The impact of climate change on nutrient flows in the catchment of the River Kokemäenjoki

Heikki Kaipainen, Tom Frisk, Ämer Bilaletdin, & Jari Rauhala
Pirkanmaa Regional Environment Centre
Tampere, Finland

PIRKANMAA
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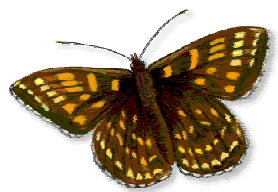


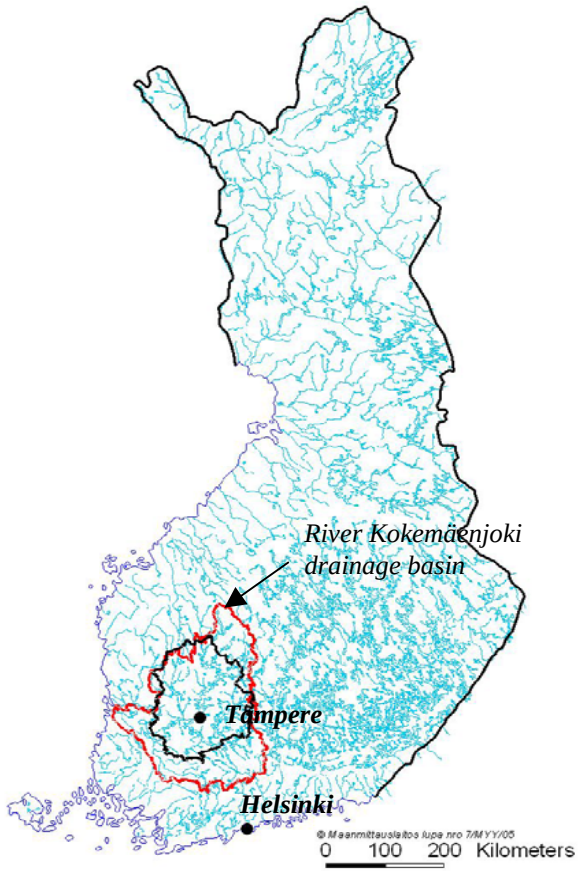
INTRODUCTION

In the case study, **the impacts of climate change on nutrient flows into lakes and to the Baltic Sea** from the drainage basin of River Kokemäenjoki are estimated.

Eutrophication of the Baltic Sea and inland waters is a major environmental problem in Finland.

The reason for eutrophication is **increased input of nutrients**. Both phosphorus and nitrogen are important.

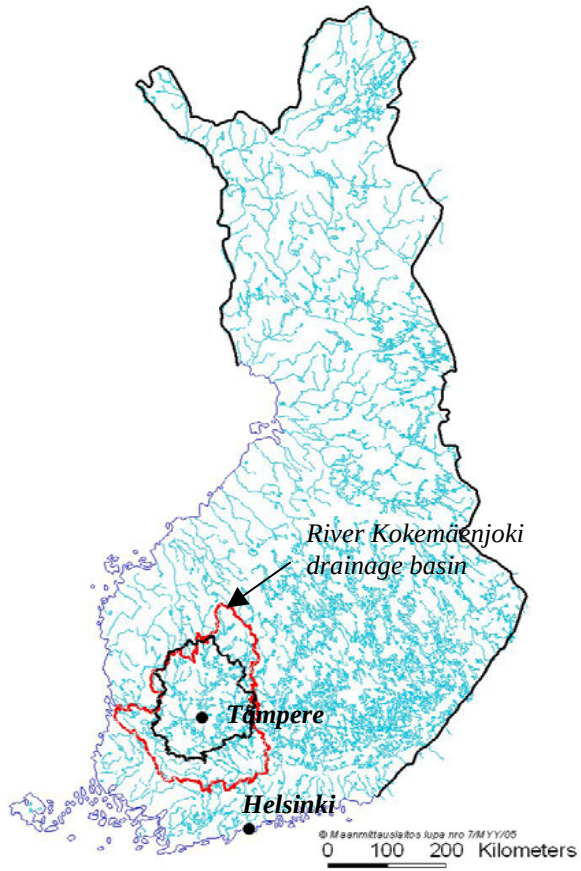
In lakes, phosphorus is a more important eutrophying factor, whereas in the Baltic Sea nitrogen is generally considered to be more important.



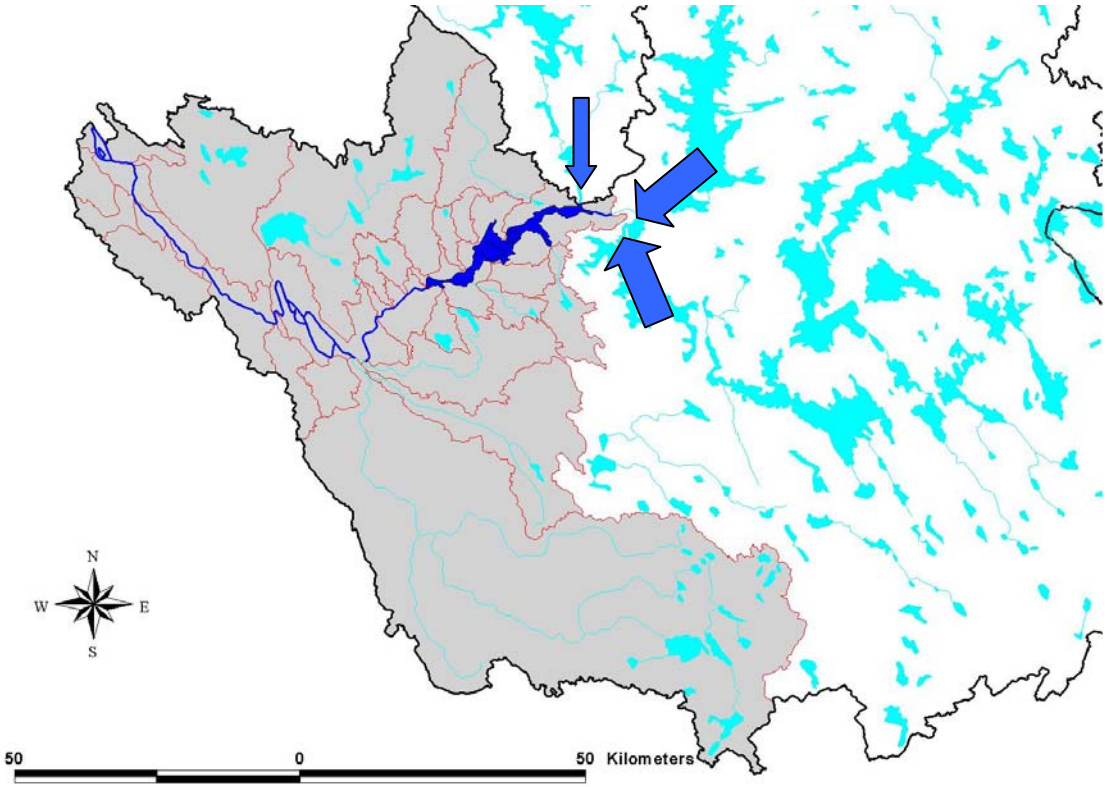
INTRODUCTION

Climate change will have great impacts on meteorological and hydrological regime and so it will also affect nutrient flows from catchments.

Quantitative assessment of this phenomenon has become possible when mathematical models have been developed for describing the different processes connected to climate change.

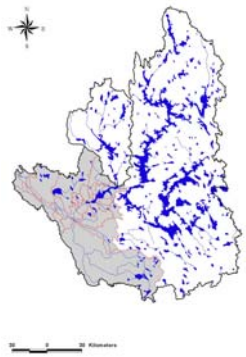


The Study Area



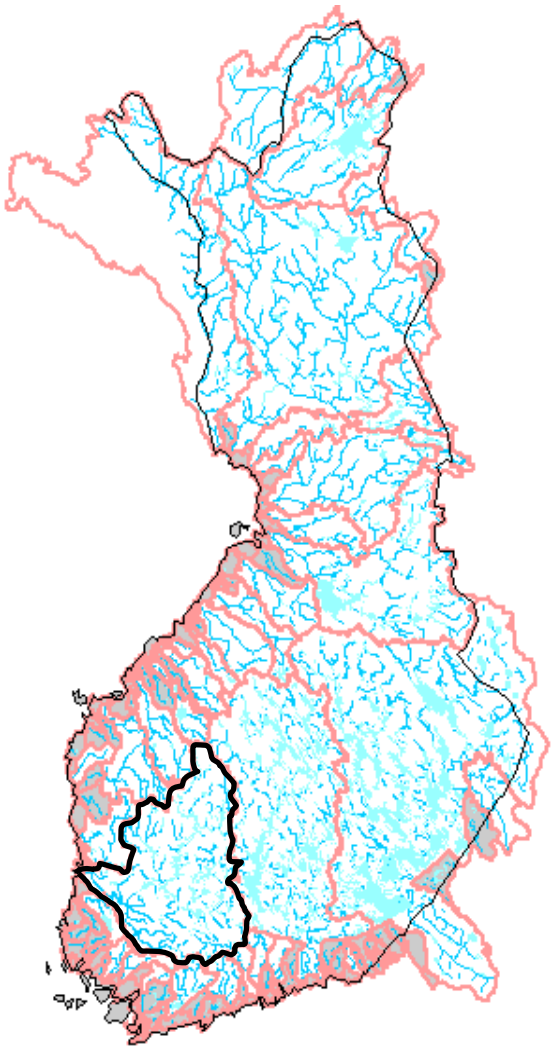
28 sub-catchments
2 lake basins
5 river sections

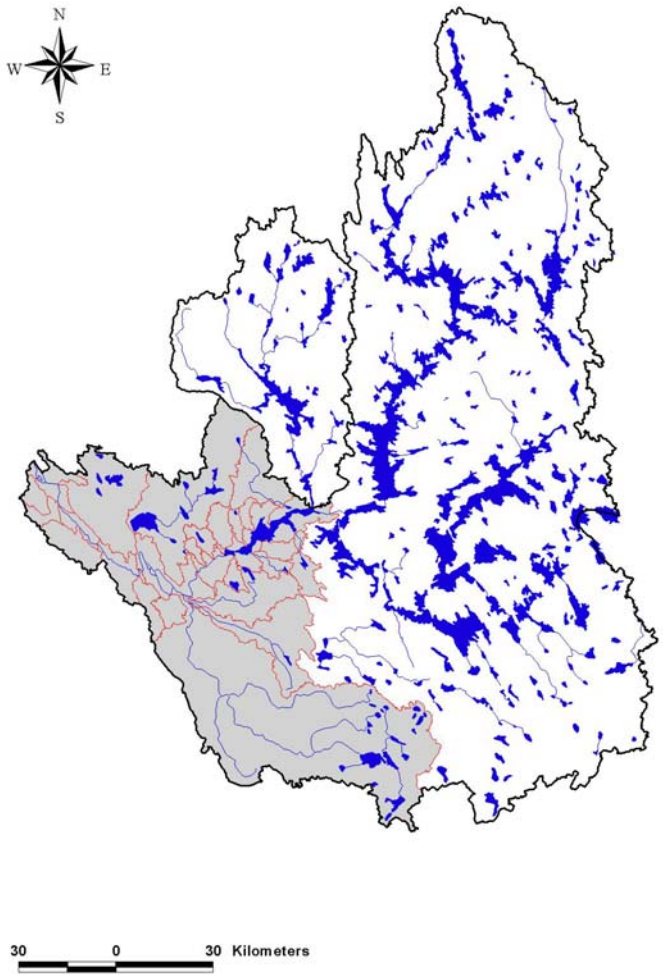
- Advection-diffusion
- Semi-distributed
- Time step 1 day



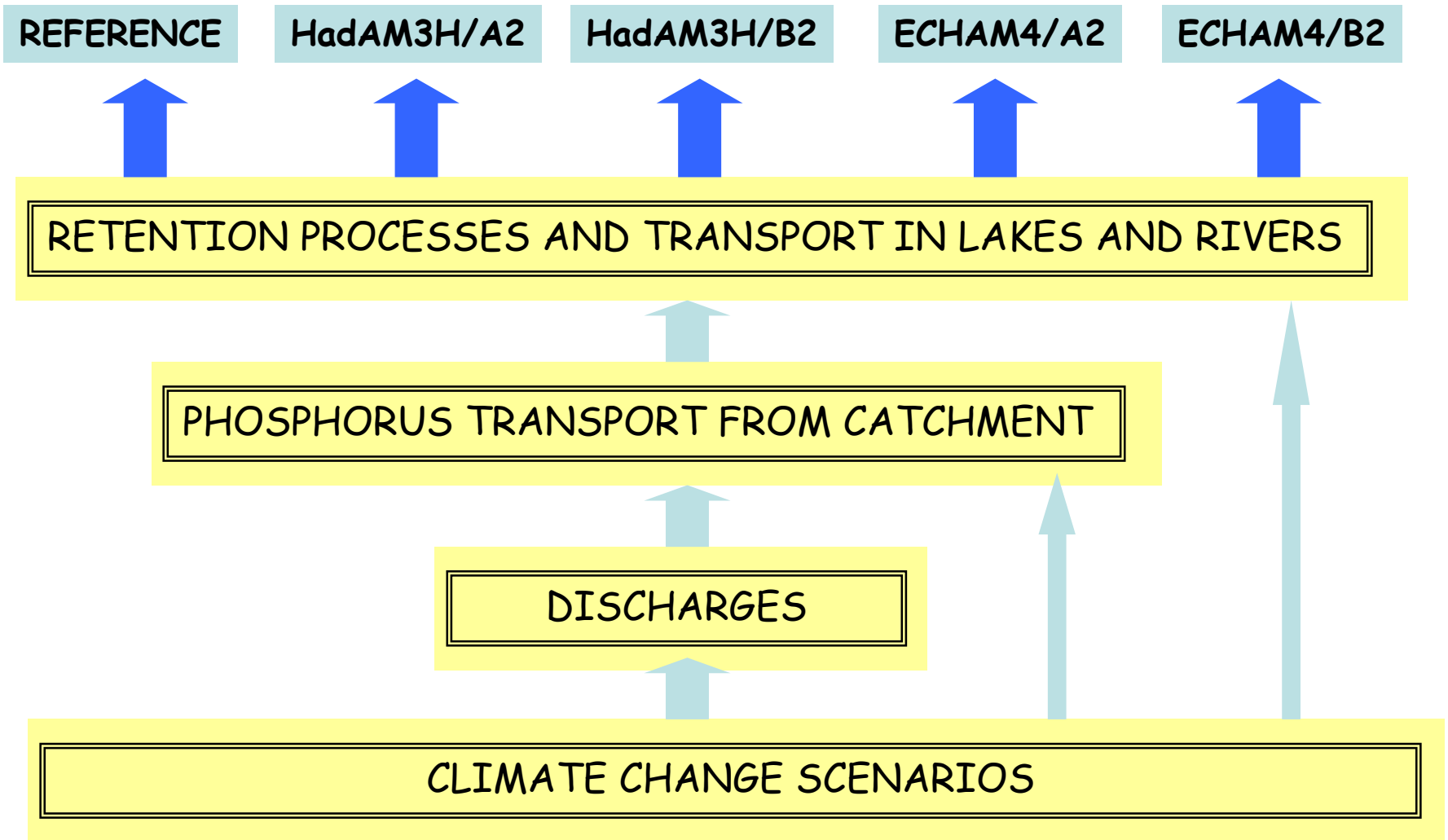
The study area, Kokemäenjoki river basin, is the fourth largest catchment in Finland with a total surface area of 27 000 km^2 and an average water discharge of 230 m^3 s^{-1}. Nutrient loading was modelled in an area that covers 26% of the entire Kokemäenjoki river basin. This area was considered to have the major effect on nutrient loading into the estuary.

The Study Area

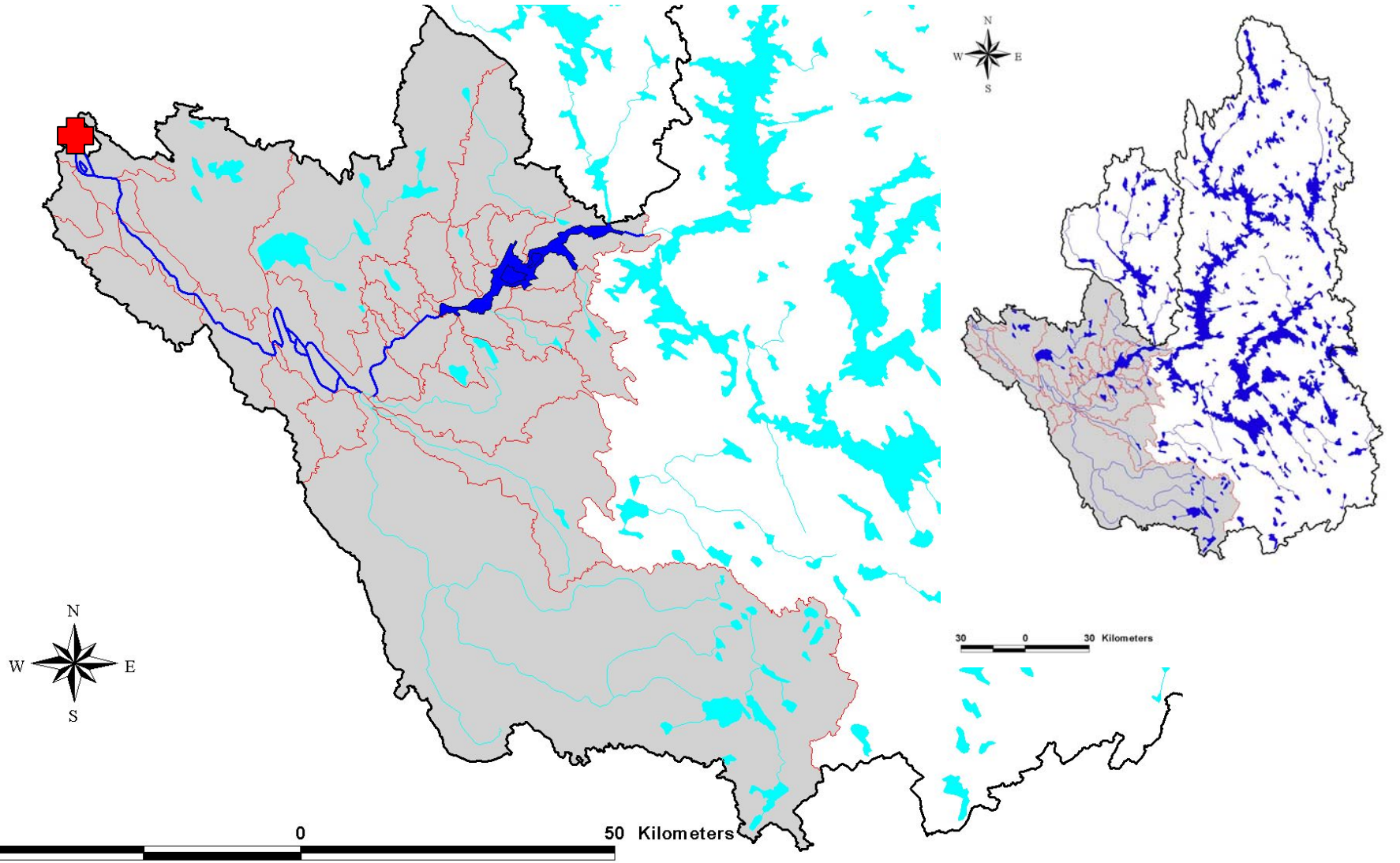




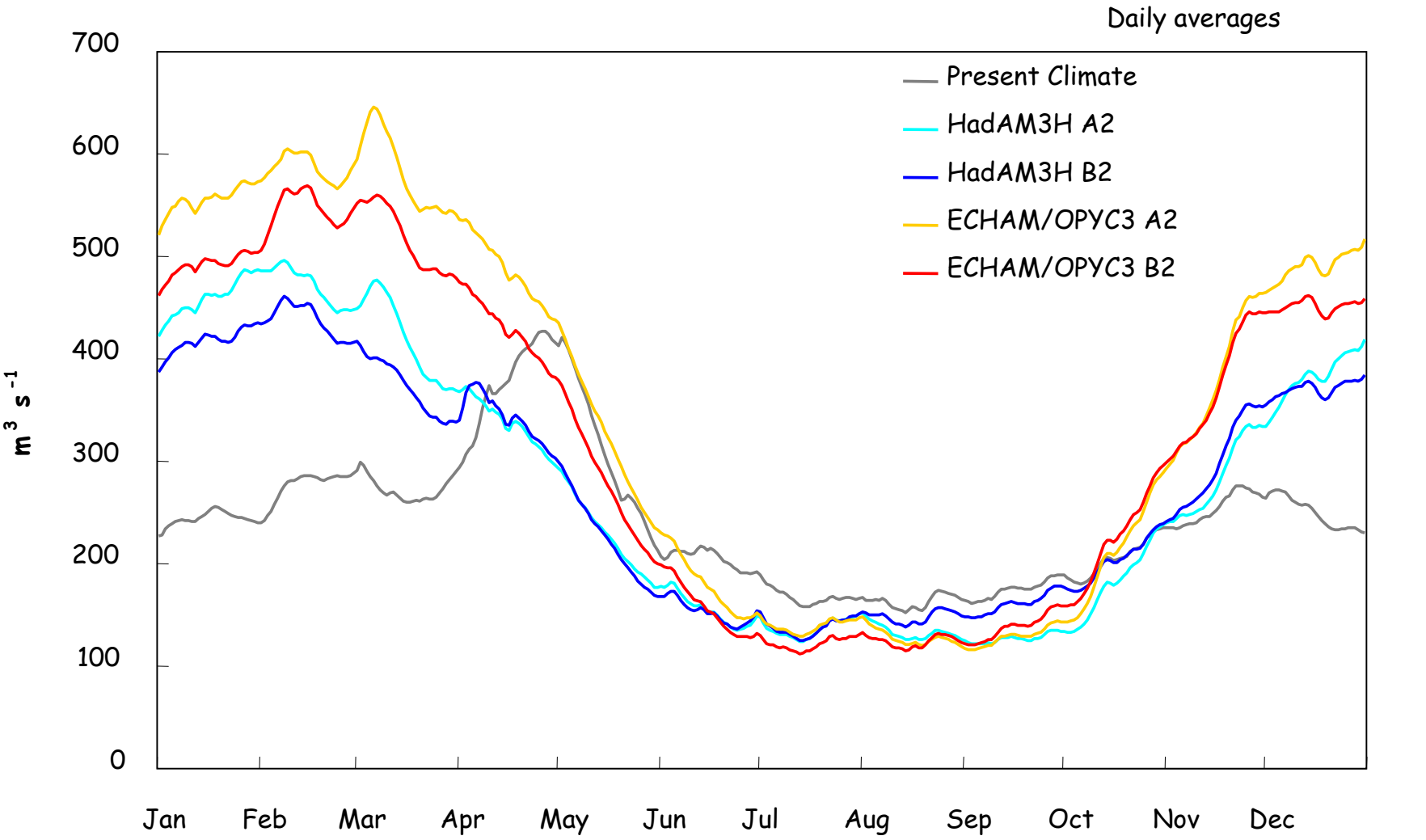
The Modelling System



Results



Discharge at the outlet of River Kokemäenjoki catchment



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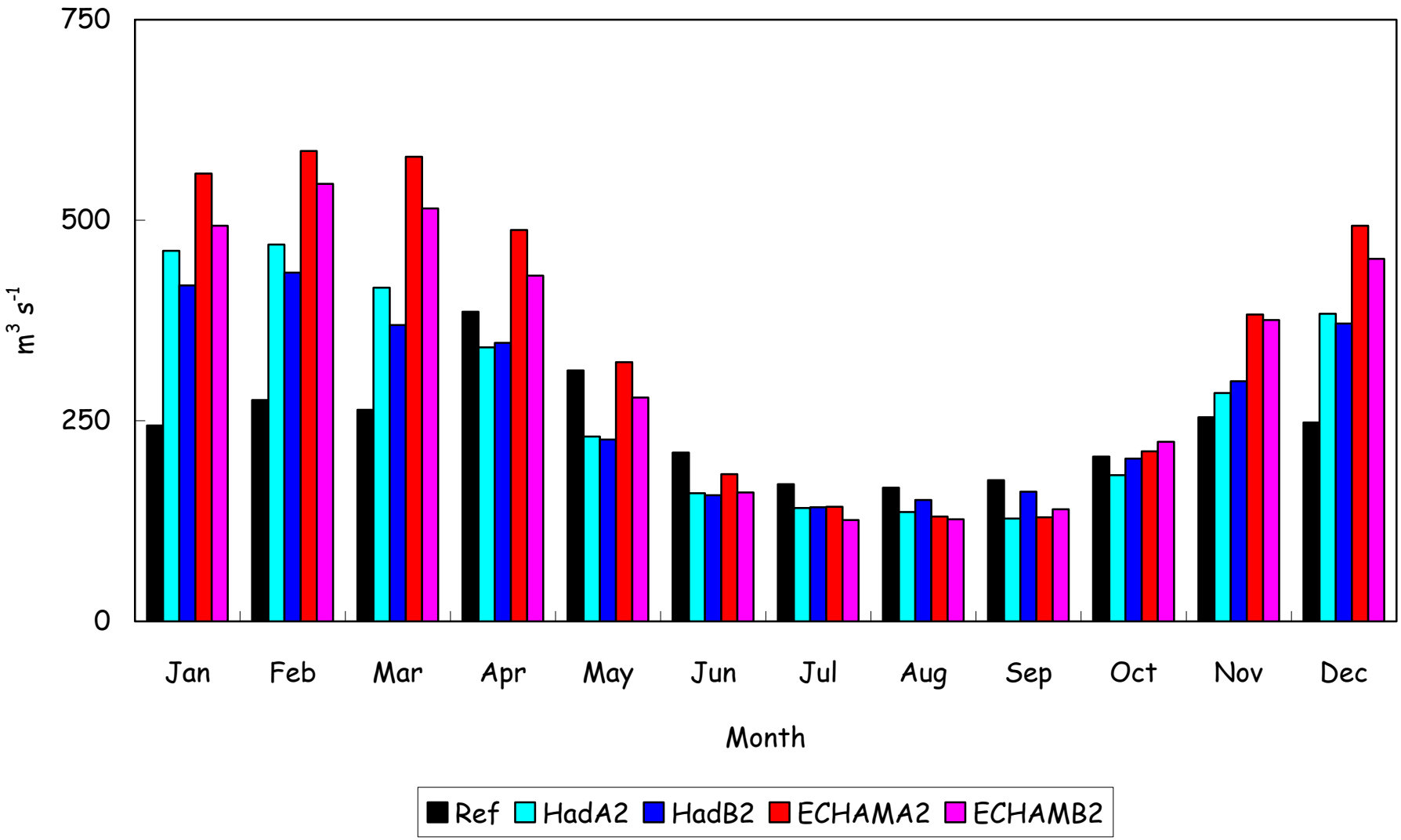
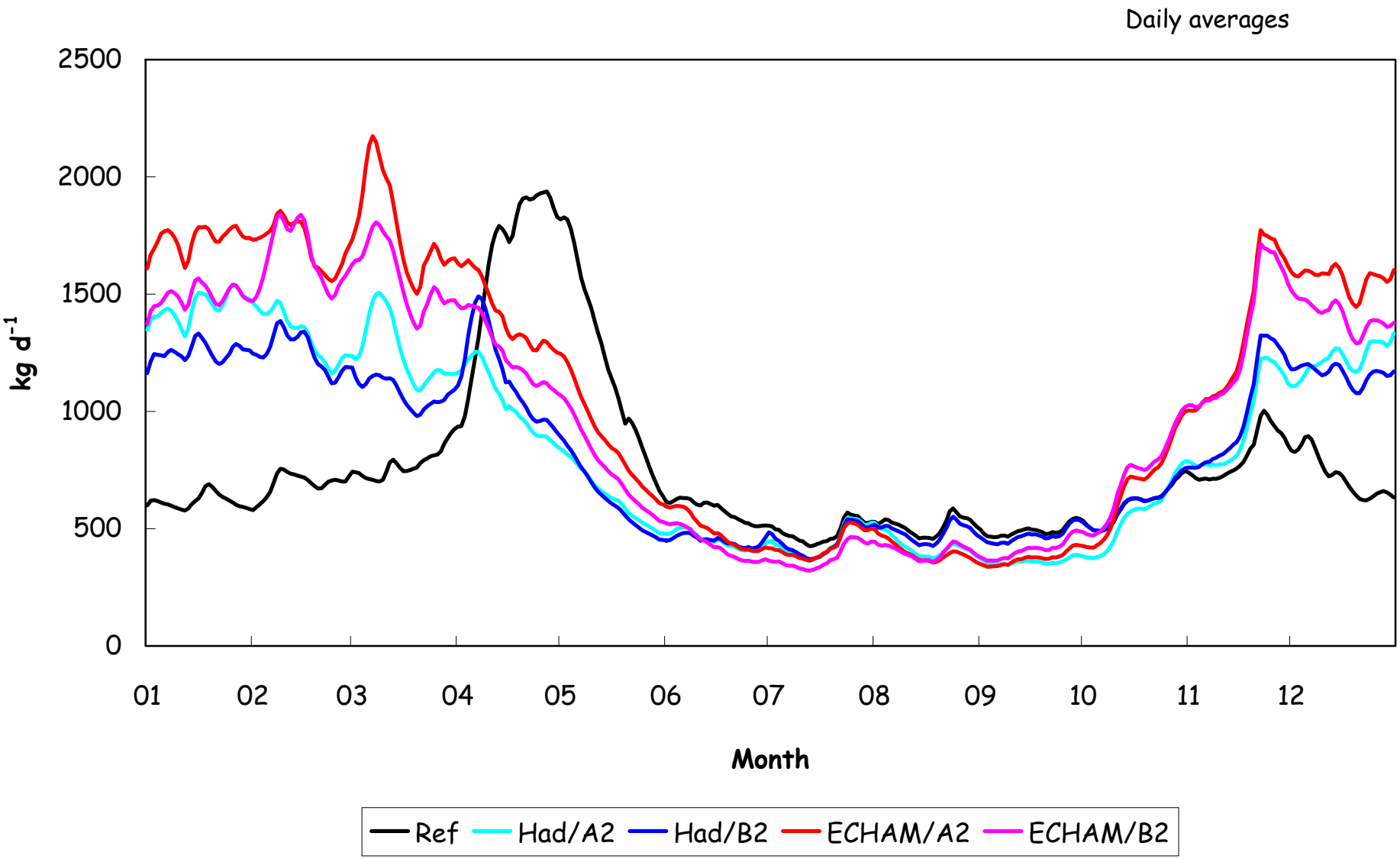


Monthly relative changes to discharge from River Kokemäenjoki catchment to Baltic Sea

Month	HadAM3H A2	HadAM3H B2	ECHAM/OPYC3 A2	ECHAM/OPYC3 B2
Jan	88 %	71 %	128 %	102 %
Feb	72 %	59 %	113 %	98 %
Mar	54 %	37 %	113 %	90 %
Apr	-10 %	-9 %	30 %	14 %
May	-26 %	-28 %	5 %	-10 %
Jun	-24 %	-25 %	-12 %	-23 %
Jul	-18 %	-18 %	-17 %	-27 %
Aug	-18 %	-9 %	-22 %	-24 %
Sep	-27 %	-8 %	-26 %	-21 %
Oct	-12 %	-1 %	2 %	8 %
Nov	11 %	17 %	49 %	46 %
Dec	53 %	48 %	97 %	81 %
	14 %	13 %	45 %	33 %

Phosphorus loading at the outlet of River Kokemäenjoki catchment



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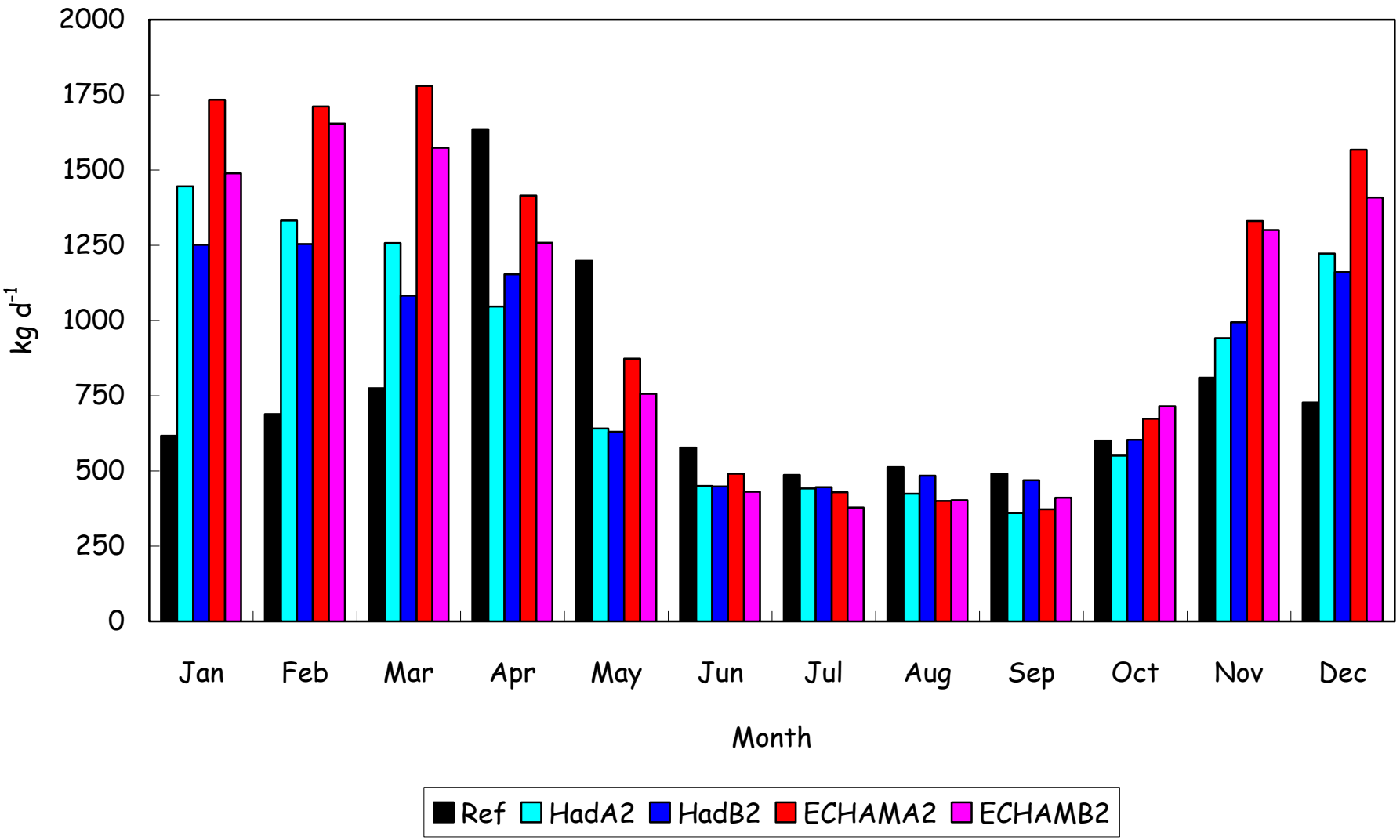

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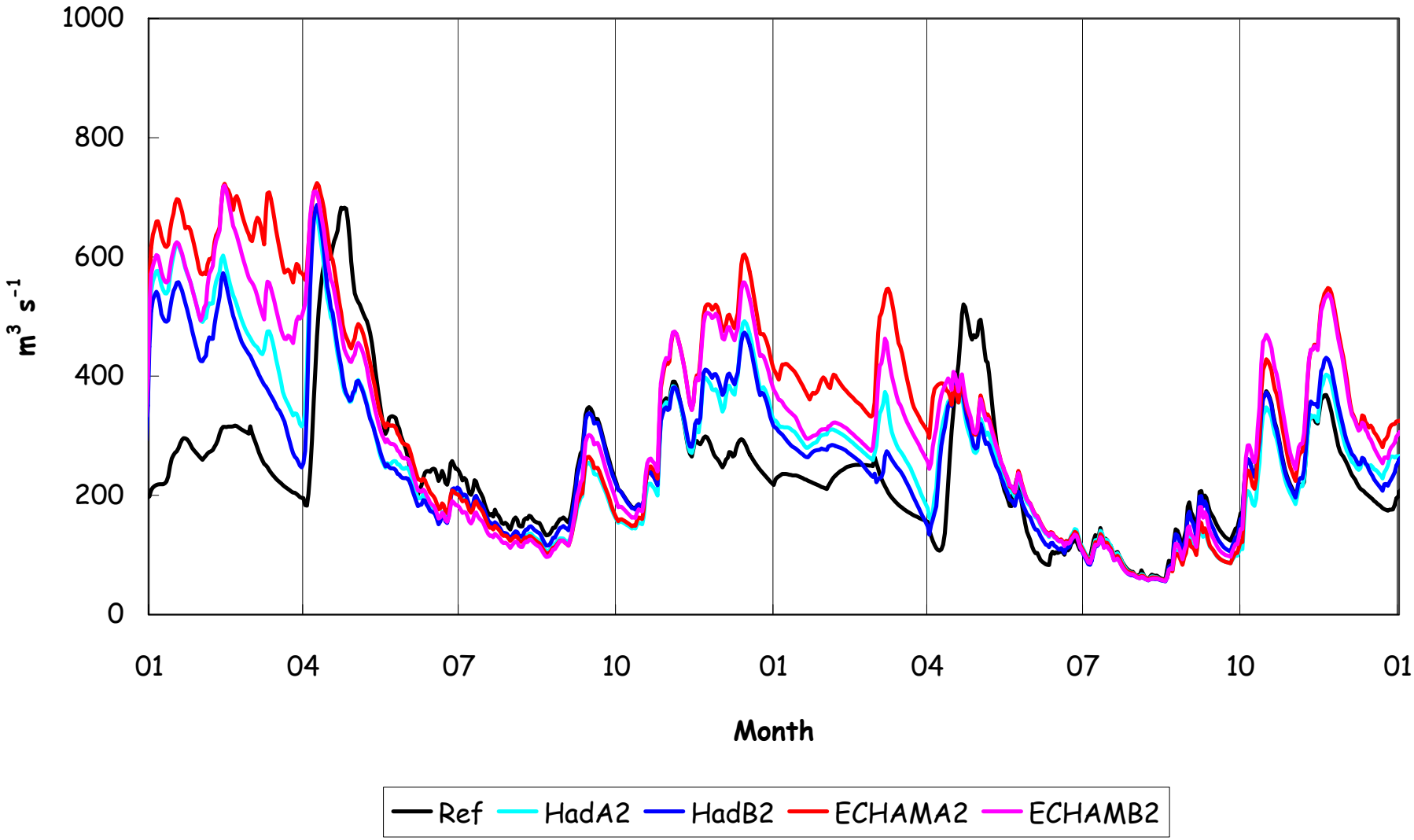

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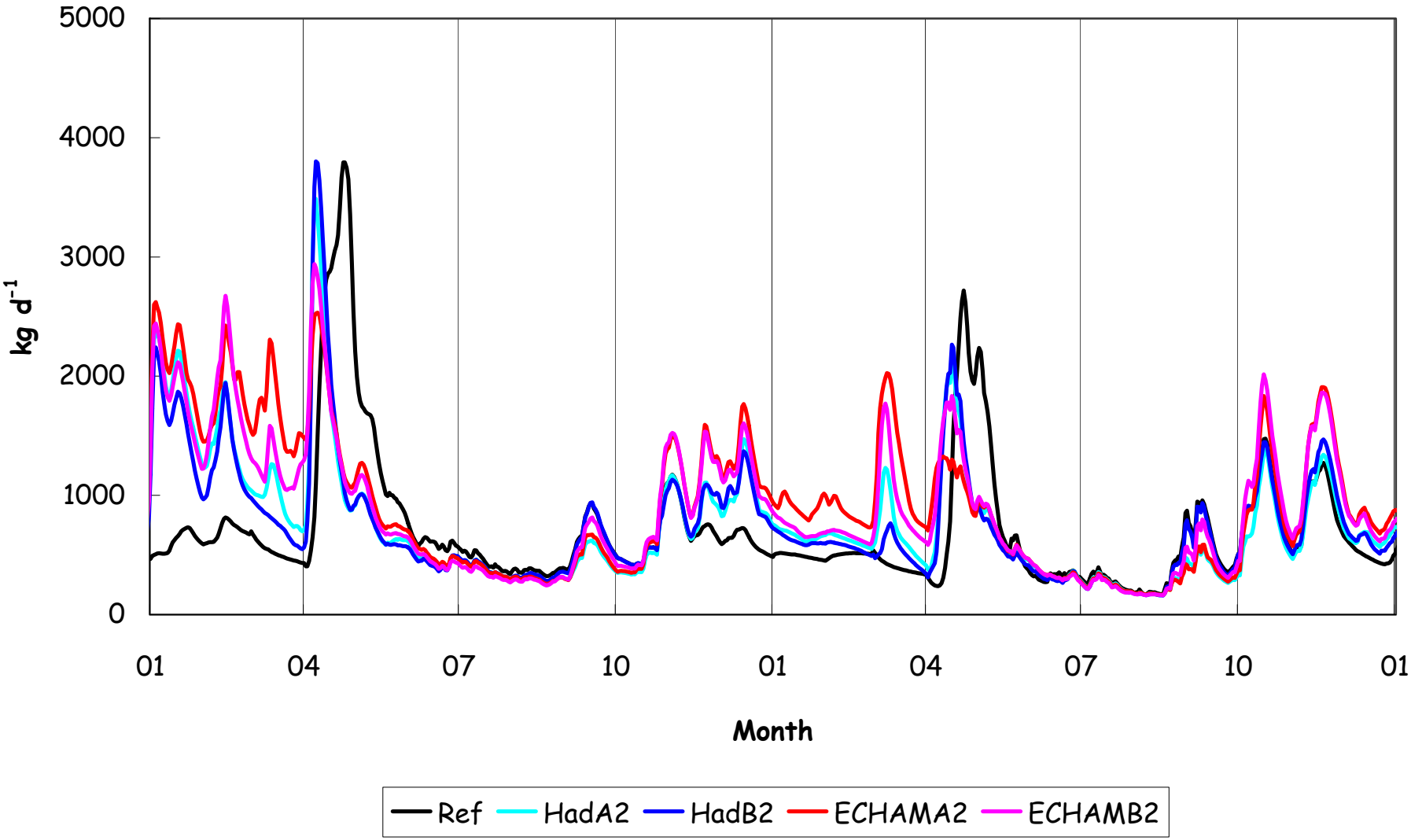
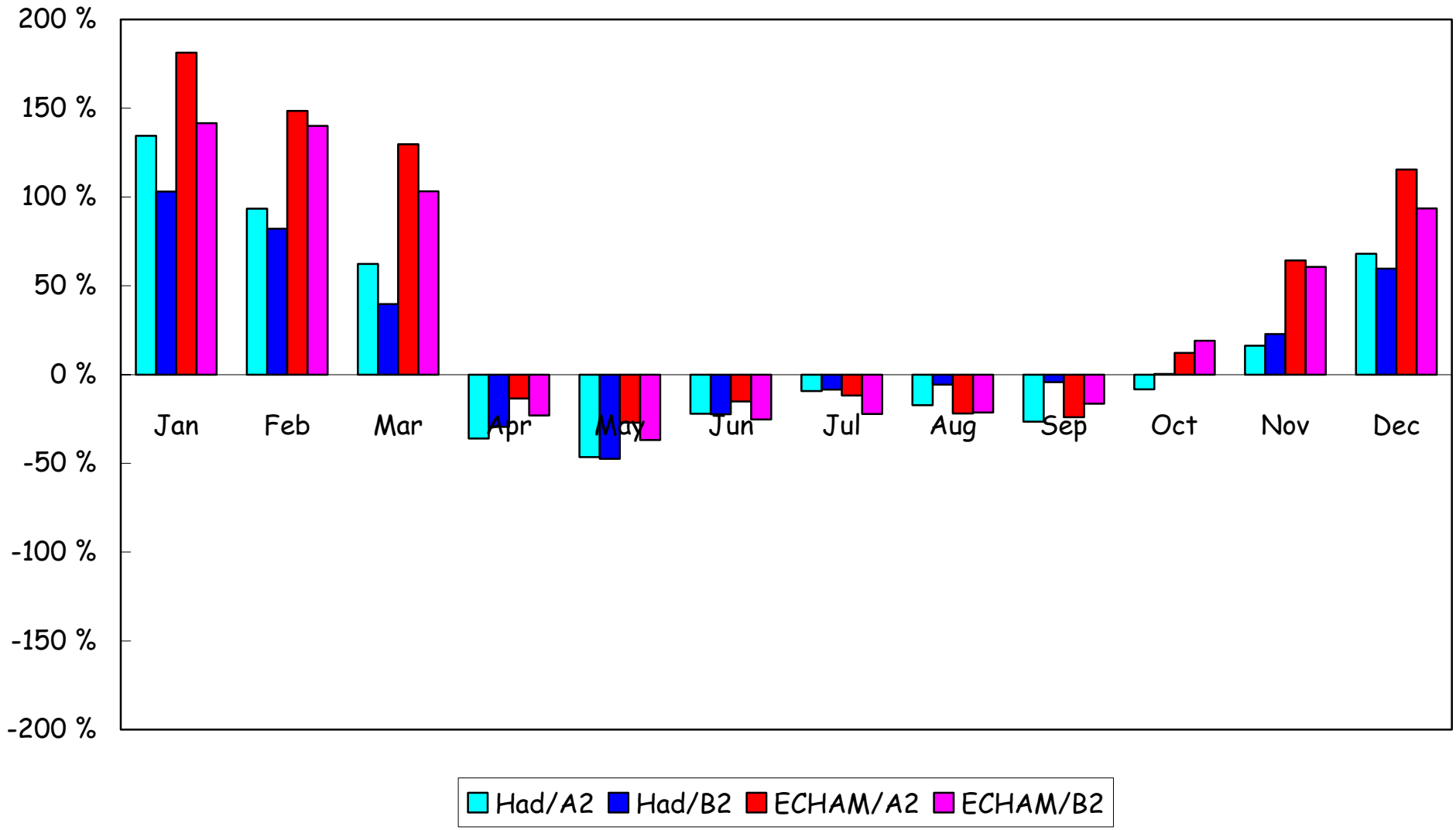
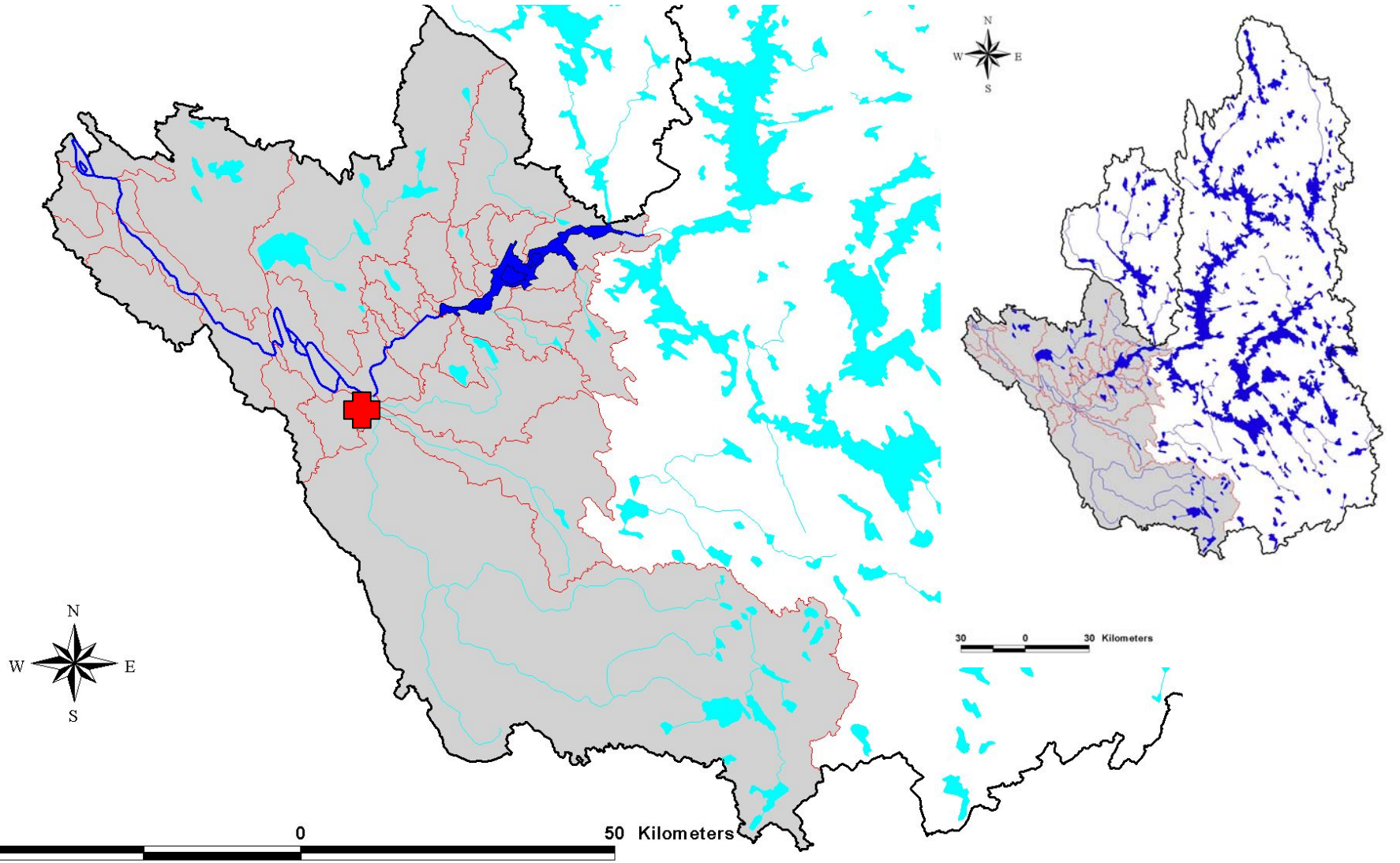


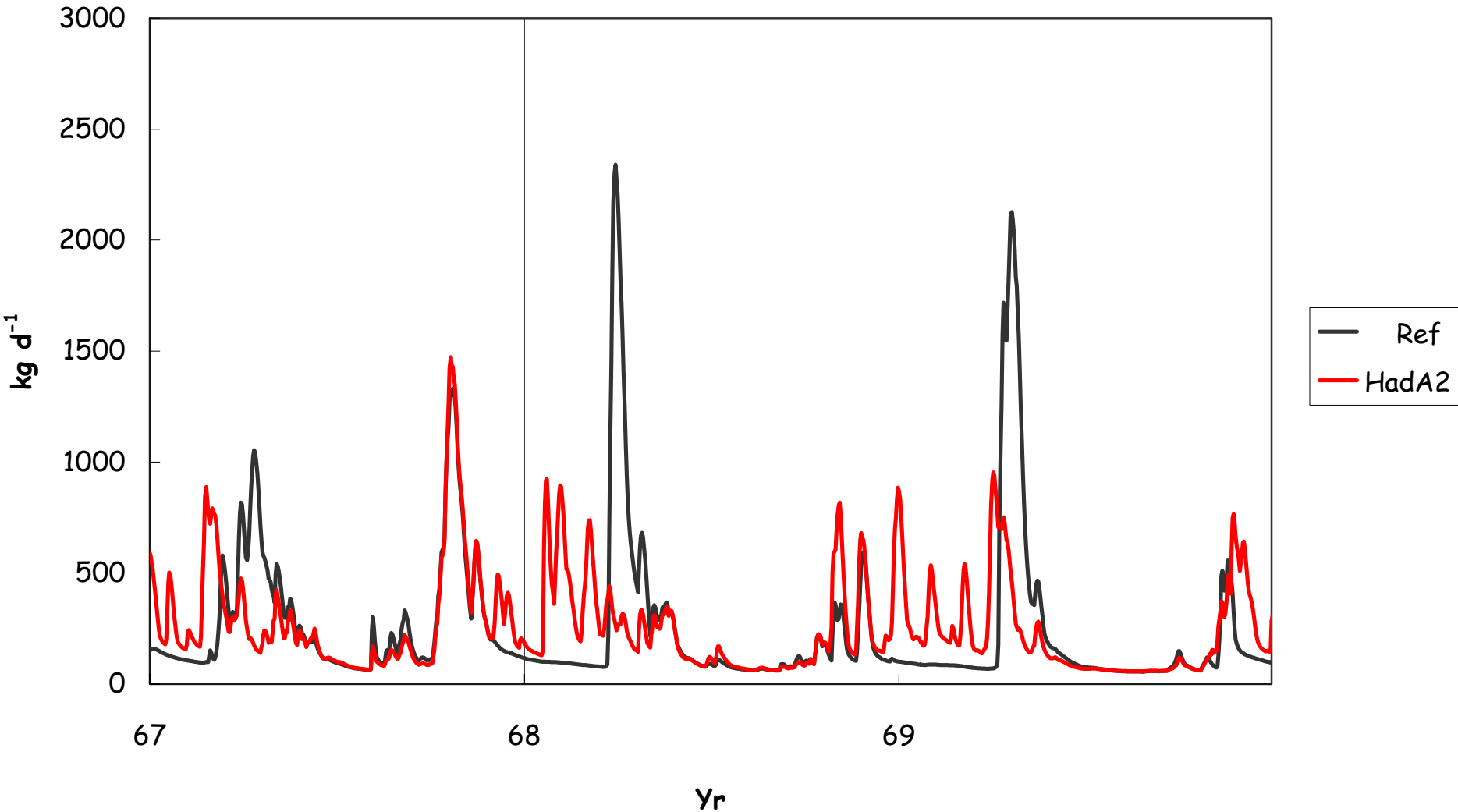
Relative change to monthly Phosphorus loading at the outlet of River Kokemäenjoki catchment

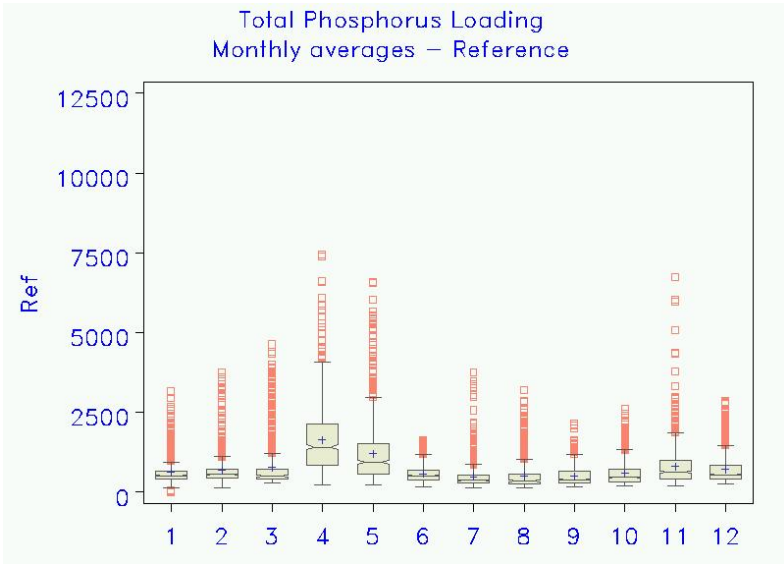


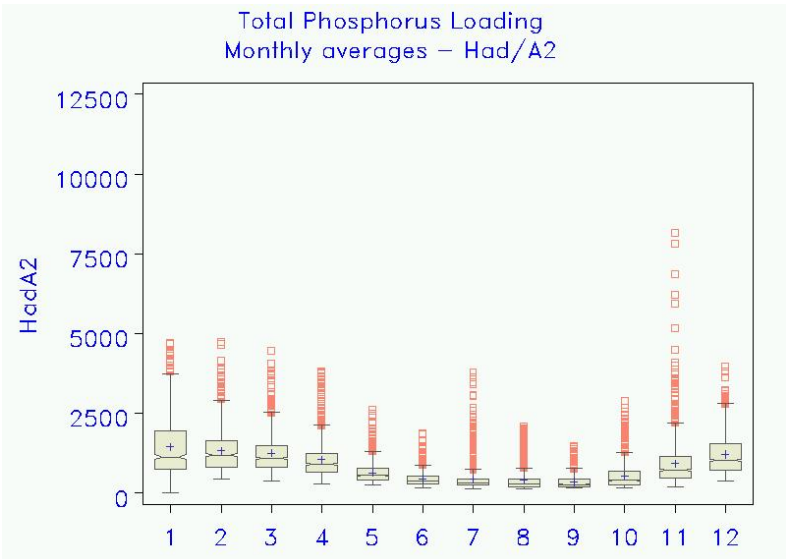
Results

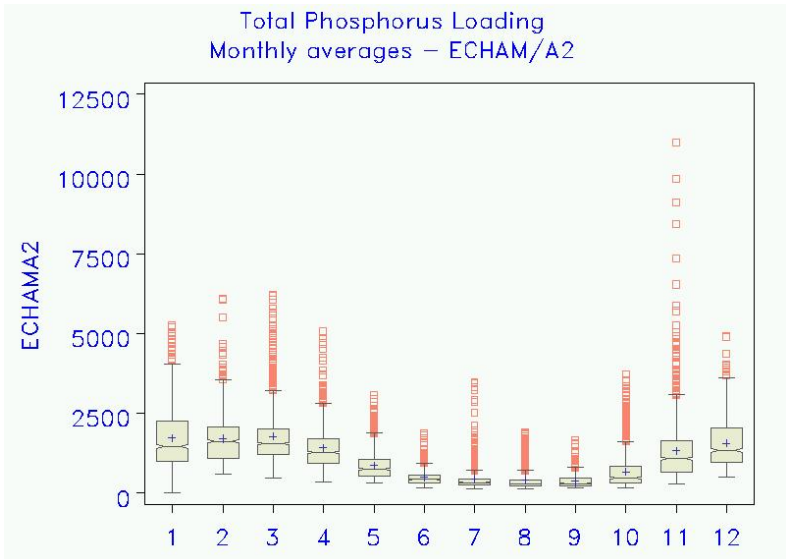


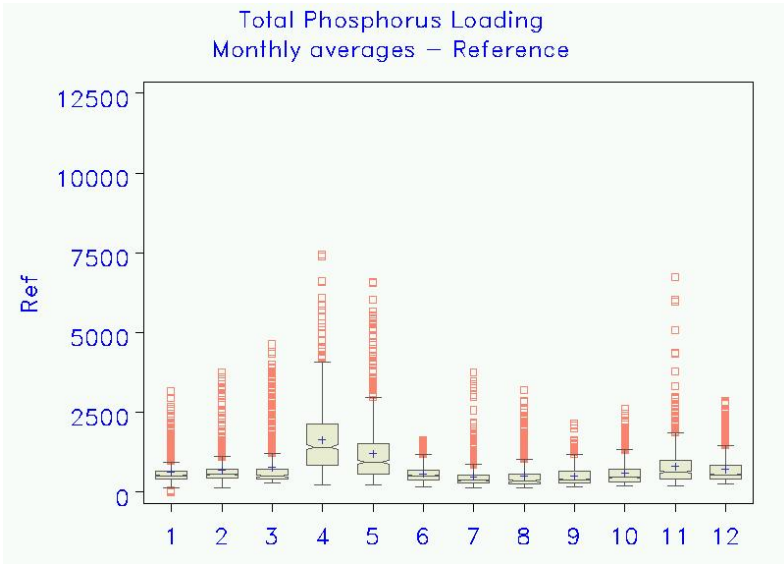
Phosphorus Loading at the outlet of River Loimijoki catchment

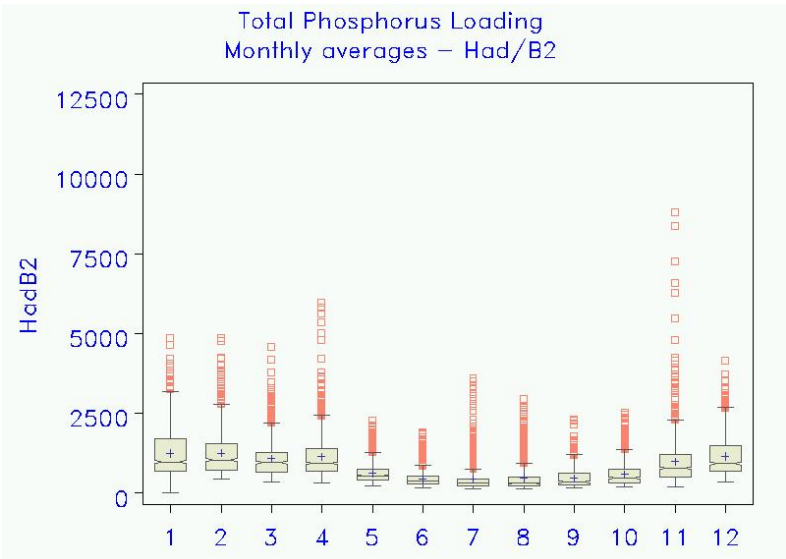


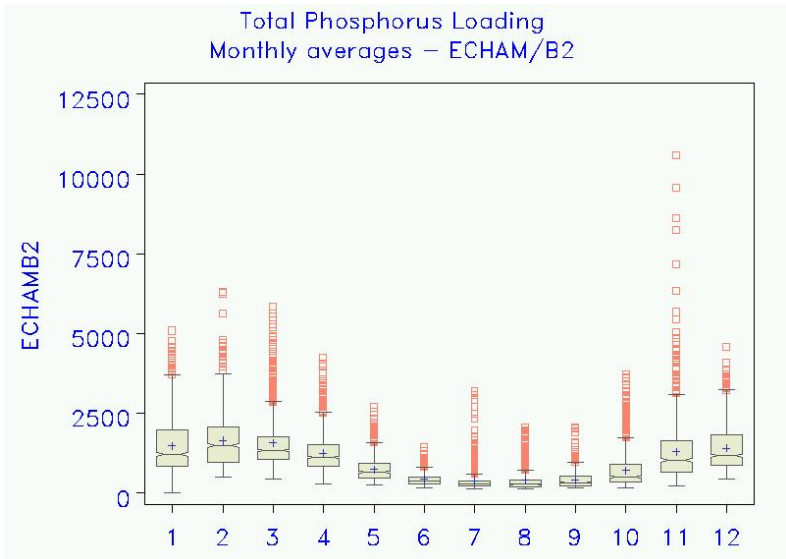

Total Phosphorus Loading
Monthly averages – Reference
Ref
12500
10000
7500
5000
2500
0
1 2 3 4 5 6 7 8 9 10 11 12


Total Phosphorus Loading
Monthly averages – Had/A2
HadA2
12500
10000
7500
5000
2500
0
1 2 3 4 5 6 7 8 9 10 11 12


Total Phosphorus Loading
Monthly averages – ECHAM/A2
ECHAMA2
12500
10000
7500
5000
2500
0
1 2 3 4 5 6 7 8 9 10 11 12


Total Phosphorus Loading
Monthly averages – Reference
Ref
12500
10000
7500
5000
2500
0
1 2 3 4 5 6 7 8 9 10 11 12


Total Phosphorus Loading
Monthly averages – Had/B2
HadB2
12500
10000
7500
5000
2500
0
1 2 3 4 5 6 7 8 9 10 11 12


Total Phosphorus Loading
Monthly averages – ECHAM/B2
ECHAMB2
12500
10000
7500
5000
2500
0
1 2 3 4 5 6 7 8 9 10 11 12

Correlations: Conc – Q - Loading

		LOADING					DISCHARGE					CONCENTRATION				
		Ref	*HadA2*	*HadB2*	*ECHAMA2*	*ECHAMB2*	*Ref*	*HadA2*	*HadB2*	*ECHAMA2*	*ECHAMB2*	*Ref*	*HadA2*	*HadB2*	*ECHAMA2*	*ECHAMB2*
LOADING	Ref	1.00														
	HadA2	0.48	1.00													
	HadB2	0.55	0.96	1.00												
	ECHAMA2	0.48	0.95	0.89	1.00											
	ECHAMB2	0.49	0.96	0.93	0.98	1.00										
DISCHARGE	Ref	**0.89**	0.57	0.62	0.56	0.57	1.00									
	HadA2	0.47	**0.93**	0.89	0.91	0.90	0.64	1.00								
	HadB2	0.53	0.92	**0.92**	0.88	0.90	0.70	0.98	1.00							
	ECHAMA2	0.48	0.89	0.84	**0.93**	0.91	0.62	0.97	0.94	1.00						
	ECHAMB2	0.48	0.91	0.87	0.93	**0.93**	0.64	0.98	0.96	0.99	1.00					
CONCENTRATION	Ref	**0.75**	0.18	0.27	0.18	0.19	**0.44**	0.06	0.12	0.08	0.09	1.00				
	HadA2	0.24	**0.55**	0.56	0.48	0.51	0.09	**0.27**	0.29	0.24	0.26	0.45	1.00			
	HadB2	0.28	0.48	**0.56**	0.39	0.44	0.11	0.21	**0.26**	0.18	0.21	0.53	0.94	1.00		
	ECHAMA2	0.23	0.53	0.51	**0.56**	0.57	0.11	0.29	0.29	**0.29**	0.30	0.39	0.88	0.79	1.00	
	ECHAMB2	0.22	0.50	0.52	0.51	**0.55**	0.09	0.25	0.27	0.24	**0.27**	0.41	0.91	0.86	0.96	1.00

Conclusions

- According to the scenario simulations, the seasonal dynamics of the phosphorus loading will change.
- Increased winter time loading and earlier spring peak will occur
- Reductions in the spring peak
- Annual loading sums will increase

Thank You

Tom Frisk
Ämer Bilaletdin
Heikki Kaipainen
Jari Rauhala
Pirkanmaa Regional Environment Centre
P.O. Box 297
FIN-33101 Tampere Finland

Telephone +358 20 490 104
Telefax +358 20 490 4000
Email:
tom.frisk@ymparisto.fi
emir.bilaletdin@ymparisto.fi
heikki.kaipainen@ymparisto.fi
jari.rauhala@ymparisto.fi

URL www.environment.fi/pir

Climate Change Scenarios

- the Rossby Centre coupled Regional Climate Model RCAO
- Boundary conditions: two Global Climate Models HadAM3H and ECHAM4/OPYC3 and emissions scenarios (SRES A2 and B2).

Temperature and precipitation changes in River Kokemäenjoki catchment (RCAO)

Month	1	2	3	4	5	6	7	8	9	10	11	12
Temperature change [°C] HadAM3 A2	5,48	3,77	3,92	4,45	4,33	2,83	3,00	2,91	3,71	4,05	4,67	5,57
HadAM3 B2	4,40	3,24	3,13	3,46	2,78	1,15	0,72	1,82	2,63	3,04	3,48	3,75
ECHAM4 A2	7,04	7,34	6,34	4,69	3,54	2,83	2,98	3,64	3,77	4,36	5,54	5,34
ECHAM4 B2	5,38	5,97	5,31	3,53	2,95	2,34	2,14	2,68	2,84	3,16	4,44	4,23
Precipitation change [%] HadAM3 A2	51,0	28,3	3,5	8,2	19,2	30,5	8,2	-16,3	-12,1	16,3	12,7	28,3
HadAM3 B2	23,3	28,4	-3,7	8,1	-1,2	43,5	11,0	-3,1	4,8	-0,3	18,8	19,4
ECHAM4 A2	60,8	70,7	58,0	51,2	22,8	11,1	2,4	-22,9	-1,5	38,5	47,7	43,3
ECHAM4 B2	40,8	70,7	32,7	29,0	10,2	4,8	0,8	-12,4	8,6	33,5	40,8	26,7

Phosphorus Loading at the outlet of Kokemäenjoki basin - Reference