10th International Drainage Workshop of ICID
6-11, July 2008, Helsinki - Tallinn

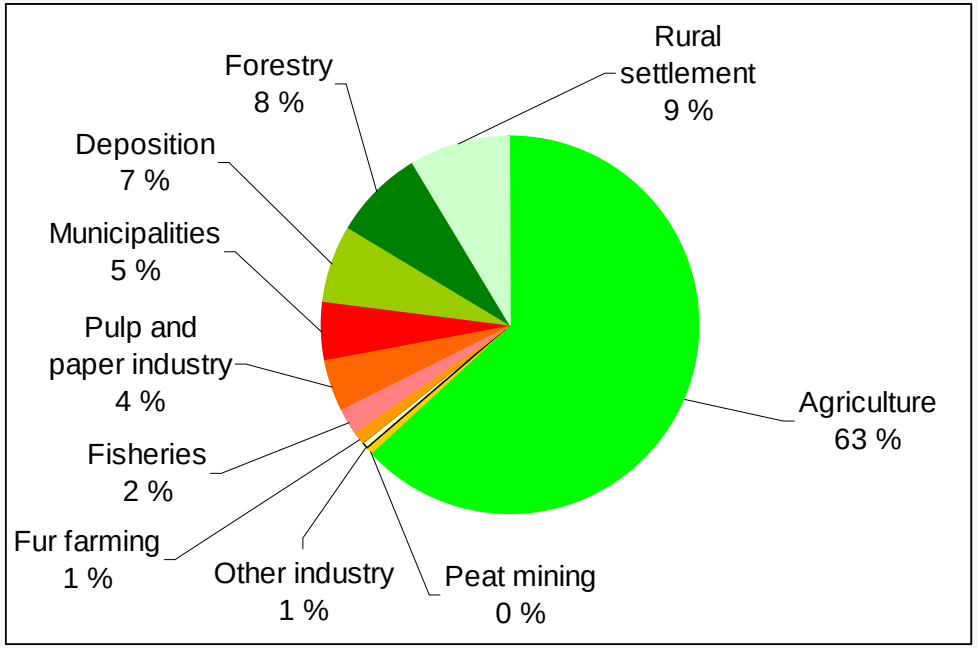
Nutrient transport through tile drains on a clayey field

Maija Paasonen-Kivekäs,
Pertti Vakkilainen, Tuomo Karvonen
Helsinki University of Technology, Water Resources

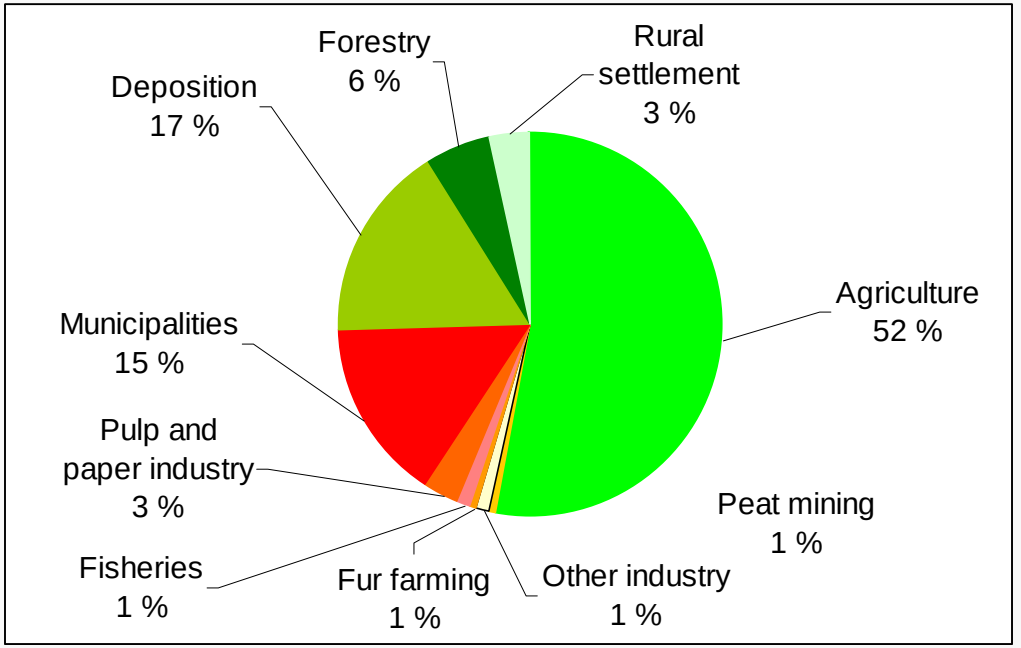
Department of Civil and Environmental Engineering
Helsinki University of Technology

Nutrient load to surface waters from human activities, in 2005

Phosphorus

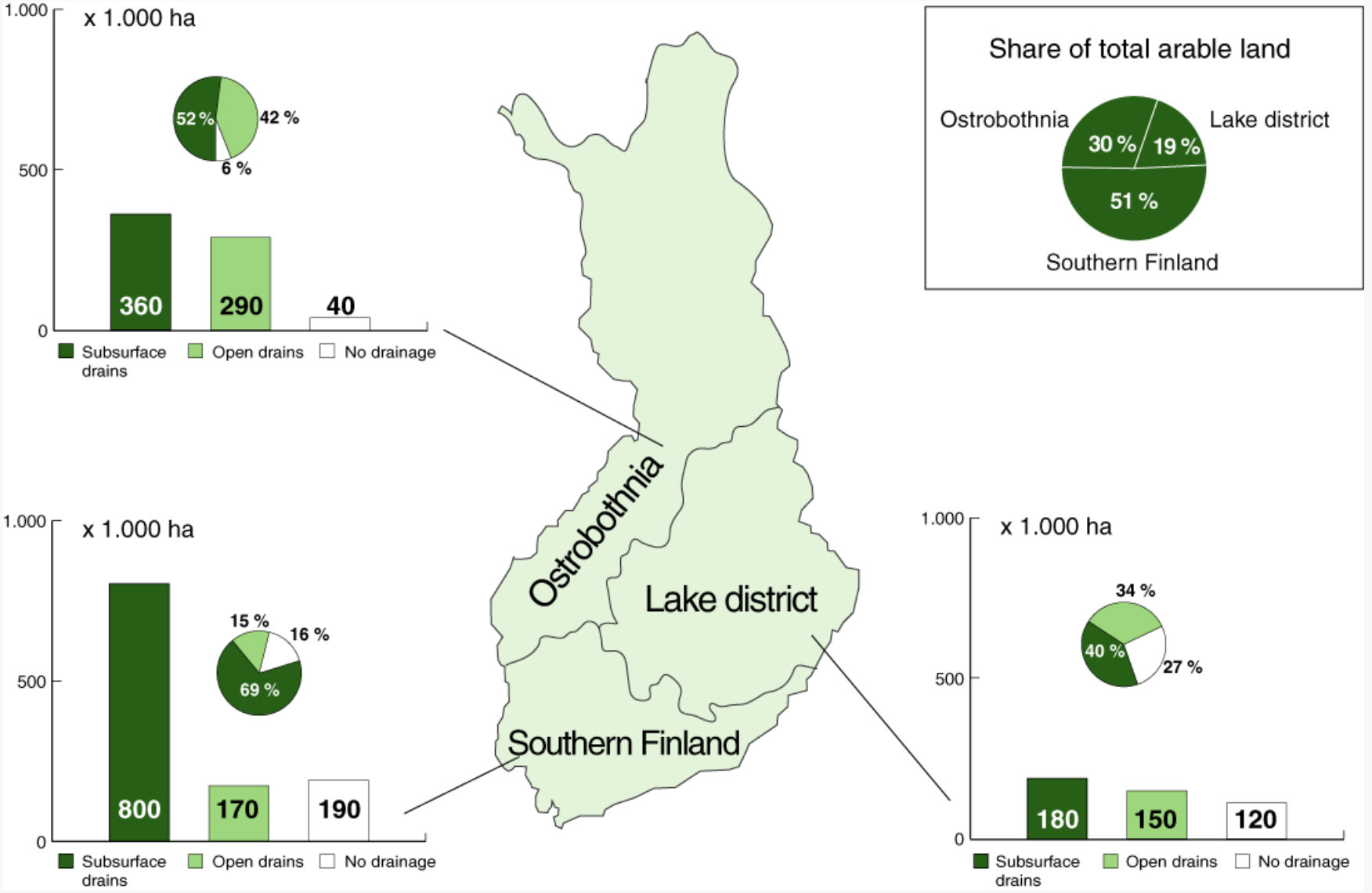


Nitrogen



Data fom Finnish Environment Institute

Subsurface drainage in Finland



Data from Field Drainage Association

Objectives

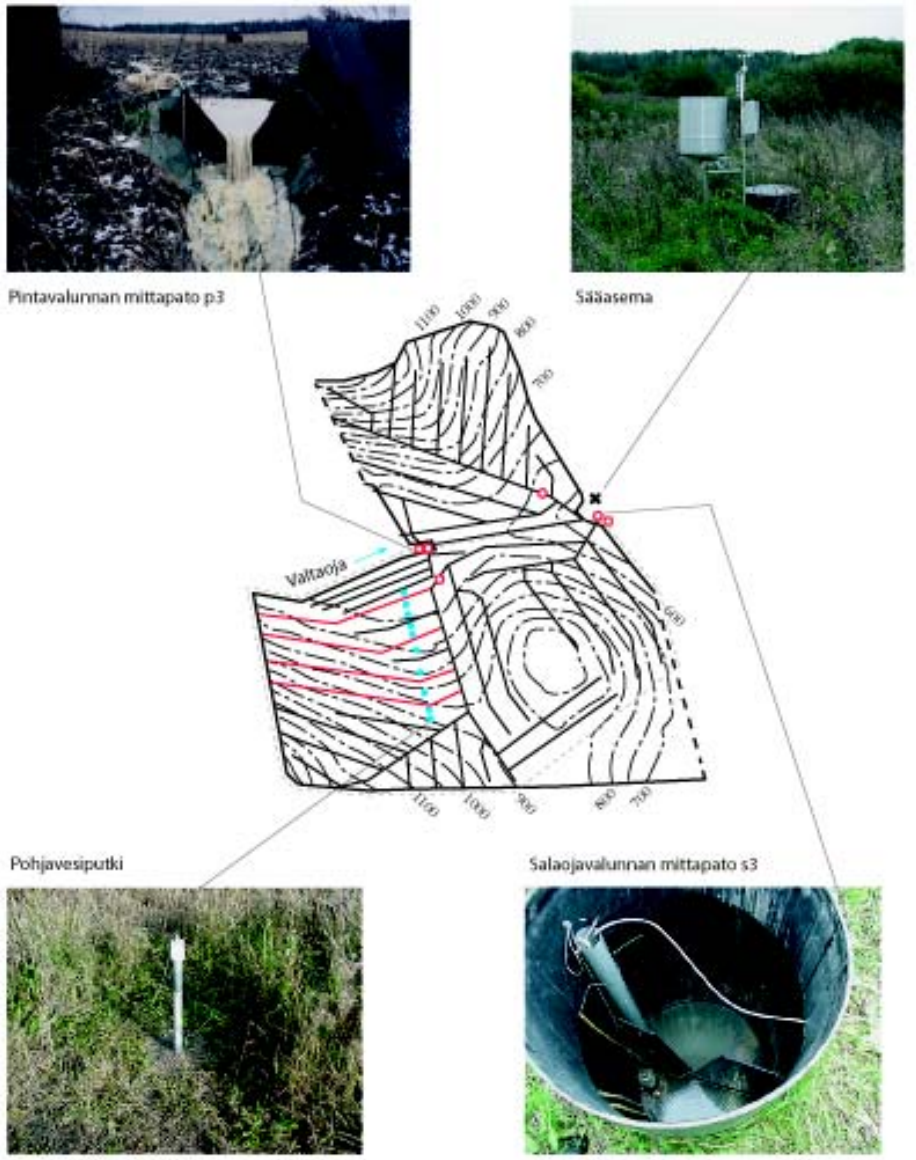
- Runoff generation and nutrient transport under actual field conditions
- Contribution of subsurface drainage to N, P and soil losses
- **Seasonal** and **event-scale** characteristics of drain flow and nutrient transport via tile drains
- Pathways of water flow and nutrient transport to tile drains (preferential flow)

Modelling of water flow and nutrient transport,
Lassi Warsta et al. (2008) in the proceedings of this workshop

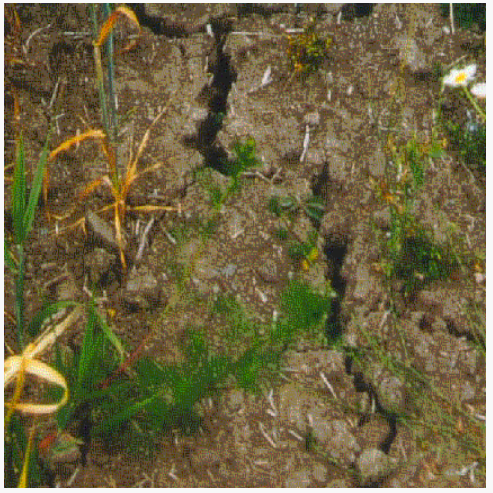
Sjökulla experimental site

- Area of 3.3 ha
- Undulating topography, max. slope ~ 5%
- Clay fraction 38-90%
- Drainage system installed in 1951
- Drain depth 0.7-1.5 m, average spacing 13 m

- Annual small grain crops (barley, wheat, autumn rye)
- N fertilizer rate 95-120 kg ha^{-1} a^{-1}
- P fertilizer rate 9-20 kg ha^{-1} a^{-1}
- Autumn ploughing or stubble cultivation



Sjökulla experimental site



Measurements/ Data

Hydrometeorological data, 1994-1996, 1997-1999

- Weather variables
- Surface runoff and **tile drainage discharge**
- Groundwater level
- **N, P** and **TSS concentrations** in runoff waters
  - grab samples
  - automatic sampler
- Mineral N in the soil profile

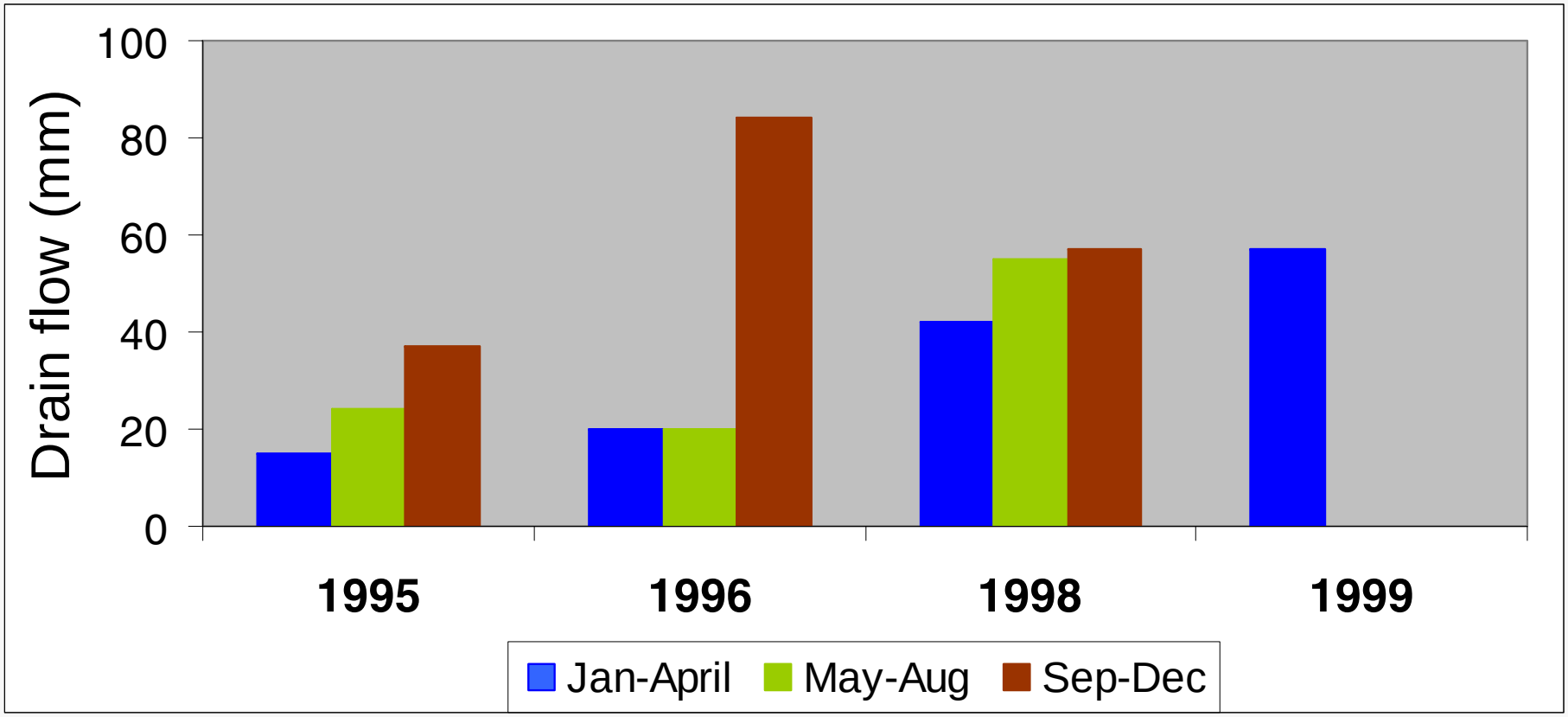
Data on soil properties,
Agrifood Research Finland MTT
Laura Alakukku and Visa Nuutinen

- Macroporosity
- Saturated hydraulic conductivity
- Earthworm species, biomass and density

- Sampling points: above a drain , 2 m apart from a drain and in the middle of two drains
- Three layers:

  0-23 cm, 23-38 cm and 38-50 cm

Seasonal tile drain flow



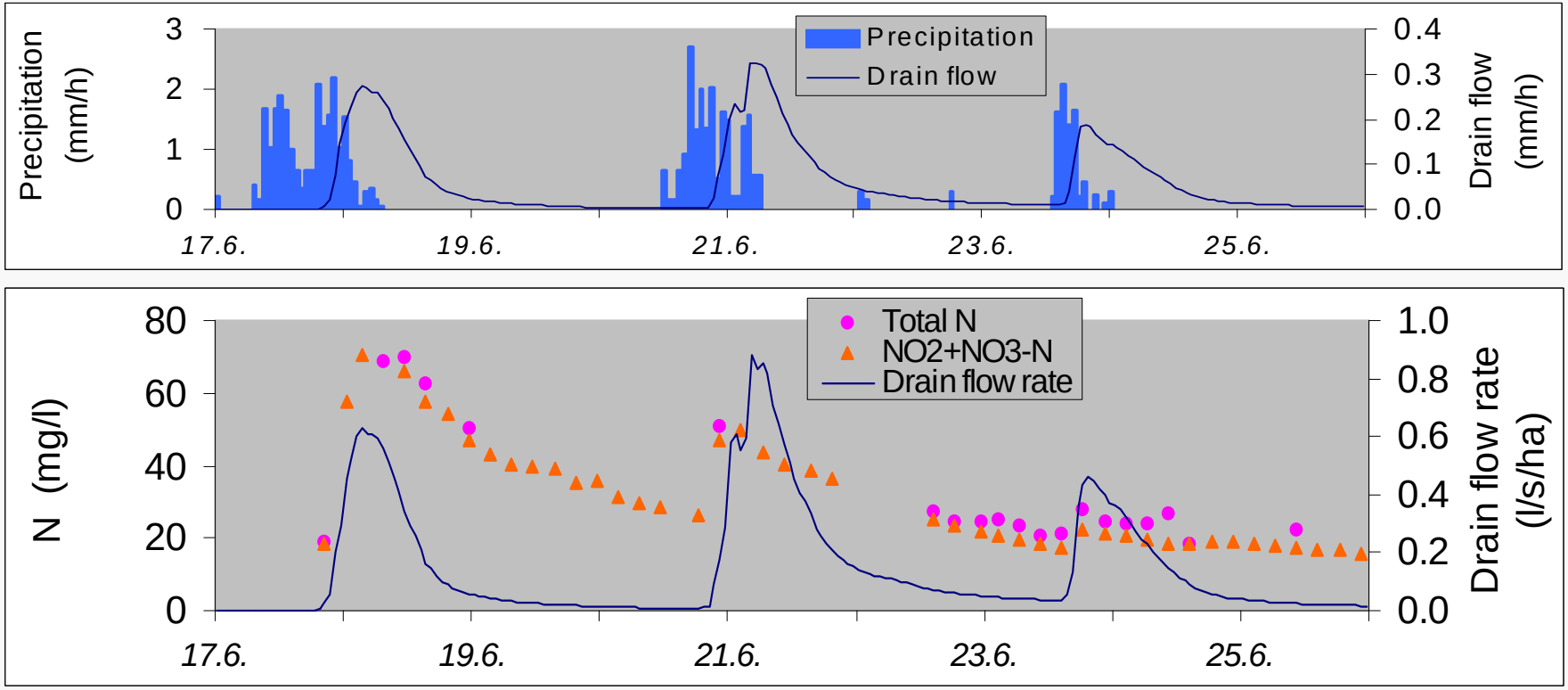
Nitrogen transport via tile drains,
average flow weighted concentrations and loads in different season

Year	Total N concentration mg/l			Total N load kg/ha			
	Jan-April	May-Aug	Sep-Dec	Jan-April	May-Aug	Sep-Dec	Jan-Dec
1995	4.1	45.6	4.0	0.6	10.8	1.5	12.9
1996	7.1	7.1	5.5	1.4	1.6	5.2	8.2
1998	7.3	13.4	5.4	3.1	7.2	3.0	13.3
1999	2.9			1.6			

TSS transport via tile drains,
average flow weighted concentrations and loads in different season

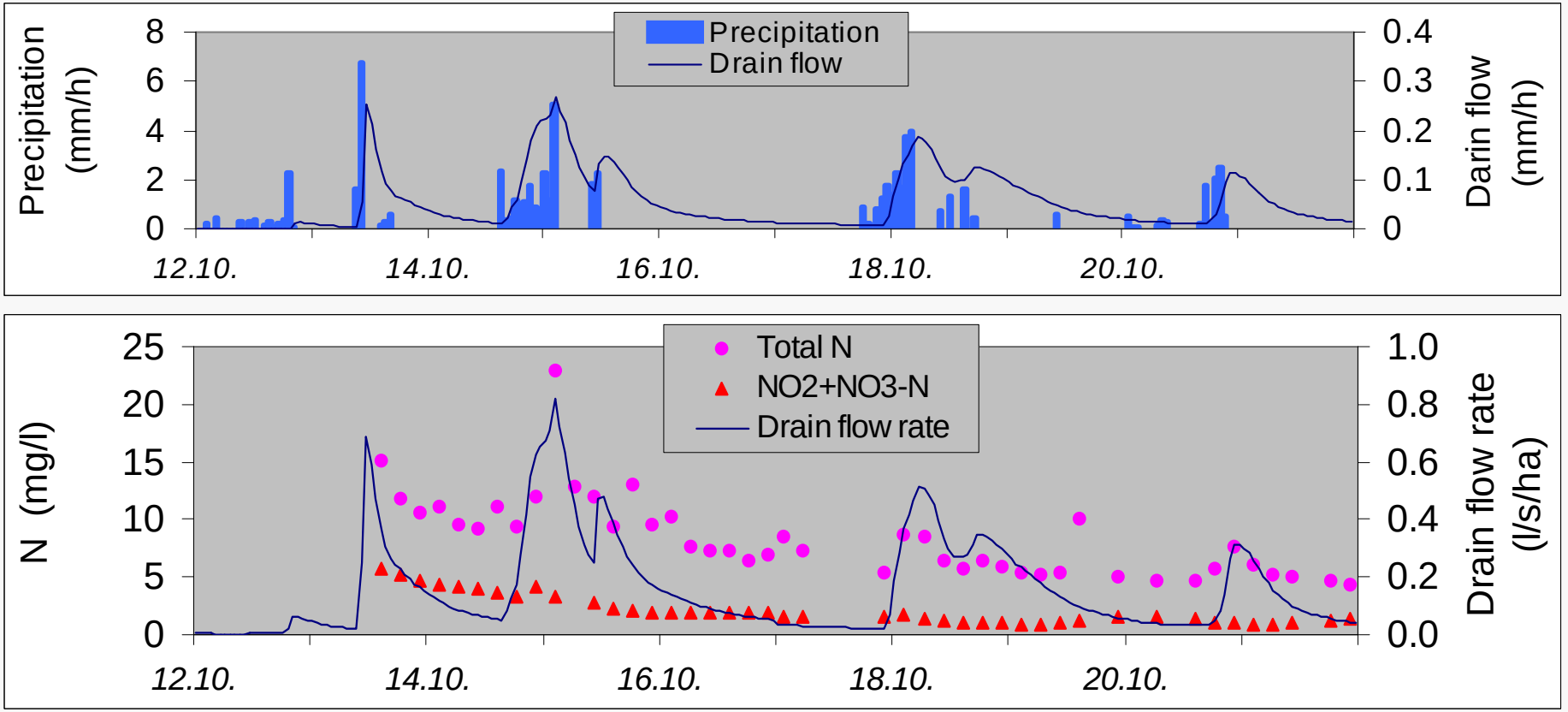
Year	TSS concentration mg/l			TSS load kg/ha			
	Jan-April	May-Aug	Sep-Dec	Jan-April	May-Aug	Sep-Dec	Jan-Dec
1995	116	203	106	18	48	39	105
1996	573	642	1750	114	140	1649	1903
1998	365	856	1664	153	461	937	1551
1999	269			154			

N transport via tile drains, June 1998 fertilization 117 kg ha^{-1}, on 16 May



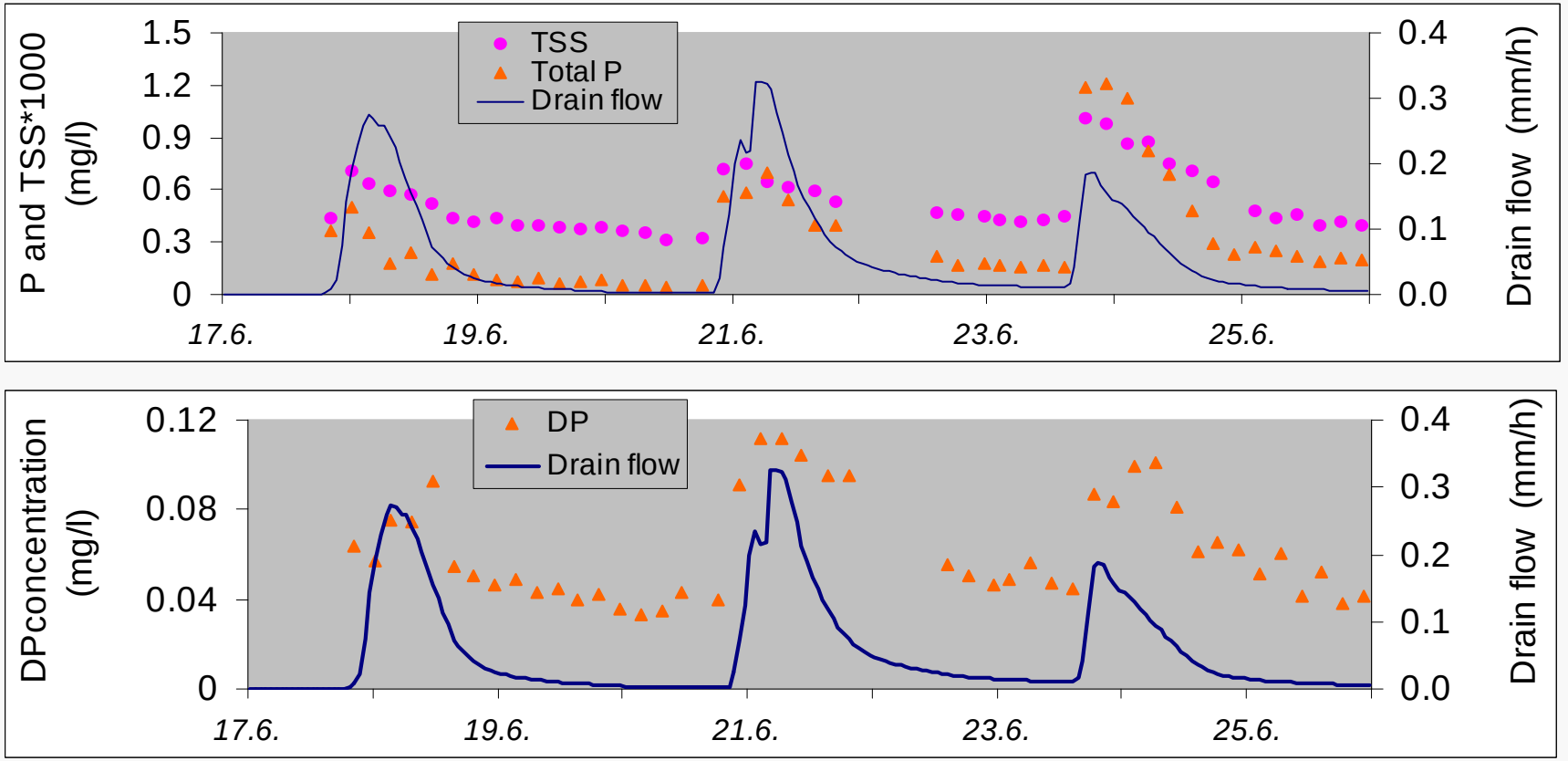
Rainfall 53 mm, tile drain flow 12.2 mm, surface runoff 0.3 mm
Total N loss 5.1 kg ha^{-1}, NO_2+NO_3-N loss 4.7 kg ha^{-1}

N transport via tile drains after tillage, October 1998



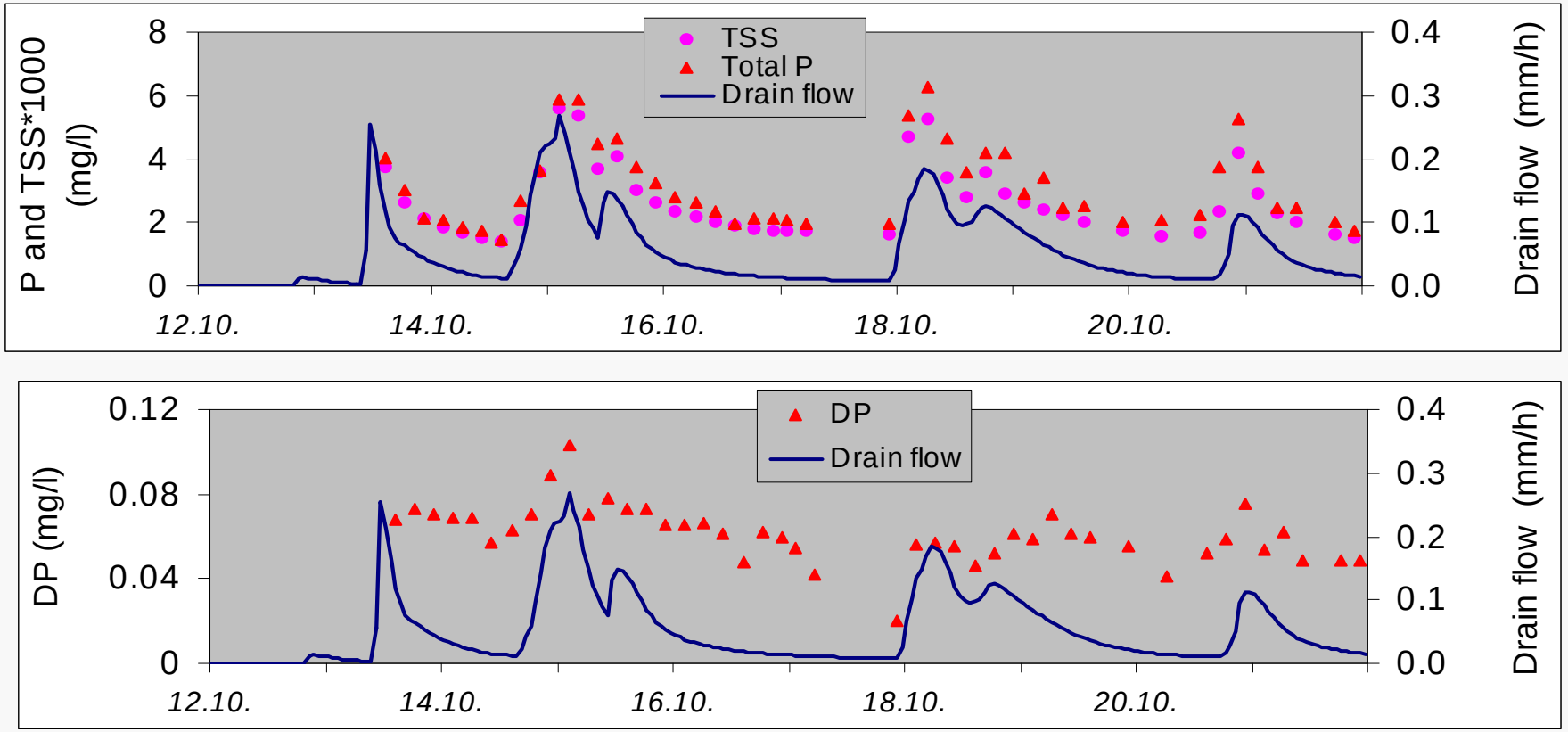
Rainfall 68 mm, tile drain flow 12.6 mm, surface runoff 33 mm
Total N loss 1.27 kg ha^{-1}, NO_2+NO_3-N loss 0.32 kg ha^{-1}

P and TSS transport via tile drains after fertilization, June 1998



Rainfall 53 mm, tile drain flow 12.2 mm, surface runoff 0.3 mm
Total P loss 0.120 kg ha^{-1}, TSS loss 149 kg ha^{-1}

P and TSS transport via tile drains after tillage, October 1998



Rainfall 68 mm, tile drain flow 12.6 mm, surface runoff 33 mm
Total P loss 0.52 kg ha^{-1}, TSS loss 441 kg ha^{-1}

Summary, Sjökulla site

- High losses of nitrogen, phosphorus and eroded soil in tile drain outflow
- High temporal variation in transport routes (tile drain flow and surface runoff), flow volumes and losses
- Preferential flow is an important component in water flow and nutrient transport through tile drains
- Risk of losses via tile drains connected with cultivation measures (fertilization and tillage) followed by heavy rainfalls

Conclusions/ Future work

Generalization of the results to other fields?

- topography
- properties of clay soils (minerals, CEC, ...)
- drainage installation (trench backfill material)
- age of subsurface drainage system
- cultivation practice

Role of subsurface drainage in control of erosion and total P transport?

Modelling of erosion and particulate P transport via tile drains

Thank you!