

10<sup>th</sup> International Drainage Workshop of ICID  
6-11, July 2008, Helsinki - Tallinn

An aerial photograph of a rural landscape. A winding river flows through the center of the image. The surrounding land is divided into agricultural fields, some of which are marked with a grid pattern, likely indicating the locations of tile drains. There are some buildings and a road visible on the right side of the image. The overall scene is a typical agricultural landscape in a rural area.

# Nutrient transport through tile drains on a clayey field

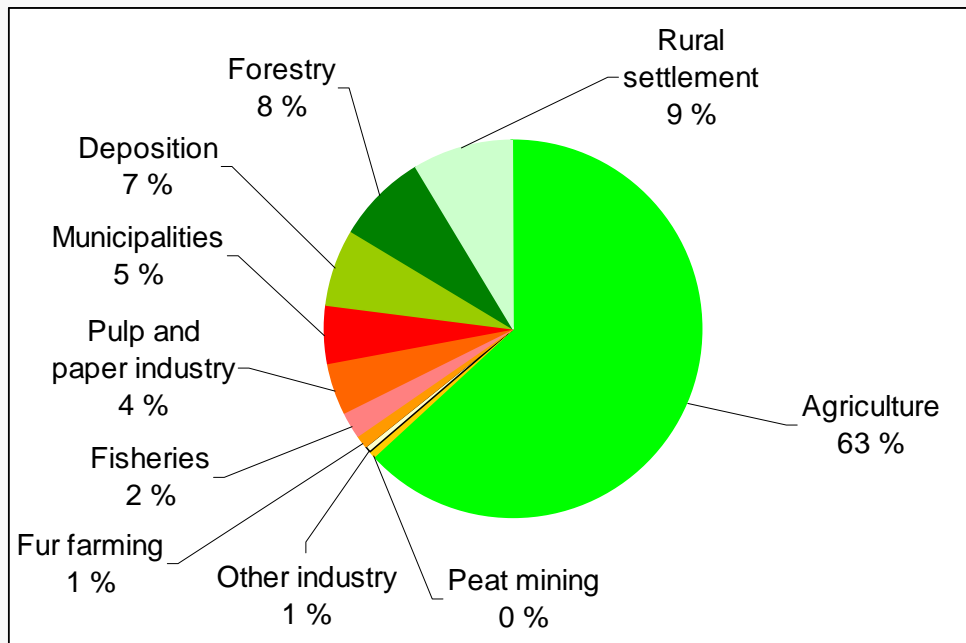
Maija Paasonen-Kivekäs,  
Pertti Vakkilainen, Tuomo Karvonen  
Helsinki University of Technology, Water Resources



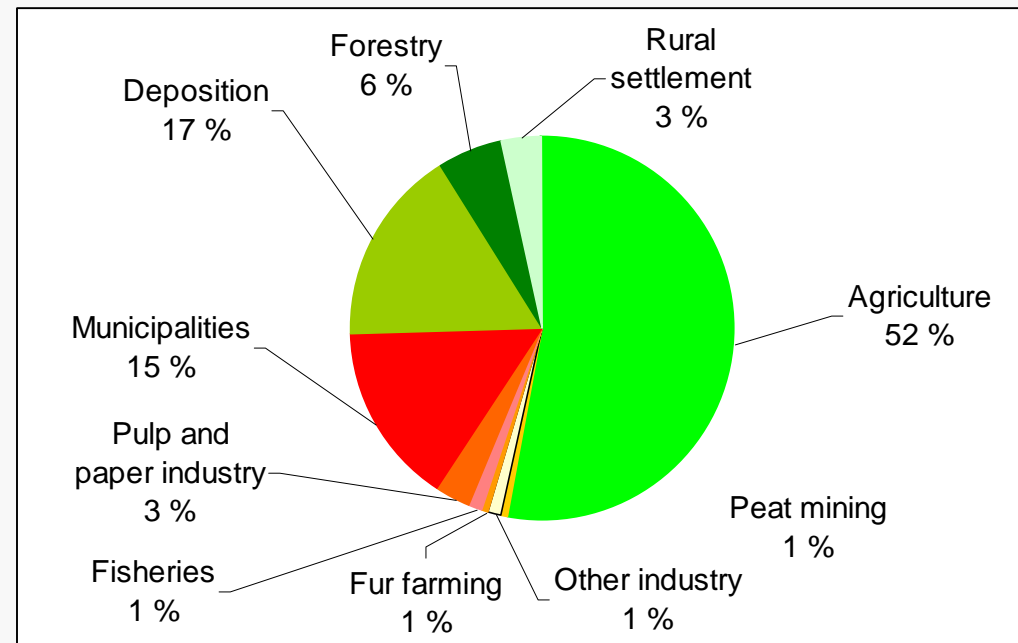
Department of Civil and Environmental Engineering  
Helsinki University of Technology

# Nutrient load to surface waters from human activities, in 2005

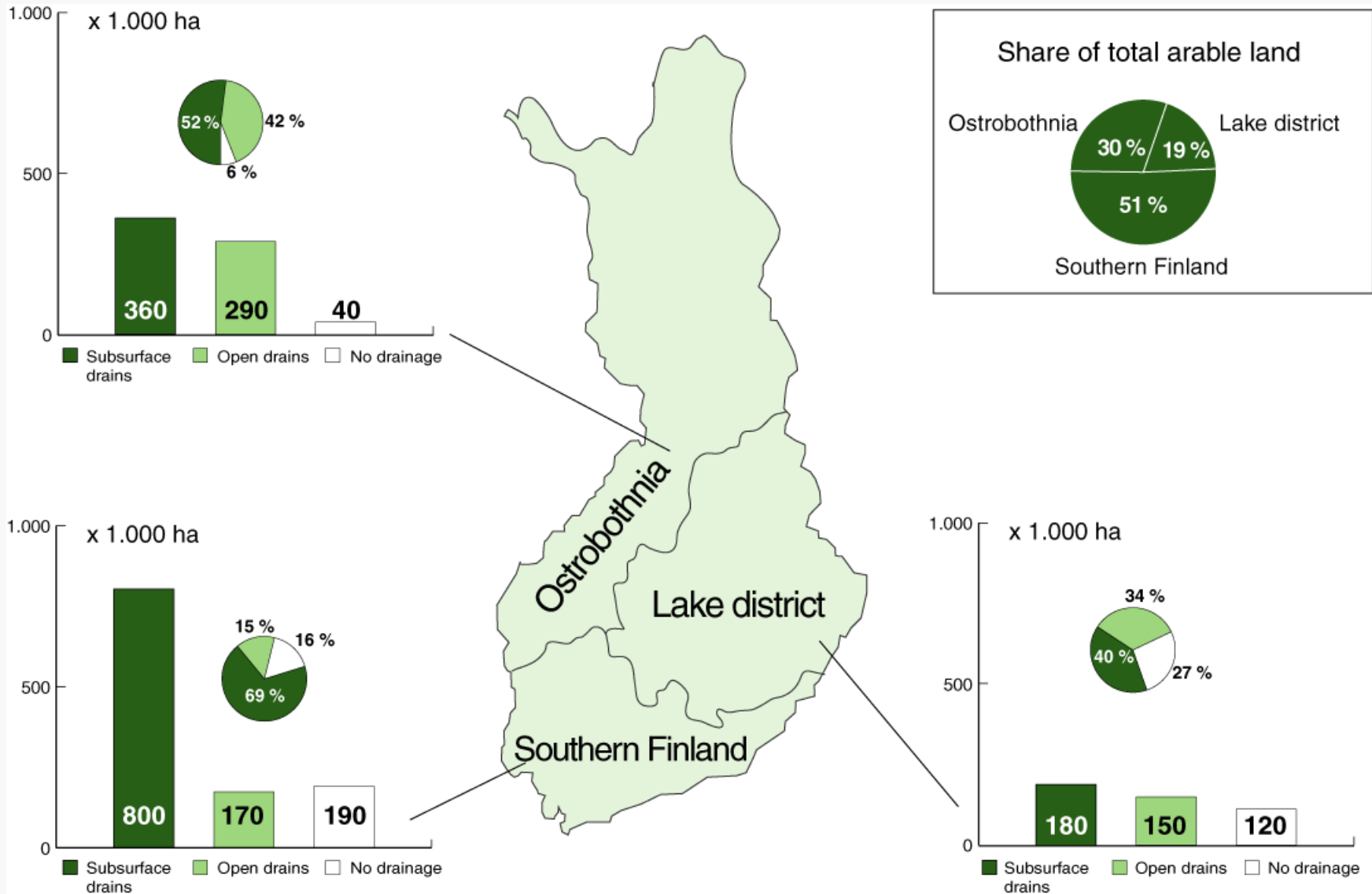
## Phosphorus



## Nitrogen



# 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<sup>-1</sup> a<sup>-1</sup>
- P fertilizer rate 9-20 kg ha<sup>-1</sup> a<sup>-1</sup>
- Autumn ploughing or stubble cultivation



Pintavalunnan mittapato p3



Sääasema



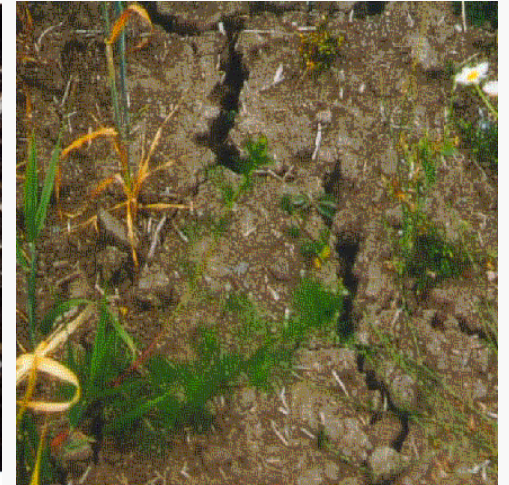
Pohjavesiputki



Salaojavalunnan mittapato s3



# 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



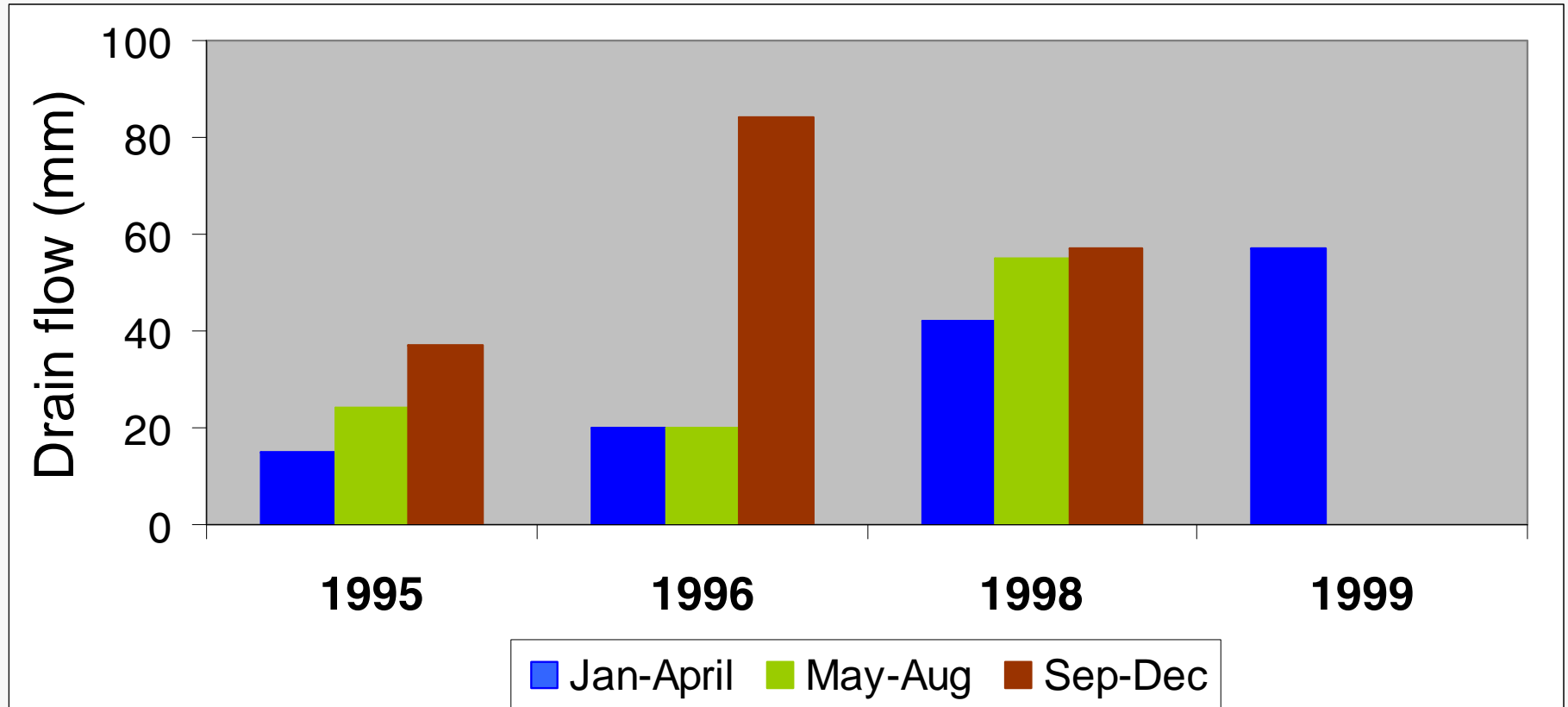
# Data on soil properties, Agrifood Research Finland MTT Laura Alakukku and Visa Nuutinen

- 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



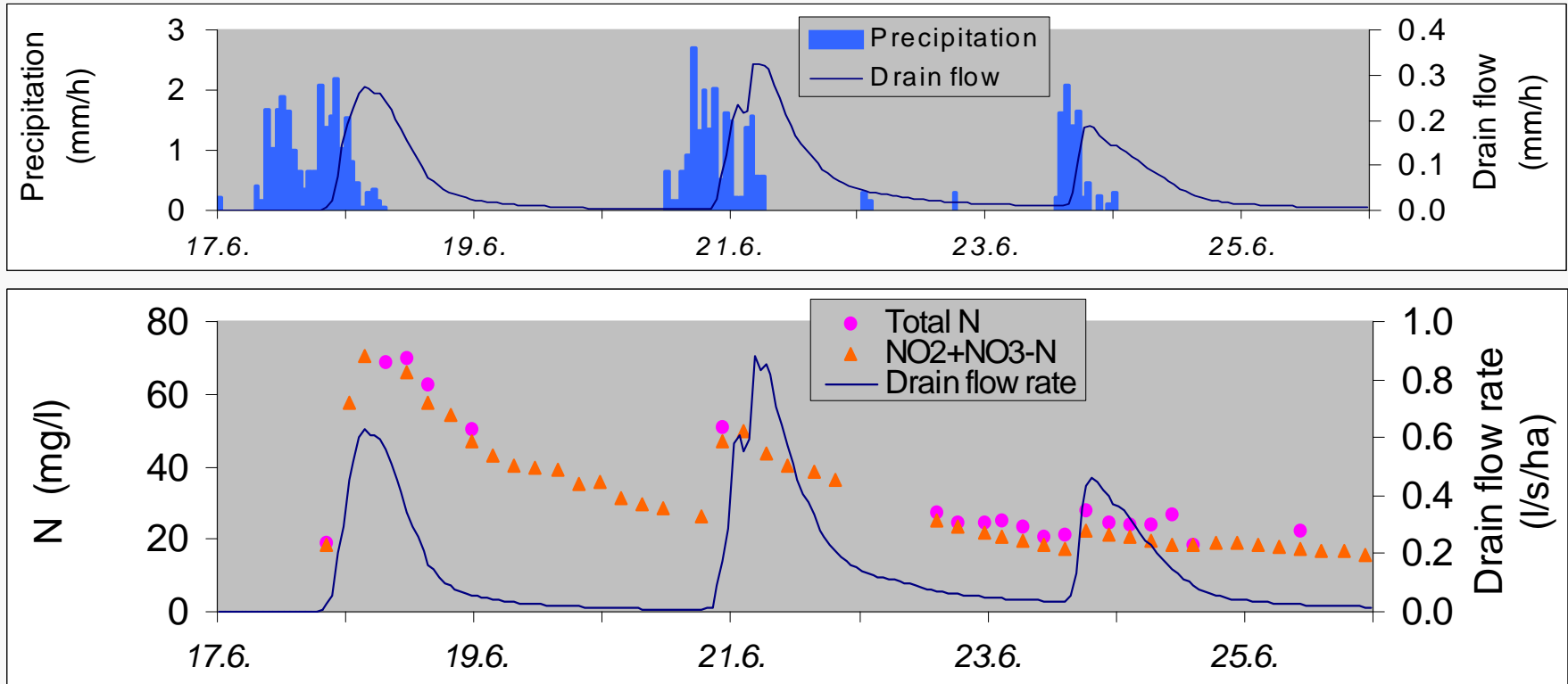
# Nitrogen transport via tile drains, average flow weighted concentrations and loads in different season

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

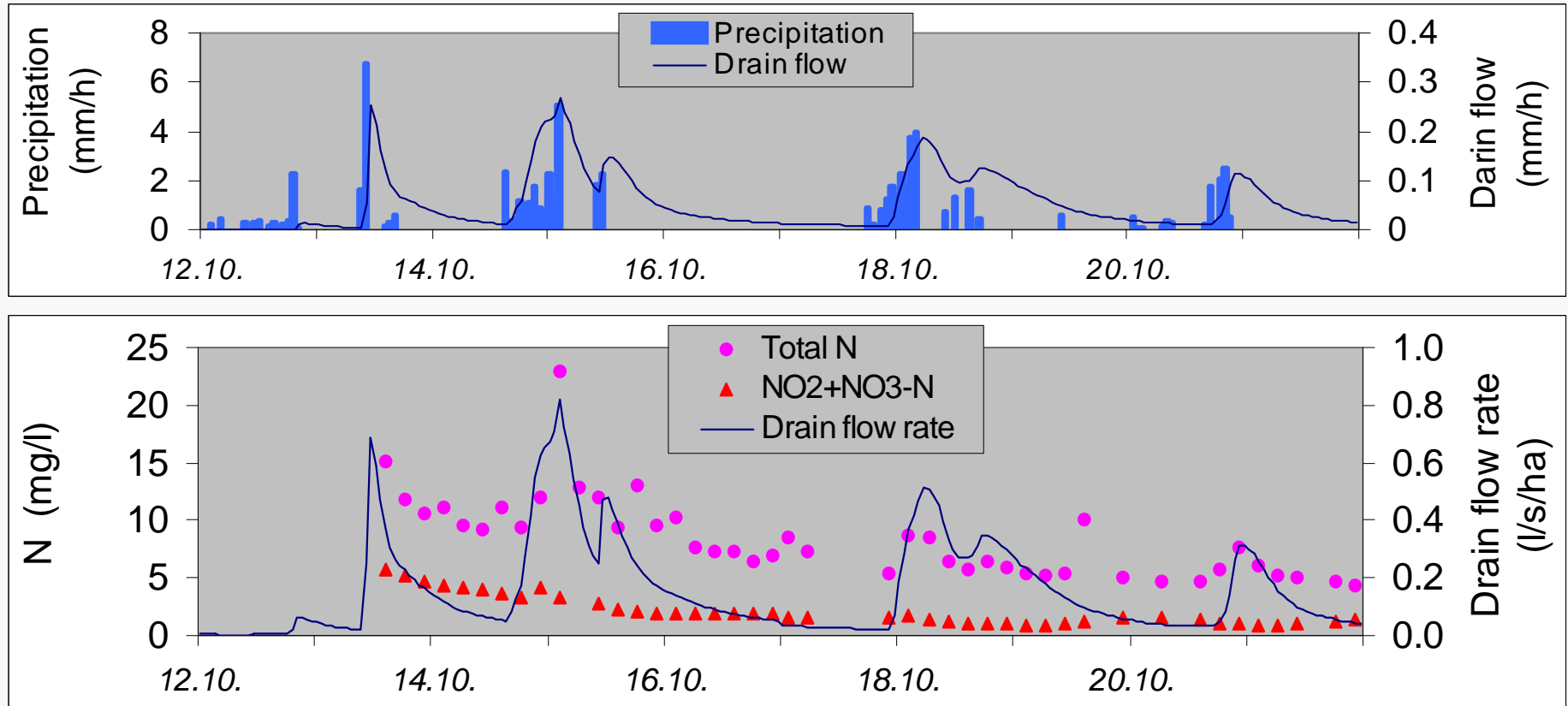
Year	TSS concentration mg/l			TSS load kg/ha			
	Jan-April	May-Aug	Sep-Dec	Jan-April	May-Aug	Sep-Dec	Jan-Dec
1995	116	203	106	18	48	39	105
1996	573	642	1750	114	140	1649	1903
1998	365	856	1664	153	461	937	1551
1999	269			154			

# N transport via tile drains, June 1998 fertilization 117 kg ha<sup>-1</sup>, on 16 May



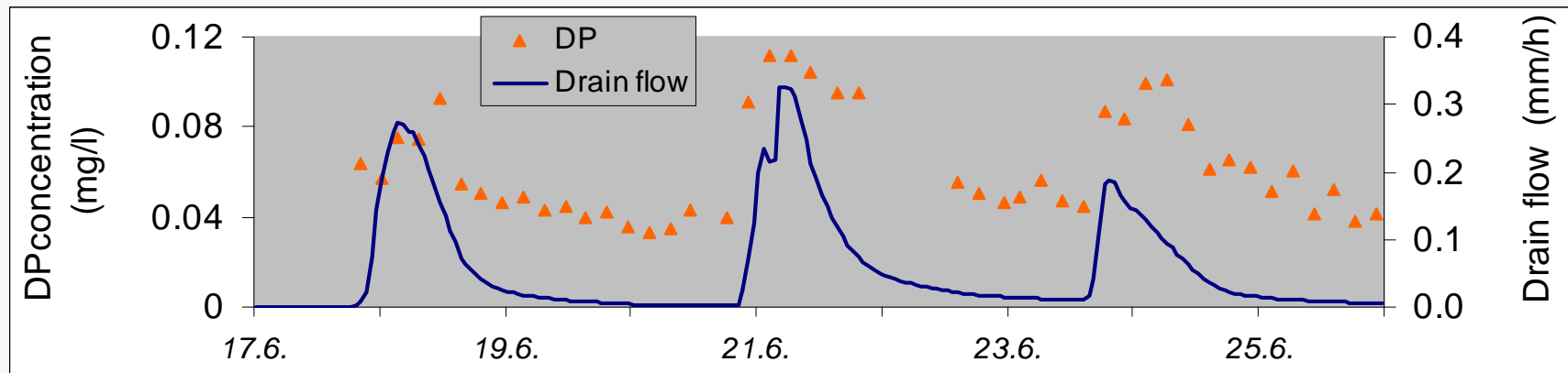
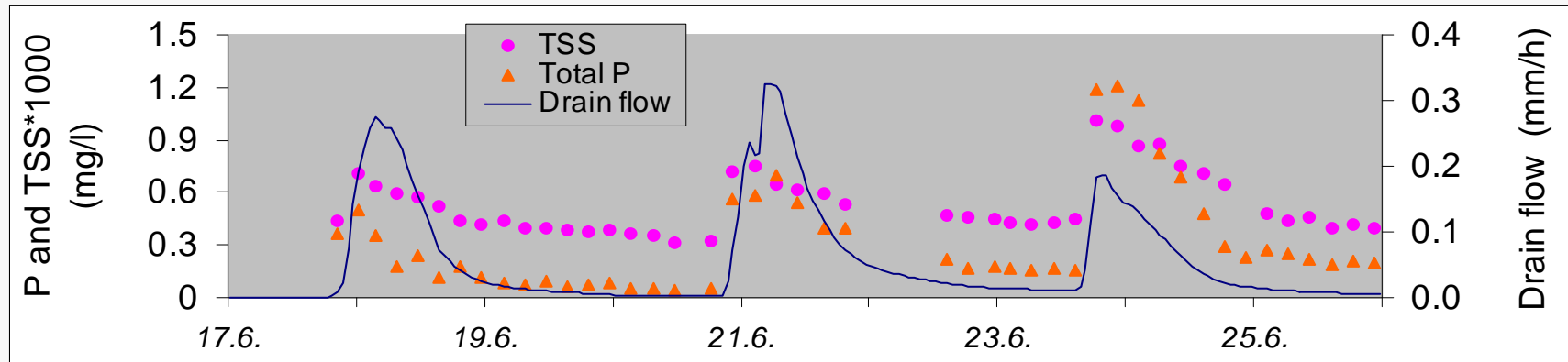
Rainfall 53 mm, tile drain flow 12.2 mm, surface runoff 0.3 mm  
Total N loss 5.1 kg ha<sup>-1</sup>, NO<sub>2</sub>+NO<sub>3</sub>-N loss 4.7 kg ha<sup>-1</sup>

# N transport via tile drains after tillage, October 1998



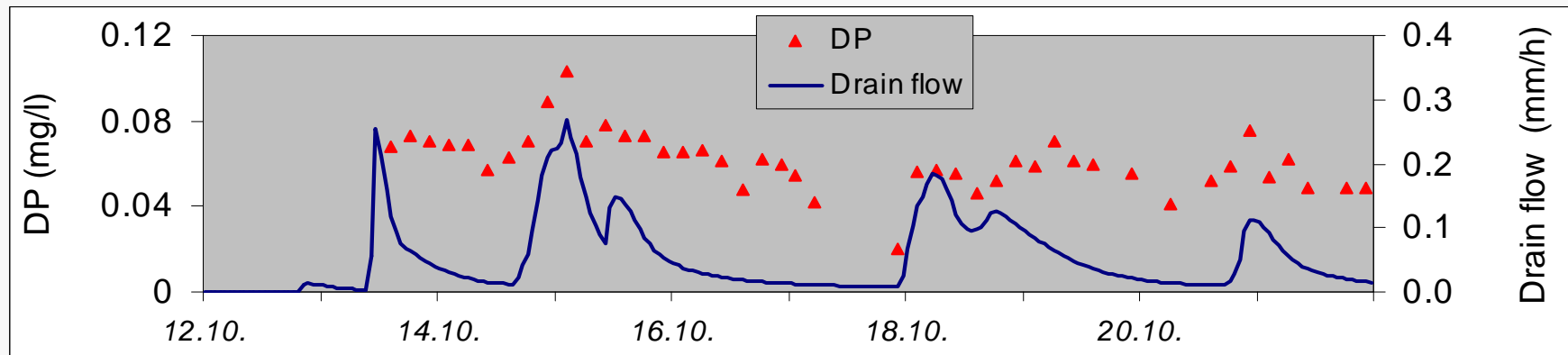
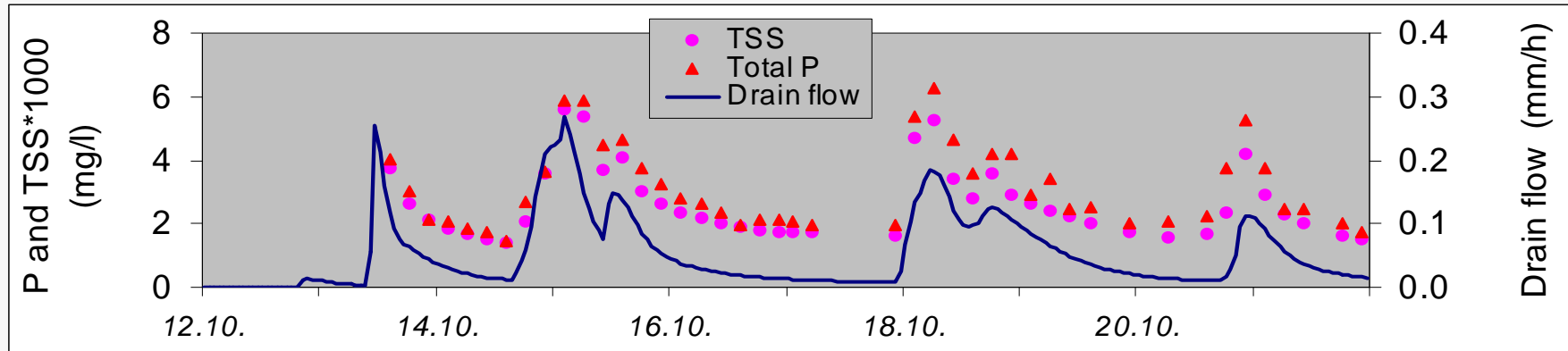
Rainfall 68 mm, tile drain flow 12.6 mm, surface runoff 33 mm  
Total N loss 1.27 kg ha<sup>-1</sup>, NO<sub>2</sub>+NO<sub>3</sub>-N loss 0.32 kg ha<sup>-1</sup>

# 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<sup>-1</sup>, TSS loss 149 kg ha<sup>-1</sup>

# 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<sup>-1</sup>, TSS loss 441 kg ha<sup>-1</sup>

# 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!

