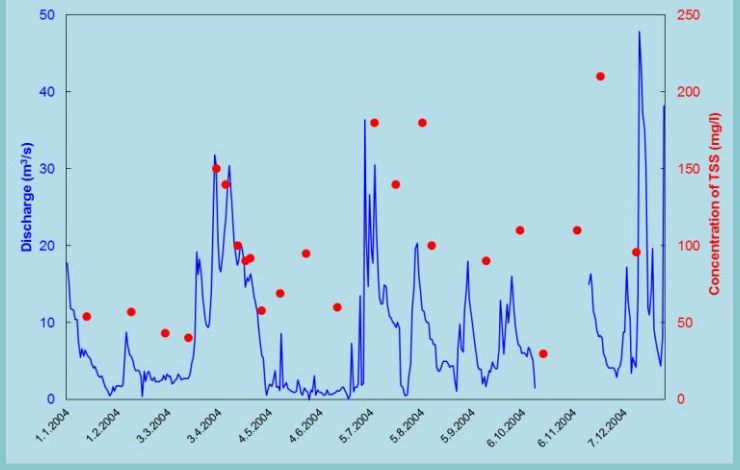
Arithmetic mean

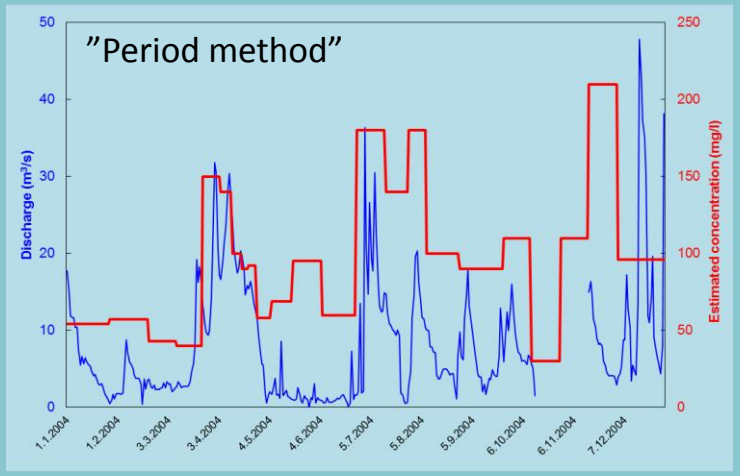
$$\overline{c} = \frac{\sum_{d=1}^{n} c_d Q_d}{\sum_{d=1}^{n} Q_d}$$

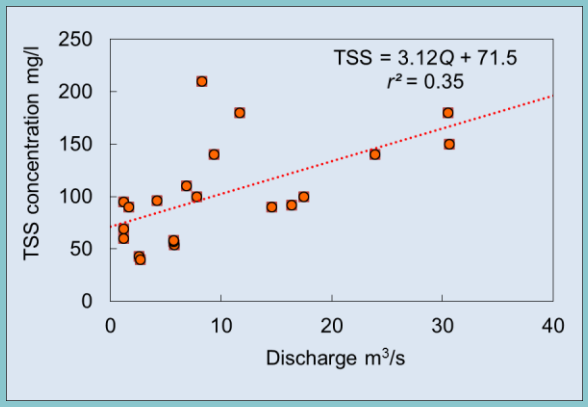
Flow-weighted mean

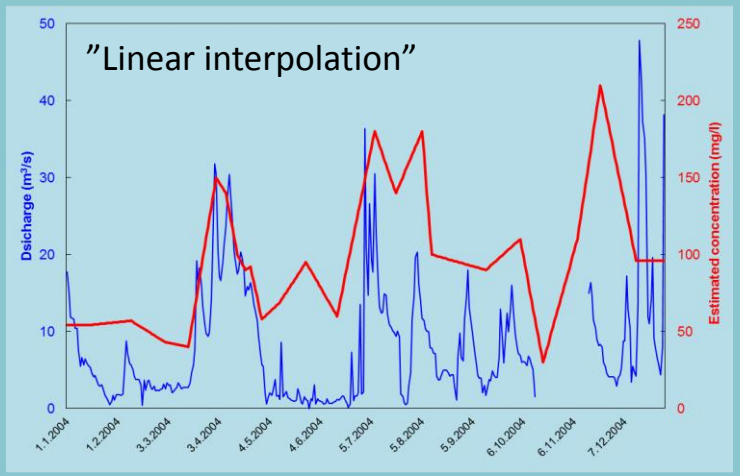
$$L = \overline{c}\,\overline{Q}$$

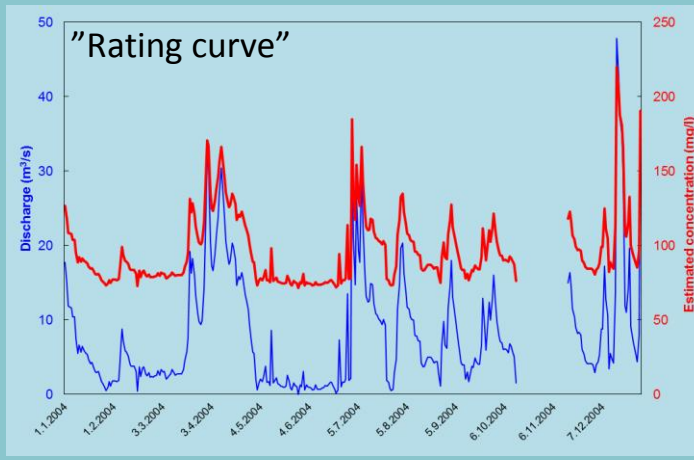
Some other methods to estimate missing concentrations



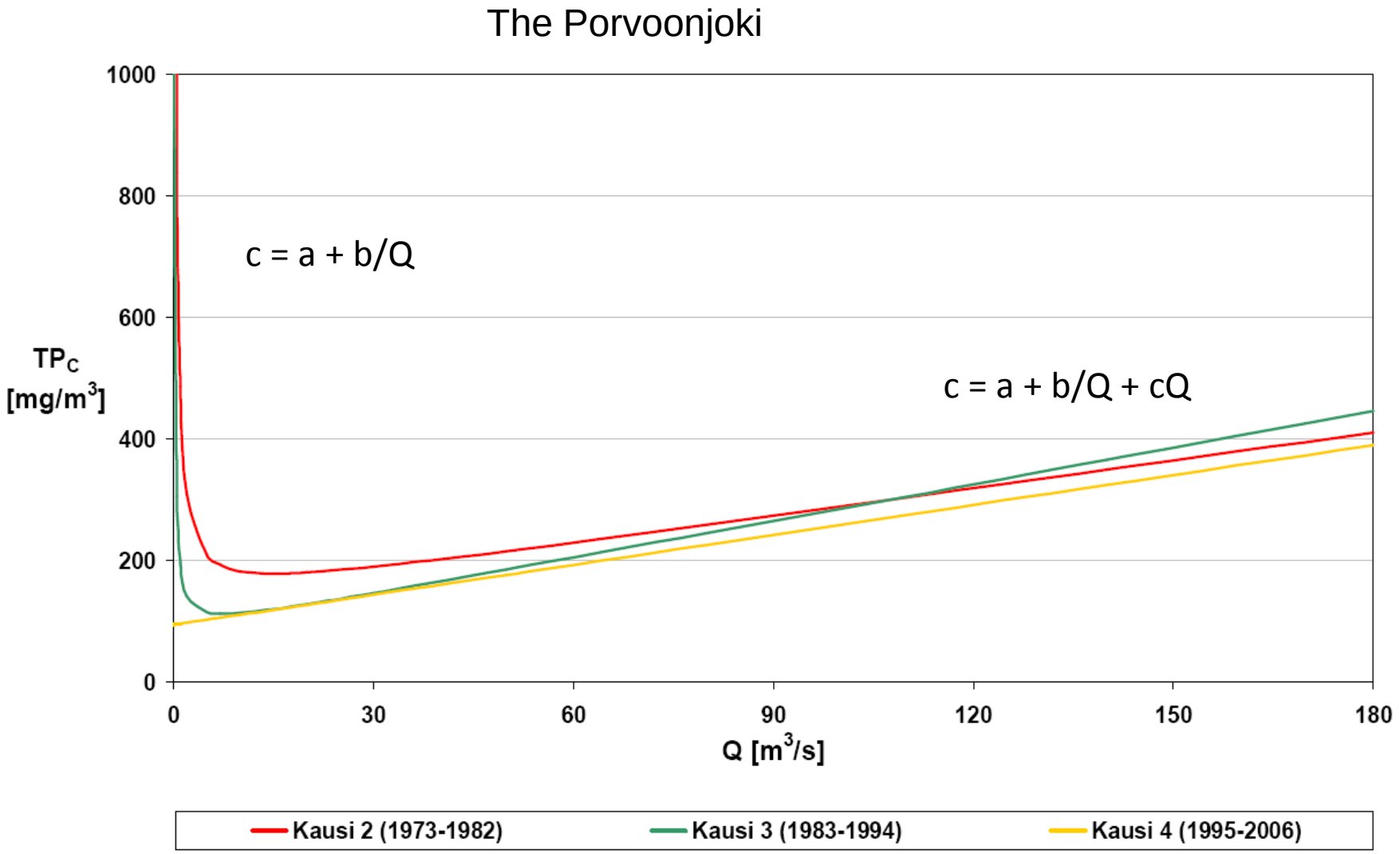








The Paimionjoki



Sjöblom. 2009. Suomesta Itämereen laskevien jokien fosfori- ja typpikuormat 1961– 2006 — arvio maatalouden kuormitusmuutoksista. Diplomityö Vesi- ja ympäristötekniikka. TKK.

Alleviating the effect of discharge

- In trend analyses, the effect of fluctuating discharge can be lowered by many techniques, e.g.
  - Non-parametric Mann-Kendall test
  - Simply by plotting concentrations against flow in different periods