Status report large scale modelling and Baltic-C

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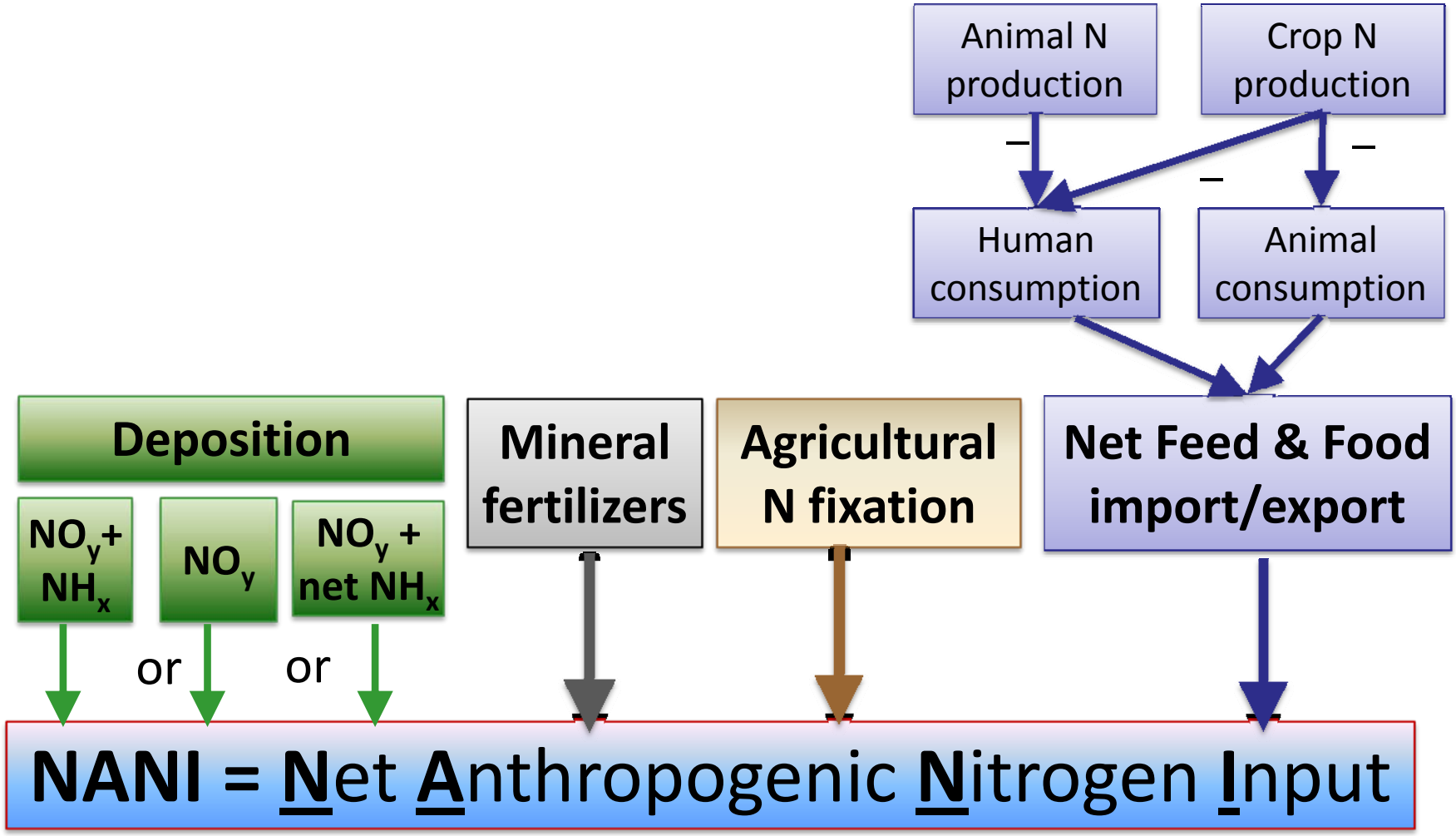
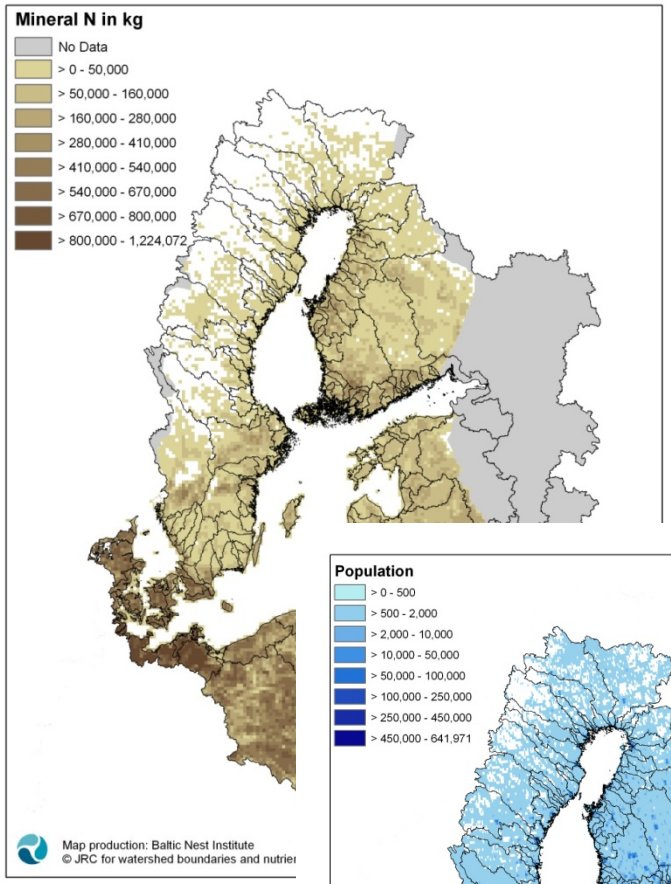
H Hägg, B Hong

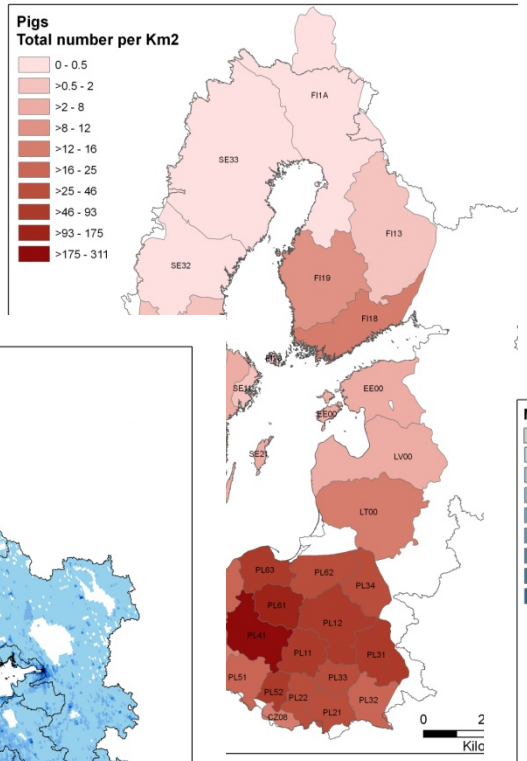
Tasks

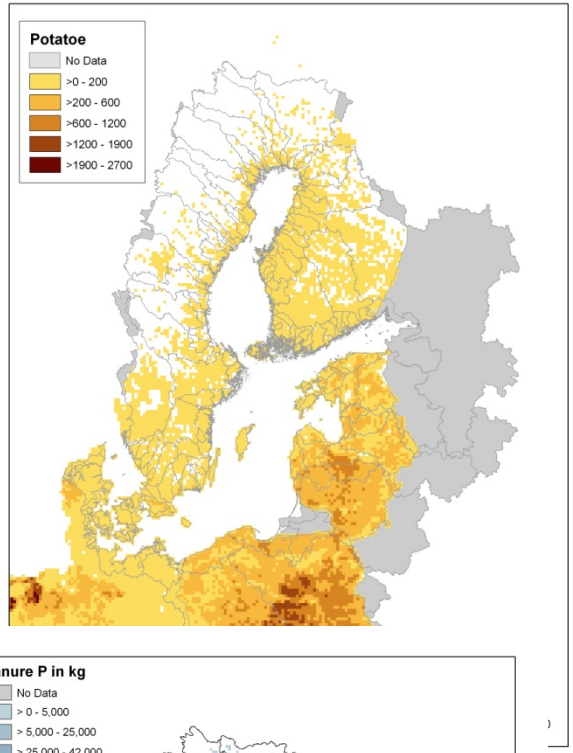
- 7.1 **Compilation of river chemistry (first six months)**
  - Together with Matti Pertillä
  - READY, but ongoing
- **7.2 Model calibration and validation (first year)**
  - **READY**
- 7.3 Scenario analysis from land cover changes and changes in climate (Ca, inorganic carbon…) (after 2 years)
- 7.4 Scenario analysis on climate change (N, P) (after 2 years)
- Scenario analysis on changes in land cover, land use (N, P) (after 2 years)

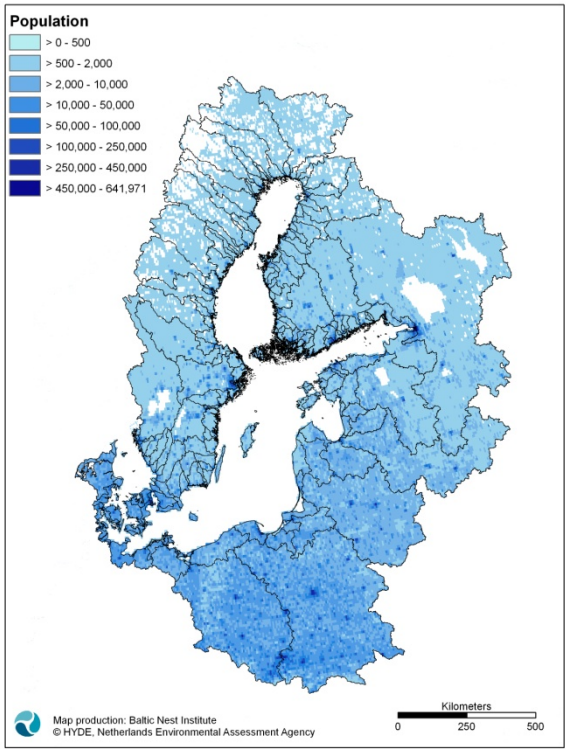

Animal N production
Crop N production
–
–
–
Human consumption
Animal consumption
Deposition
Mineral fertilizers
Agricultural N fixation
Net Feed & Food import/export
NO_y+ NH_x
NO_y
NO_y + net NH_x
or
or
NANI = Net Anthropogenic Nitrogen Input

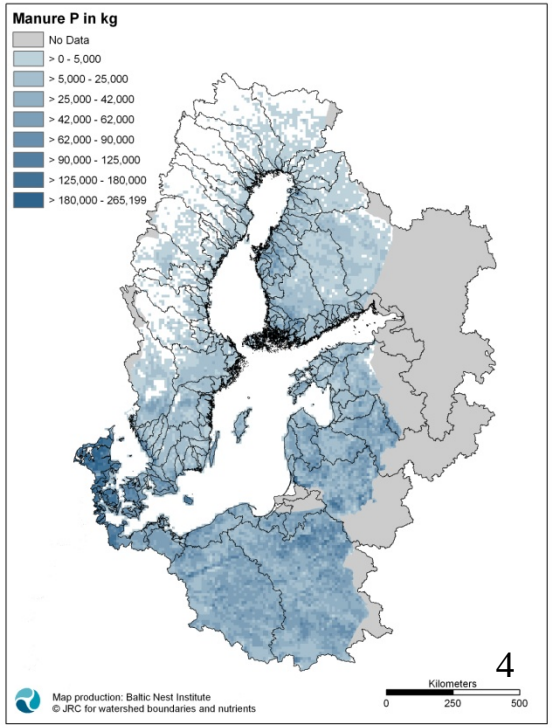
Input Data





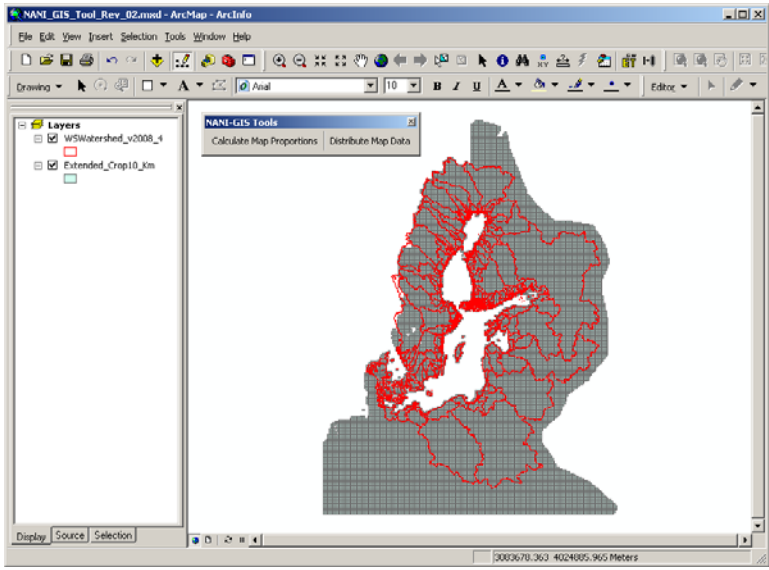




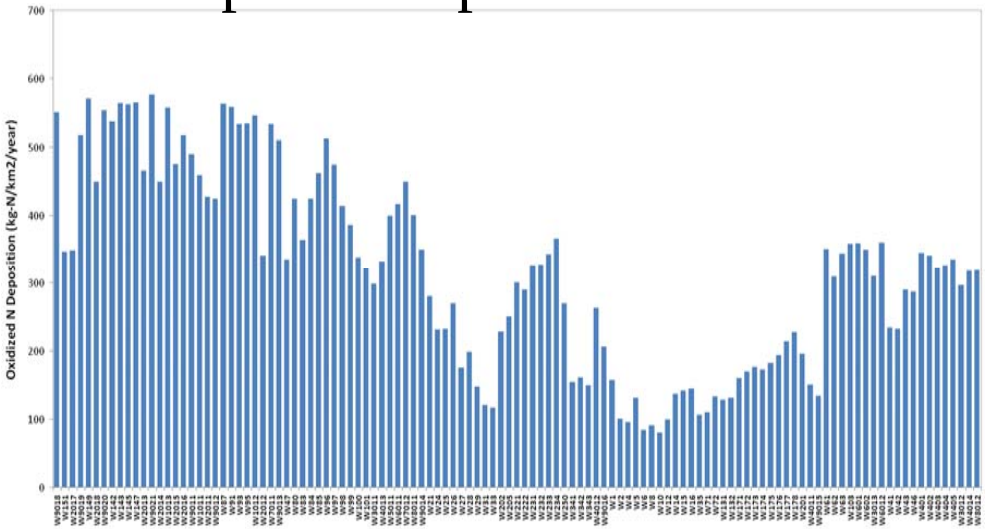


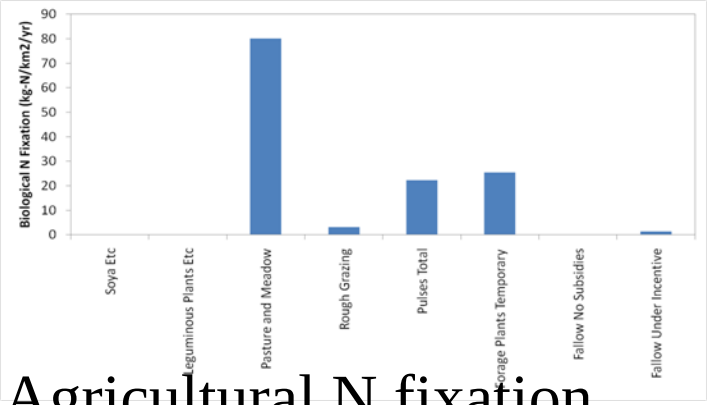
Stockholn
Research for Gover

NANI TOOLBOX



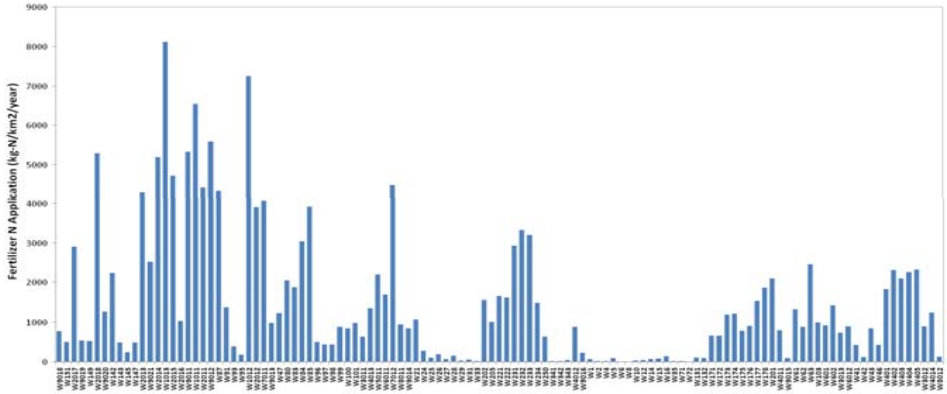
Atmospheric deposition

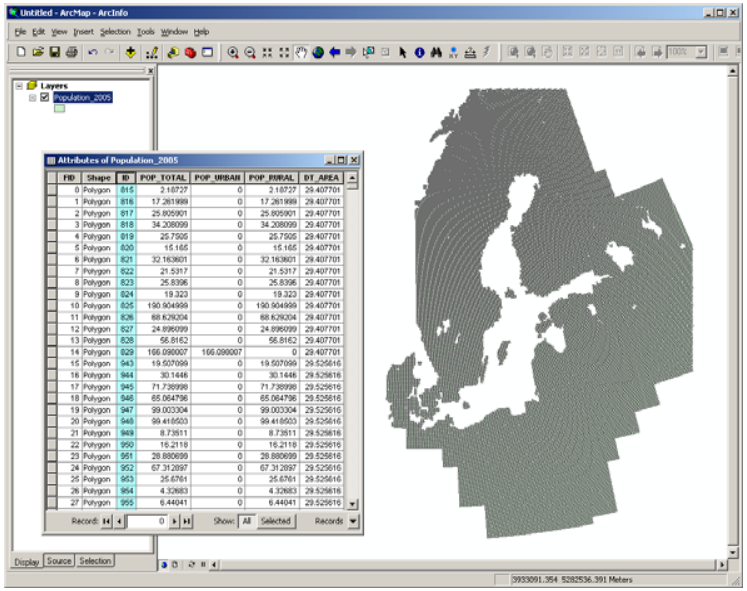




Agricultural N fixation

Fertilizer use





FID	Shape	ID	POP_TOTAL	POP_URBAN	POP_RURAL	DT_AREA
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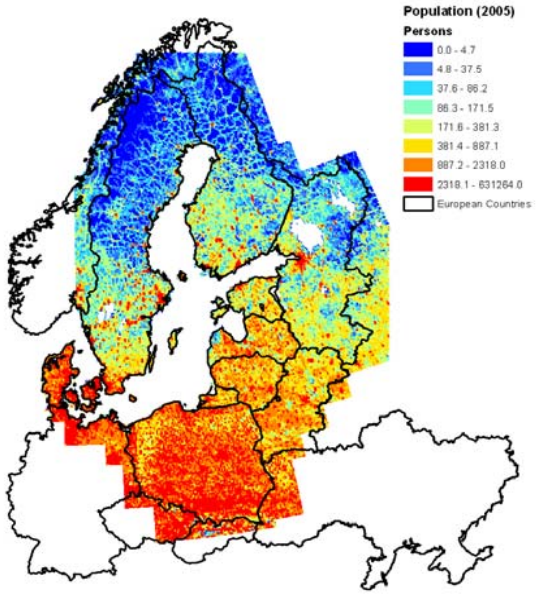
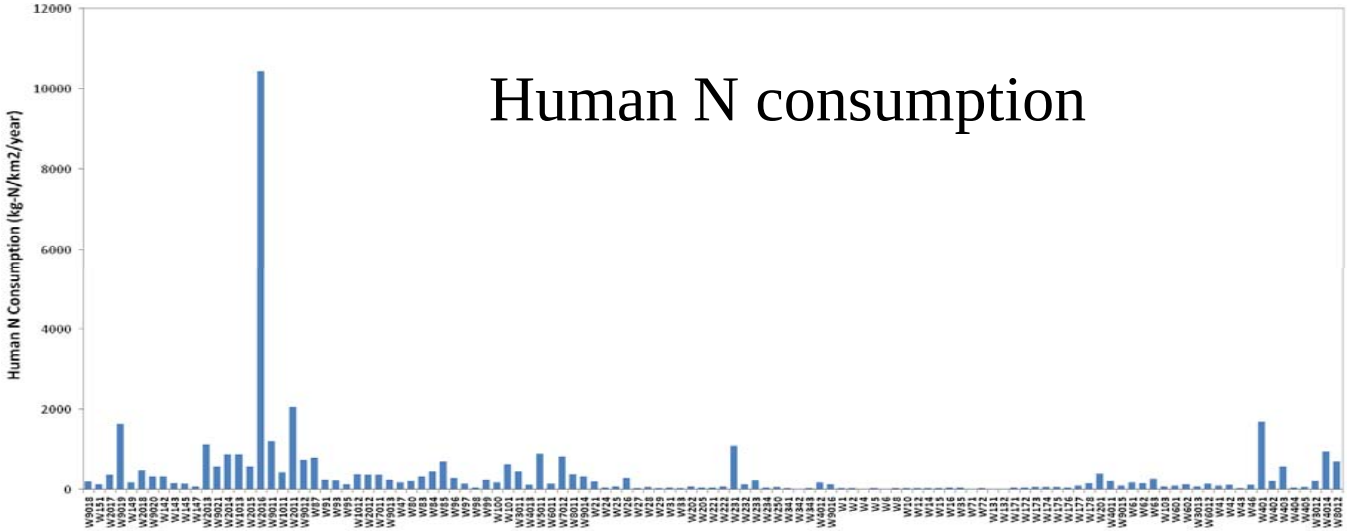
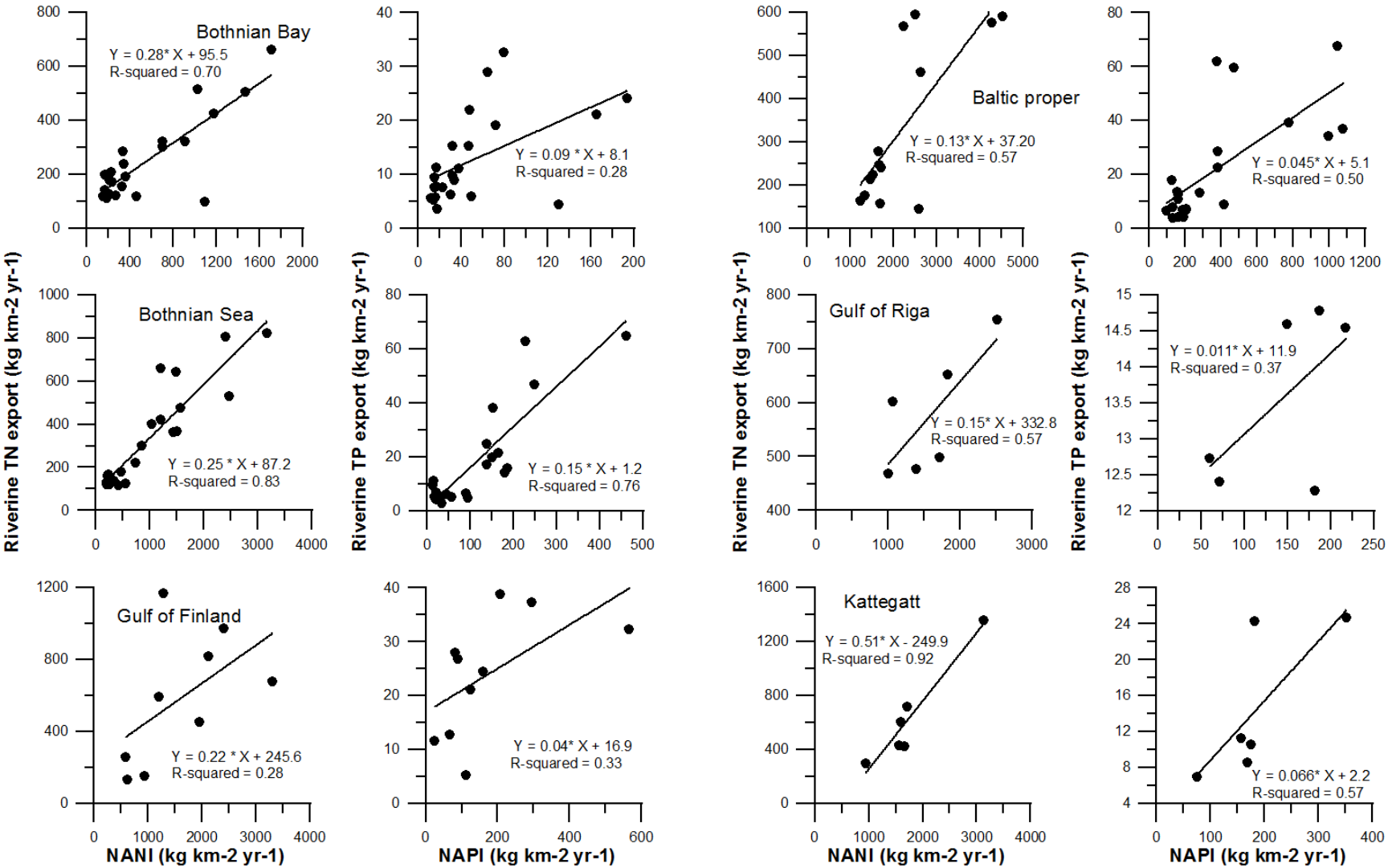
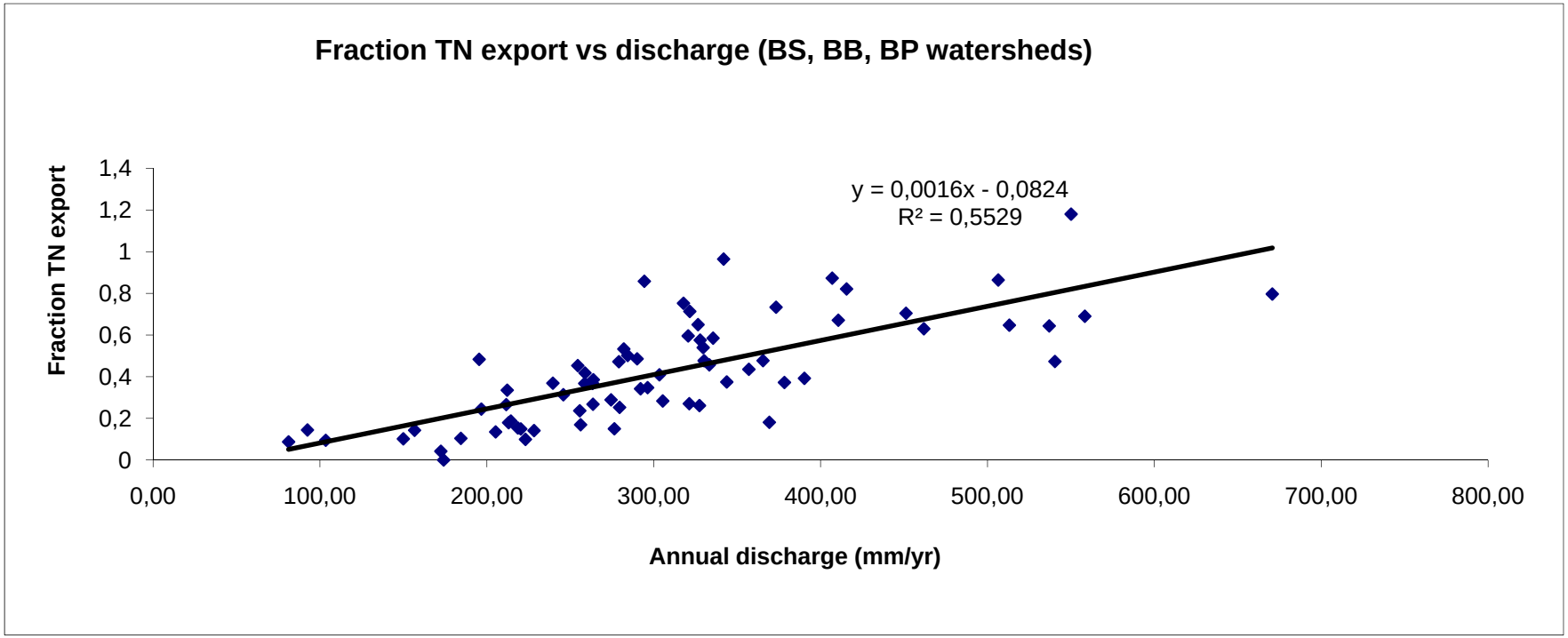
1	Polygon	816	17.261989	0	17.261989	29.407701
2	Polygon	817	25.905901	0	25.905901	29.407701
3	Polygon	818	34.208099	0	34.208099	29.407701
4	Polygon	819	25.7505	0	25.7505	29.407701
5	Polygon	820	15.165	0	15.165	29.407701
6	Polygon	821	32.163801	0	32.163801	29.407701
7	Polygon	822	21.5317	0	21.5317	29.407701
8	Polygon	823	25.8396	0	25.8396	29.407701
9	Polygon	824	19.323	0	19.323	29.407701
10	Polygon	825	190.904999	0	190.904999	29.407701
11	Polygon	826	68.629204	0	68.629204	29.407701
12	Polygon	827	24.896099	0	24.896099	29.407701
13	Polygon	828	56.8162	0	56.8162	29.407701
14	Polygon	829	166.099007	166.099007	0	29.407701
15	Polygon	943	19.507099	0	19.507099	29.525616
16	Polygon	944	30.1446	0	30.1446	29.525616
17	Polygon	945	71.736998	0	71.736998	29.525616
18	Polygon	948	65.064796	0	65.064796	29.525616
19	Polygon	947	99.003304	0	99.003304	29.525616
20	Polygon	948	99.416503	0	99.416503	29.525616
21	Polygon	949	8.73511	0	8.73511	29.525616
22	Polygon	950	16.2118	0	16.2118	29.525616
23	Polygon	951	28.880699	0	28.880699	29.525616
24	Polygon	952	67.312097	0	67.312097	29.525616
25	Polygon	953	25.6761	0	25.6761	29.525616
26	Polygon	954	4.32683	0	4.32683	29.525616
27	Polygon	955	6.44041	0	6.44041	29.525616

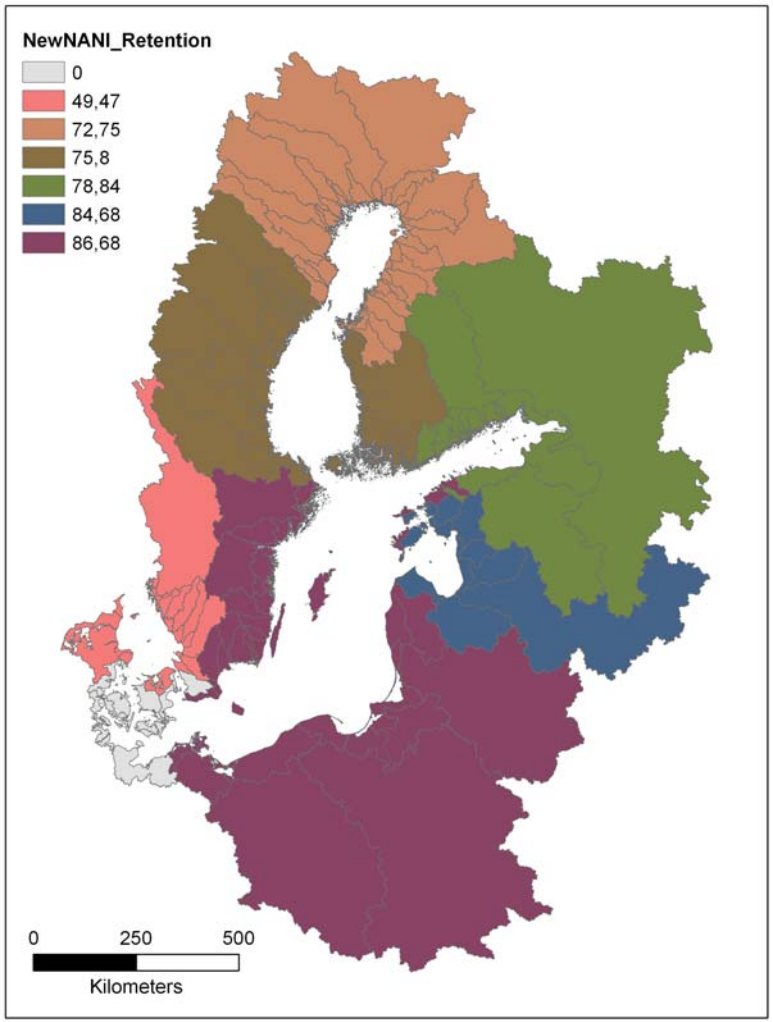


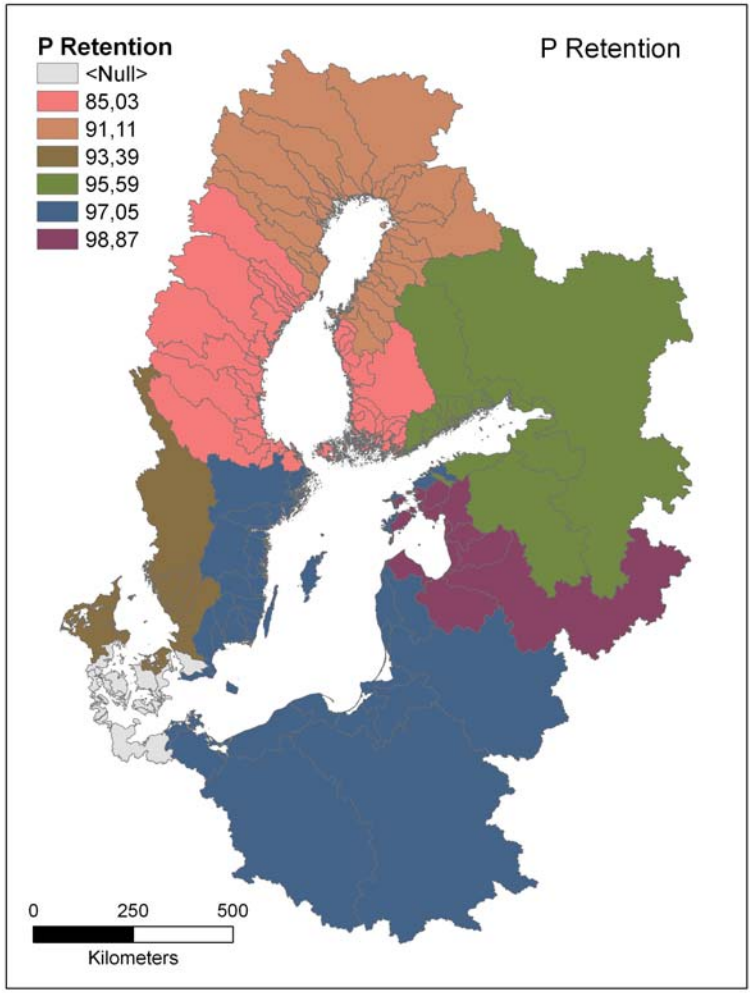
Human N consumption



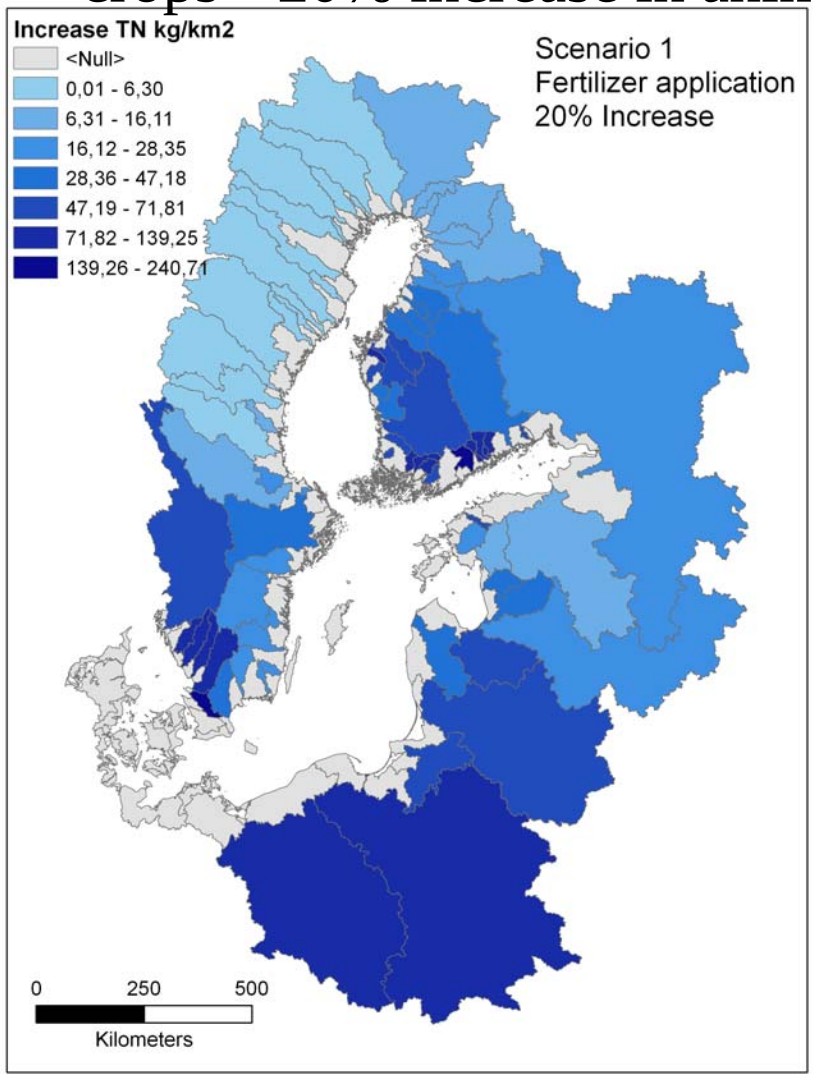

Bothnian Bay
Y = 0.28* X + 95.5
R-squared = 0.70
Y = 0.09 * X + 8.1
R-squared = 0.28
Baltic proper
Y = 0.13* X + 37.20
R-squared = 0.57
Y = 0.045* X + 5.1
R-squared = 0.50
Bothnian Sea
Y = 0.25 * X + 87.2
R-squared = 0.83
Y = 0.15 * X + 1.2
R-squared = 0.76
Gulf of Riga
Y = 0.15* X + 332.8
R-squared = 0.57
Y = 0.011* X + 11.9
R-squared = 0.37
Gulf of Finland
Y = 0.22 * X + 245.6
R-squared = 0.28
Y = 0.04* X + 16.9
R-squared = 0.33
Kattegatt
Y = 0.51* X - 249.9
R-squared = 0.92
Y = 0.066* X + 2.2
R-squared = 0.57
Riverine TN export (kg km-2 yr-1)
Riverine TP export (kg km-2 yr-1)
NANI (kg km-2 yr-1)
NAPI (kg km-2 yr-1)

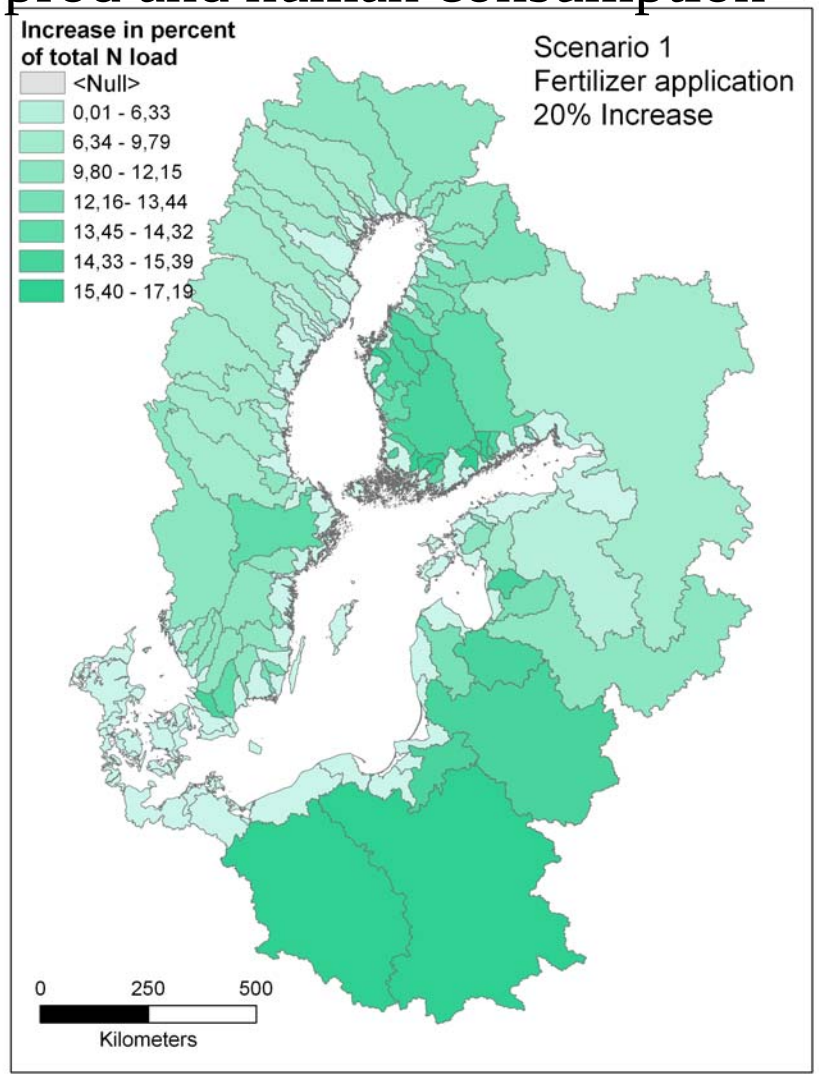

Fraction TN export vs discharge (BS, BB, BP watersheds)
y = 0,0016x - 0,0824
R² = 0,5529
Fraction TN export
1,4
1,2
1
0,8
0,6
0,4
0,2
0
0,00
100,00
200,00
300,00
400,00
500,00
600,00
700,00
800,00
Annual discharge (mm/yr)

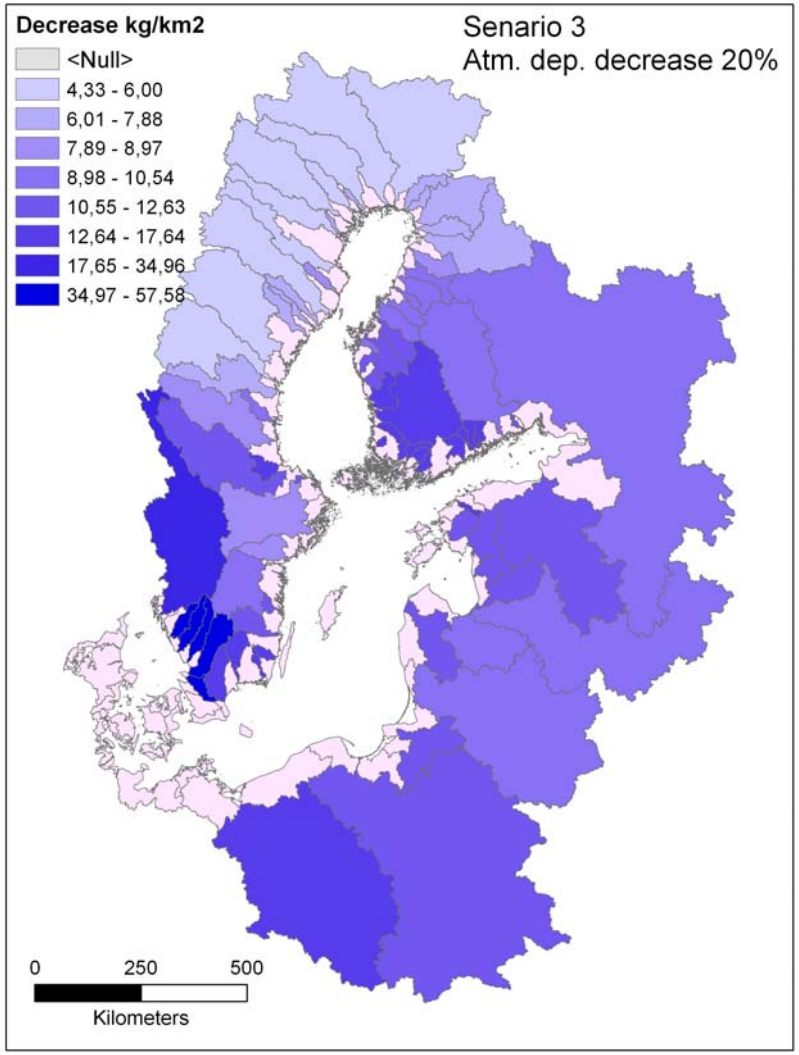

NewNANI_Retention
0
49,47
72,75
75,8
78,84
84,68
86,68
0
250
500
Kilometers

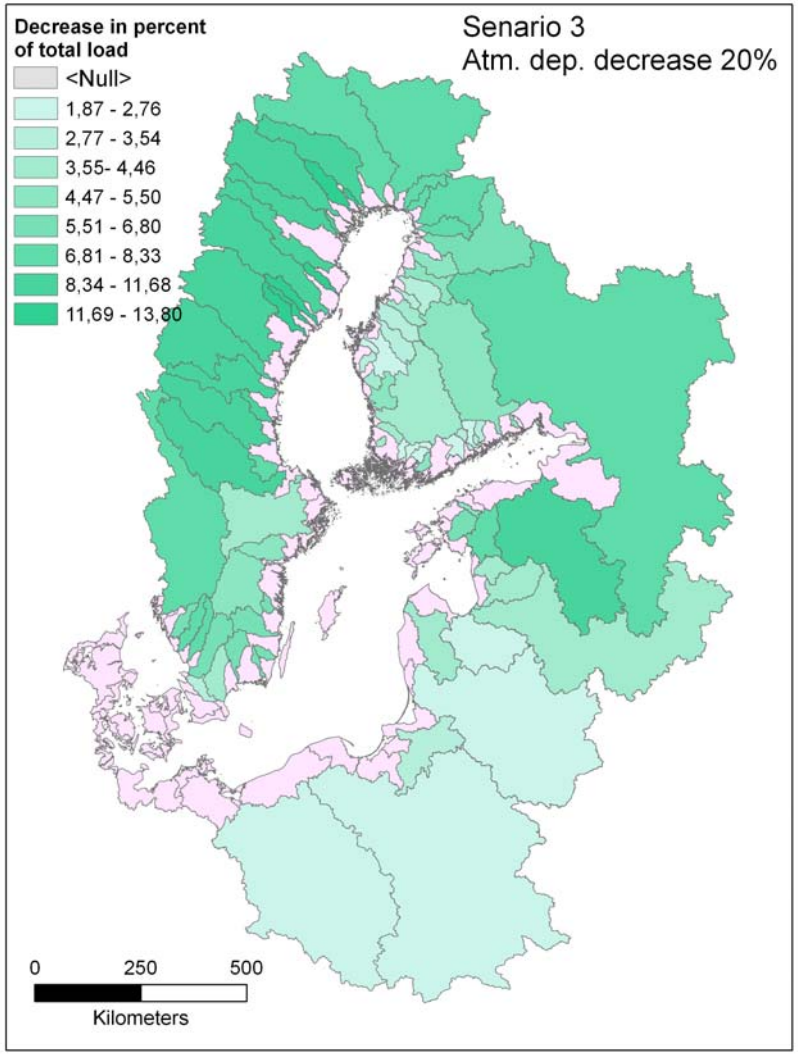

P Retention
<Null>
85,03
91,11
93,39
95,59
97,05
98,87
P Retention
0
250
500
Kilometers

Scenario 1: 20% increase in fertilizer use-> 20% increase crops->20% increase in animal prod and human consumption






Decrease kg/km2
<Null>
4,33 - 6,00
6,01 - 7,88
7,89 - 8,97
8,98 - 10,54
10,55 - 12,63
12,64 - 17,64
17,65 - 34,96
34,97 - 57,58
Senario 3
Atm. dep. decrease 20%
0
250
500
Kilometers


Decrease in percent of total load
<Null>
1,87 - 2,76
2,77 - 3,54
3,55- 4,46
4,47 - 5,50
5,51 - 6,80
6,81 - 8,33
8,34 - 11,68
11,69 - 13,80
Senario 3
Atm. dep. decrease 20%
0
250
500
Kilometers

DIC, DOC, cations and anions

- Subtract cyclic salts to calculate weathering
  - Mortatti, Probst approach
- Carbonates very fast weathering
- Silicates, approx. 8% increase in weathering per degree celsius
- Modelled by setting
  - DIC=HCO_3- + CO_2(g)
  - SBC= $2Ca^{2+} + 2Mg^{2+} + Na^{+} + K^{+}$
  - SAA= $Cl^{-} + 2SO_4^{2-}$
  - SBC=f(landscape)
  - SAA=f(landscape)
  - DIC=f(landscape)
  - DOC=f(landscape)
- **Model assumption is that water flow path is the most important factor regulating river chemistry**

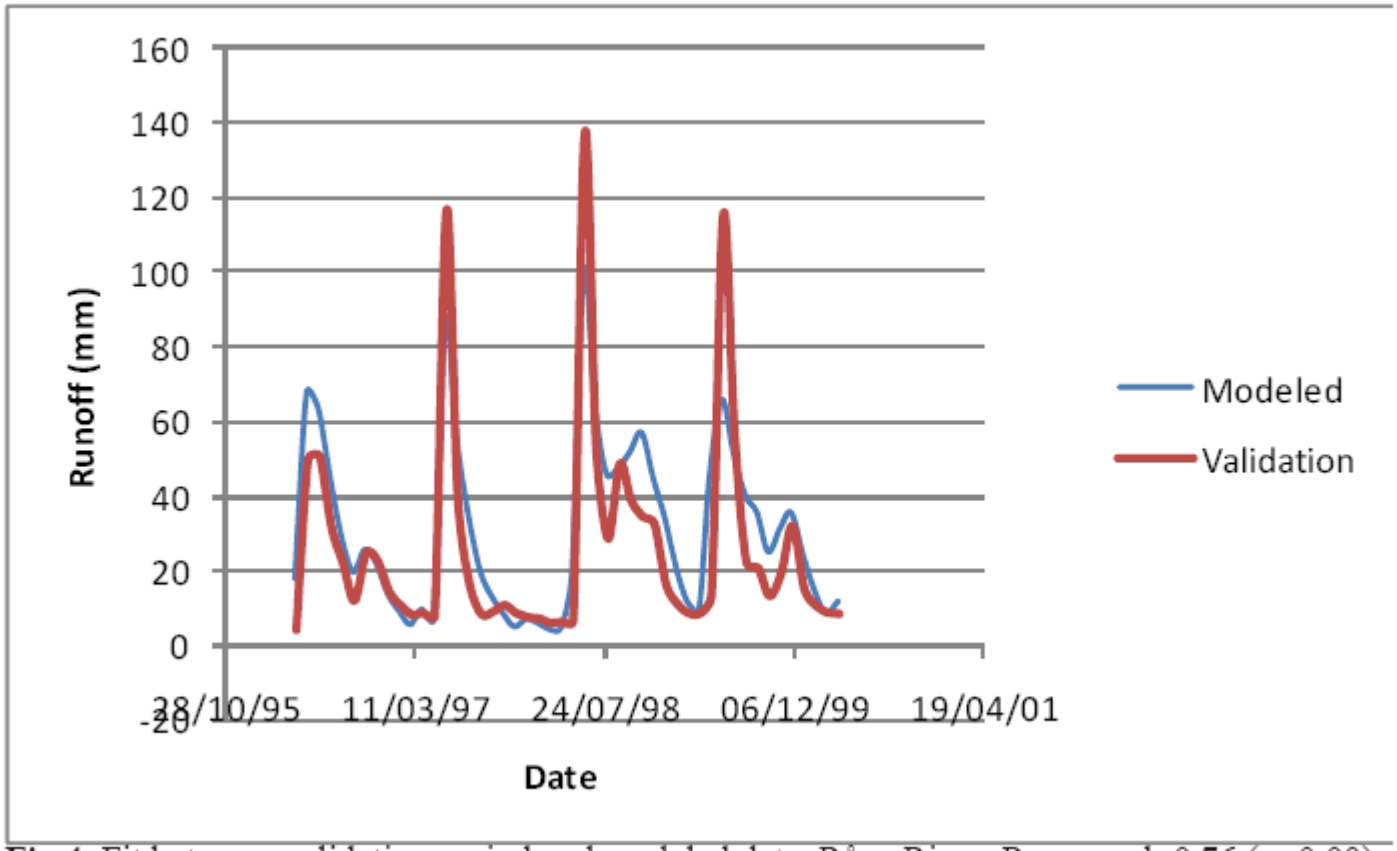


Fig 4. Fit between validation period and modeled data, Råne River, R-squared=0.76 (p=0.00).

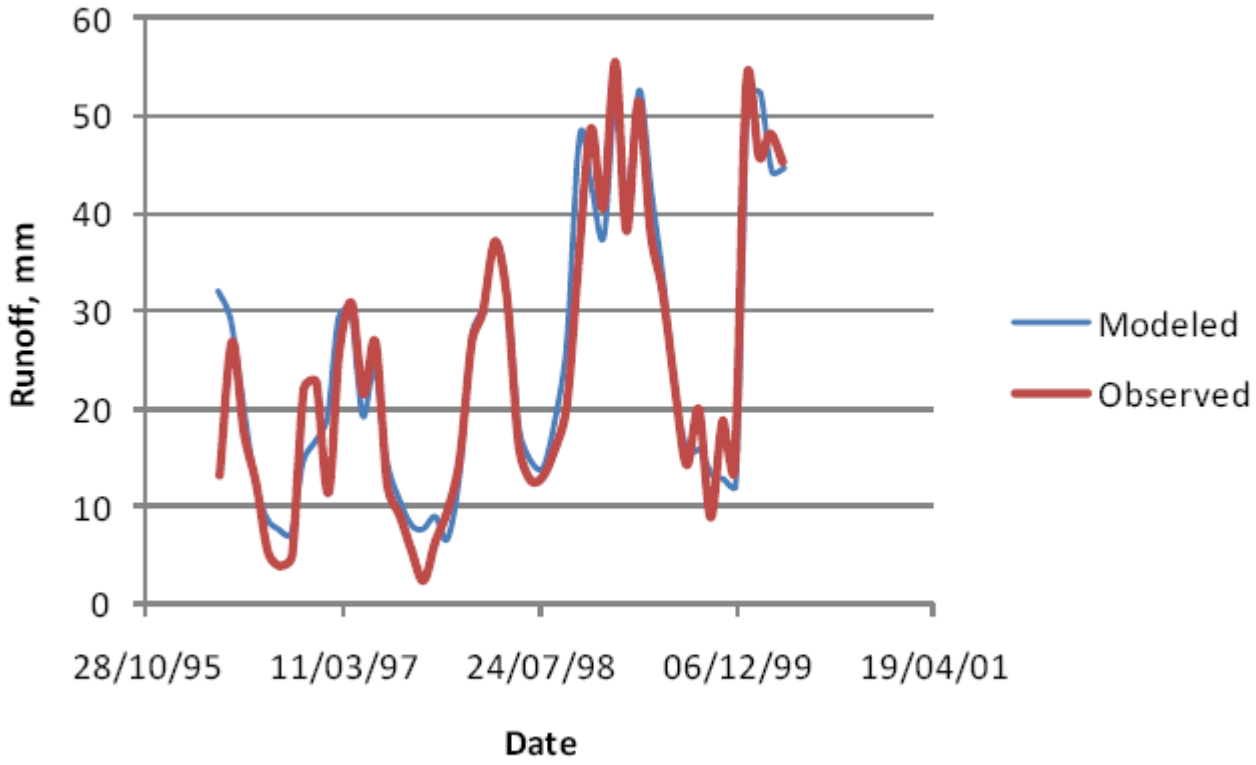


Fig 5. Fit between validation period and modeled data, Helge å. R-squared=0.90 (p=0.00).

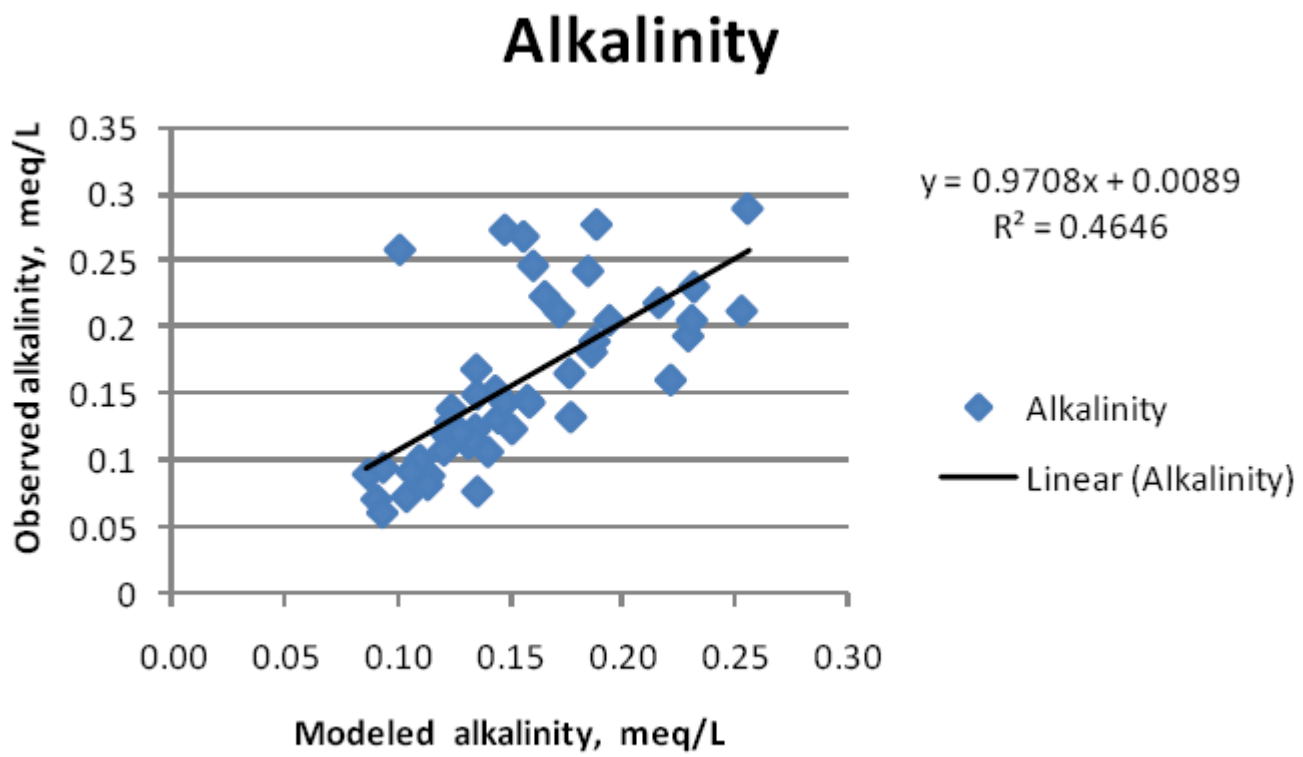


Fig 6. Fit between validation period and modeled data (p=0.00), Råne River.

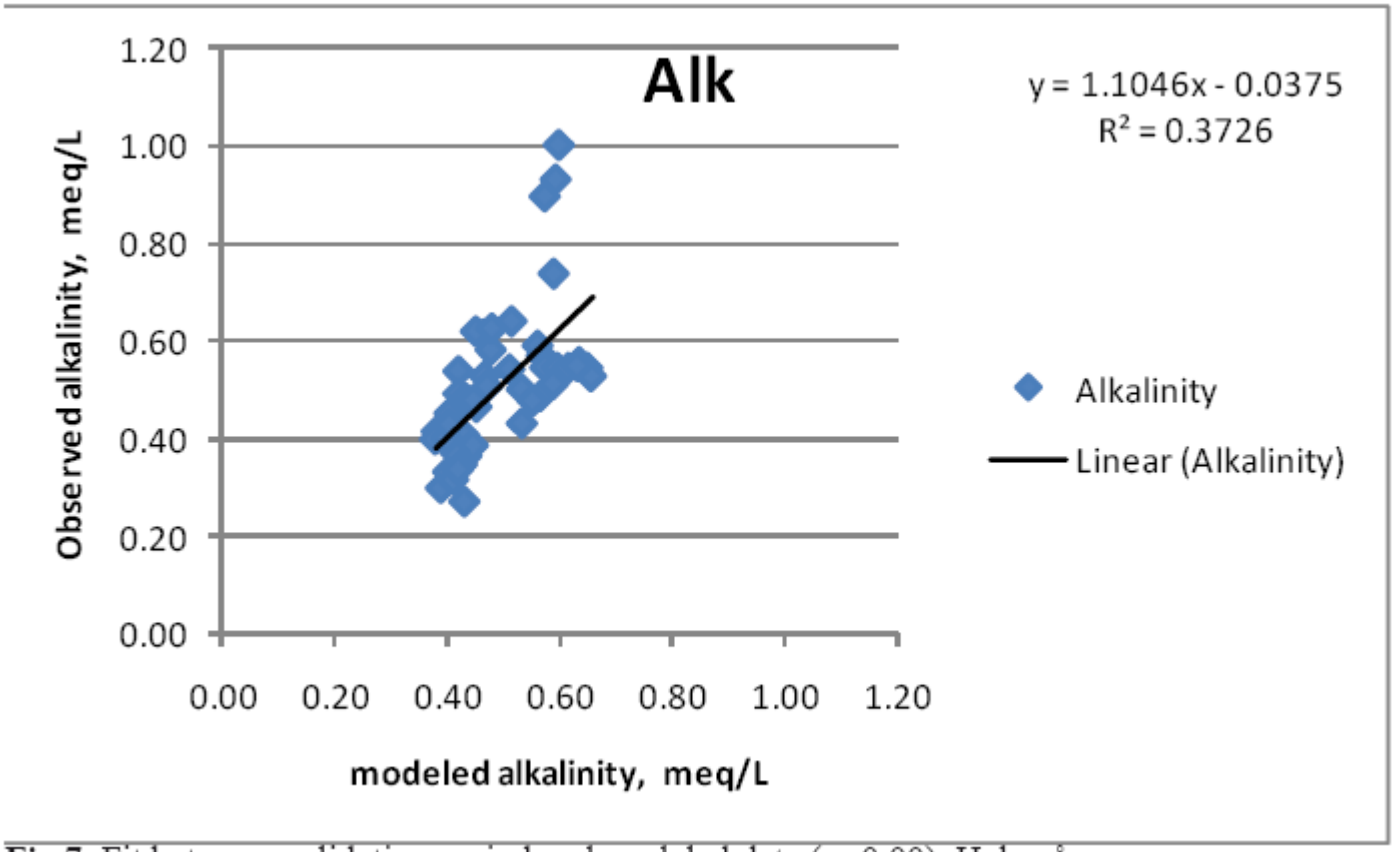


Fig 7. Fit between validation period and modeled data (p=0.00), Helge å.

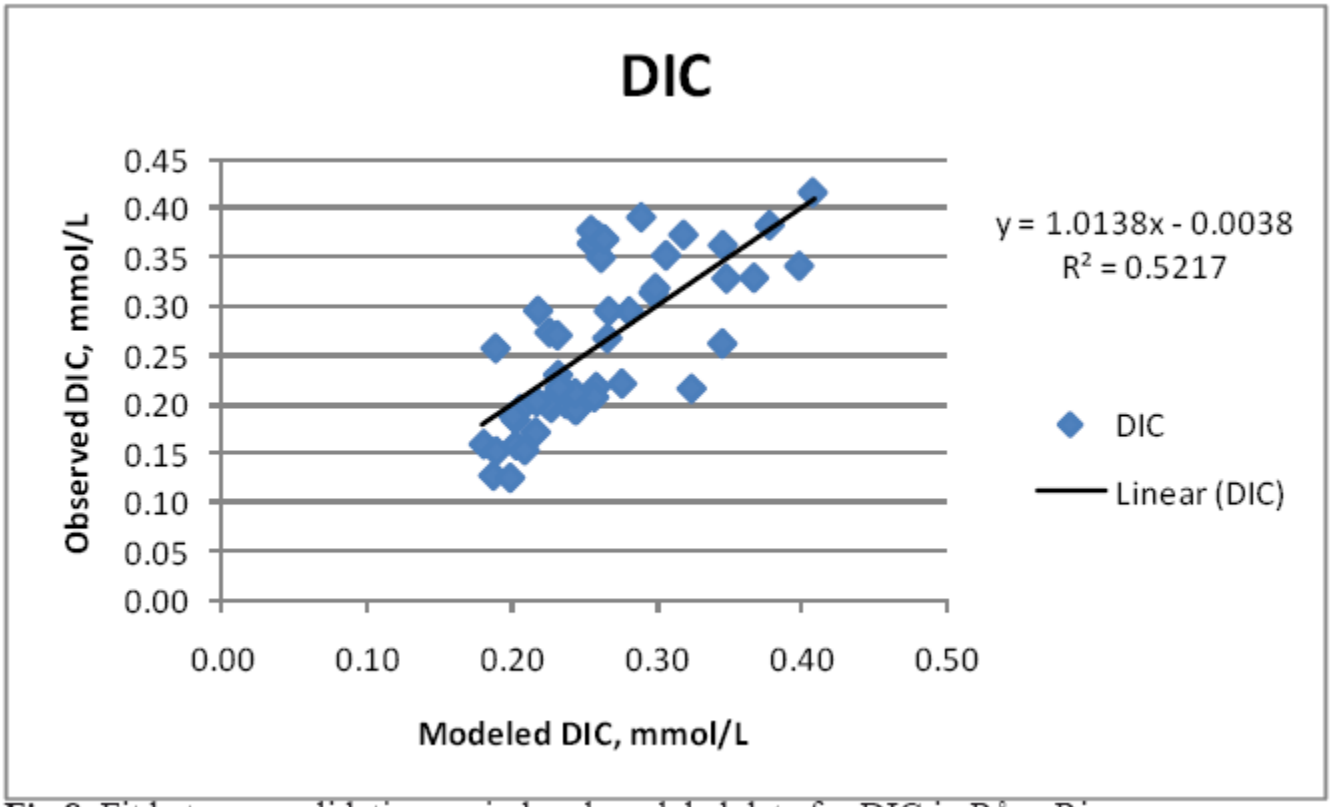


Fig 8. Fit between validation period and modeled data for DIC in Råne River.

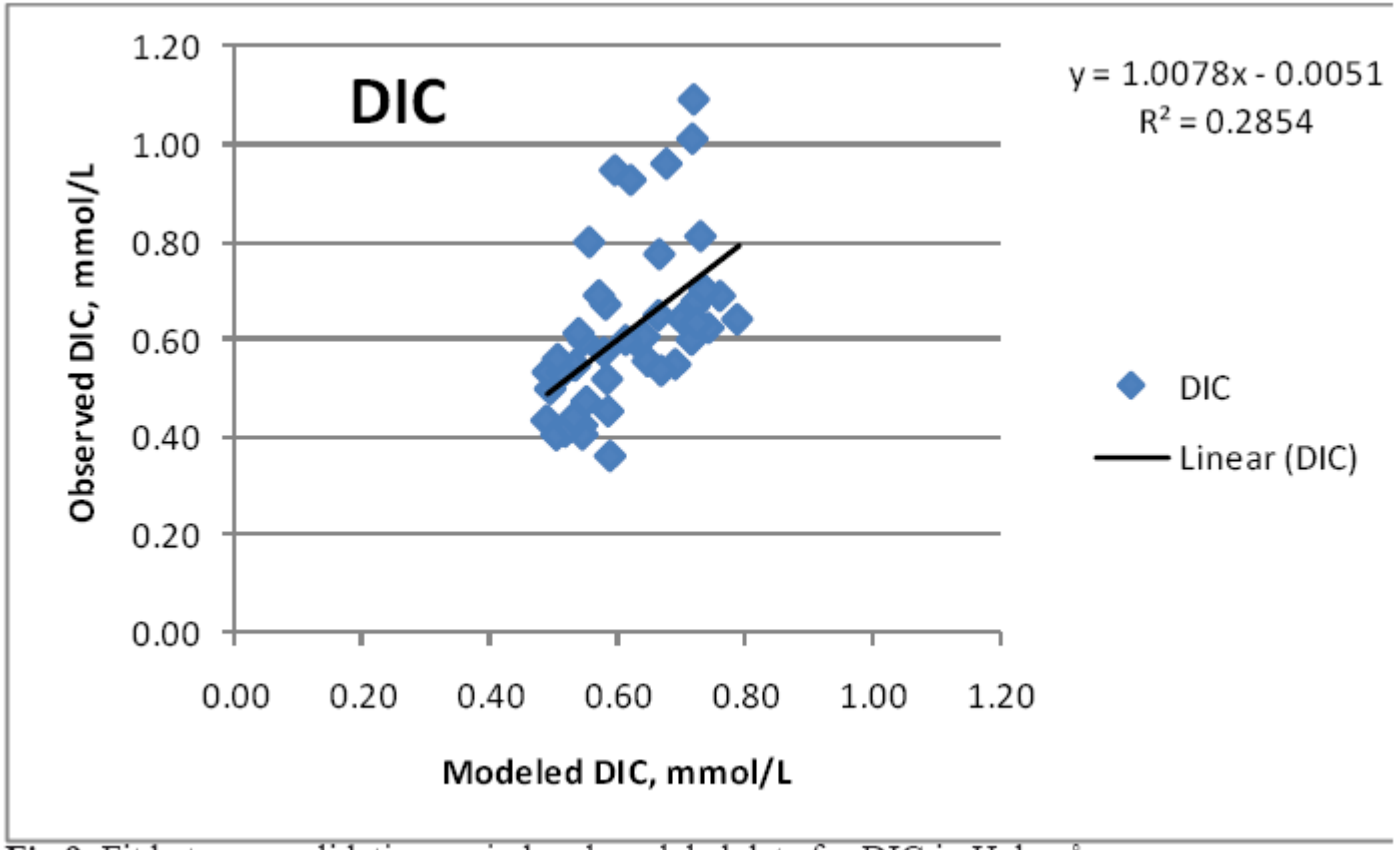
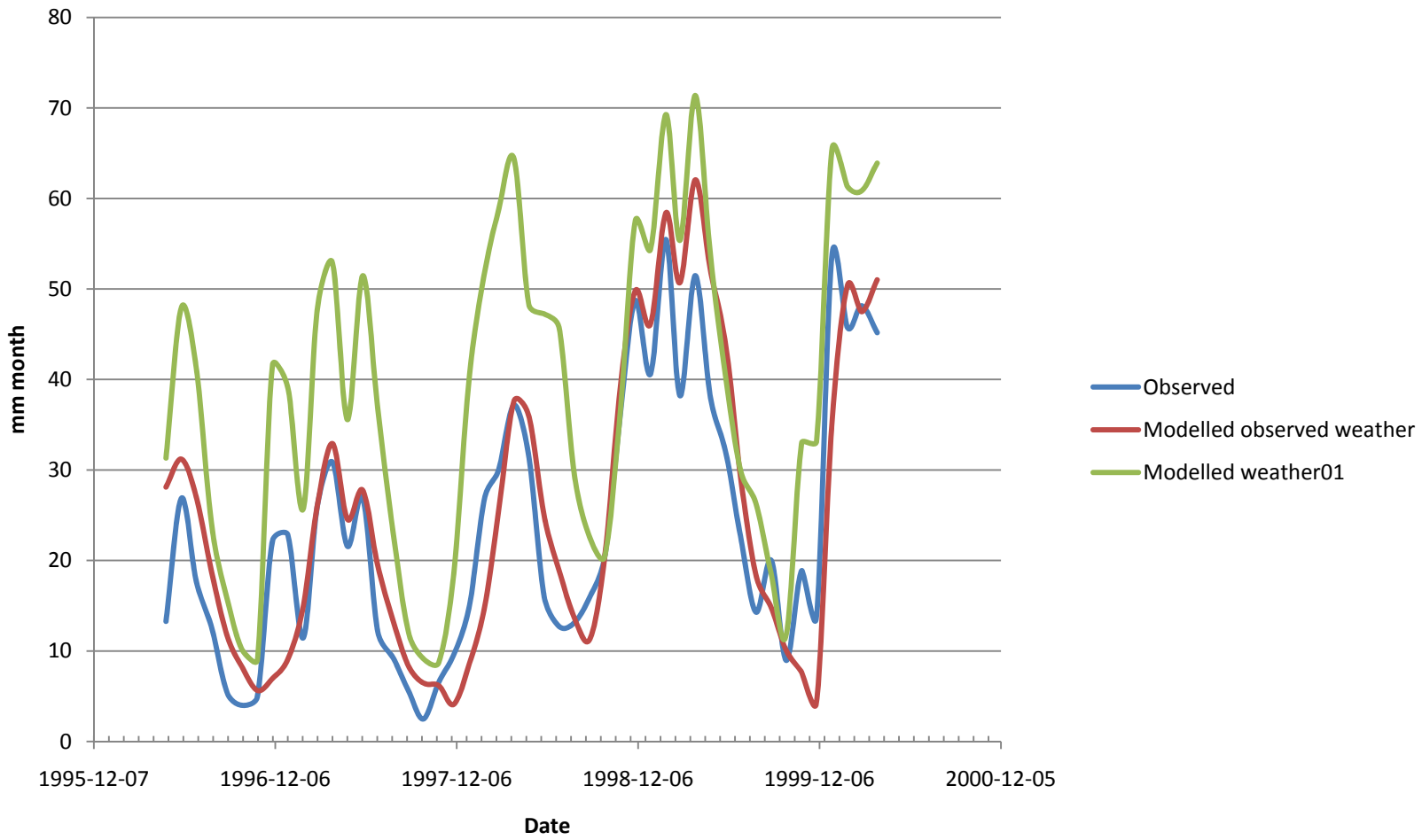


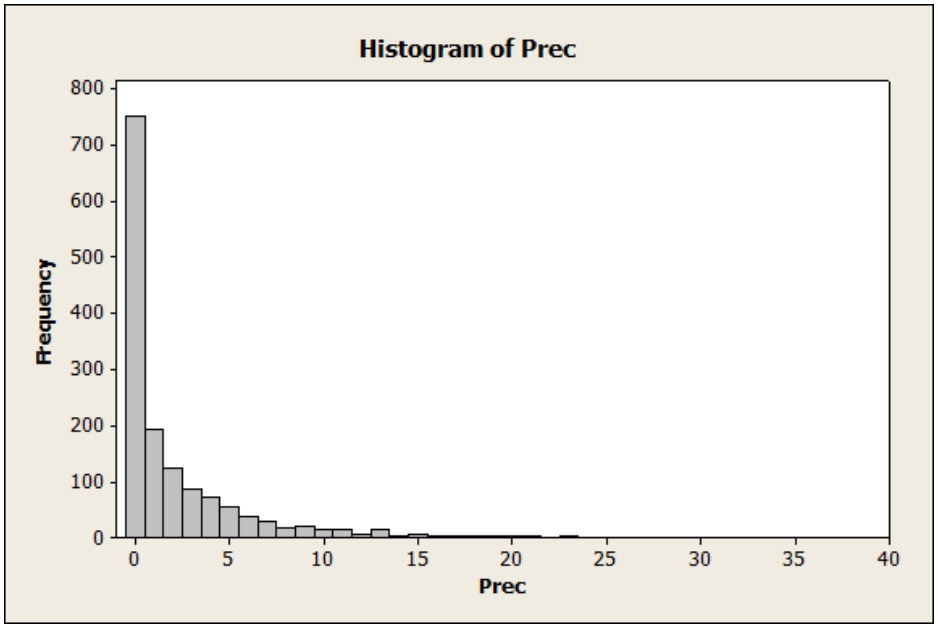
Fig 9. Fit between validation period and modeled data for DIC in Helge å.

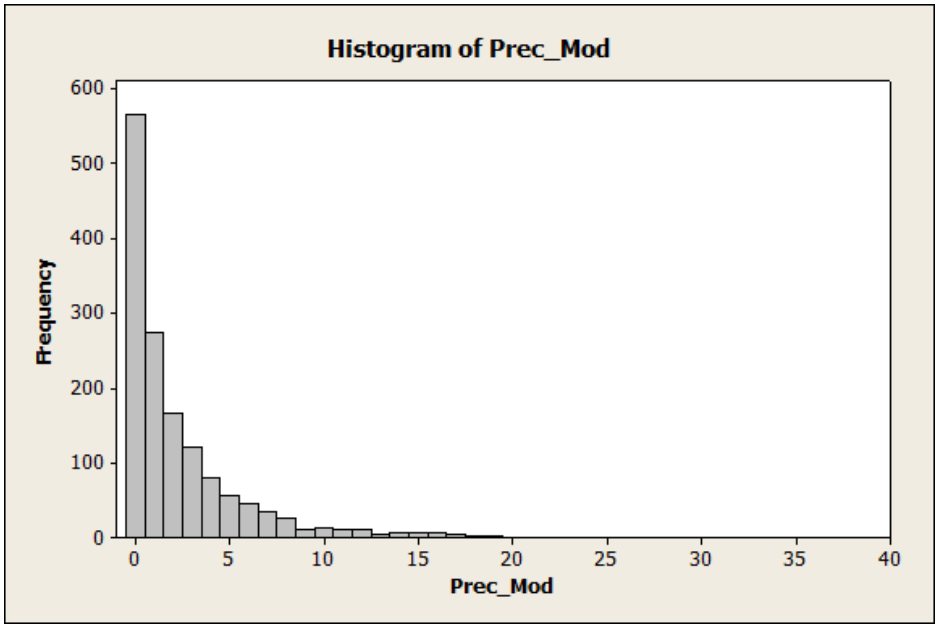
	Description	Baltic-C	ECOSUPPORT
1	Re – analyzed true weather 1961-2009	RCA-ERA40, 50 km	RCA-ERA40, 25 km
2	IPCC Scenario A1B, ECHAM global model	RCA-ECHAM5 A1B_1, 50 km	RCAO-ECHAM5 A1B_1, 25 km
3	IPCC Scenario A1B, ECHAM global model	RCA-ECHAM5 A1B_2, 50 km	N/A
4	IPCC Scenario A1B, ECHAM global model	RCA-ECHAM5 A1B_3, 50 km	RCAO-ECHAM5 A1B_3, 25 km
5	IPCC Scenario A1B, HadCM global model	RCA-HadCM3 A1B, 50 km	RCAO-HadCM3 A1B, 25 km
6	IPCC Scenario A2, ECHAM global model	RCA-ECHAM5 A2, 50 km	RCAO-ECHAM5 A2, 25 km
7	IPCC Scenario B1, ECHAM global model	RCA-ECHAM5 B1, 50 km	N/A
8	IPCC Scenario A1B, CCSM3 global model	RCA-CCSM3 A1B, 50 km	N/A

Helge å


80
70
60
50
40
30
20
10
0
mm month
1995-12-07
1996-12-06
1997-12-06
1998-12-06
1999-12-06
2000-12-05
Date
Observed
Modelled observed weather
Modelled weather01

Weather vs weather





Solutions

- Calibrate/validate with weather observation data and run all as modelled data. Compare runs with re – analysed data.
  - Loads too high
- Test if scale evens out these effects.
  - Work on-going, no results yet
- Other suggestions?

Which data do we have?

Country	No of rivers	Expected obs. [1]	ANC available obs.		TOC available obs.		pH available obs.		Temp available obs.	
		n	n	(%)	n	(%)	n	(%)	n	(%)
Sweden	36	7776	7490	96	7509	97	7509	97	1983	26
Finland	29	6264	3749	60	3992	64	4554	73	4480	72
Estonia	4	864	**0**	**0**	*138*	*16*	807	93	*0*	*0*
Lithuania	1	216	*67*	*31*	*73*	*34*	158	73	*0*	*0*
Latvia	5	1080	**2**	**0**	**25**	**2**	**25**	**2**	*24*	*2*
Poland	2	432	**86**	**59**	**24**	**6**	*126*	*29*	*125*	*29*
Russia	2	432	**0**	**0**	**0**	**0**	**0**	**0**	*0*	*0*

[1] Based on monthly sampling, 1990-2007
[2] One river only (Vistula)

Which data do we have?

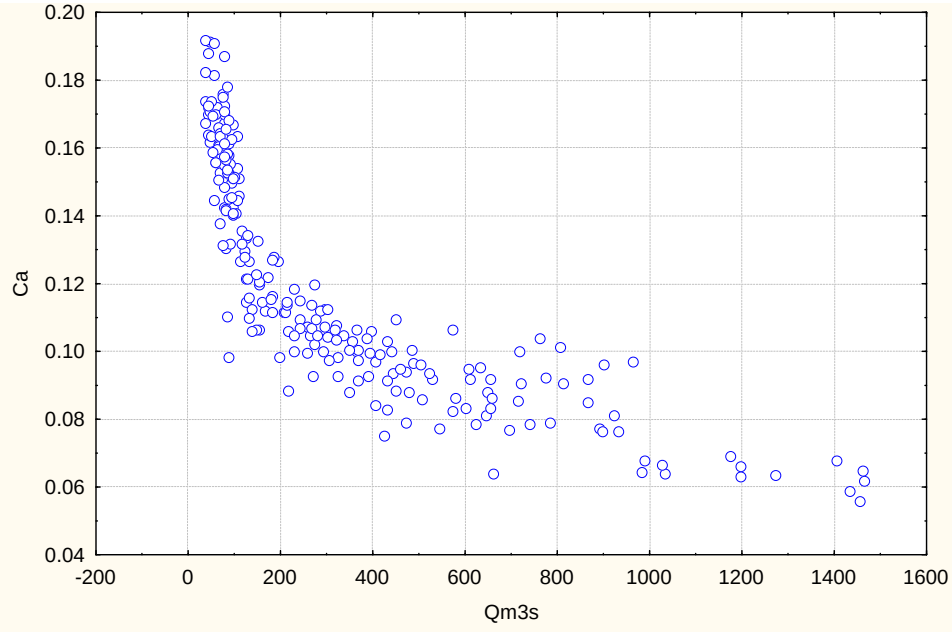
Country	No of rivers	Expected obs. [1]	ANC available obs.		TOC available obs.		pH available obs.		Temp available obs.	
		n	n	(%)	n	(%)	n	(%)	n	(%)
Sweden	36	7776	7490	96	7509	97	7509	97	1983	26
Finland	29	6264	3749	60	3992	64	4554	73	4480	72
Estonia	4	864	**0**	**0**	*138*	*16*	807	93	*0*	*0*
Lithuania	1	216	*67*	*31*	*73*	*34*	158	73	*0*	*0*
Latvia	5	1080	**2**	**0**	**25**	**2**	**25**	**2**	*24*	*2*
Poland	2	432	250	20	*24* (130)	*6* (32)	*310*	*29*	*125*	*29*
Russia	2	432	**27**	**12**	**0**	**0**	*65*	*30*	*65*	*30*

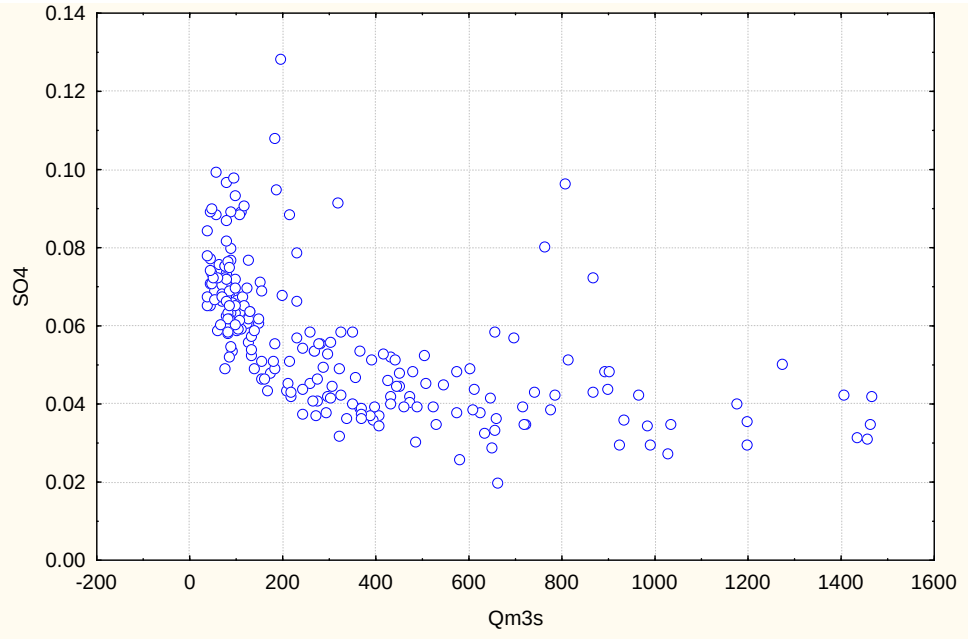
[1] Based on monthly sampling, 1990-2007

Ca^{2+} and SO_4^{2-}

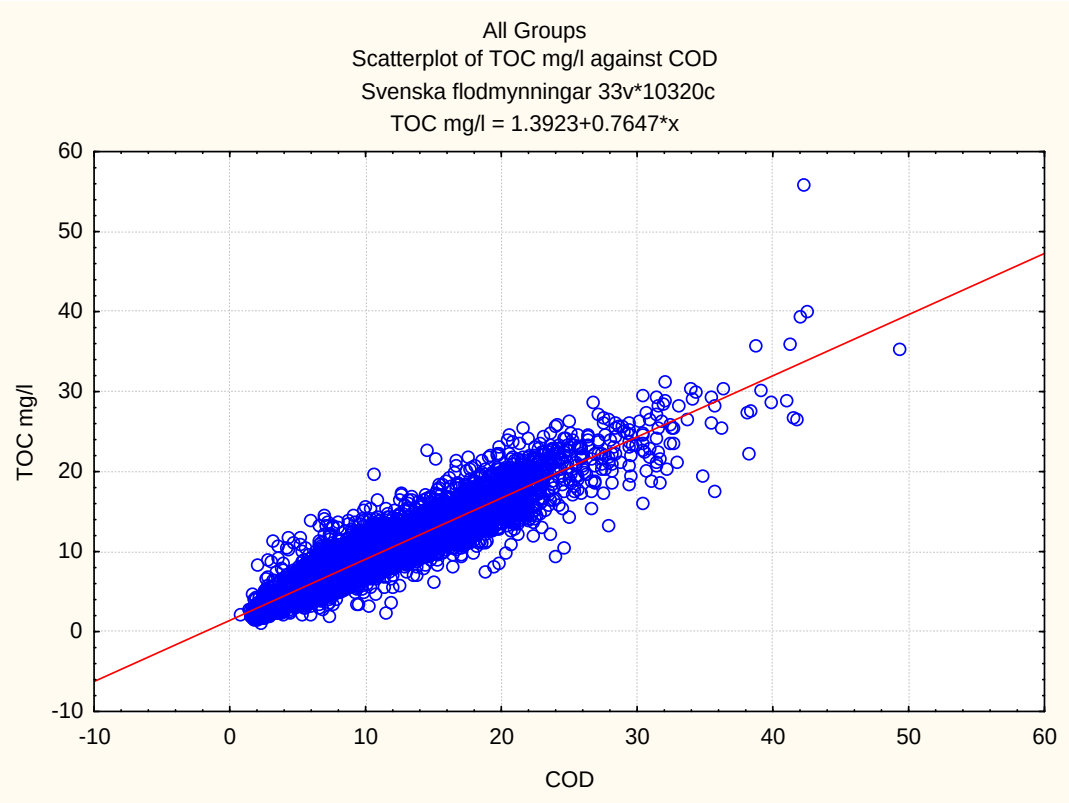
dependence of discharge.

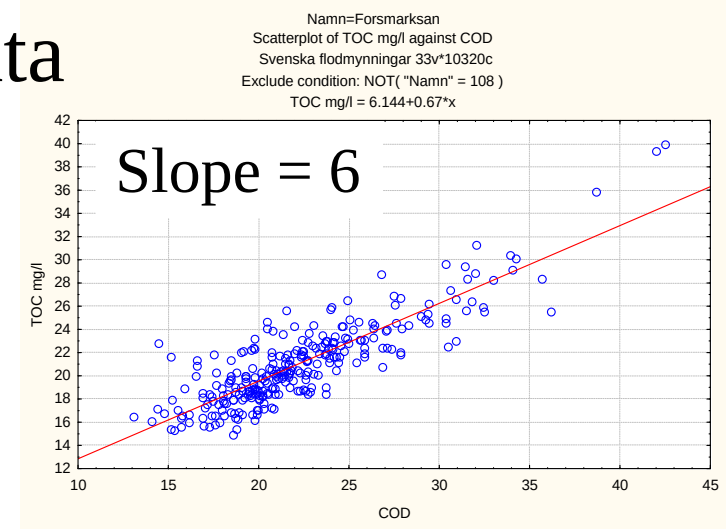
Kalix Älv

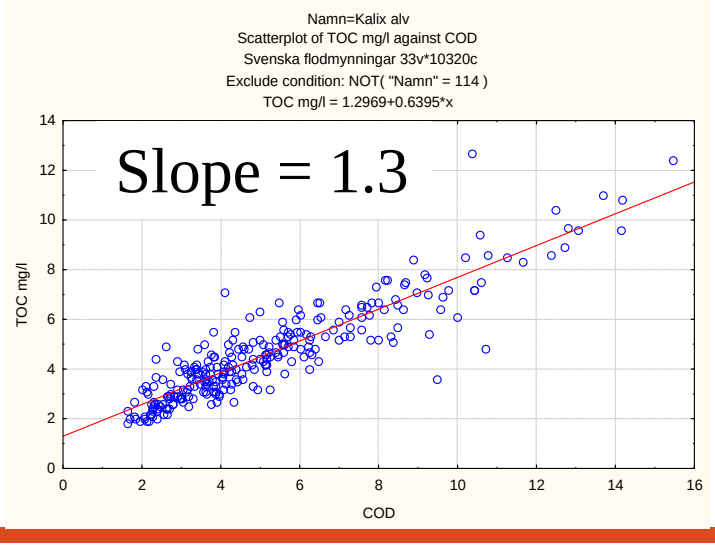




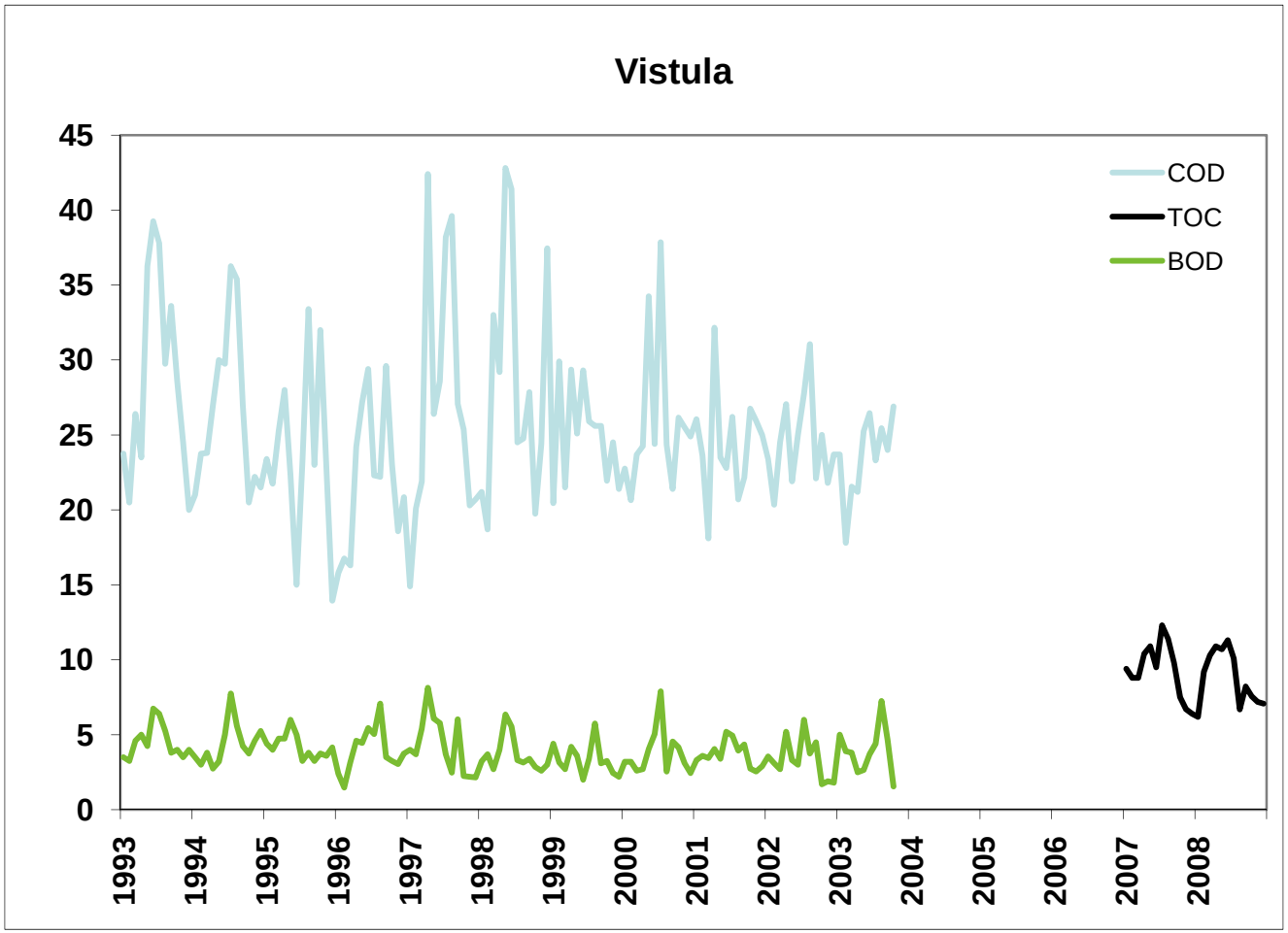
Relation COD-TOC
Swedish data



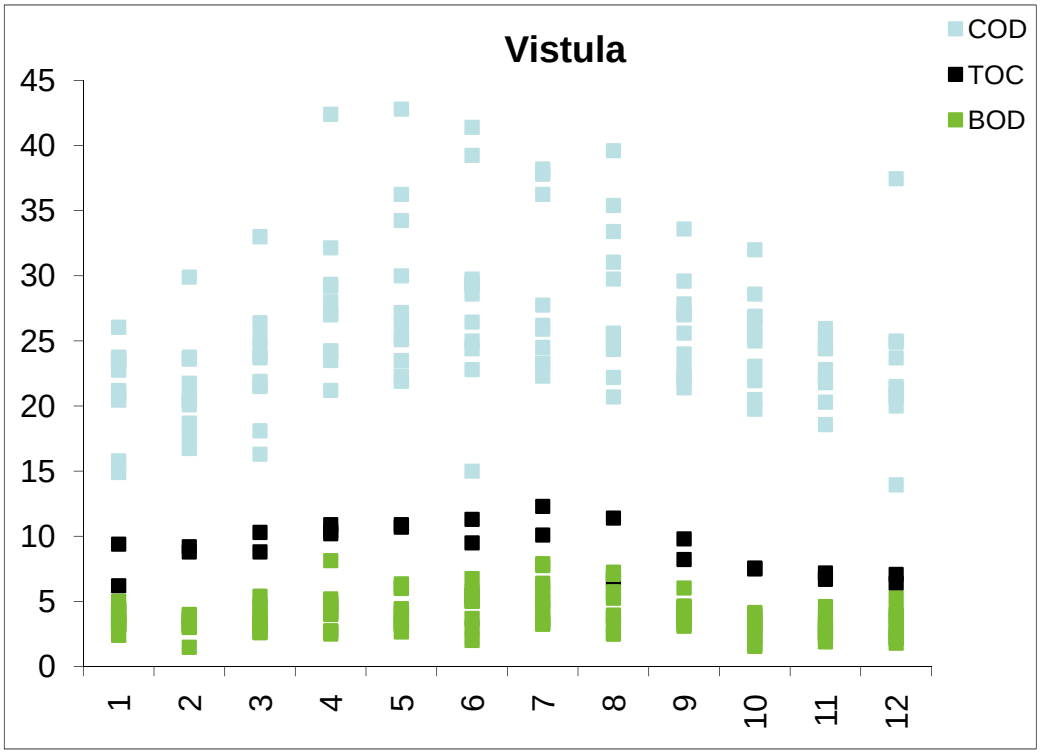


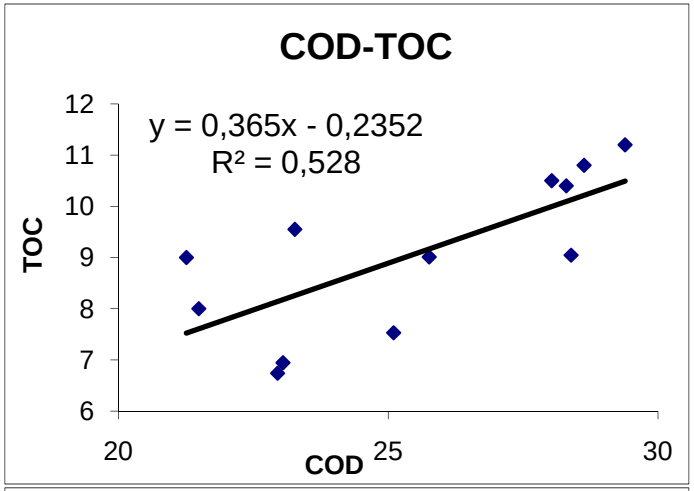


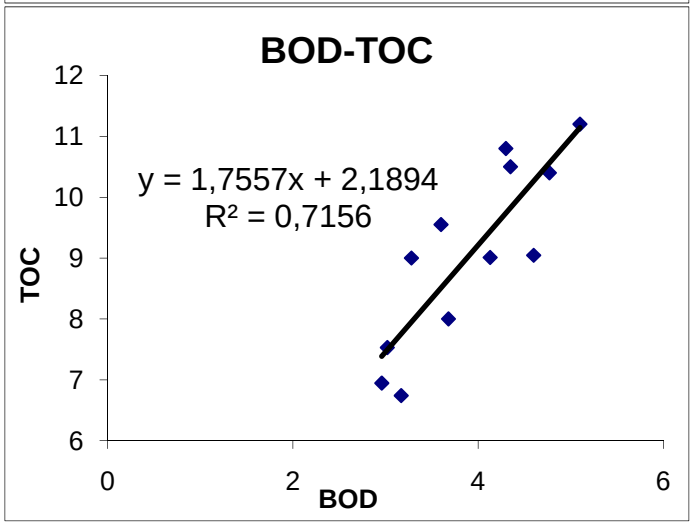
TOC from COD and BOD?



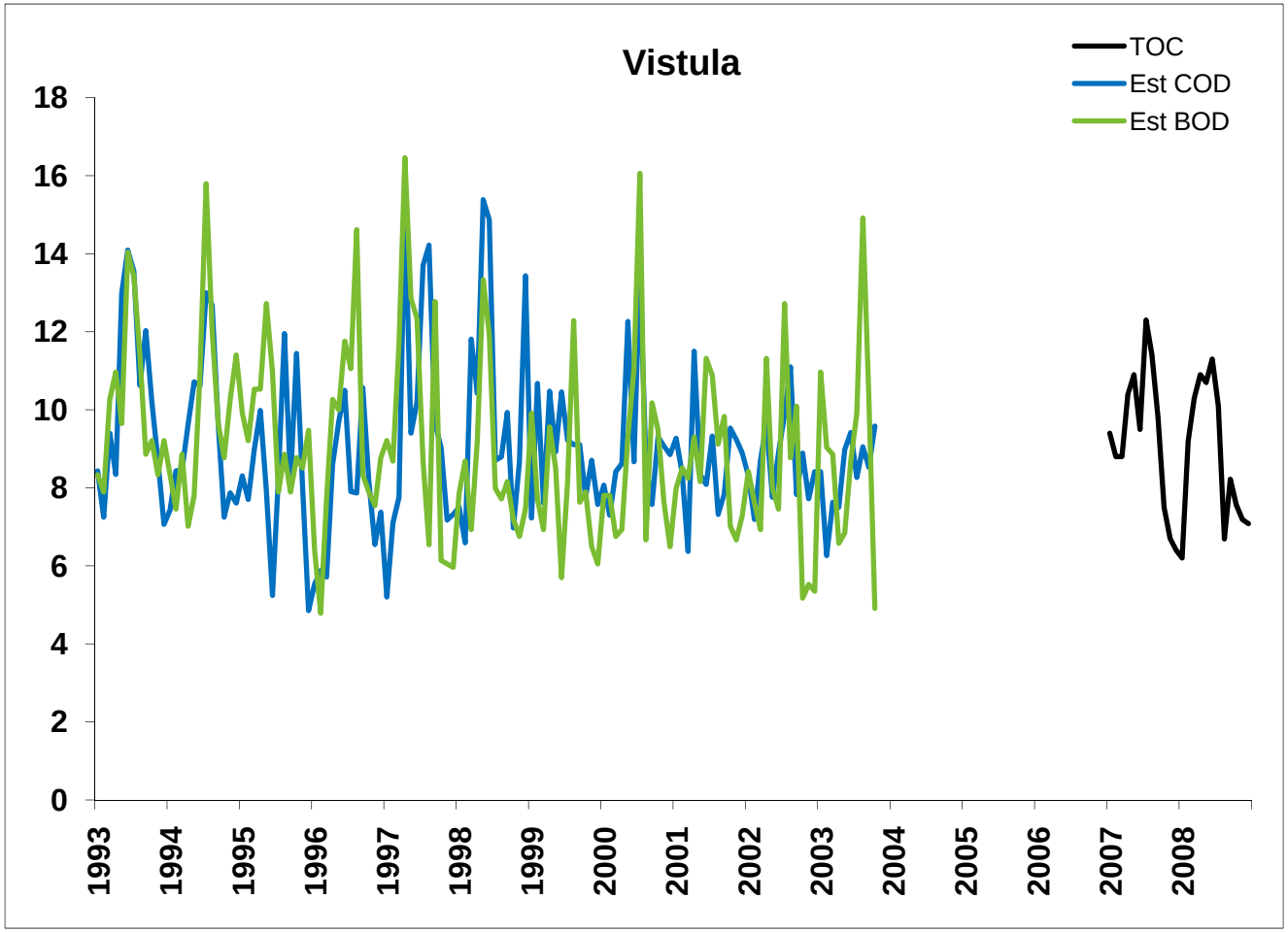
TOC from COD and BOD?



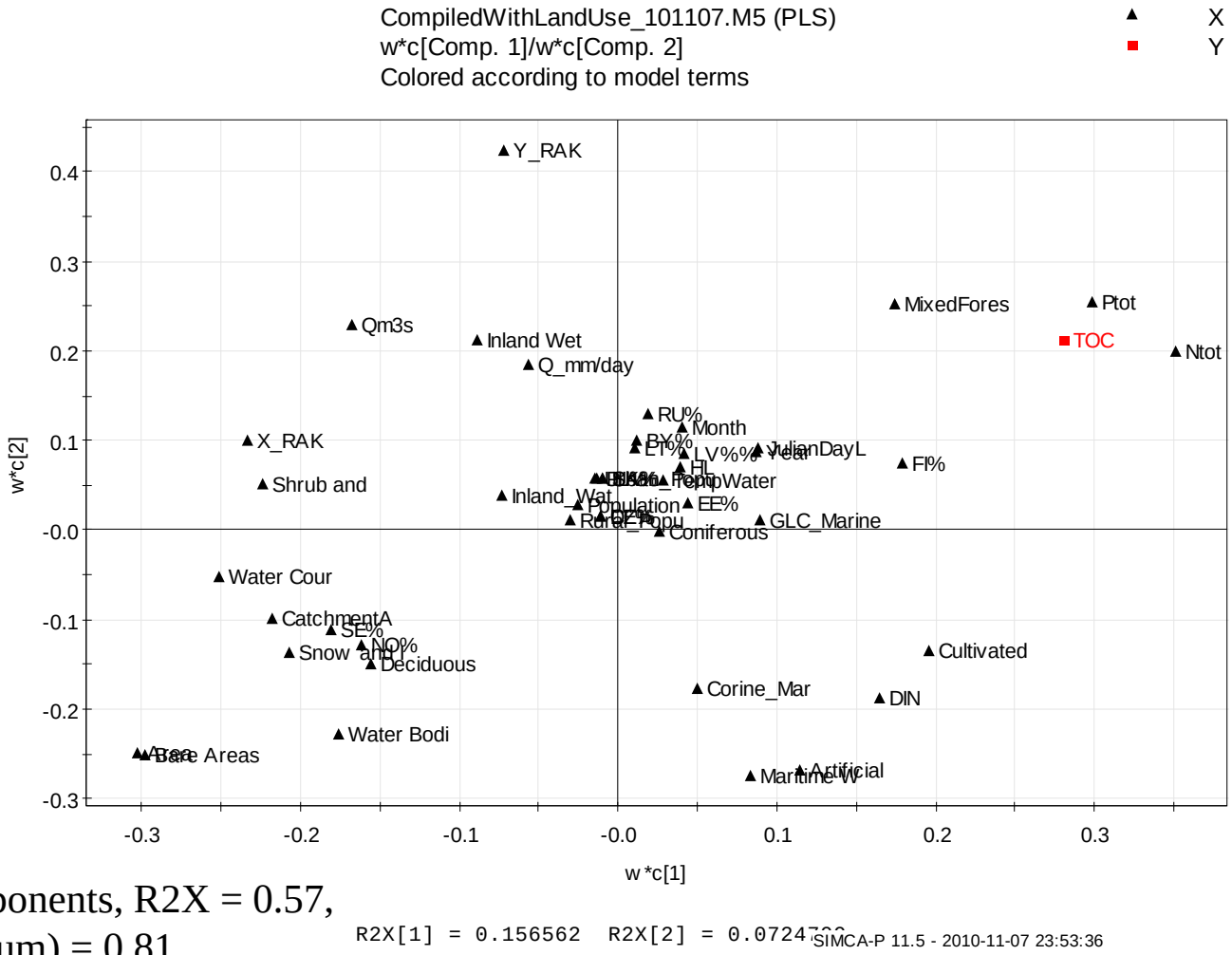




TOC from COD and BOD?

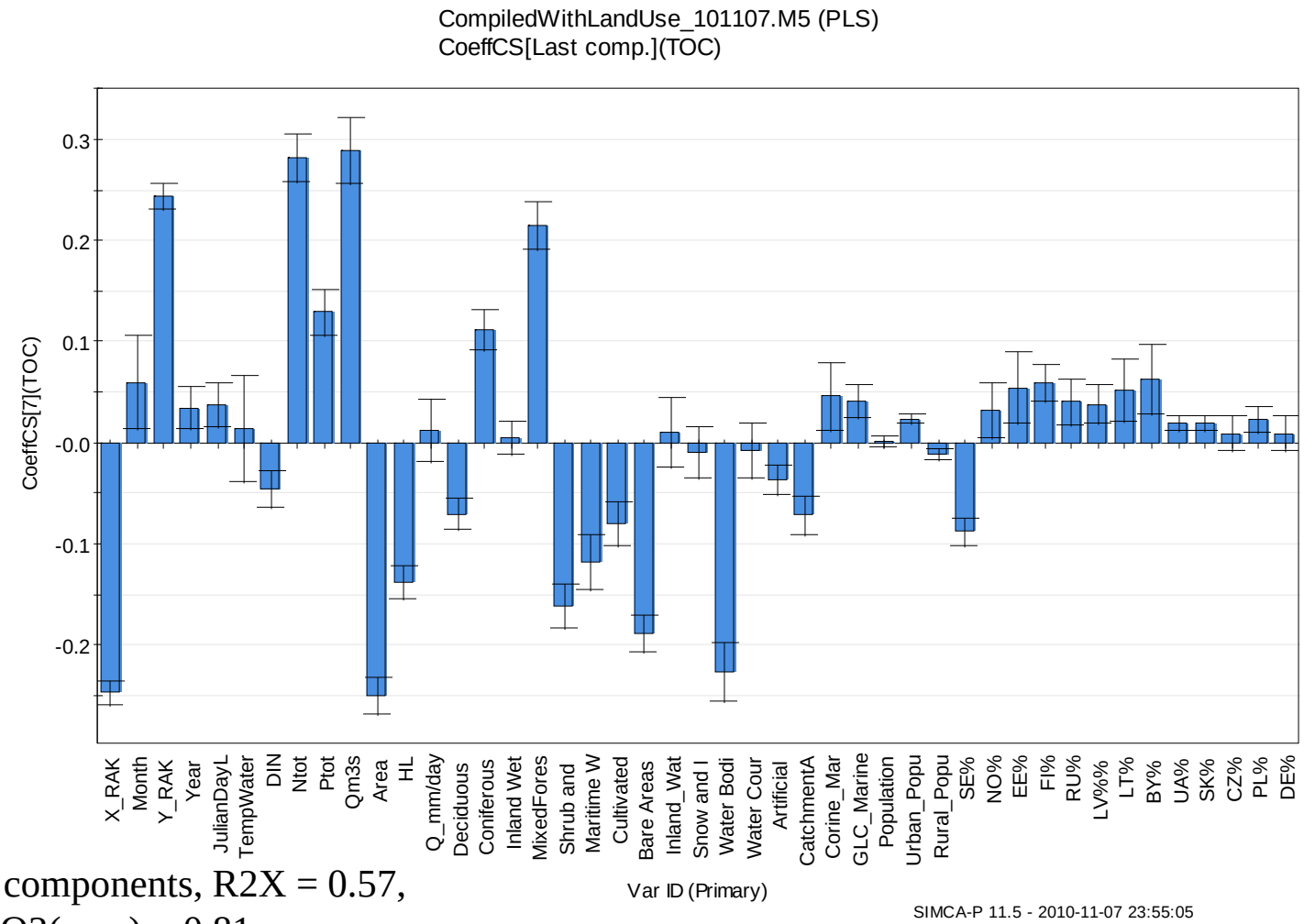


PLS, TOC as Y, Loading scatter



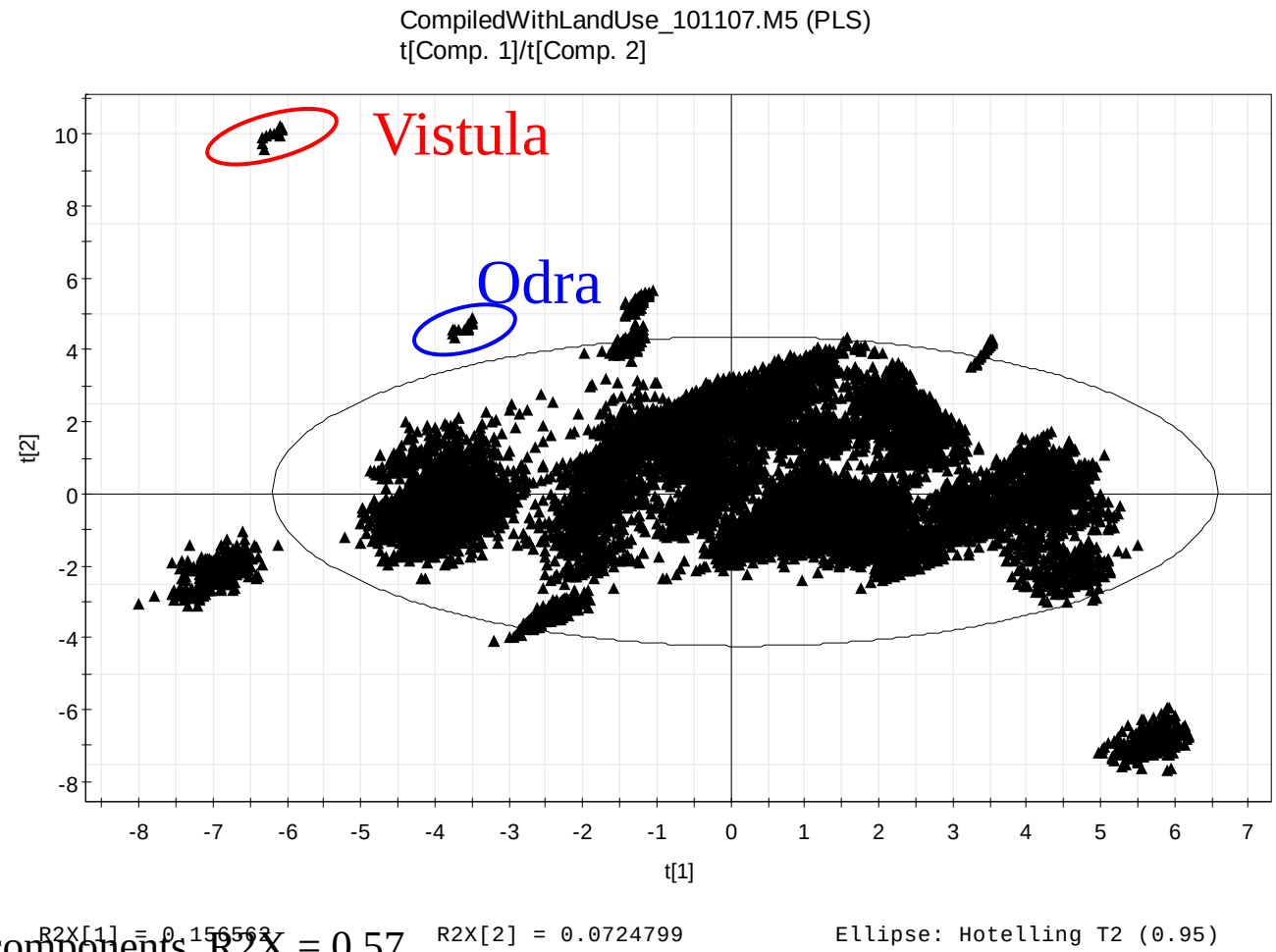
7 significant components, R2X = 0.57, R2Y = 0.81, Q2(cum) = 0.81

PLS, TOC as Y, Coefficient plot



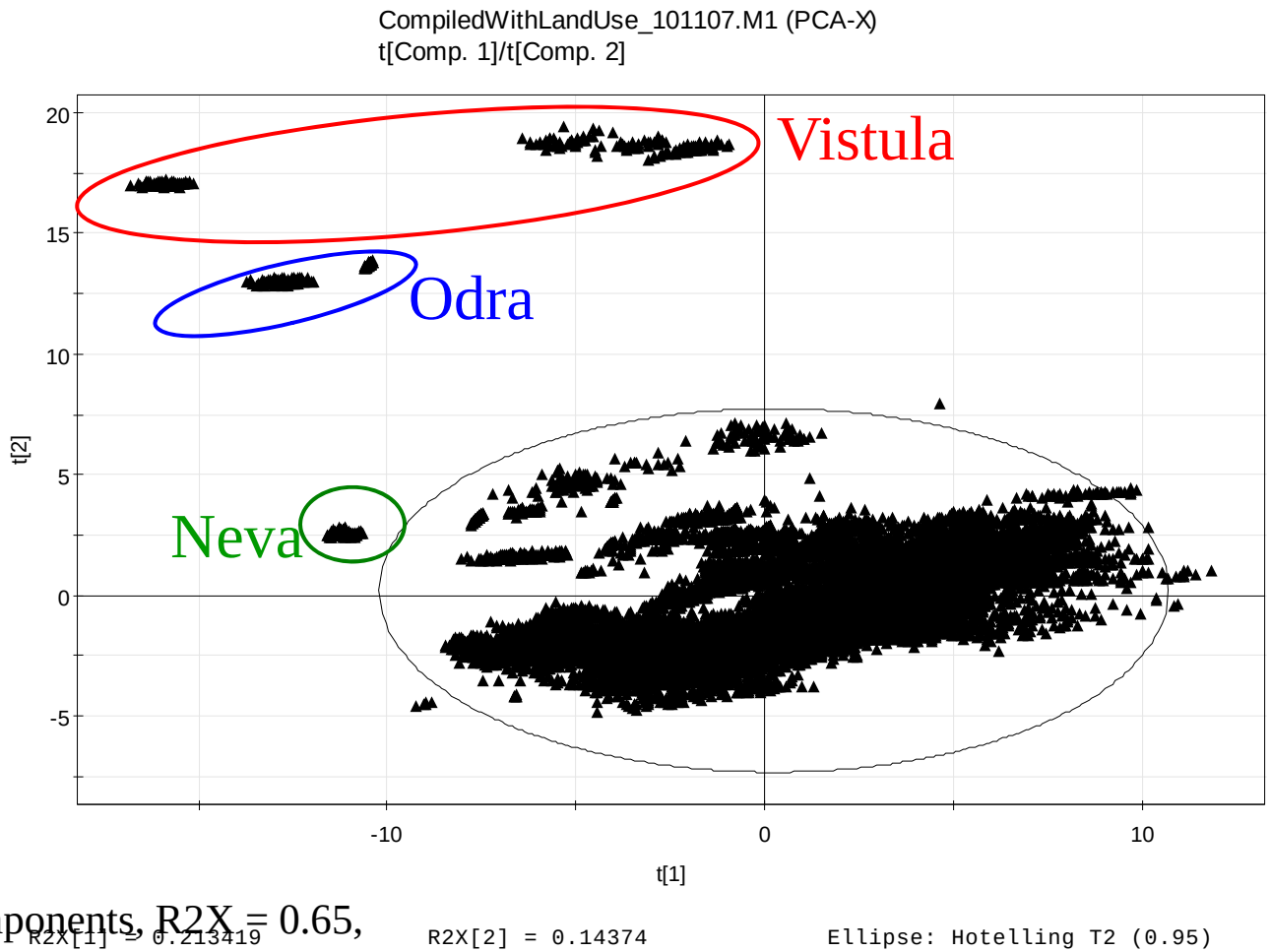
7 significant components, R2X = 0.57, R2Y = 0.81, Q2(cum) = 0.81

PLS, TOC as Y, Score scatter



7 significant components, R2X = 0.57, R2Y = 0.81, Q2(cum) = 0.81

PCA, entire dataset, Score scatter



7 significant components, R2X = 0.65, Q2(cum) = 0.45