An approach to assess SWAT model performance in evaluating management actions in a Finnish catchment

16.3.2004

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The project and its aim

EU project
Benchmark Models for the Water Framework Directive
(2002-2004)

- EU Water Framework Directive
- Management plans for catchments
- Tools for responsible authorities

One aim of the project:

- To establish a set of criteria to assess the appropriateness of models for the use in the implementation of WFD, the *benchmarking protocol*
- To test the protocol and models in case studies

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The benchmarking protocol

A set of 23 questions for the **water manager** and **modeller** to be considered in a common session.

The issues:

1. Definition of the management and modelling tasks
   - GO/NO GO: Is any modelling approach approriate?
2. Model functionality and data
   - GO/NO GO: Is the model code suitable for this management task?
   - GO/NO GO: Is the model code suitable for this application?
3. Model performance assessment
4. *A posteriori* review

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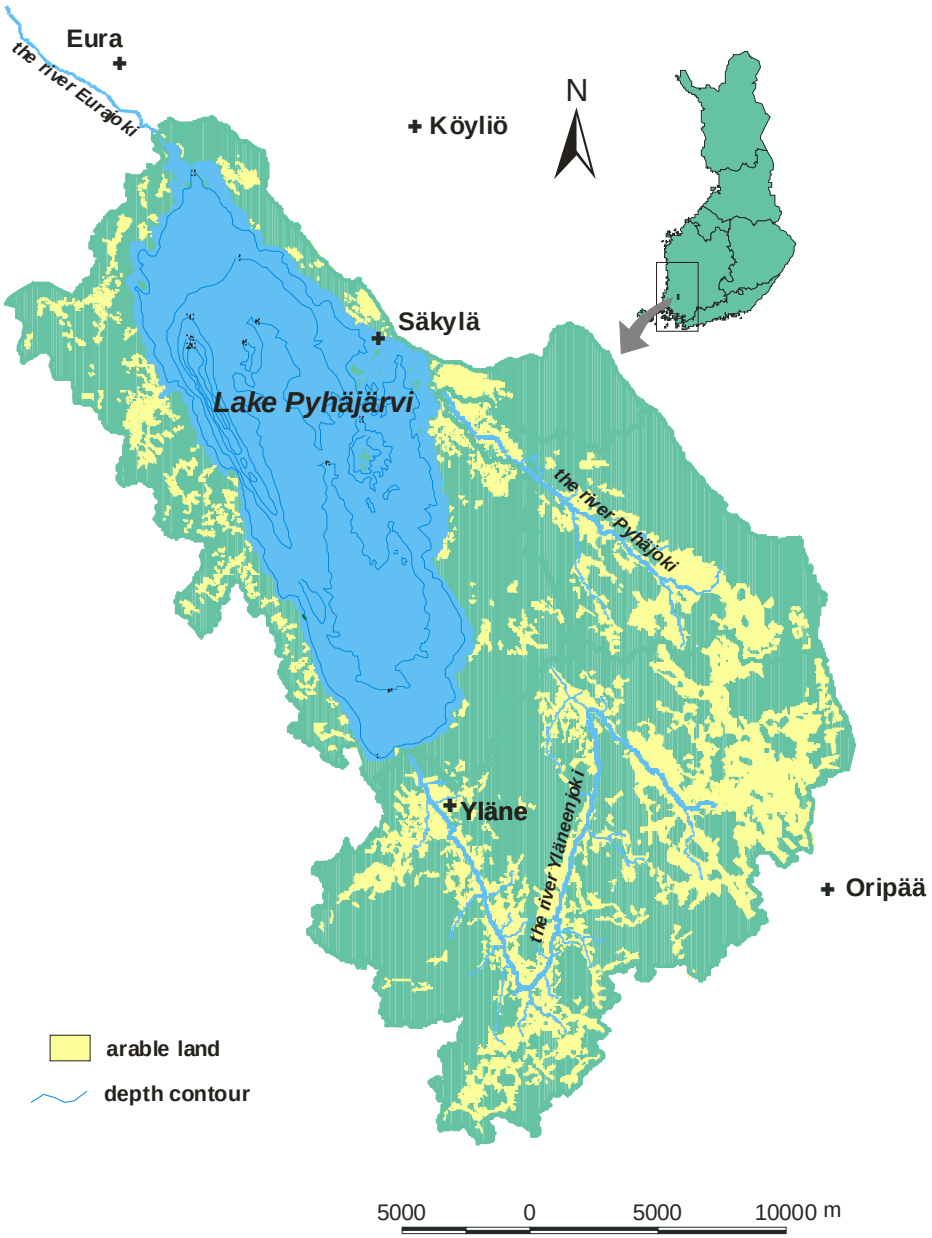
Hutchins, M., Urama, K., Penning, E., Icke, J., Dilks, C., Bakken, T., Perrin, C., Saloranta, T. & Candela, L. Model Evaluation Protocol: Guidance for applying benchmark criteria. In press for **Archiv für Hydrobiologie supplement Large Rivers.**

The area



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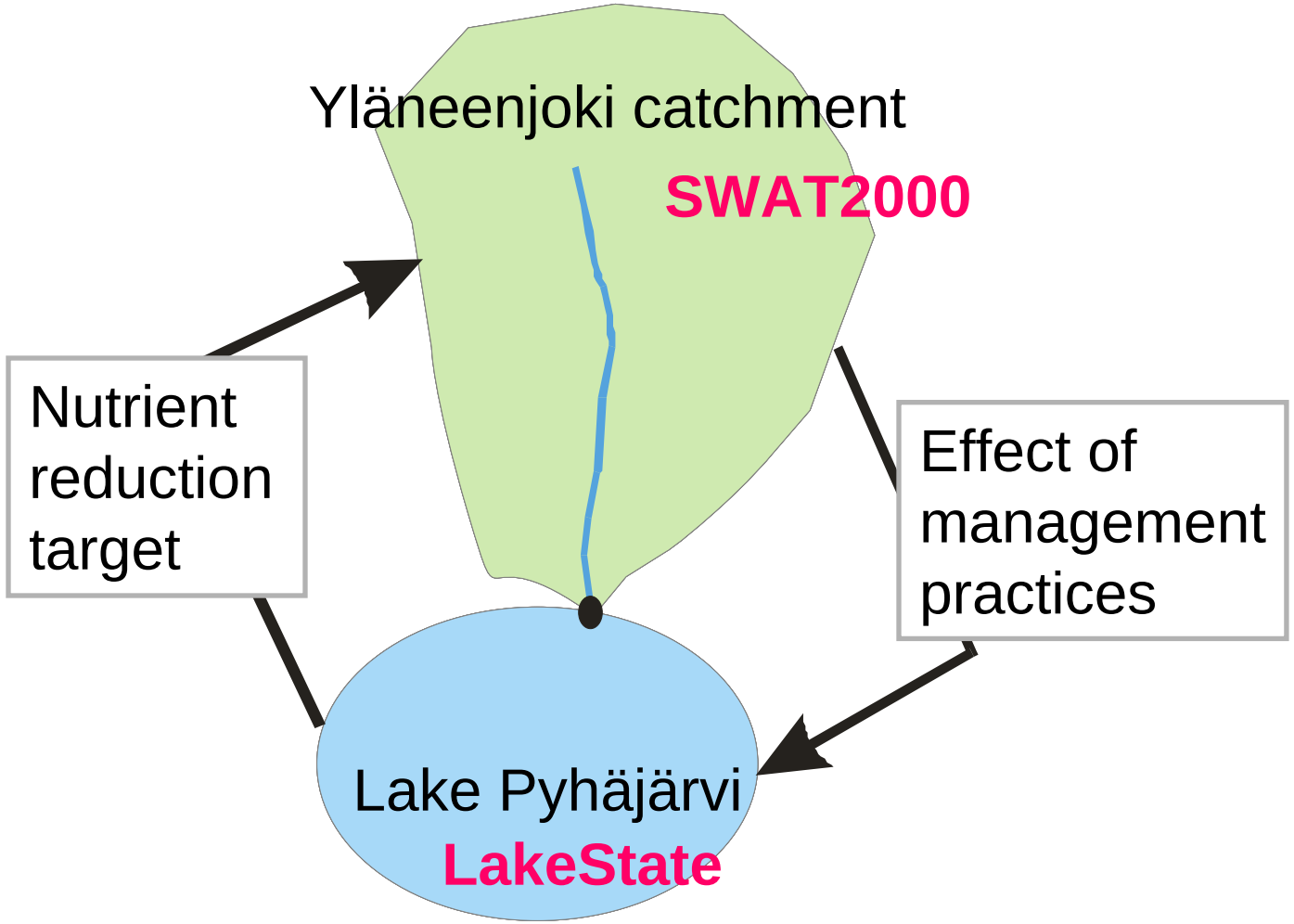
Modelling concept with respect to WFD



LakeState: *Cyanobakteria* biomass < 0.2 mg l^{-1}
⇒optimisation of the external total P & total N load
⇒ reduction **40%**

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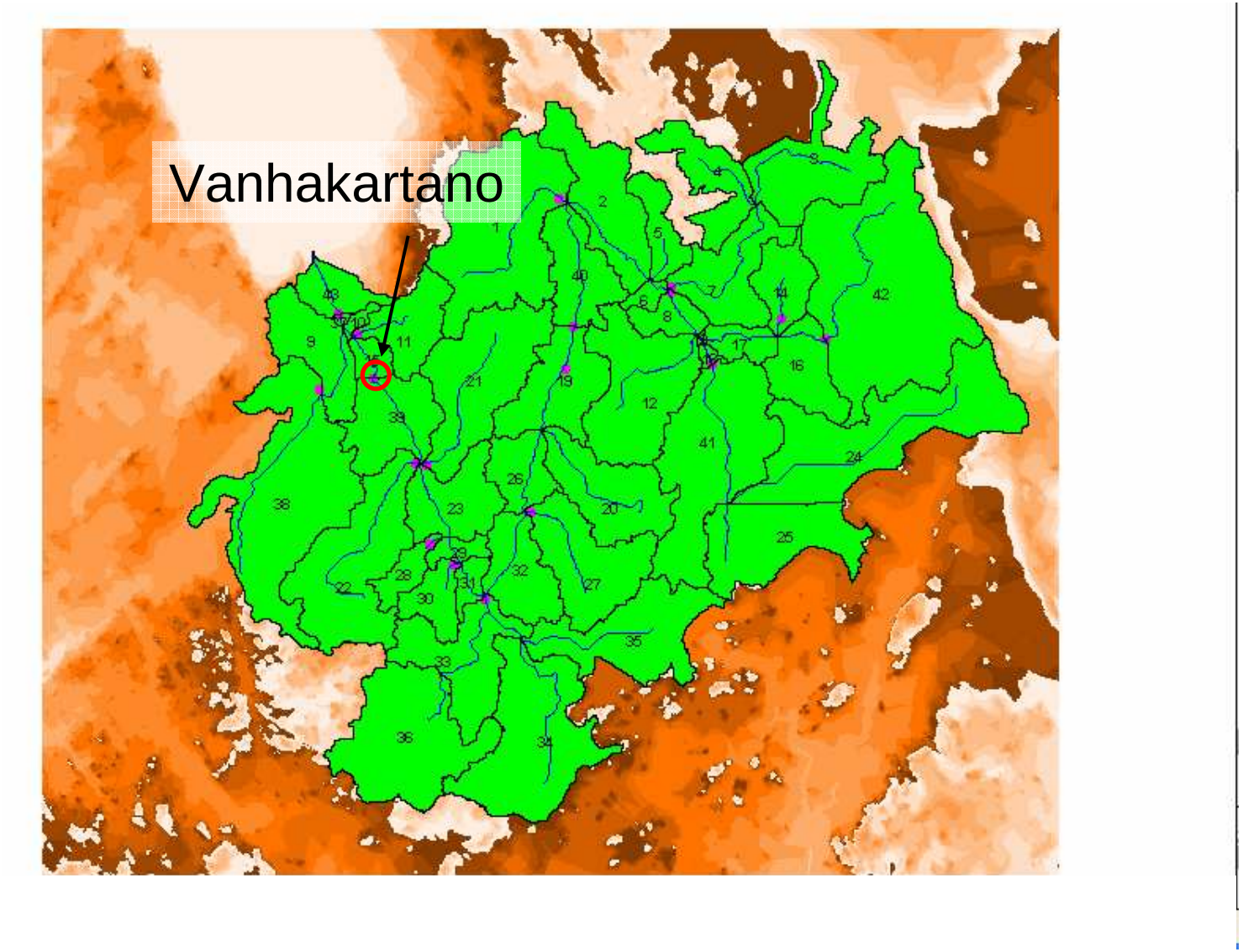
Modelling set-up

43
subbasins

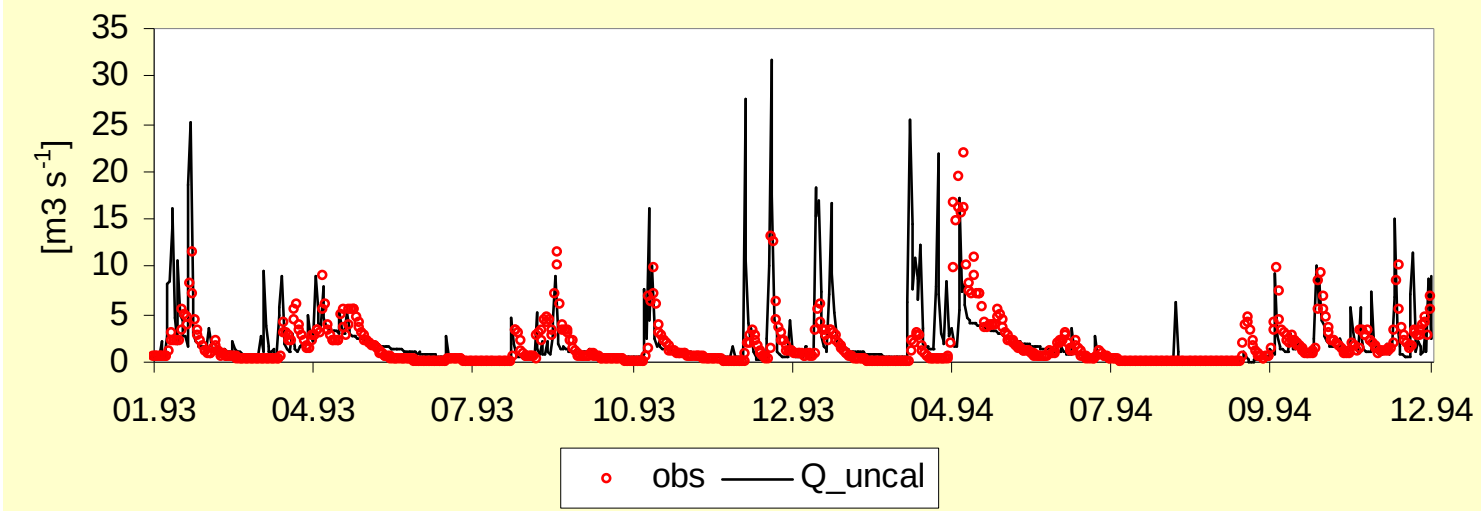
267
HRU’s

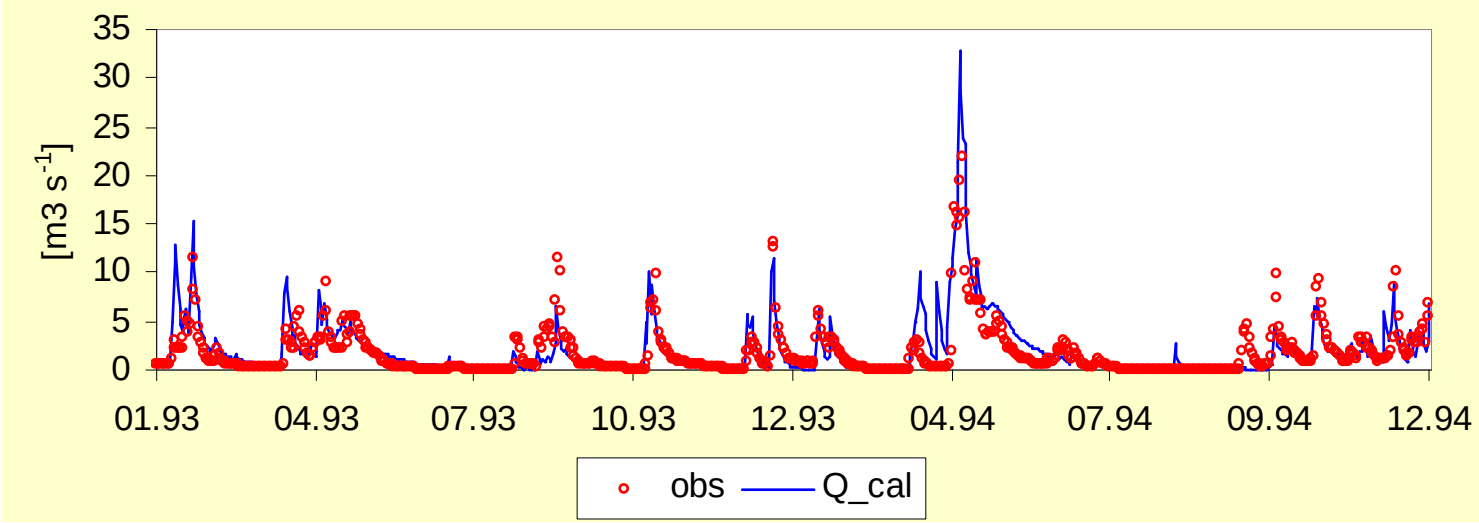


Calibration at Vanhakartano

No.	Parameter	Starting value	End value	Calibrated against
1	SFTMP	-3.2	-0.2	discharge
2	SMTMP	-0.3	-0.1	discharge
3	SNOCOVMX	1	10	discharge
4	SURLAG	4	1	discharge
5	GW_DELAY	31	25	discharge
6	RECHRG_DP	0	0.1	discharge
7	CANMX (forest)	5 & 10	50 & 70	discharge
8	T_BASE (forest)	2, 5	0	discharge
9	BLAI (forest)	5	9	discharge
10	PHU (forest)	2000, 2500	3500	discharge
11	OV_N (agricultural land)	0.04	0.19	discharge
12	CH_N (tributaries)	0.05	0.08	discharge
13	GDRAIN	12	48	discharge
14	PRF	0.8	1	sediment conc.
15	CN2 (forest on clay, silt and turf)	78, 77, 70	55	discharge, NO_{23}-N
16	CN2 (forest on moraine, open rock)	25	34	discharge, NO_{23}-N
17	CN2 (agricultural land on clay)	83	70	discharge, NO_{23}-N
18	CN2 (agricultural land on clay, tillage)	83, 89	75	discharge, NO_{23}-N
19	CLAY (agric. subsoil, clay)	74	55	discharge, NO_{23}-N
20	BD (agric. subsoil, clay)	1.1	1.3	discharge, NO_{23}-N
21	AWC (agric. subsoil, clay)	0.25	0.17	discharge, NO_{23}-N
22	CLAY (agric. subsoil & forest topsoil, turf)	33	3	discharge, NO_{23}-N
23	AWC (agric. subsoil & forest topsoil, turf)	0.60	0.50	discharge, NO_{23}-N
24	NPERCO	0.2	0.9	NO_{23}-N
25	MINPCNST (point sources)	*1	*0.25	PO_4-P
26	SOL_LABP1 (moraine, clay)	30, 40	20, 30	PO_4-P
27	ORGPCNST (point sources)	*1	*0.25	total P
28	SOL_ORGP1 (all soils)	465	207 (calc. intern.)	total P

Calibration





Nash-Suthcliffe coefficient –0.66 => 0.43

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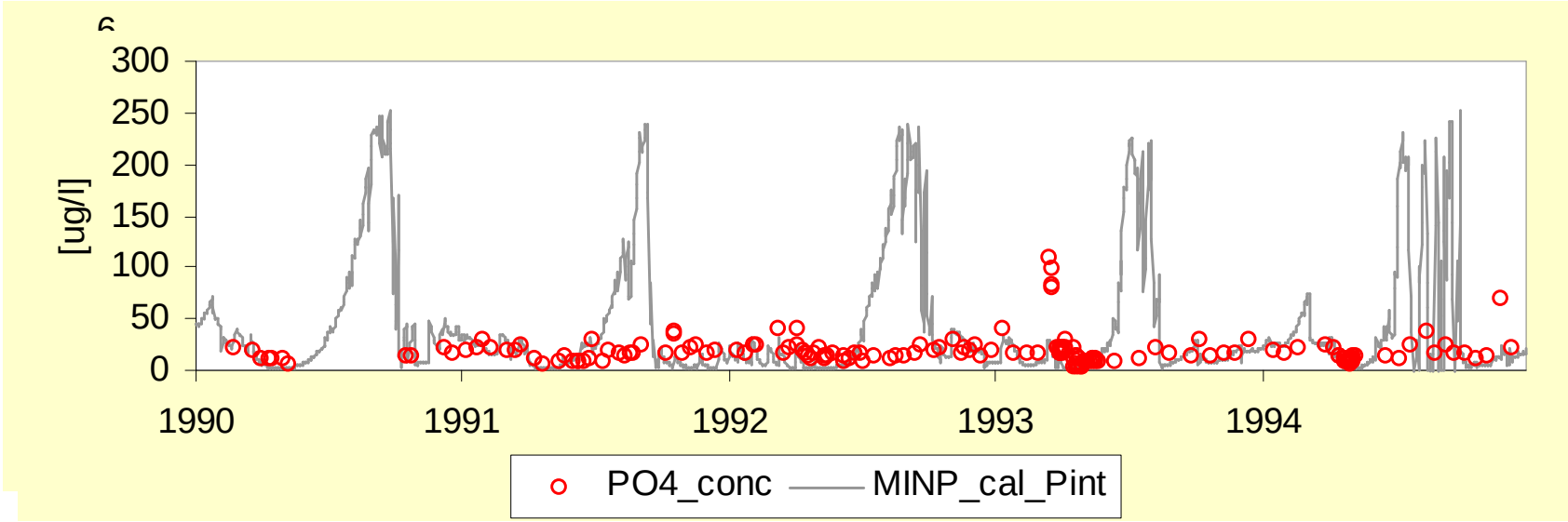
Calibration at Vanhakartano

Variable	NSI	R^2	n
discharge	0.43	0.57	1826
sediment load	-0.11	0.21	172
sediment conc.	0.01	0.20	172
NH_4-N load	0.01	0.02	124
NH_4-N conc.	-263	0.02	124
NO_{23}-N load	0.16	0.14	95
NO_{23}-N conc.	-0.11	0.22	95

Variable	NSI	R^2	n
total N load	0.32	0.46	180
total N conc.	-2.2	0.01	180
PO_4-P load	0.15	0.29	171
PO_4-P conc.	-9.3	0.03	171
total P load	0.01	0.13	191
total P conc.	-2.0	0.07	191



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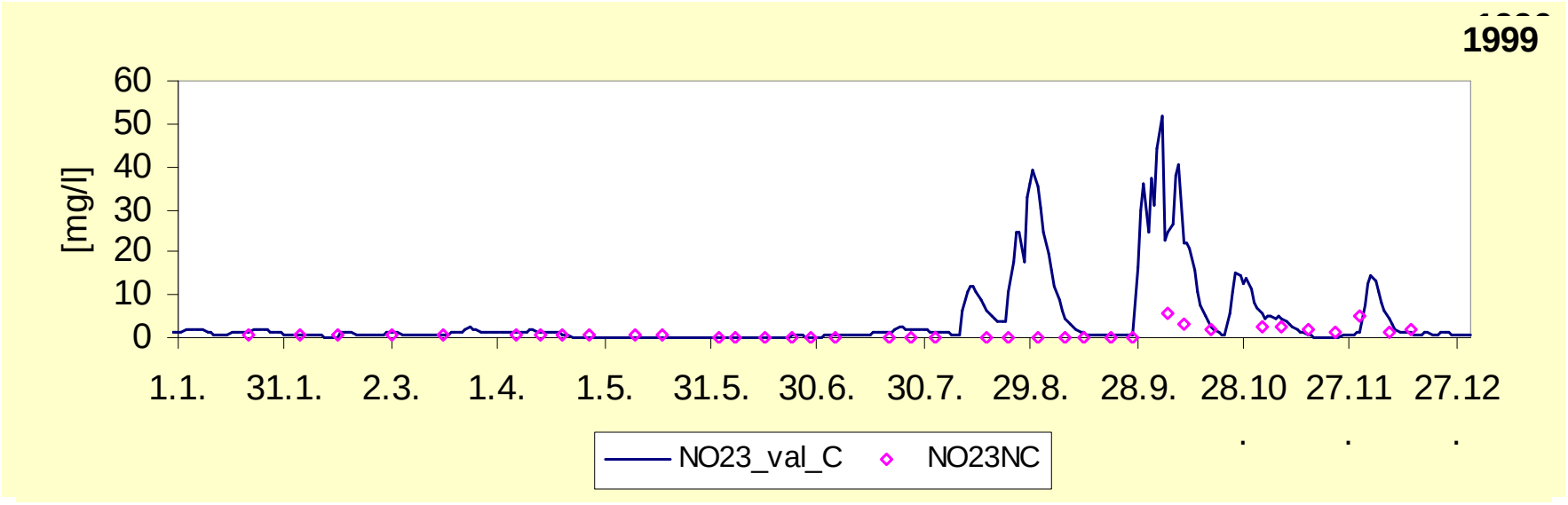
Validation (attempt) at Vanhakartano

Variable	NSI	R^2	n
Q (1995-1999)	0.18	0.32	1826
Q (1985-1989)	0.24	0.42	1826
sediment load	-0.18	0.21	191
sediment conc	0.10	0.11	191
NH_4-N load	0.0	0.00	155
NH_4-N conc	-401	0.01	155
NO_{23}-N load	-8.3	0.37	157

Variable	NSI	R^2	n
NO_{23}-N conc	-53	0.03	157
totN load	-2.7	0.33	191
totN conc	-34	0.07	191
PO_4-P load	-0.39	0.10	181
PO_4-P conc	-17	0.01	181
totP load	-3.5	0.05	189
totP conc	-21	0.00	189



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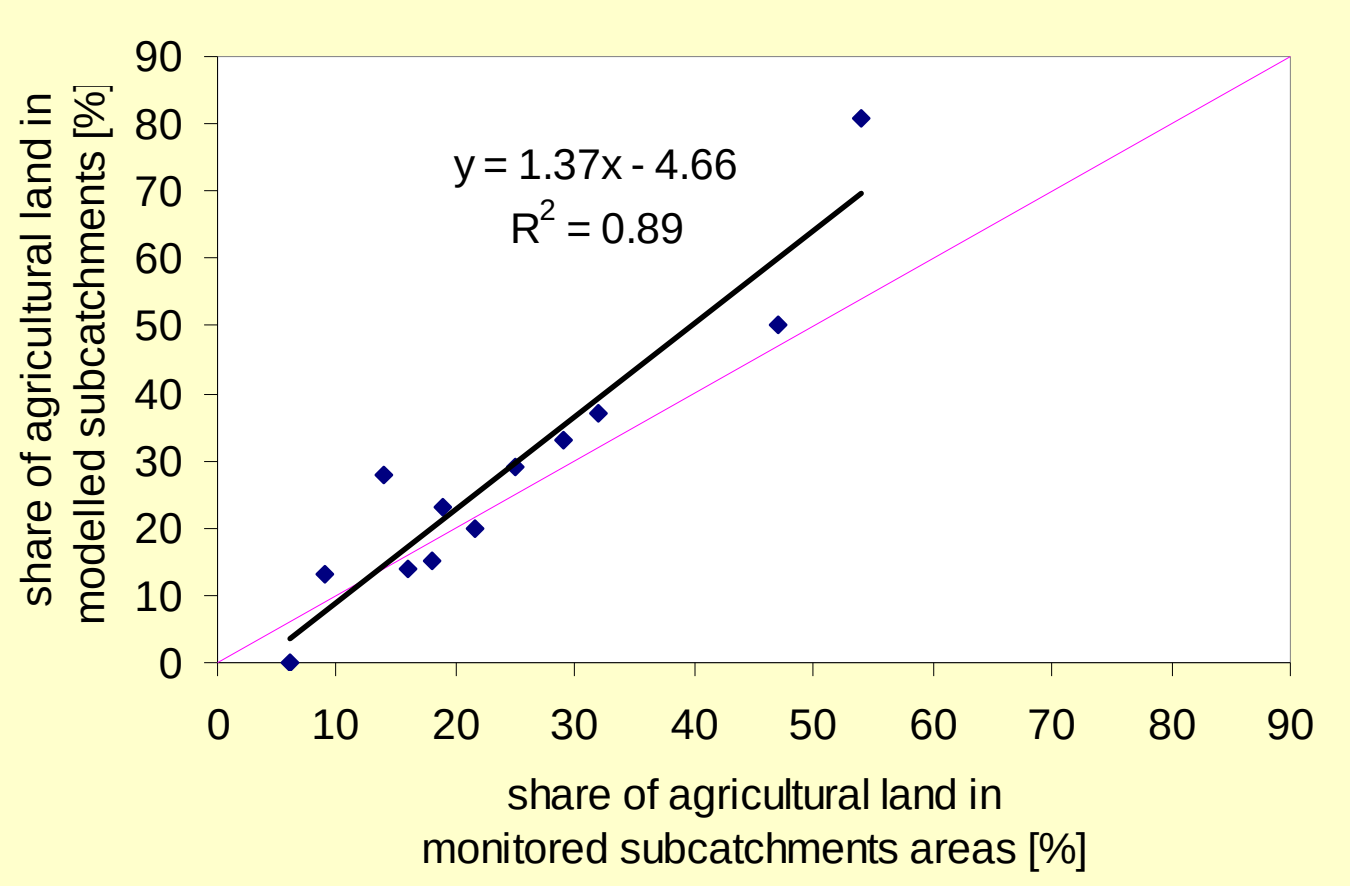
Relationship between agricltural land in monitored and simulated subcatchments



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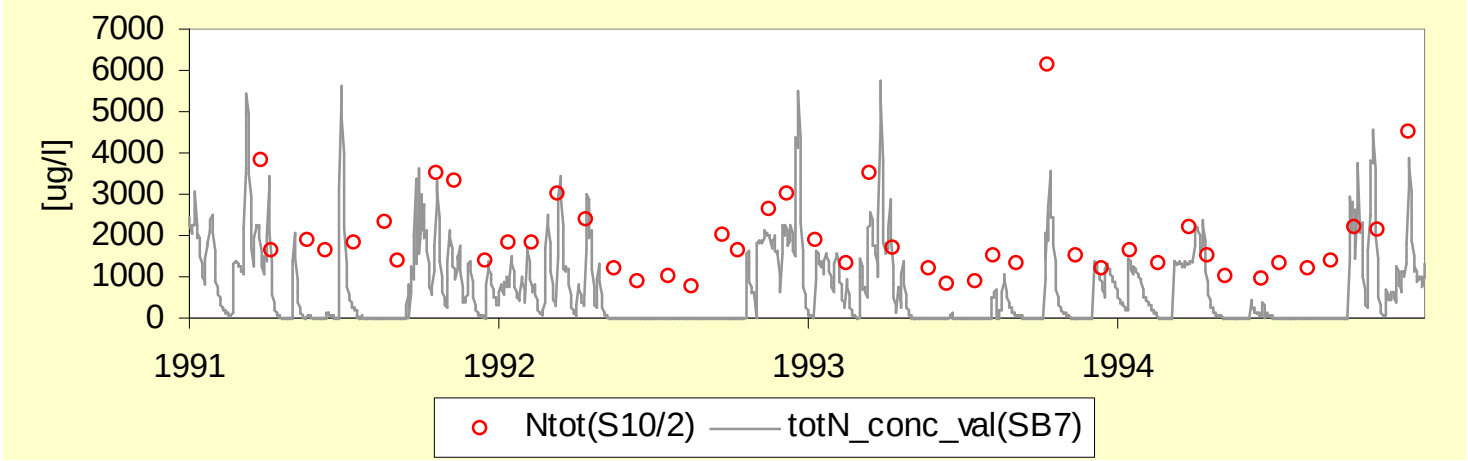
Validation (attempt) at subcatchment level

AGR



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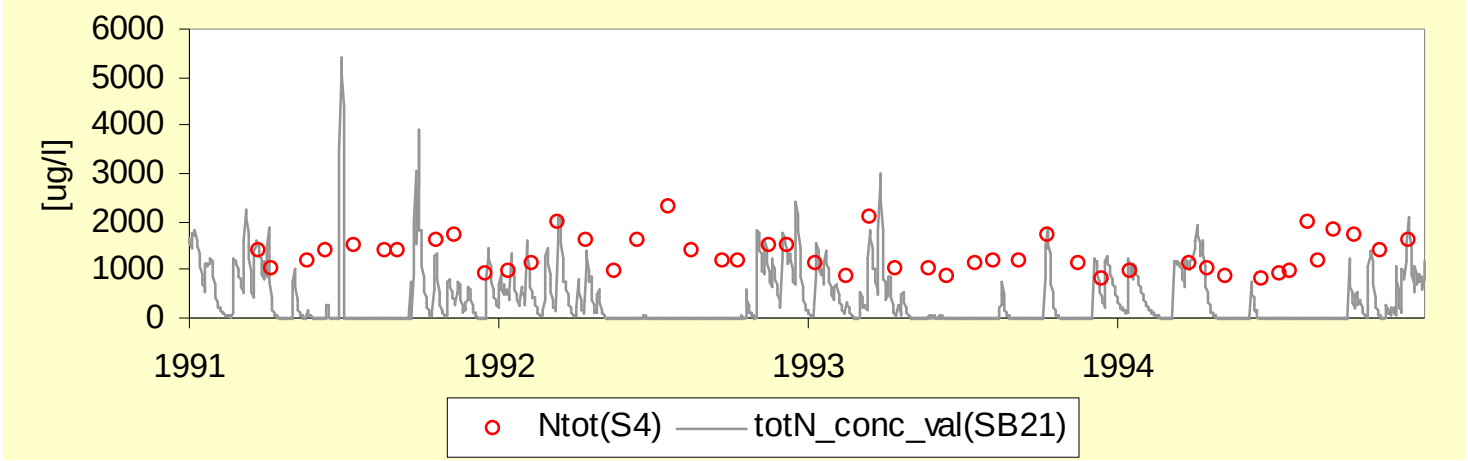

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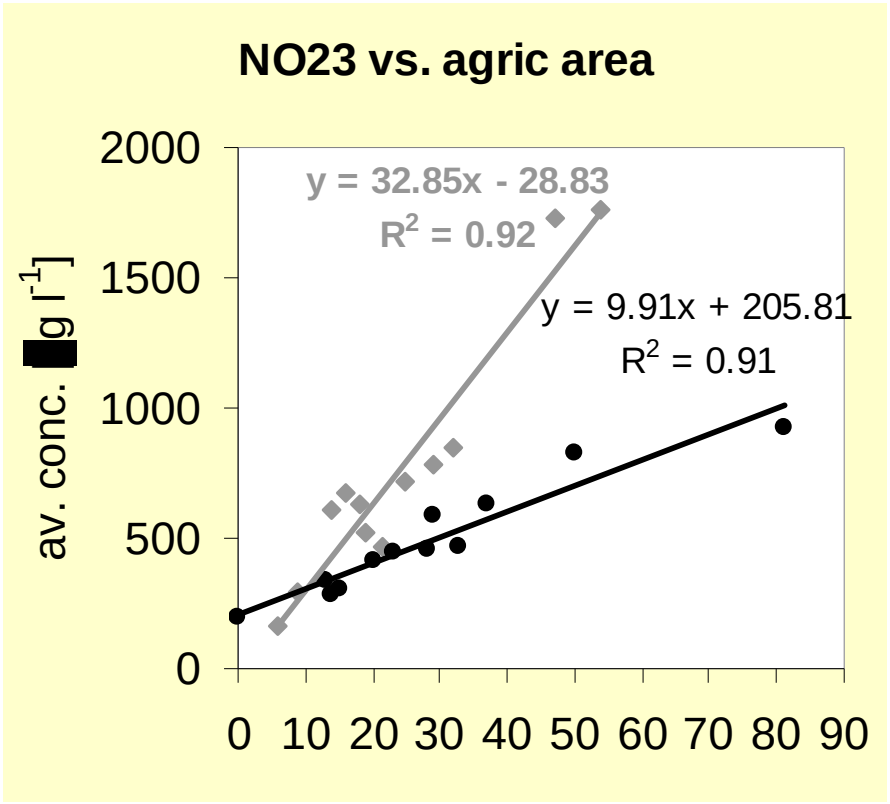
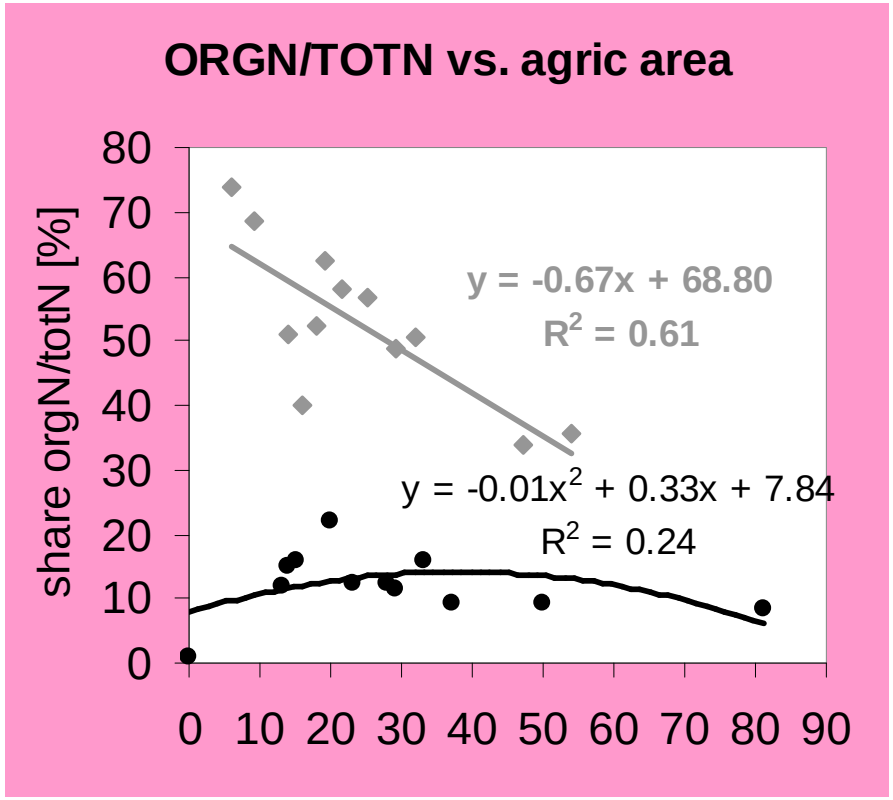
Relationship to % agricultural land





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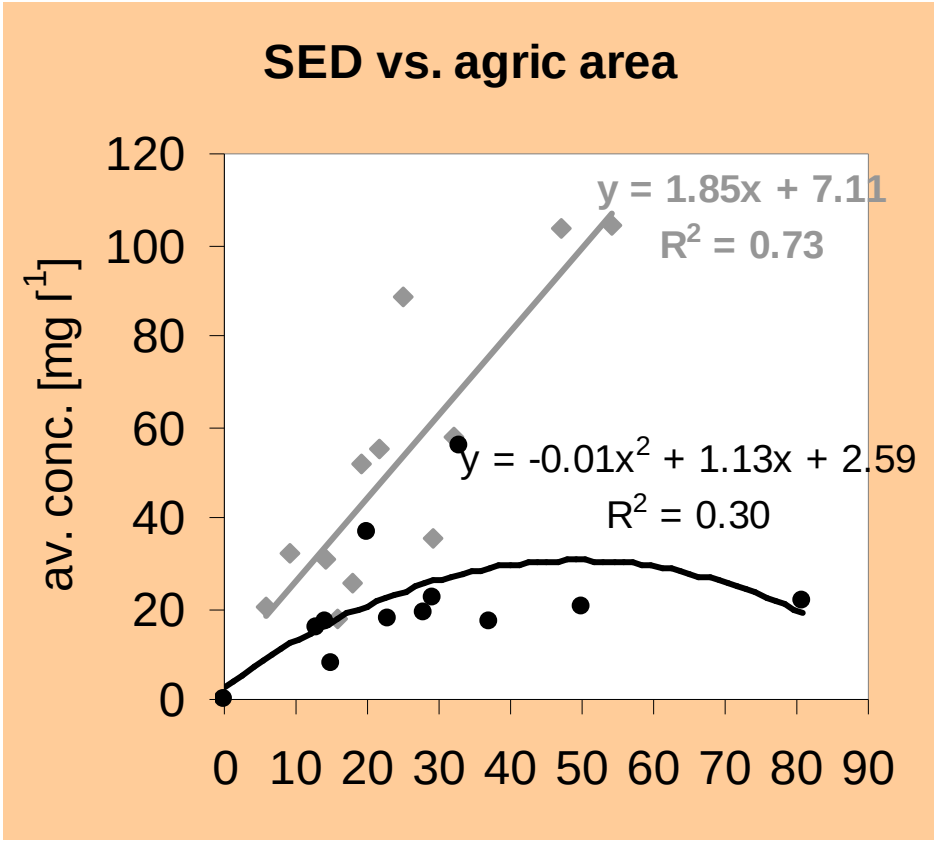
Relationship to % agricultural land



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Sensitivity analysis

par	Q	par	SED	par	orgN	par	orgP	par	NO3	par	minP
rchrg_dp	H	ch_n	VH	TIMP	VH	TIMP	VH	NPERCO	VH	TIMP	VH
ESCO	H	CH_COV	VH	surlag	VH	surlag	VH	gwno3	VH	surlag	VH
SOL_AWC	H	surlag	VH	SMTMP	VH	SMTMP	VH	rchrg_dp	H	SMTMP	VH
GWQMN	H	SMFMN	H	SMFMX	VH	SMFMX	H	SOL_AWC	H	SOL_LABP	VH
SMTMP	H	SMFMX	H	SMFMN	H	SMFMN	H	GWQMN	H	SMFMX	H
		CH_EROD	H	SOL_AWC	H	SOL_AWC	H	ESCO	H	SMFMN	H
		SOL_AWC	H	sol_z	H	sol_z	H	SMTMP	H	BIOMIX	H
		TIMP	H	sol_k	H	CN2	H	GW_REVAP	H	SOL_AWC	H
		rchrg_dp	H	CN2	H	BIOMIX	H			CN2	H
		ESCO	H	ESCO	H	sol_k	H			ESCO	H
		SMTMP	H	SFTMP	H	ESCO	H			sol_z	H
		SPEXP	H	BIOMIX	H	SFTMP	H			sol_k	H
		SFTMP	H	SLSUBBSN	H	SOL_LABP	H			canmx	H
										SFTMP	H
										epco	H

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Conclusions and outlook

Further calibration and validation required
⇒ need to understand the model better!
⇒ HRU and subcatchment scale
⇒ sensitivity analysis

Organic soils, forested areas, erosion, snow accumulation and melting?
⇒ “the Nordic dimension”

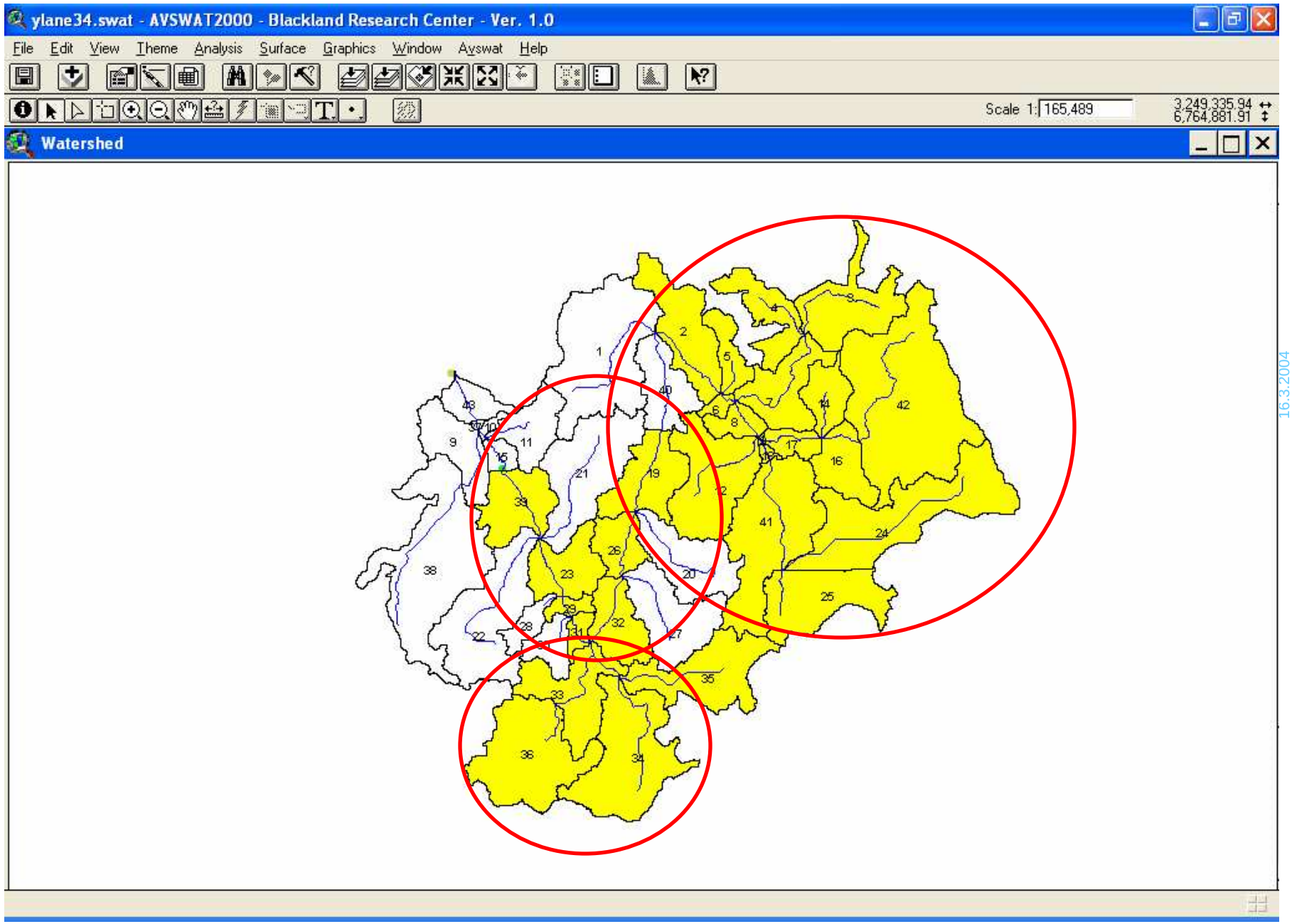
New project application
⇒ €€€

Applicability for WFD purposes in Finland?

Dialog between water manager and model user!

Management options …

PS.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3,249,335.94
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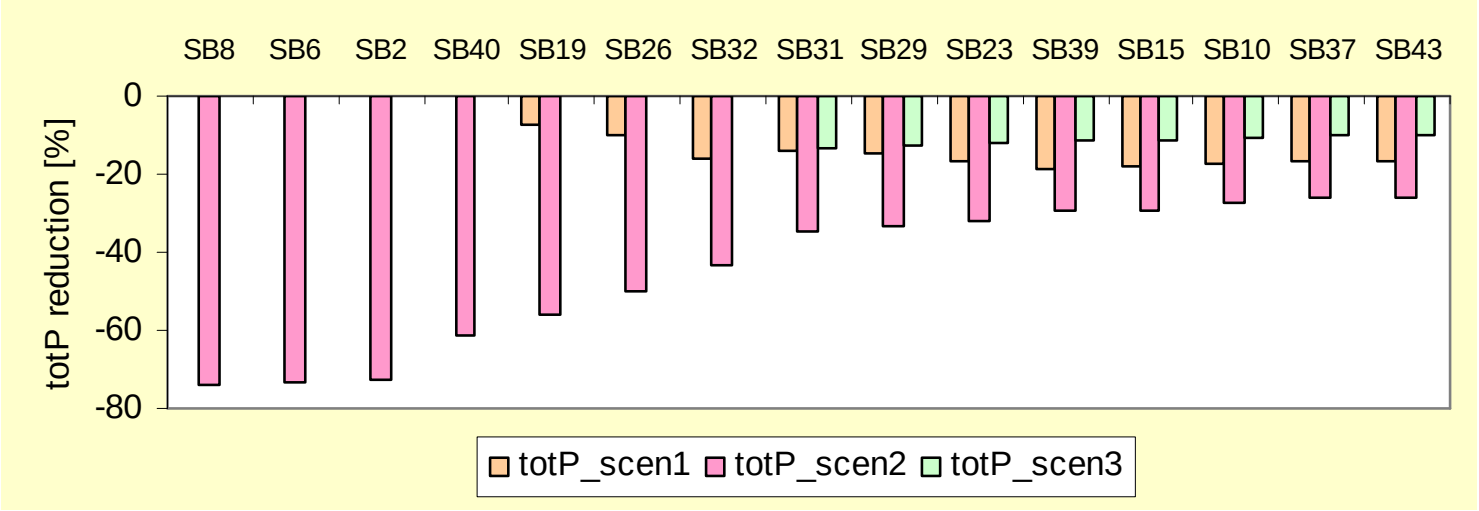
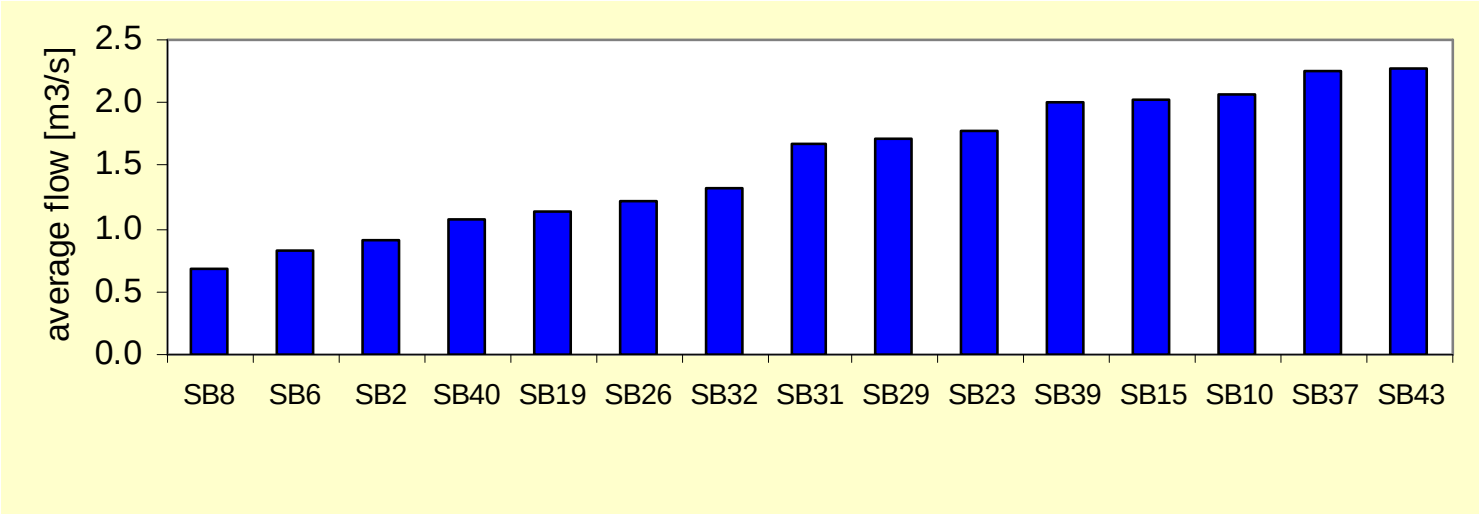
PS.





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Kuva: Aulis Jämsä