Assessment of Hydrology and Sediment Transport and Prospects of Simulating Agri-Environmental Measures with SWAT

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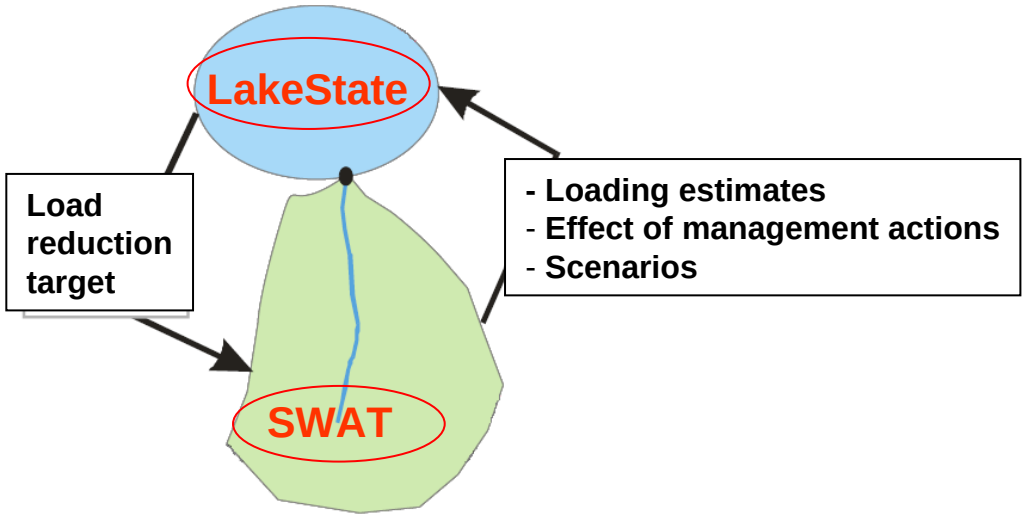
CATCH_LAKE project and SWAT modelling

Integrated use of catchment and lake models



is developed by using…

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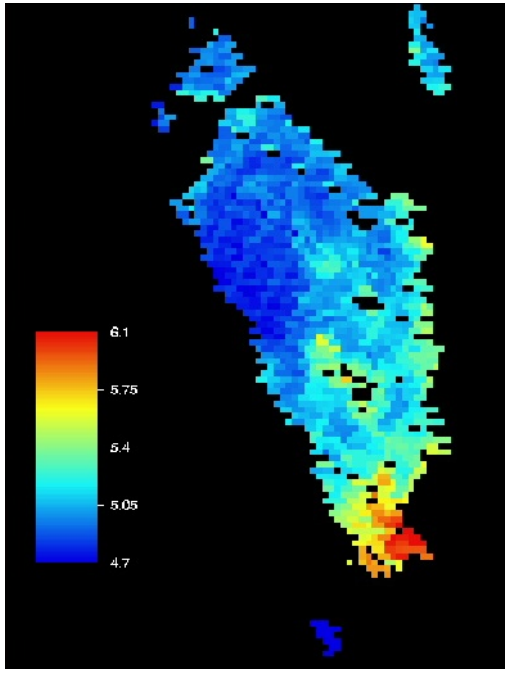
…remote sensing technology



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and

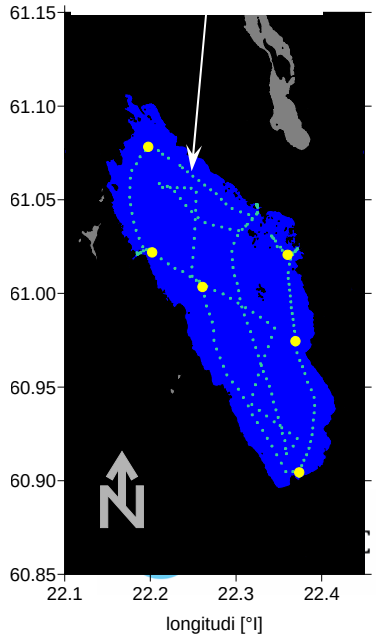
intensive measurements with water quality sensors in the catchment and in the lake

Datalogger with modem transmitter

Water height gauge

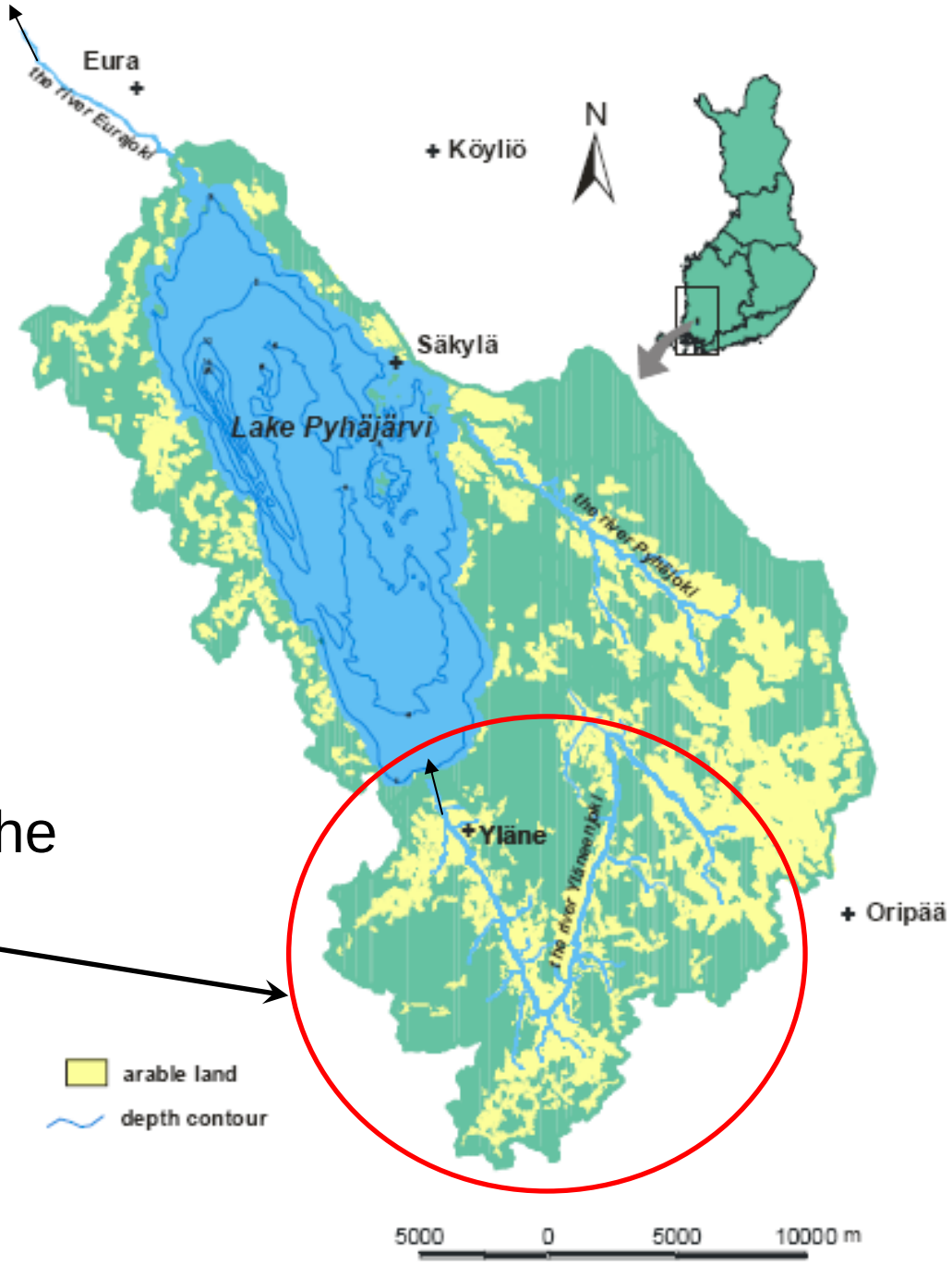
Sensors in the boat, 19 000 obs. of 6 variables (NO3, chl-a etc.) per trip

Boat route



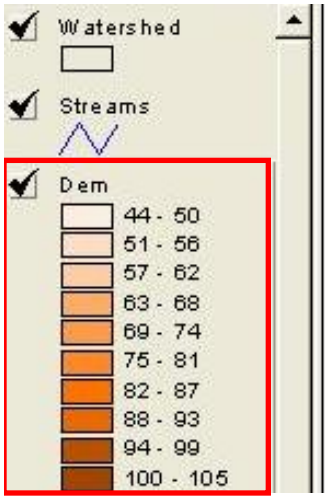
The study area

Lake Pyhäjärvi and its catchment



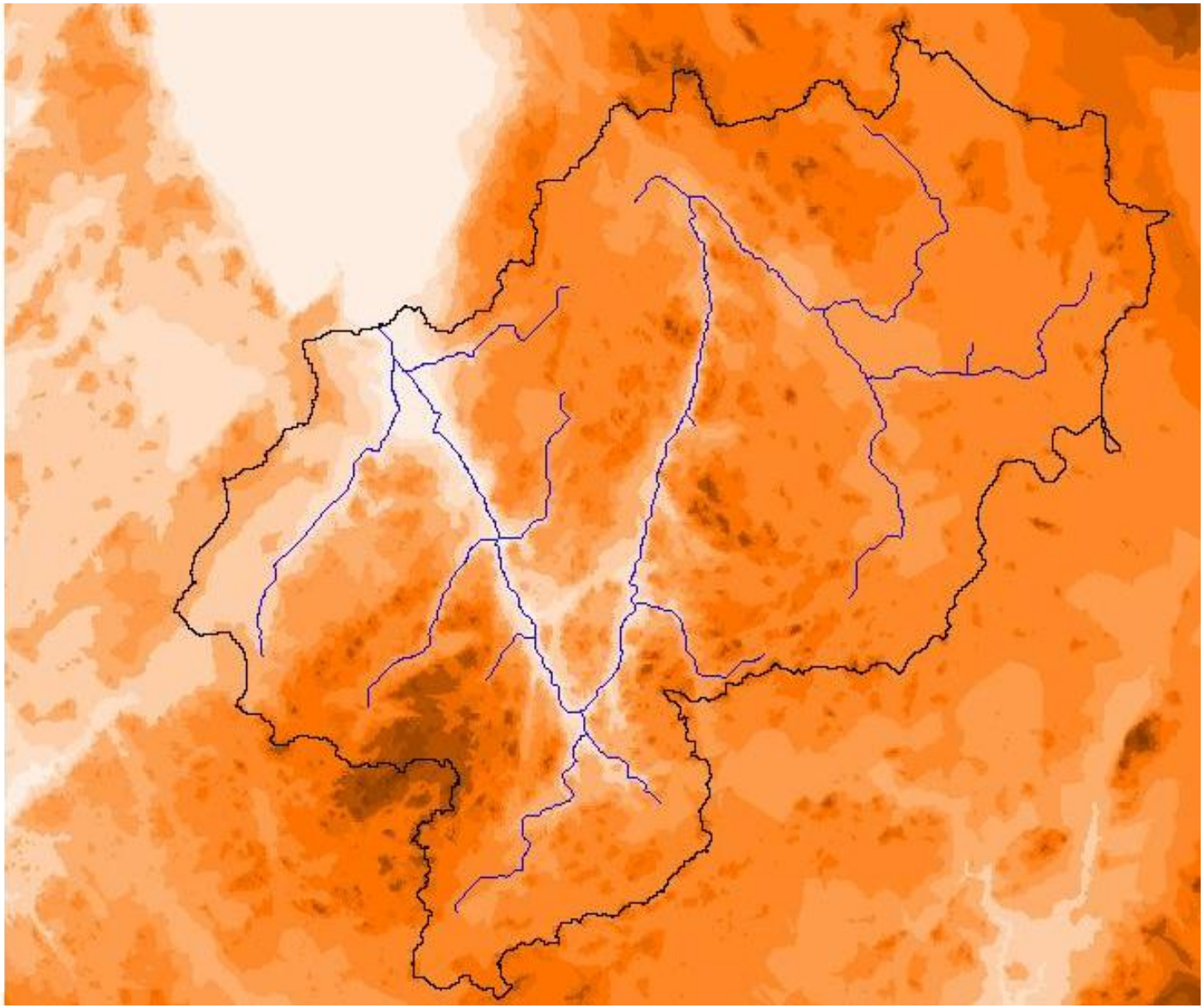
SWAT application in the
<u>Yläneenjoki basin</u>
- 233 km^2
- ca 30% agricultural

Land elevation in the Yläneenjoki basin

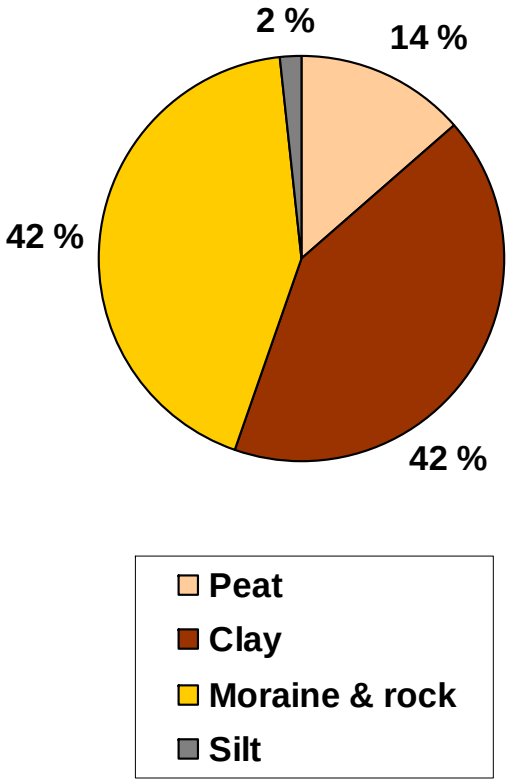


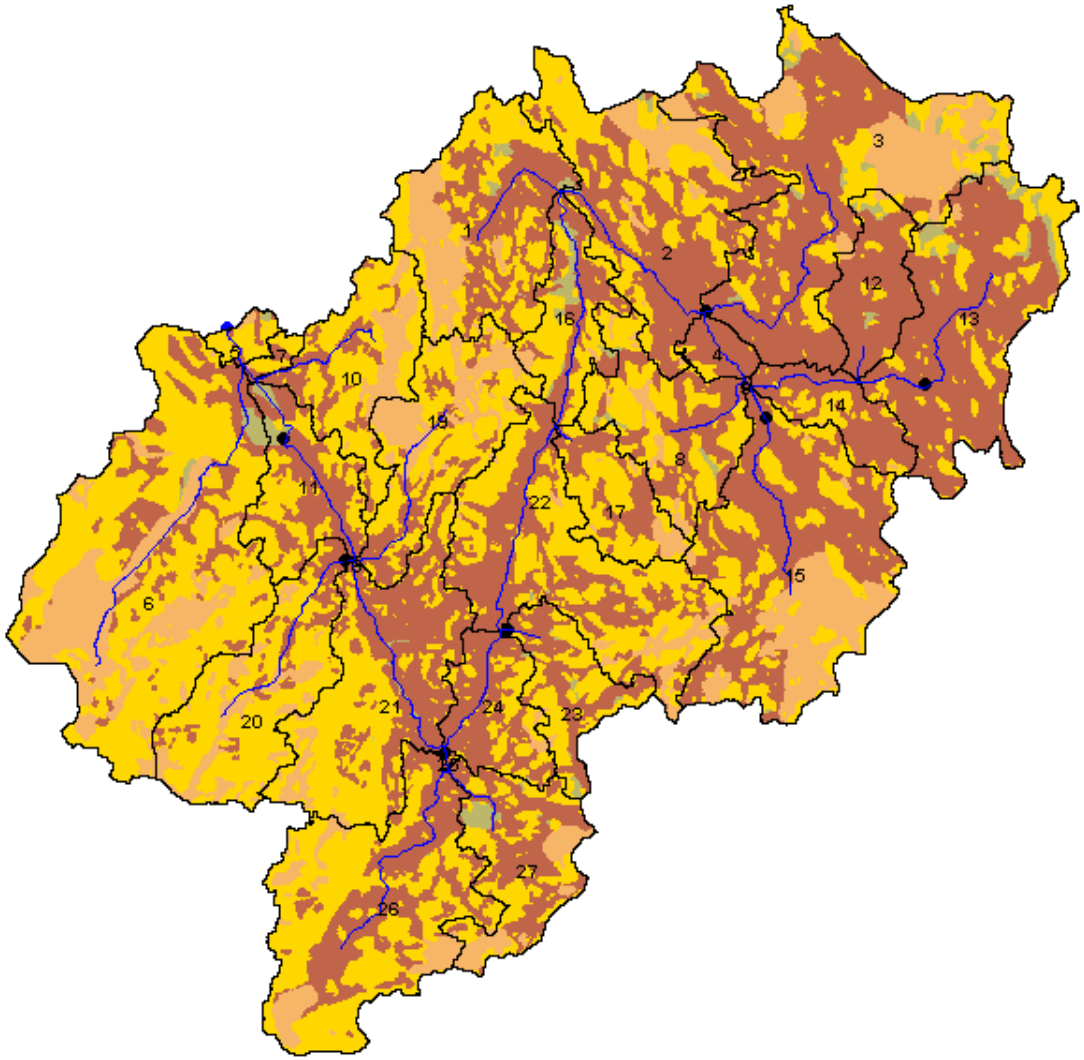
50–100 m a.s.l.

5-m resolution



Soil in the Yläneenjoki basin





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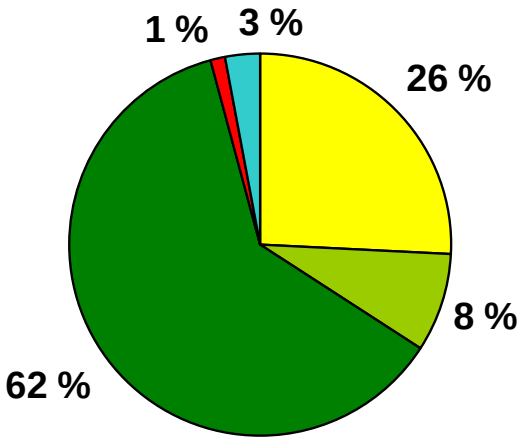
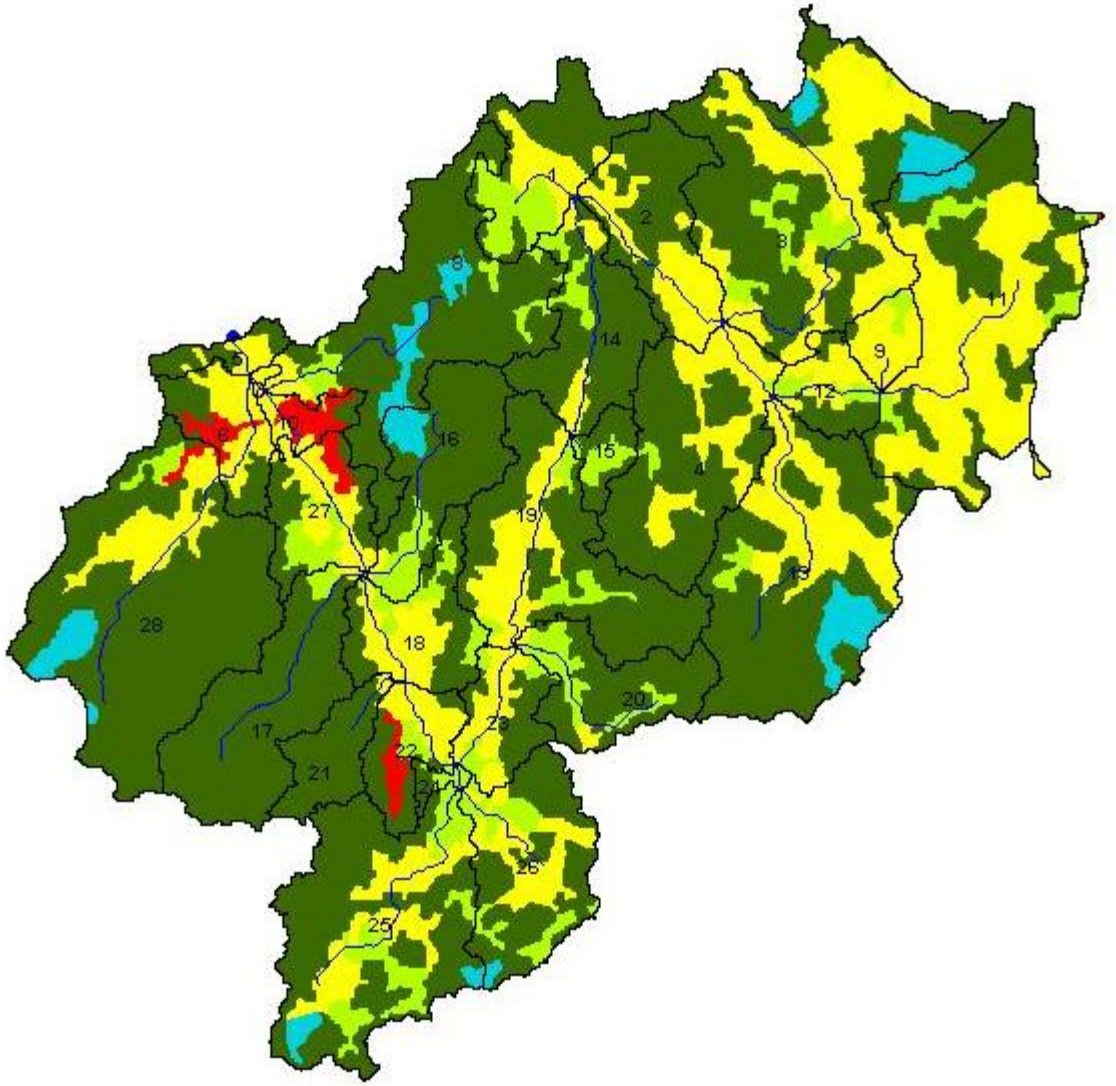
Land-use in the Yläneenjoki basin





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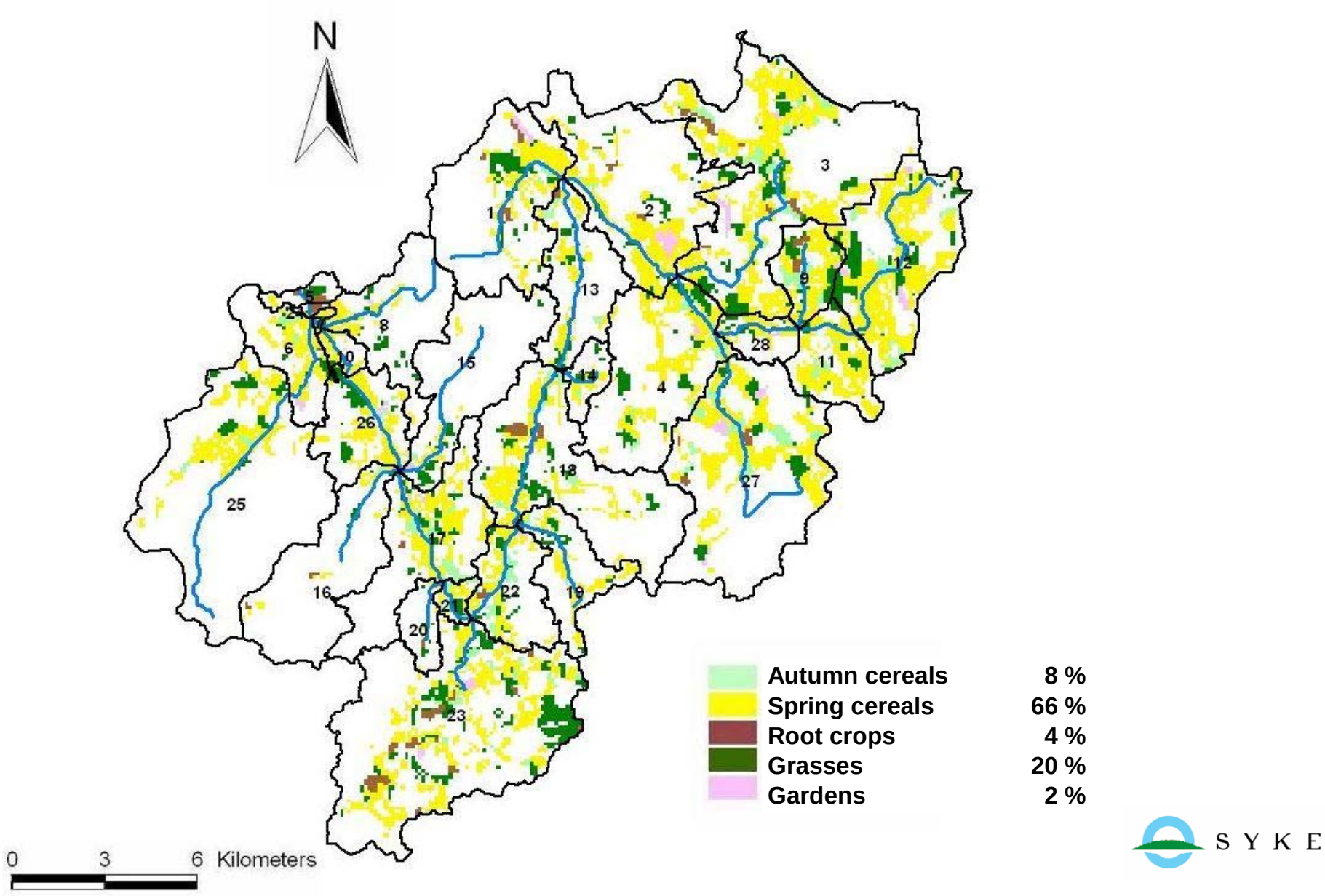
Agricultural land-use from the TIKE database



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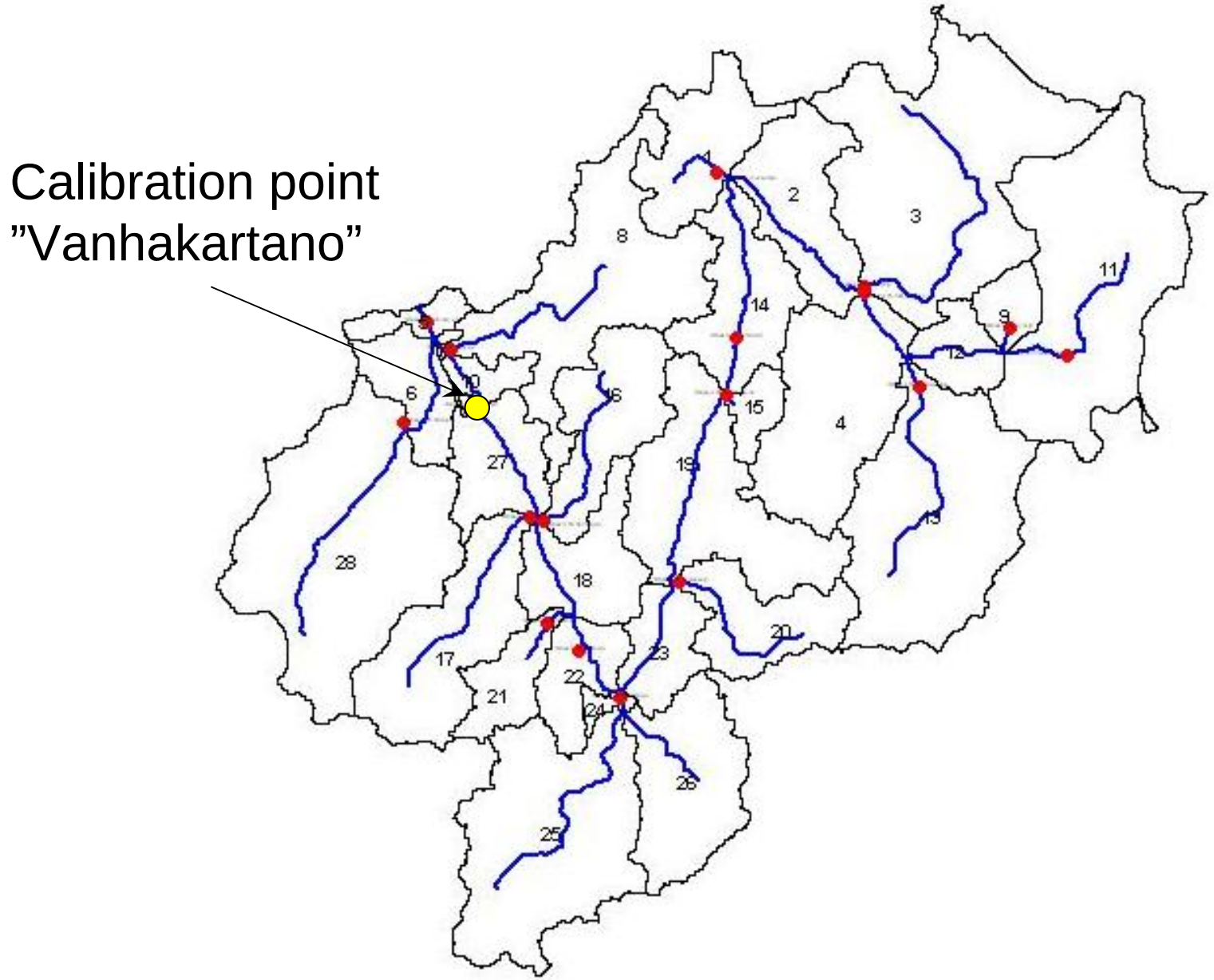
Subbasins and sampling points in the Yläneenjoki area



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Calibration point “Vanhakartano”

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Sensitivity analysis for flow and sediment concentration

FLOW, no observed data

Rank	Mean	Parname
1	0,41	SURLAG
2	0,30	TIMP
3	0,16	SMFMX
4	0,13	SMFMN
5	0,10	SOL_AWC
6	0,09	GWQMN
7	0,08	CH_K2
8	0,07	SMTMP
9	0,06	ESCO

FLOW, with observed data

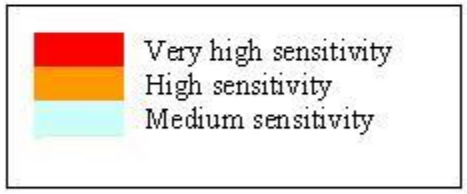
Rank	Mean	Parname
1	0,71	GWQMN
2	0,38	SOL_Z
3	0,37	TIMP
4	0,36	ESCO
5	0,33	SOL_AWC
6	0,30	CN2
7	0,20	SOL_K
8	0,19	REVAPMN
9	0,09	RCHRG_DP
10	0,08	SMTMP
11	0,06	SFTMP
12	0,06	SMFMX
13	0,06	SMFMN
14	0,06	SURLAG

SED.CONC., no observed data

Rank	Mean	Parname
1	8,23	SPCON
2	2,49	CH_COV
3	1,90	CH_EROD
4	1,15	SURLAG
5	1,06	CN2
6	0,98	CH_N
7	0,70	SPEXP
8	0,64	GWQMN
9	0,63	ESCO
10	0,57	SOL_K
11	0,52	SMFMN
12	0,49	TIMP
13	0,48	SOL_AWC
14	0,43	SMFMX
15	0,42	SMTMP
16	0,37	CH_K2
17	0,30	SOL_Z
18	0,29	REVAPMN
19	0,20	RCHRG_DP
20	0,17	ALPHA_BF
21	0,12	GW_DELAY
22	0,12	SLOPE
23	0,06	SFTMP
24	0,05	USLE_C

SED.CONC., with obs. data

Rank	Mean	Parname
1	4,35	SPCON
2	2,61	CH_COV
3	1,80	CH_EROD
4	1,04	SURLAG
5	0,77	GWQMN
6	0,76	TIMP
7	0,53	CH_K2
8	0,49	CH_N
9	0,45	CN2
10	0,34	ESCO
11	0,24	SOL_AWC
12	0,17	REVAPMN
13	0,15	SPEXP
14	0,14	SOL_Z
15	0,13	SMTMP
16	0,12	SMFMX
17	0,11	RCHRG_DP
18	0,08	SOL_K
19	0,07	SMFMN
20	0,06	SLOPE
21	0,05	SFTMP
22	0,05	ALPHA_BF
23	0,05	GW_DELAY



Surface runoff parameters

Groundwater parameters

Snow-related parameters

Channel parameters

Sediment routing parameters

Autocalibration for flow

Parameter	Initial guess	Best parameter	Good range
SMTMP	-0.1	1.28	0.92 - 1.63
SMFMX	2.6	4.56	3.6 - 6
SMFMN	1.3	0.096	0 - 0.46
TIMP	0.9	0.983	0.8 - 1
ESCO	0.95	0.891	0.79 - 1
EPCO	1	0.889	0.79 - 1
SURLAG	4	0.424	0.25 - 0.52
GWQMN	0.4	158	0 - 206
SOL_AWC	0.22	0.94	0.78 - 1
CN2	82	81	77 - 90

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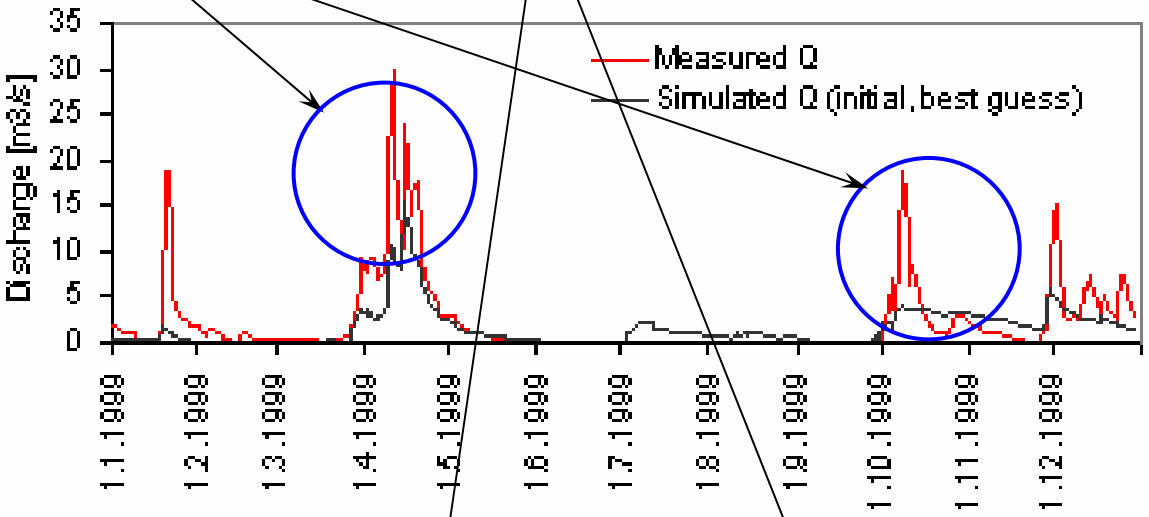
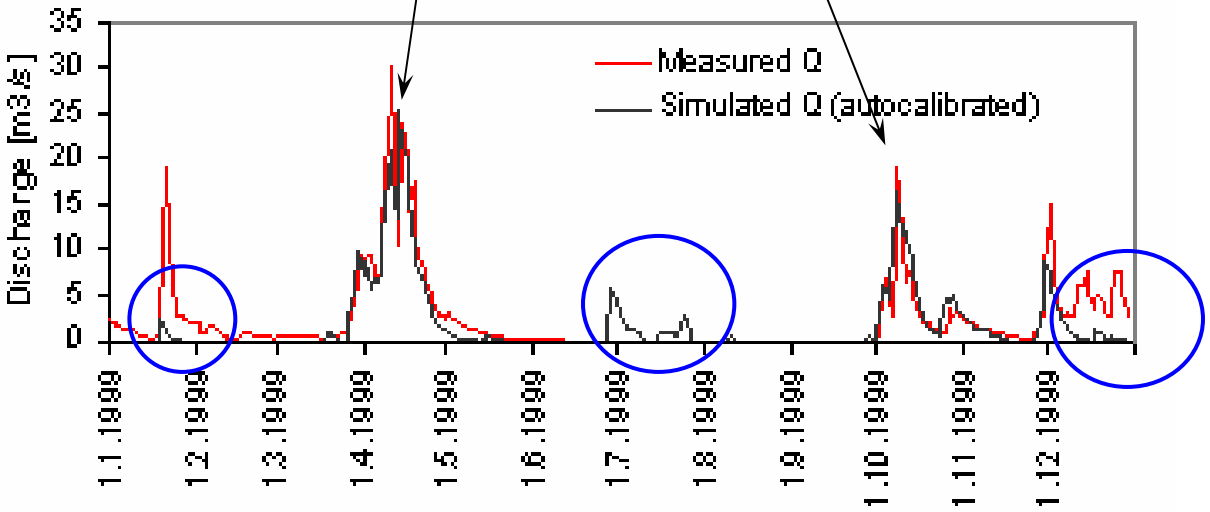
Uncalibrated and calibrated vs. measured flow

Too low spring flow peaks



Poorly simulated flow dynamics in autumn

Calibration improved these issues, but…



… we still have periods with problems

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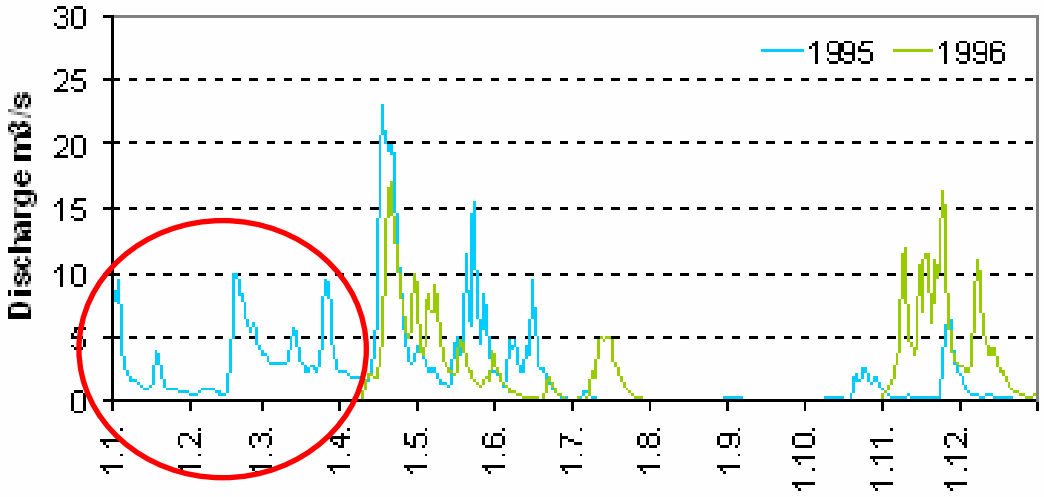
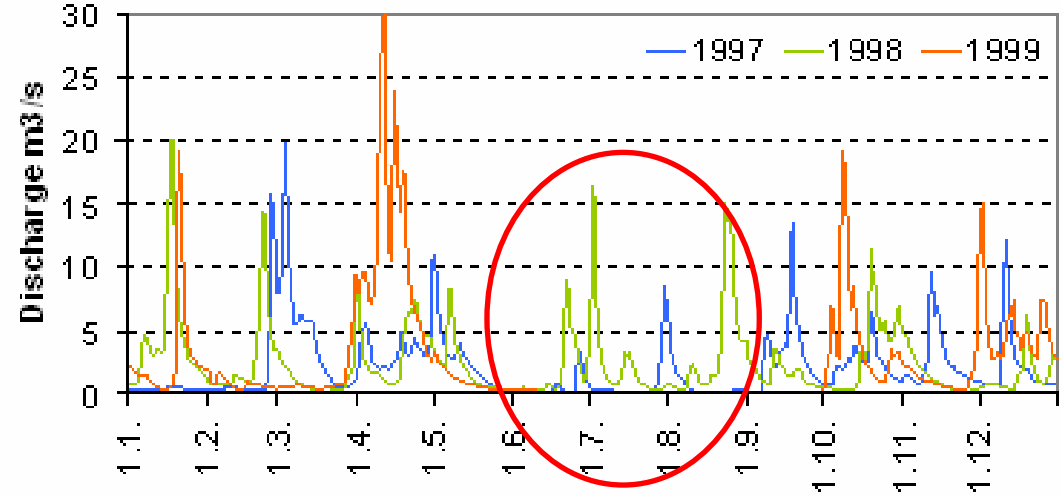
Daily flow at Vanhakartano 1995–1999



Wet (1995) vs. dry (1996) winter



Wet (1998) vs. dry (1999) summer

Parameterization was complicated by hydrologically varying years, e.g. …

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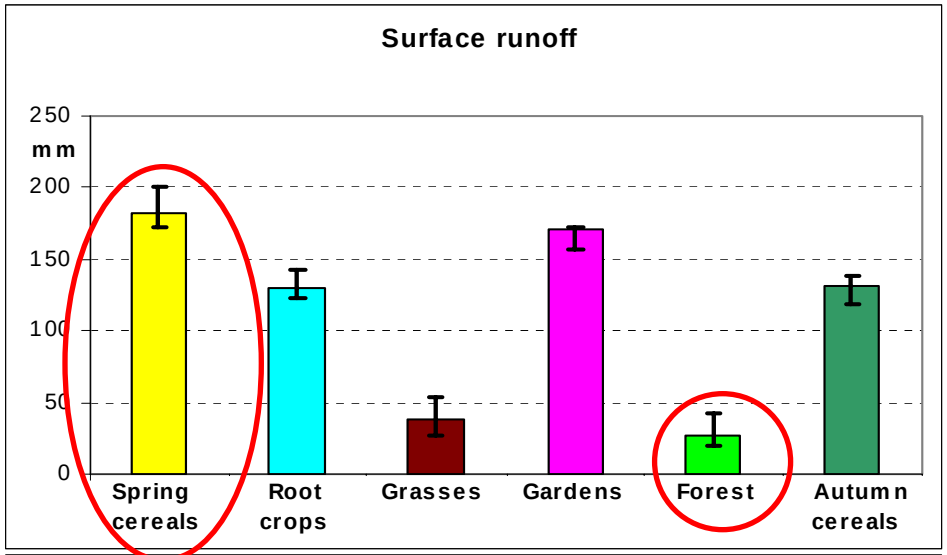
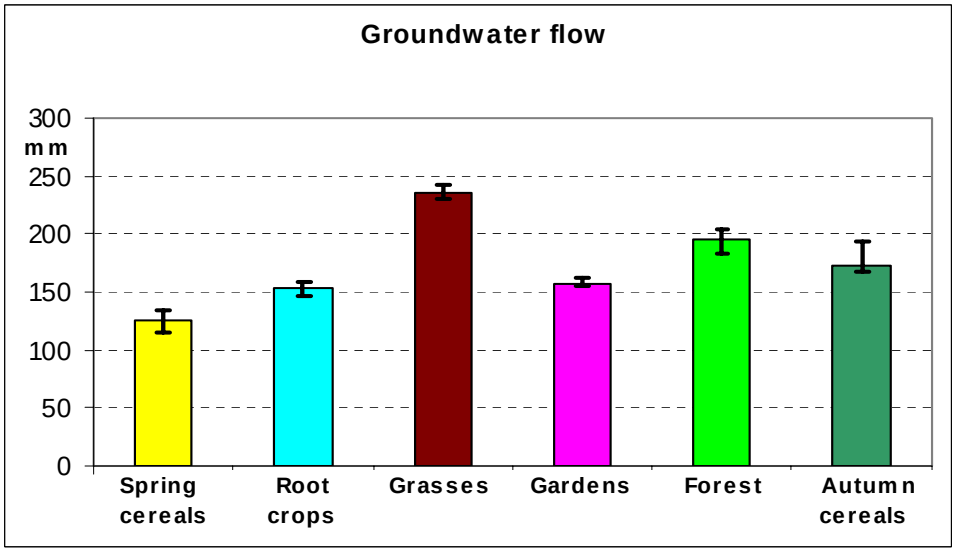
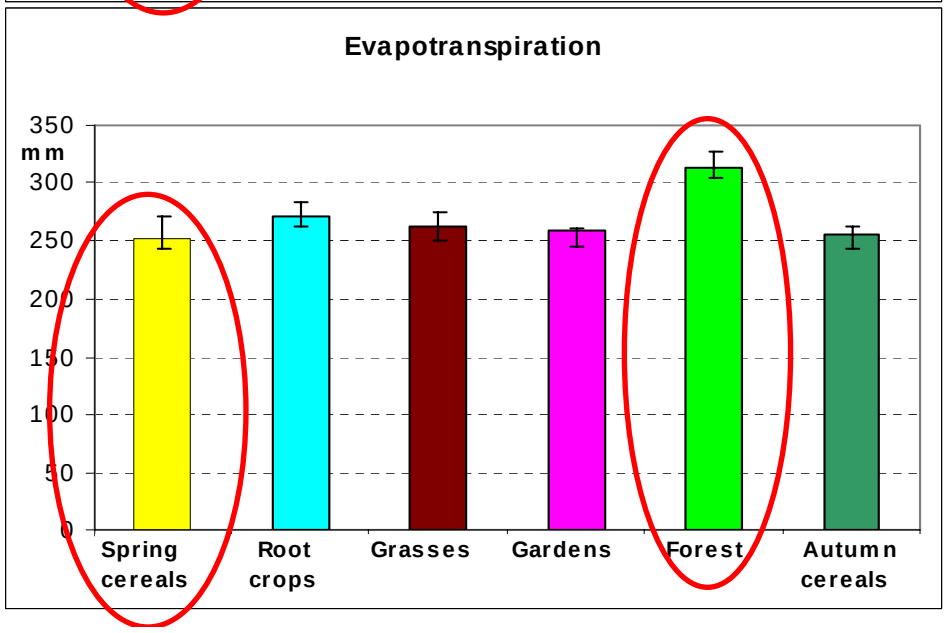
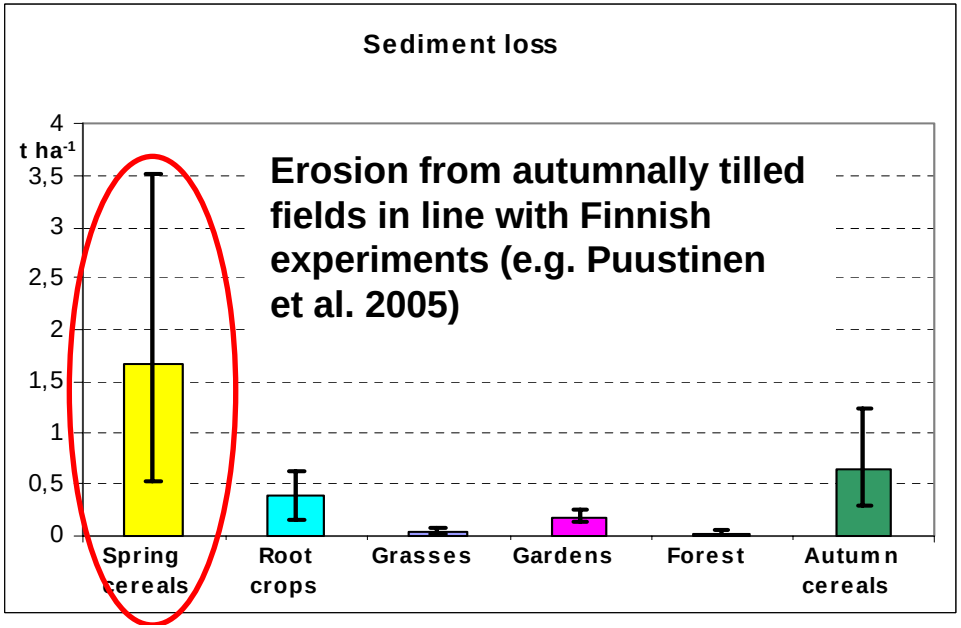
Hydrologic factors and sediment loss in different land uses

Difference between agricultural and forested areas correct

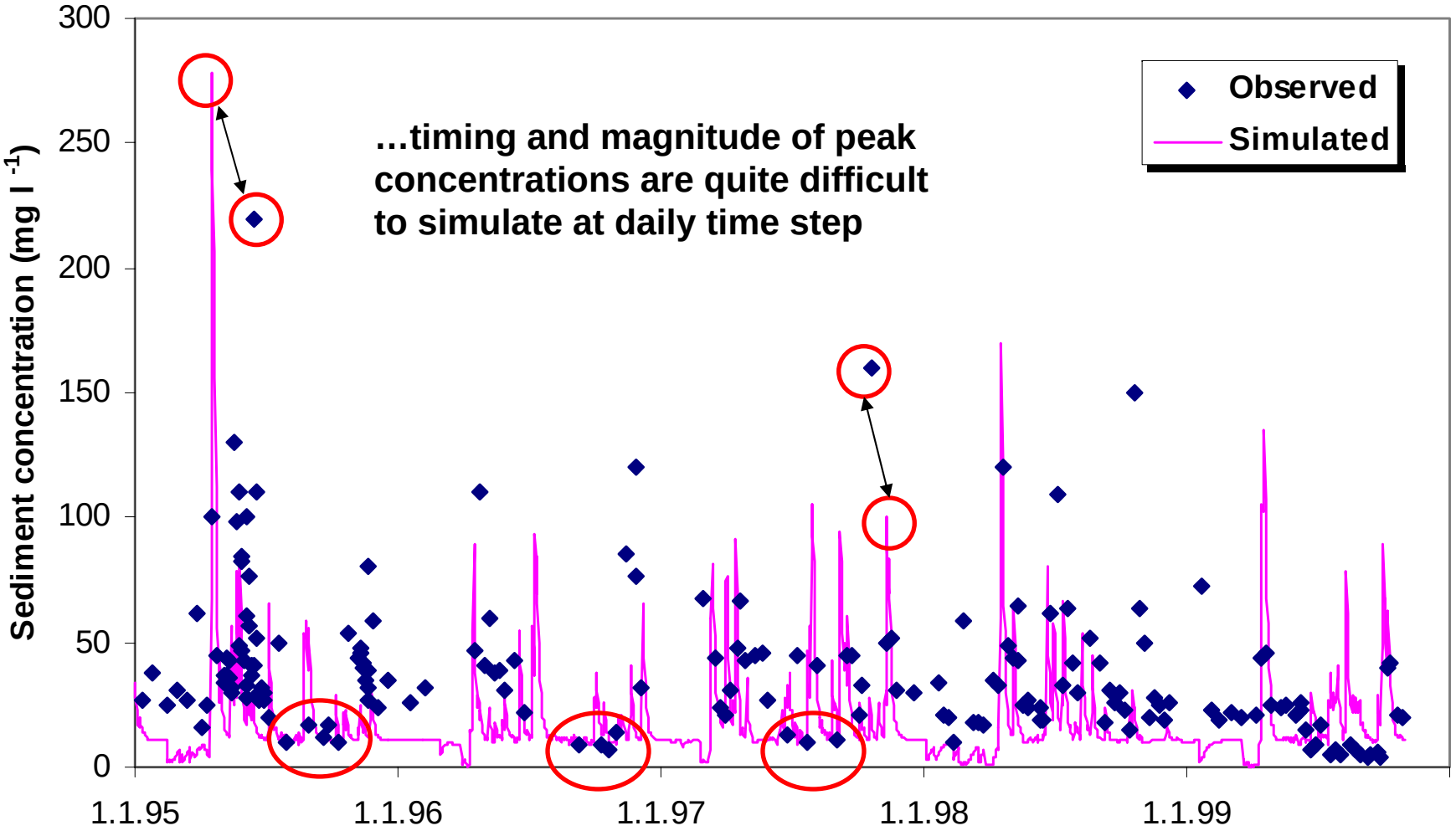






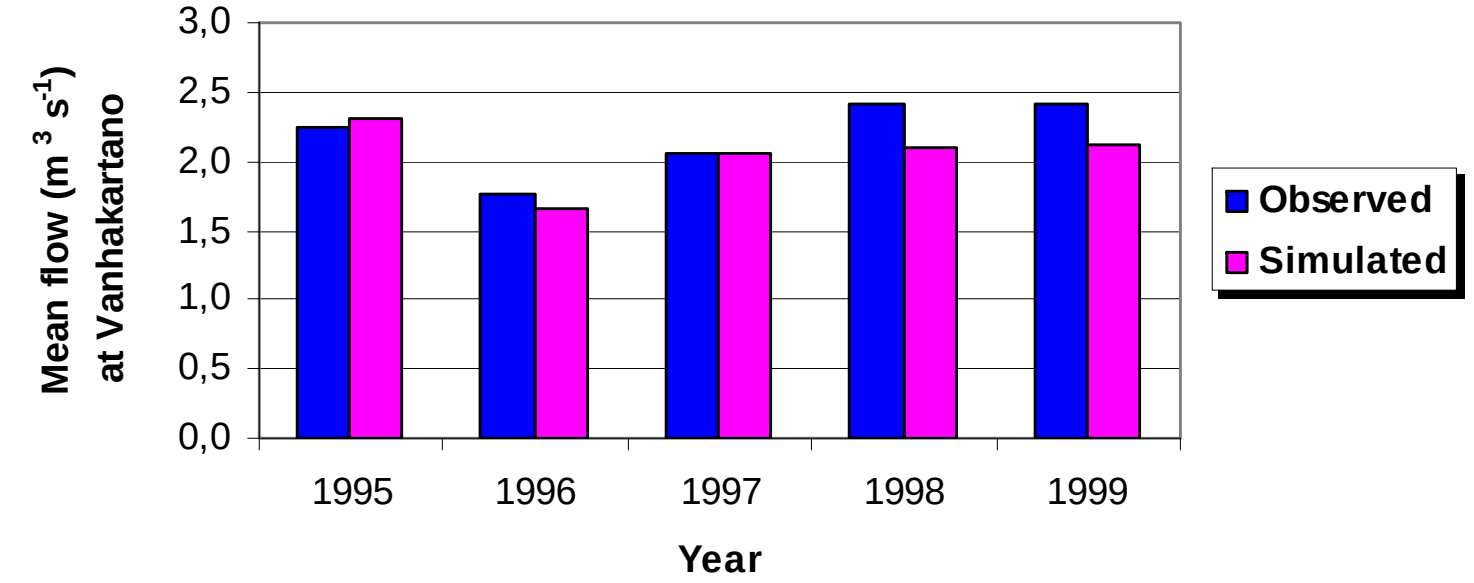


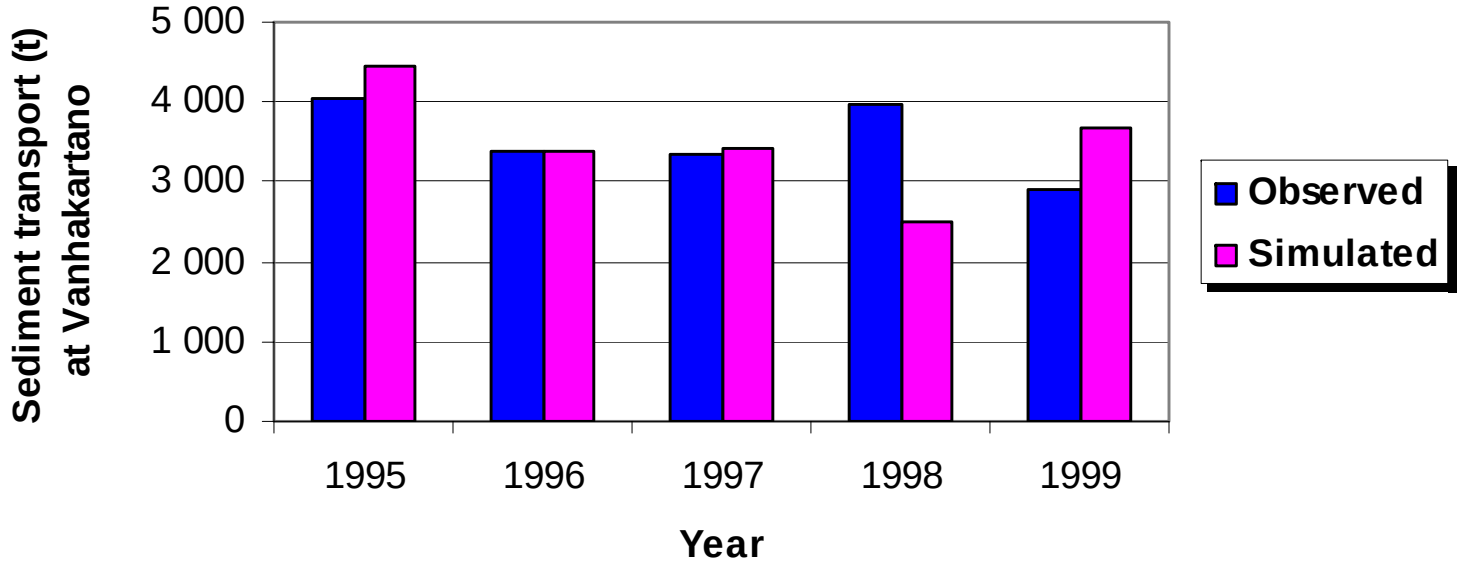
Observed and simulated sediment concentration 1995–1999 at Vanhakartano



The average and "<u>base</u>" concentrations mostly OK, but…

…annual results still acceptable





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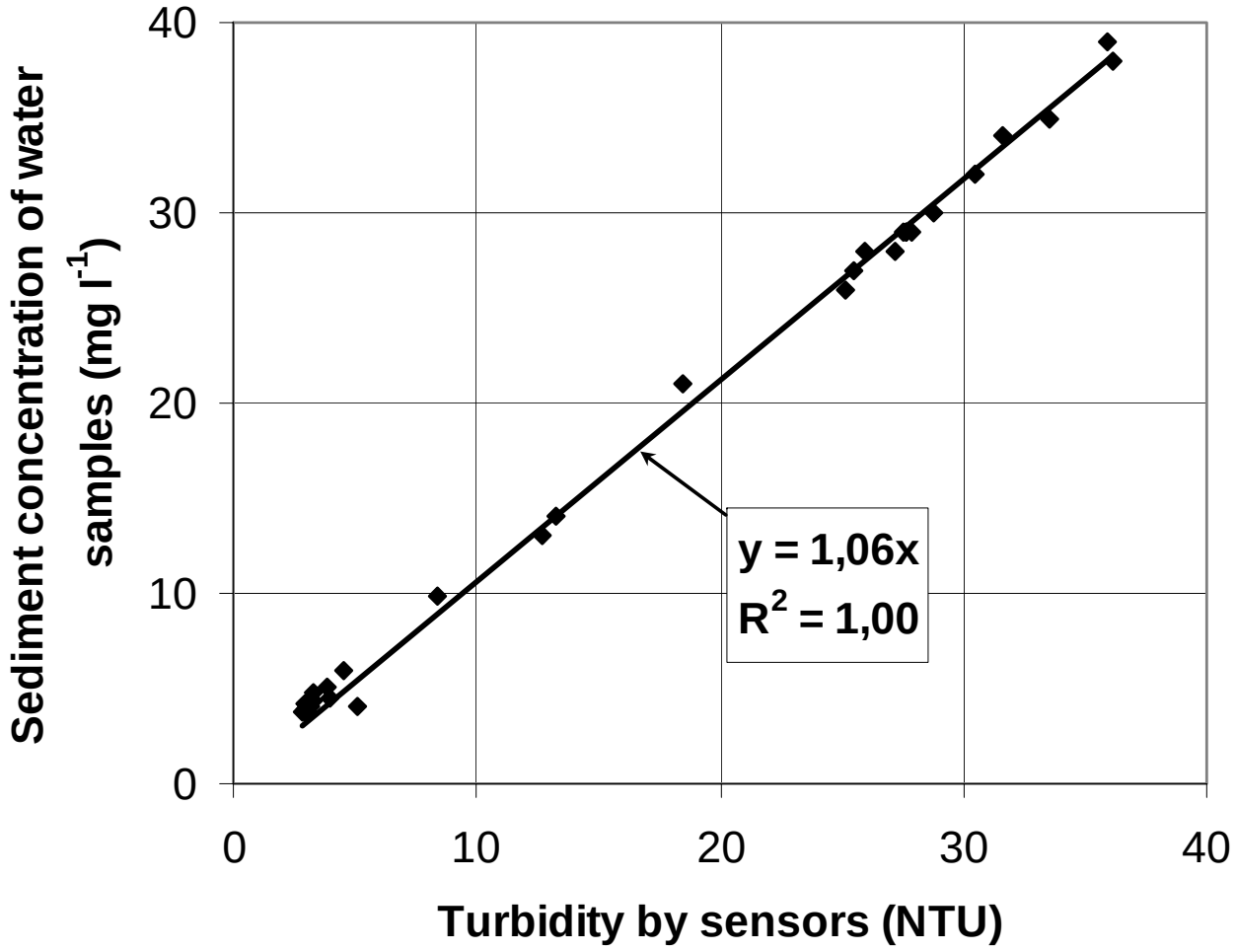
Frequent turbidity data for model testing

In the Yläneenjoki basin, the correlation between turbidity and sediment concentration is very high…



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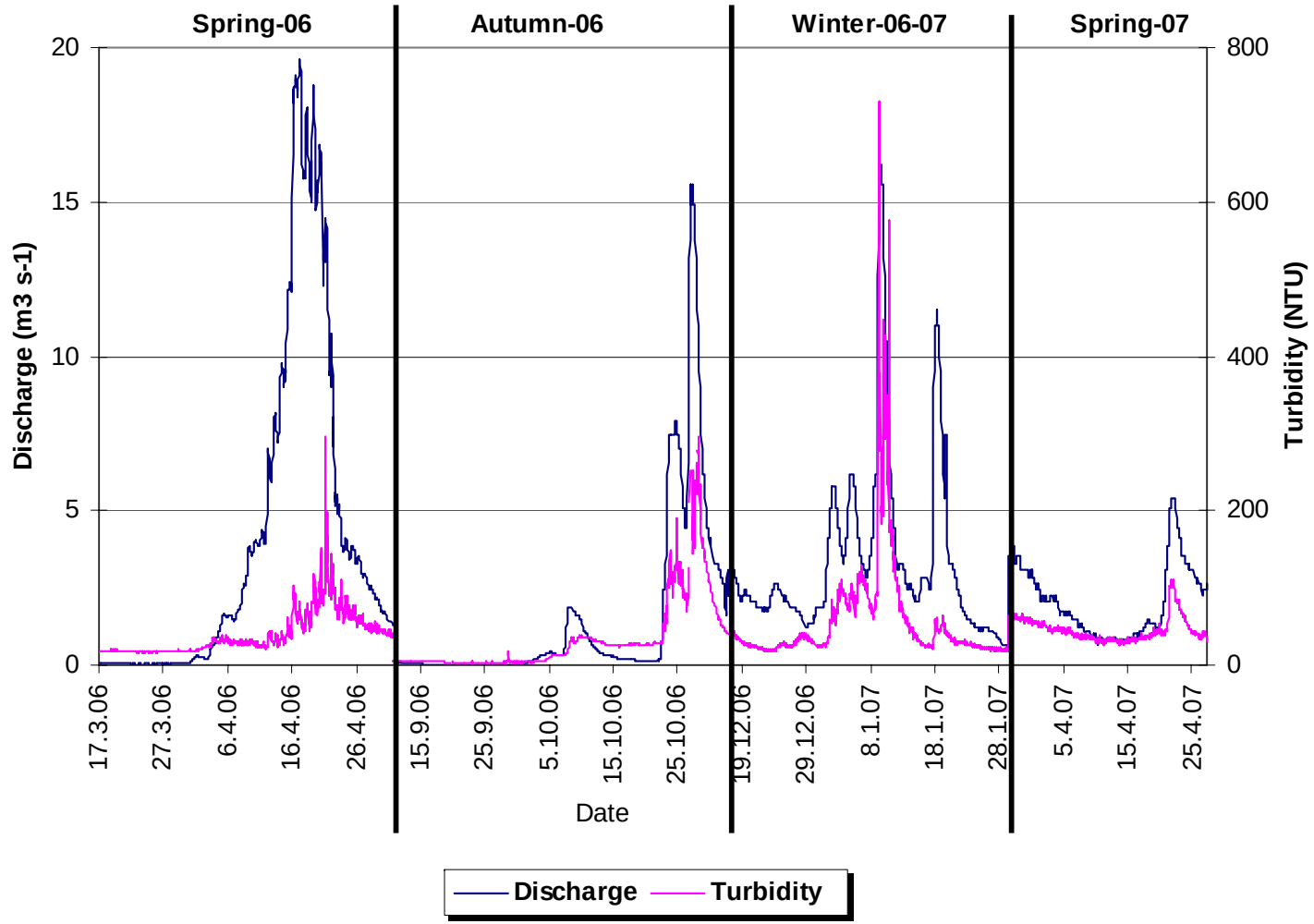
Frequent turbidity data for model testing

…thus, the frequently recorded turbidity data could be used for sediment loading assessments as well as for model testing in the area.



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Prospects of simulating constructed wetlands and other agri-environmental measures

SWAT offers possibities of simulating a wide range of agricultural management actions both ”on-field”…

- land-use changes
- tillage intensity and timing
- drainage systems
- fertilization
- etc.

… and ”off-field”

- buffer zones
- constructed wetlands
- sedimentation ponds

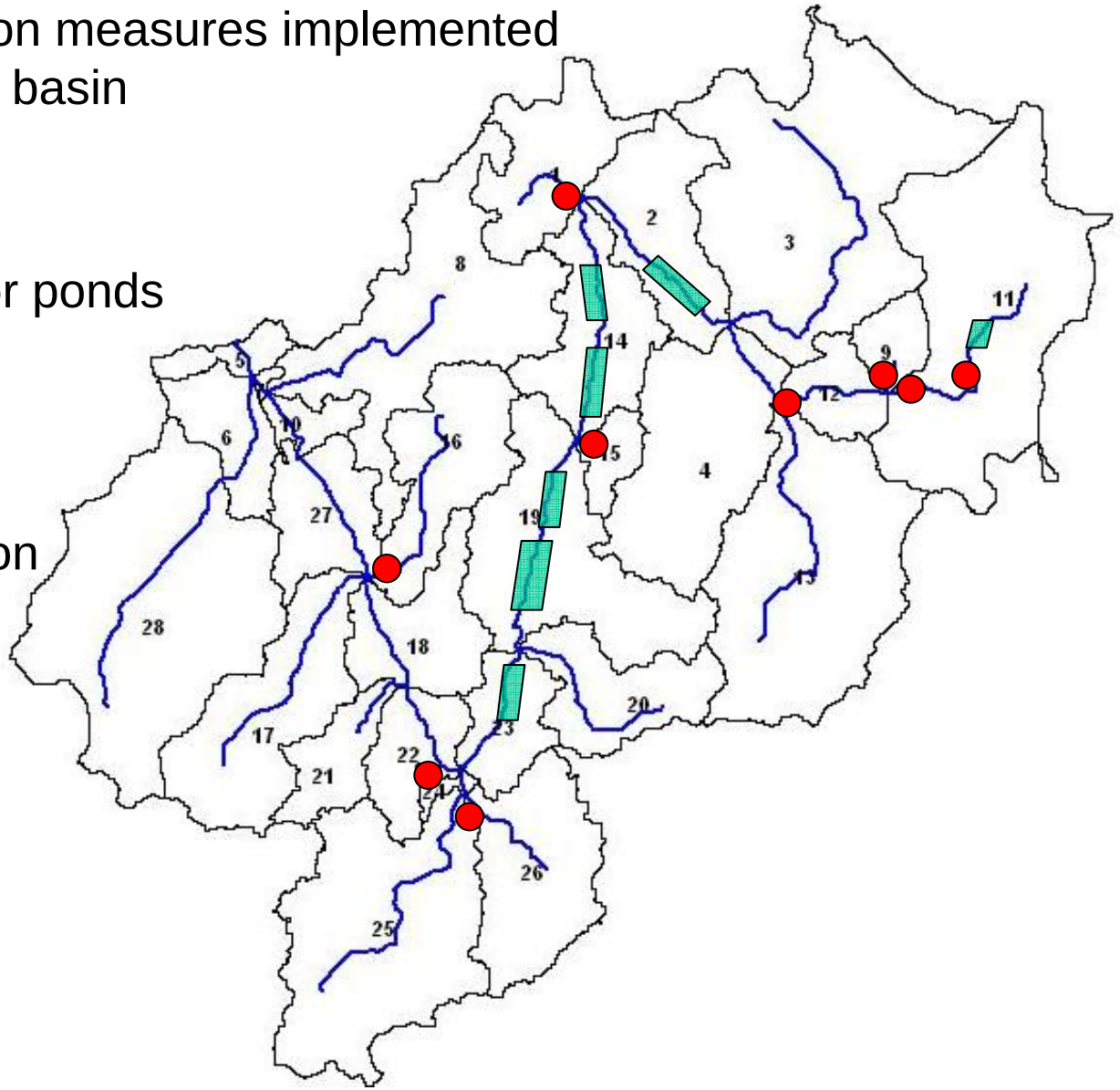
Prospects of simulating constructed wetlands and other agri-environmental measures

Agricultural water protection measures implemented thus far in the Yläneenjoki basin

Buffer zones

Constructed wetlands or ponds

Moreover, specific information on agricultural management practices is available from co-operative local farmers



Buffer zones in the mid-reaches of Yläneenjoki

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Conclusions and further work in the Yläneenjoki basin with SWAT

- Sensitivity analysis and autocalibration tool proved useful
- Simulated flow and sediment transport estimates reasonable on an annual basis
- However, improvements in dynamics of hydrology and sediment concentrations still has to be made

- Modeling of nutrients, loading assessments of N and P
- Model testing with frequent turbidity data
- Simulating the effects of agri-environmental management actions carried out in the area
- Making scenarios with different locations and magnitudes of management actions

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THANK YOU!

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