Joint Task Force of ICP Waters and ICP IM 2017
– presentations Wednesday 8 May 2017 - Thursday 11 May 2017

Biology responses to air pollution
Environmental drivers of leaf litter decomposition in streams,
Andreas Bruder and Julien Cornut, Switzerland

Species sensitivity to acidification in highly endemic regions of South Africa
Londiwe M Khuzwayo, South Africa

Nitrogen deposition impacts in the Austrian IM site Zöbelboden
Ika Djukic, Austria

Gas supersaturation may cause effects on the biota comparable to acidification
Gaute Velle, Norway

Co-analysis of coniferous forest state parameters and atmospheric deposition data series obtained by ICP IM and EMEP at European part of Russia
Ekaterina Pozdnyakova, Russia

Recovery of benthic algal assemblages from acidification - how long does it take, and is there a link to eutrophication?
Jakub Hruska, Czech Republic

Critical loads/Dynamic modelling
Soil modelling study VSD+Opens in new window
Maria Holmberg, Finland, ICP IM Programme Centre

Acidification and Critical Loads of Surface Waters in European Territory of Russia and Western Siberia
Tatyana Moiseenko, Marina Dinu, Russia.

Relationships between critical load exceedances and empirical impact indicators - Update of N assessment
Jussi Vuorenmaa, Finland, ICP IM Programme Centre

Common Task Force meeting for both ICPs
Chemical intercomparison
Øyvind Garmo, Norway, ICP Waters Programme Centre

Separate meetings: ICP IM TF meeting
Explanatory notes presentation ICP IM TF
Lars Lundin, Sweden, ICP IM Chair

ICPIM database status
Sirpa Kleemola, Finland, ICP IM Programme Centre

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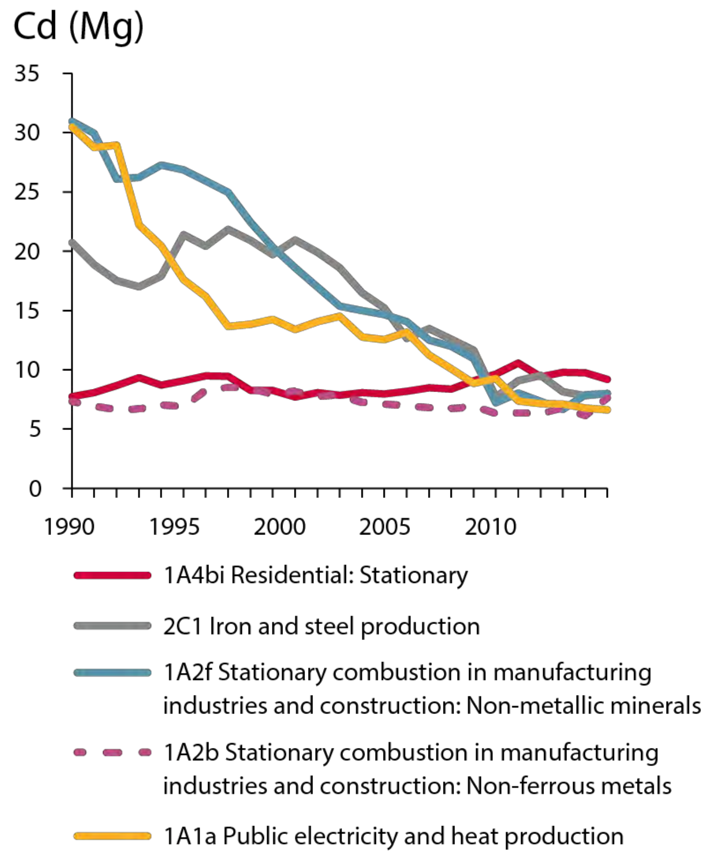
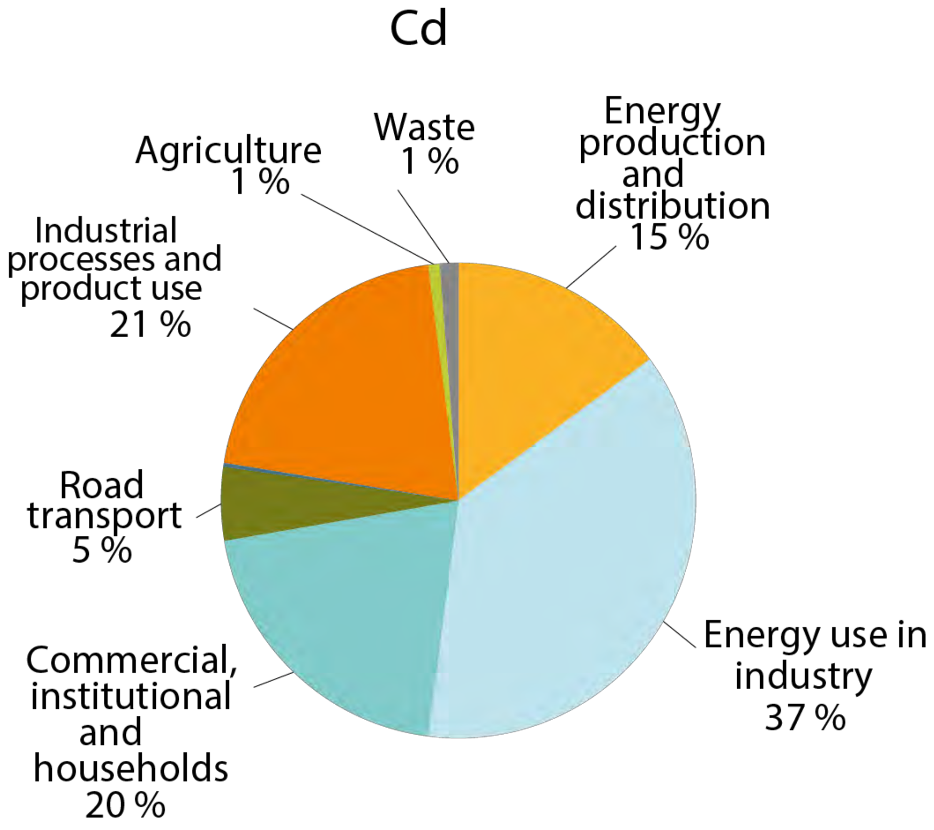
Cd emissions in the EU

From the *European Union emission inventory report 1990–2014 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) (2016)*





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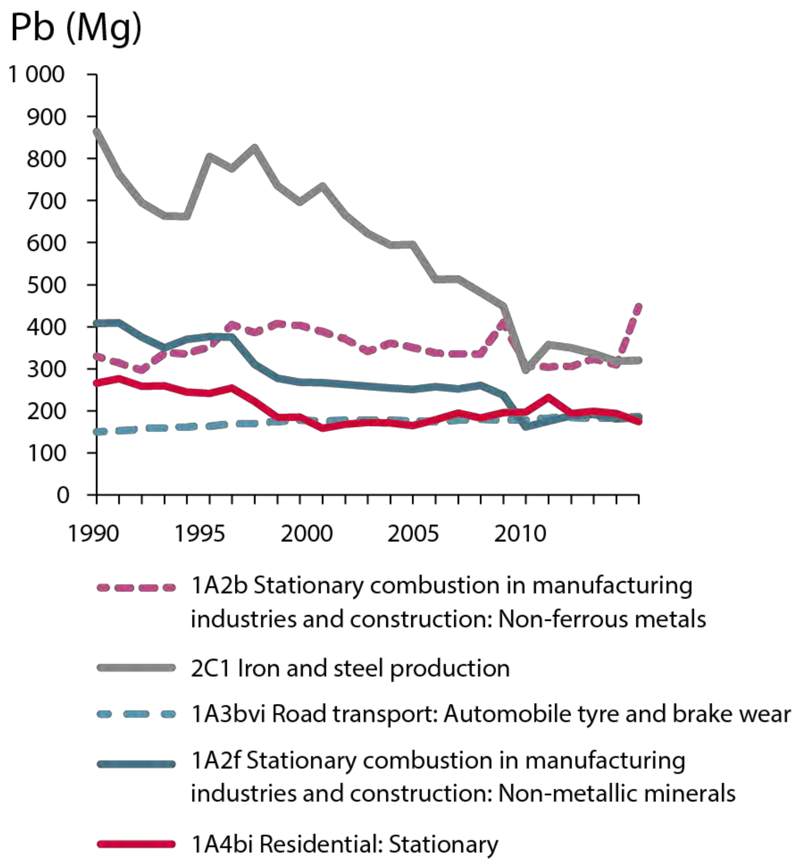
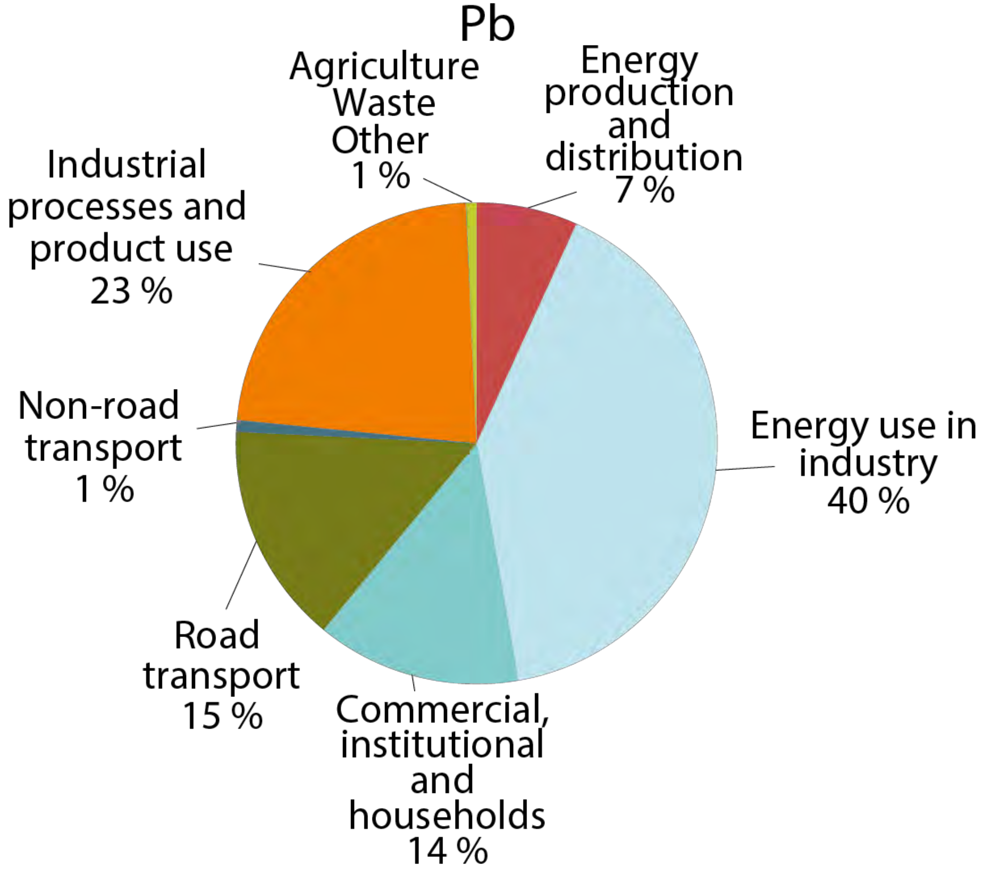
Pb emissions in the EU

From the *European Union emission inventory report 1990–2014 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) (2016)*





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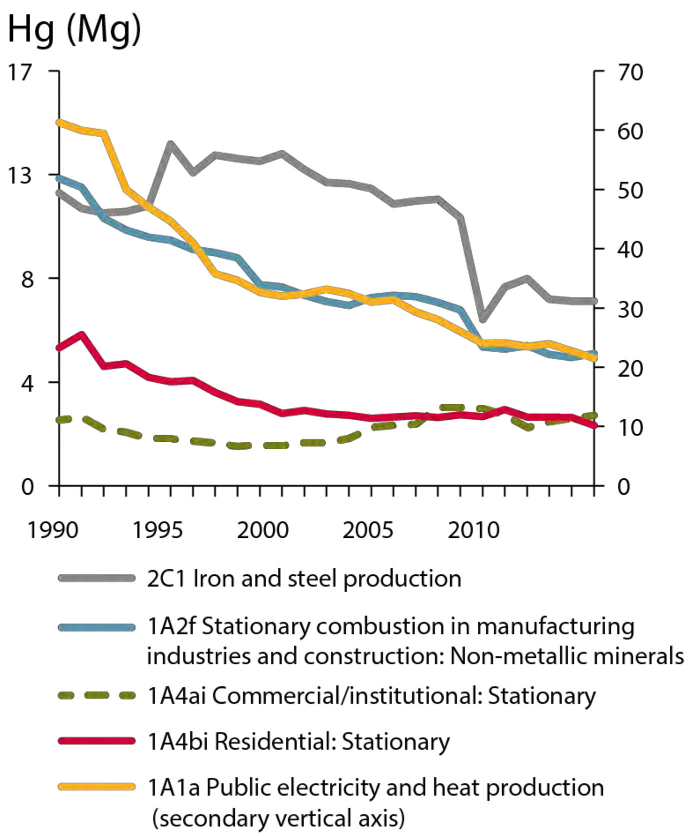
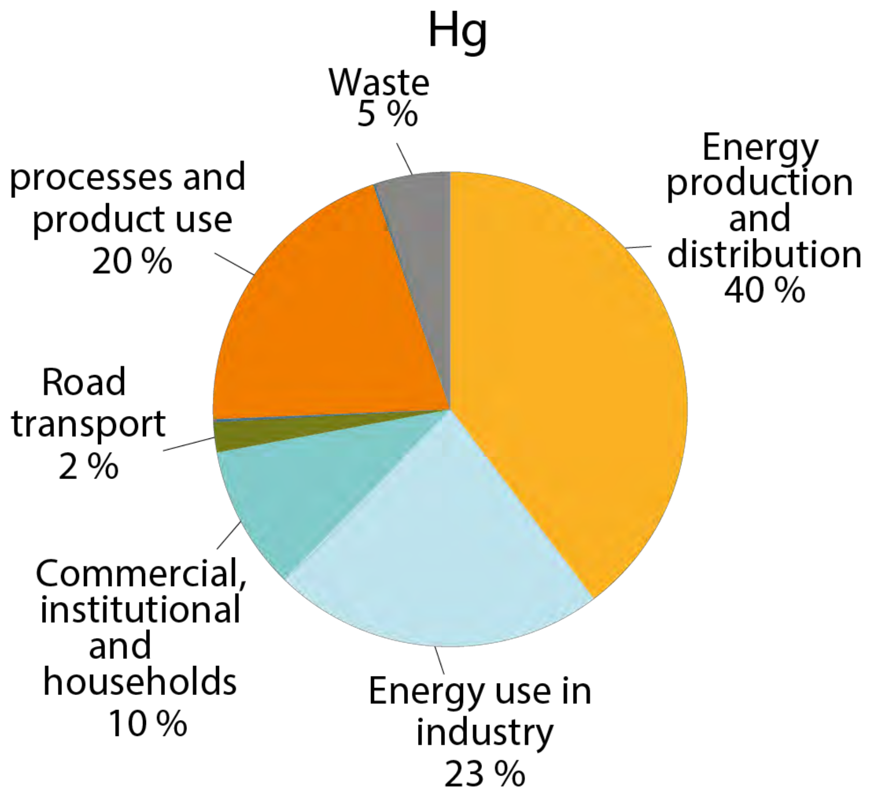
Hg emissions in the EU

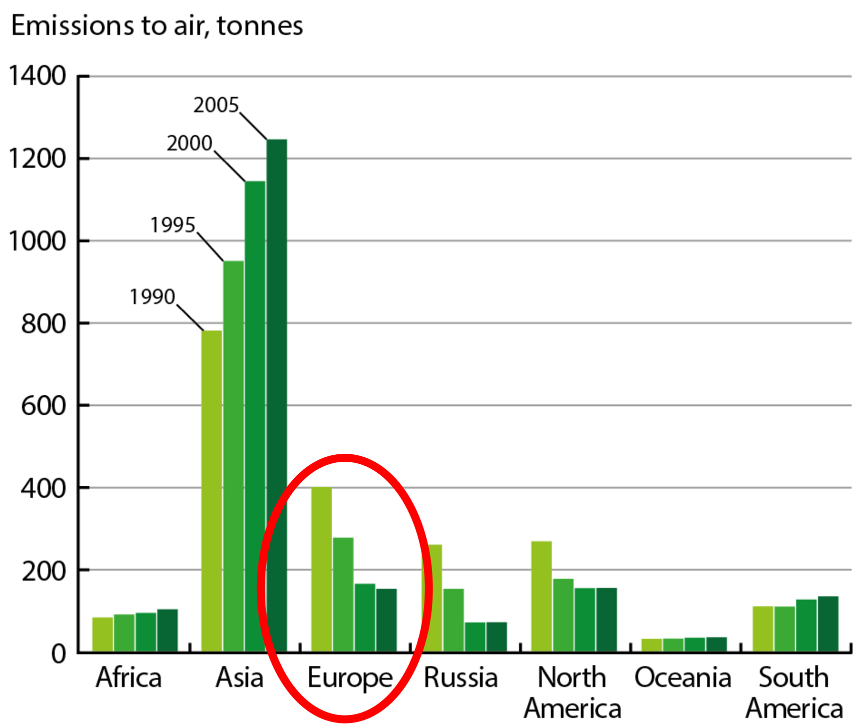
From the *European Union emission inventory report 1990–2014 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) (2016)*



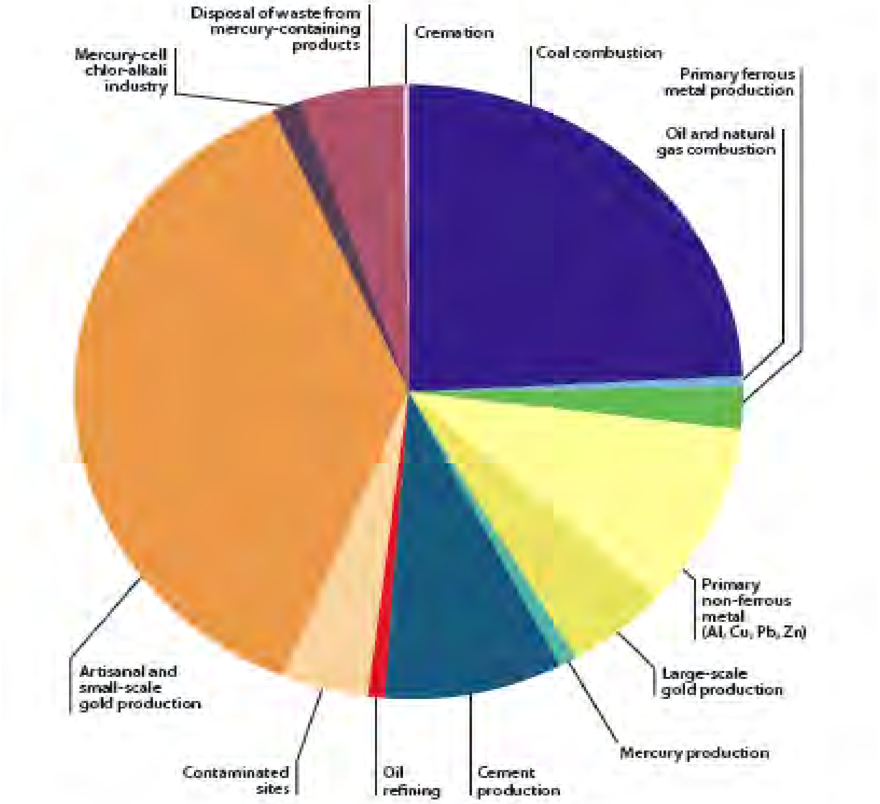


Global Hg emissions

From *UNEP, 2013. Global Mercury Assessment 2013: Sources, Emissions, Releases and Environmental Transport.*

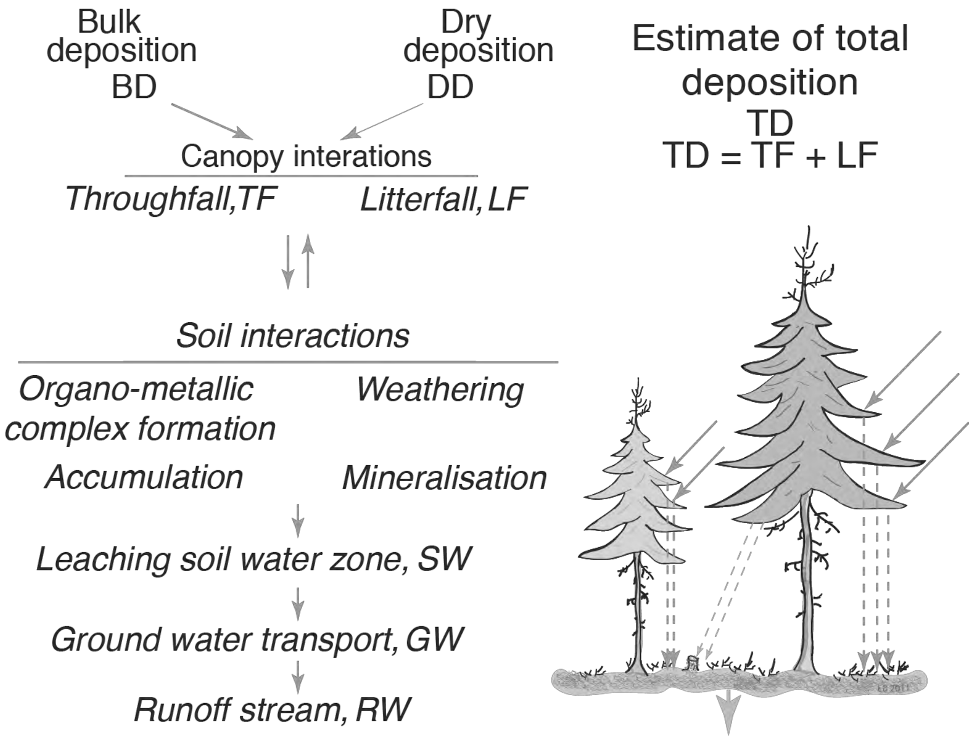


Estimates of annual anthropogenic mercury emissions from different continents/regions, 1990-2005.



Relative contributions to estimated emissions to air from anthropogenic sources in 2010.

Processes involving metals in forest catchment mass balance

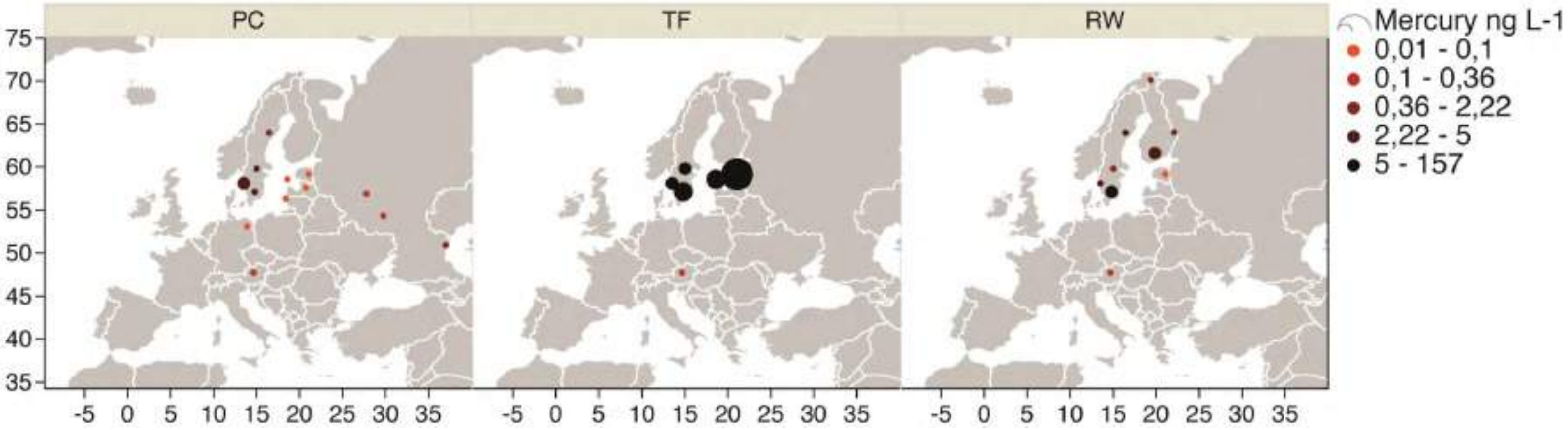


Retention = 1 - RW / Input
Input = TF (+ LF for Hg and Pb)

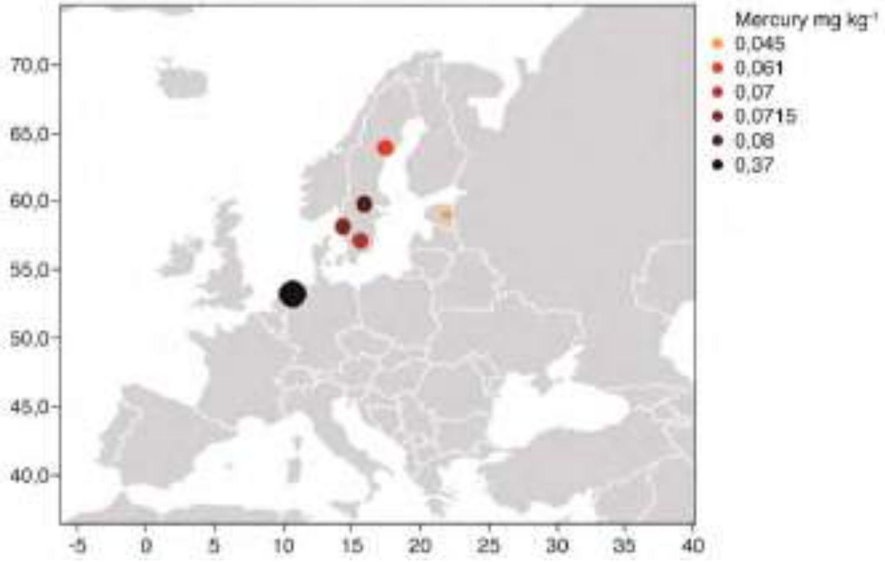
Retention of heavy metals in catchments:
Cd: (0) – 91%
Pb: 74 – 94 %
Hg: 86 – 99 %
Cu: 80 – 97 %
Zn: 38 – 96 %

From *Bringmark, L. et al. 2013. Trace metal budgets for forested catchments in Europe-Pb, Cd, Hg, Cu and Zn. Water Air Soil Pollut. 224, 1501-1515.*

Mercury

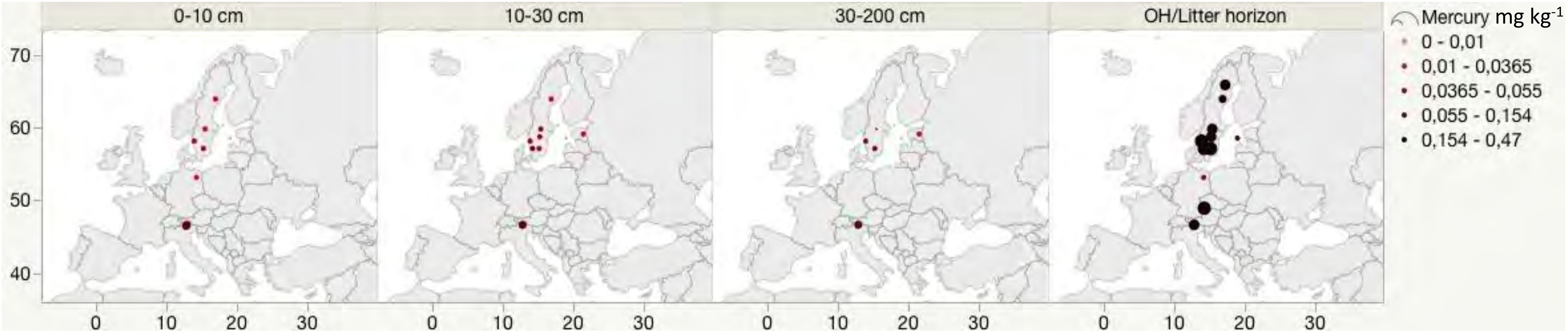


Litterfall



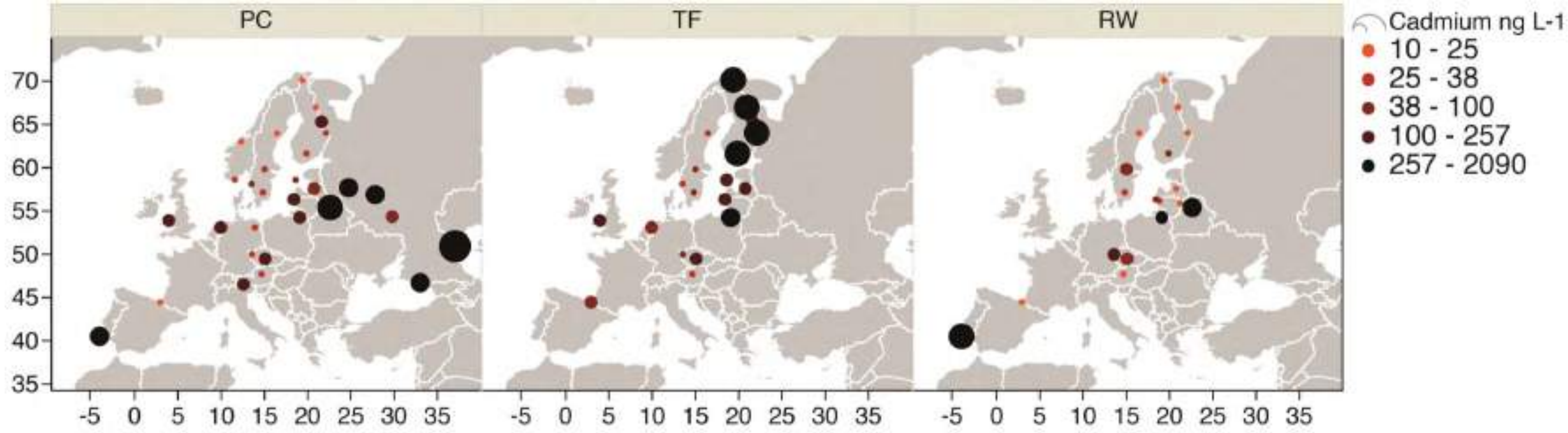
Hg Enrichment	mean	SD	n sites
RW/TF	0.40	0.40	4
TF/PC	160	349	5

Mercury
Soil chemistry

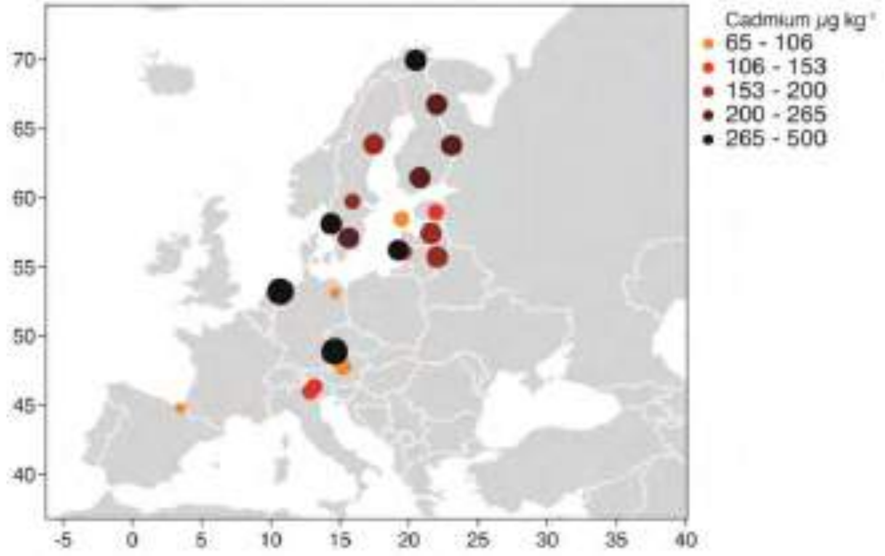


Mercury	Depth (cm)	Mean	median	min	max	n sites
BD ng L^{-1}		1.23	0.25	0.01	4.6	13
TF ng L^{-1}		85.3	33.5	18.8	250	6
LF mg kg^{-1}		0.12	0.07	0.05	0.37	6
RW ng L^{-1}		2.90	2.21	0.1	7.4	9
SC mg kg^{-1}	0 – 10	0.05	0.04	0.005	0.15	8
	10 – 30	0.05	0.04	0.005	0.15	11
	30 – 200	0.03	0.01	0.005	0.12	10
	OH/litter	0.23	0.23	0.06	0.47	12

Cadmium

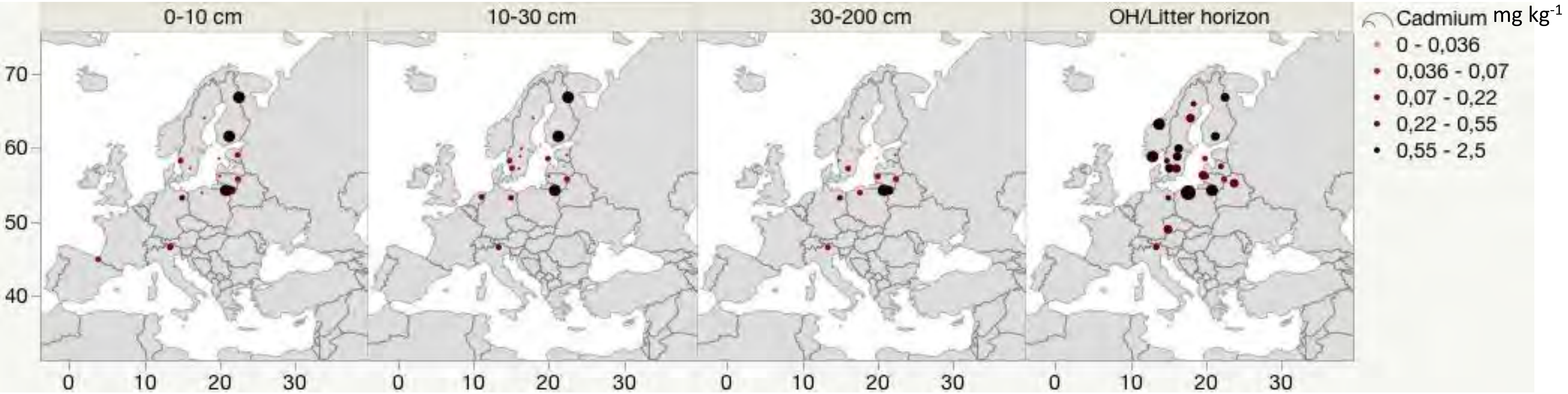


Litterfall



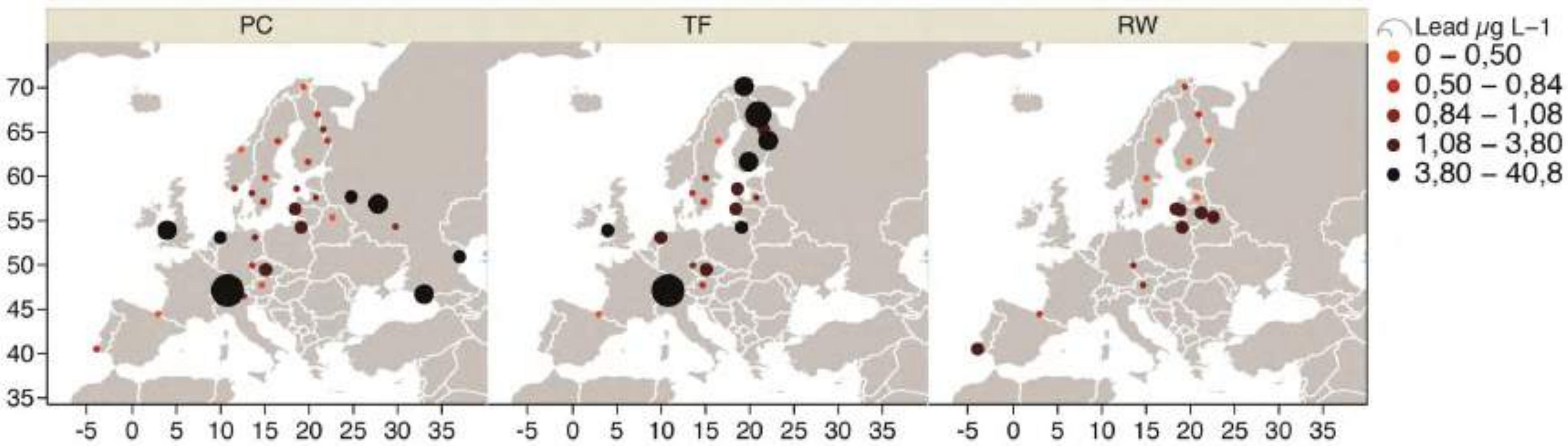
Cd Enrichment	mean	SD	n sites
RW/TF	0.64	1.13	14
TF/PC	9.9	17.4	19

Cadmium
Soil chemistry

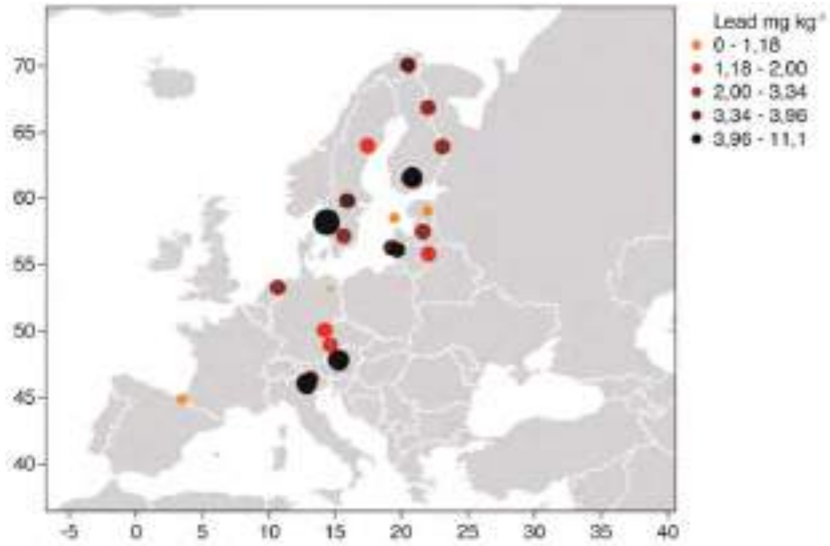


Cadmium	Depth (cm)	Mean	median	min	max	n sites
BD ng L^{-1}		0.24	0.06	0.01	2.09	30
TF ng L^{-1}		0.32	0.15	0.03	1.10	19
LF mg kg^{-1}		0.21	0.20	0.07	0.5	21
RW ng L^{-1}		0.12	0.03	0.01	0.85	19
SC mg kg^{-1}	0 – 10	0.30	0.082	0.01	1.54	19
	10 – 30	0.25	0.07	0.01	1.55	21
	30 – 200	0.19	0,07	0.015	1.44	17
	OH/litter	0.63	0.44	0.11	2.5	23

Lead

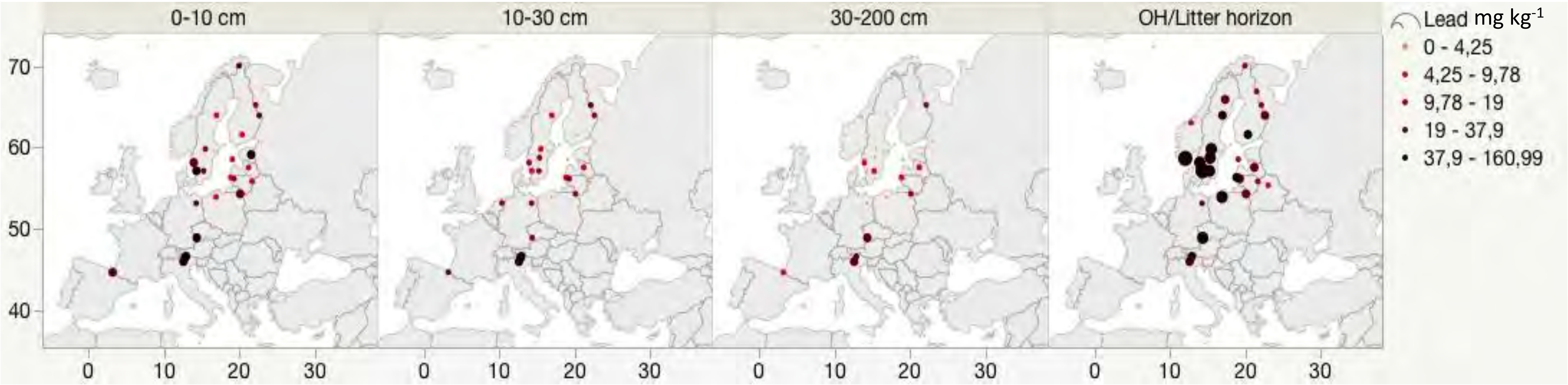


Litterfall



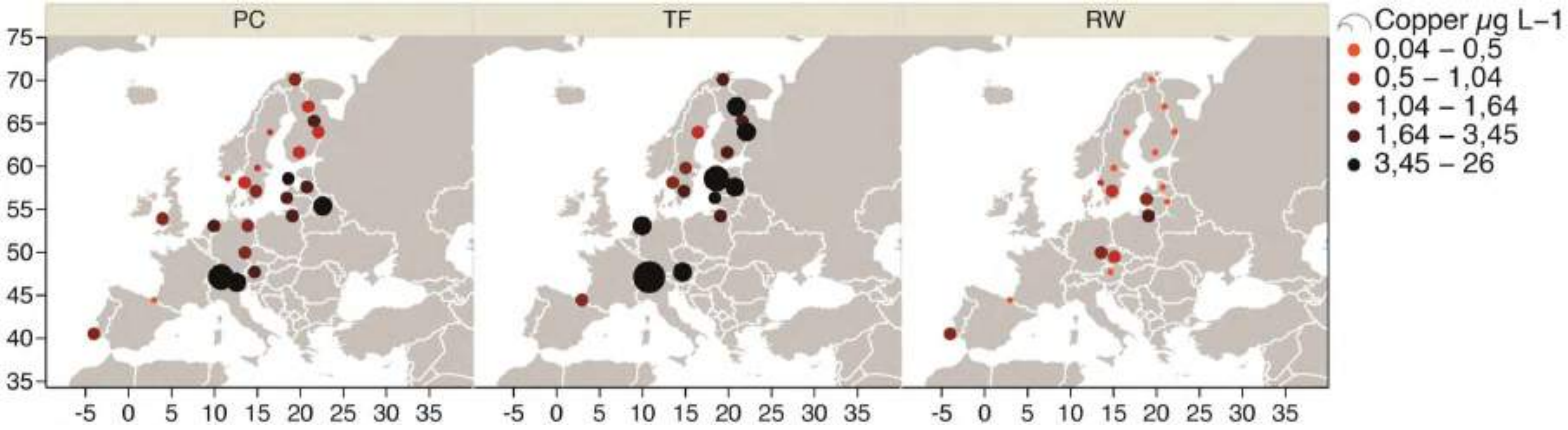
Pb Enrichment	mean	SD	n sites
RW/TF	0.57	0.67	13
TF/PC	5.7	9.9	20

Lead
Soil chemistry

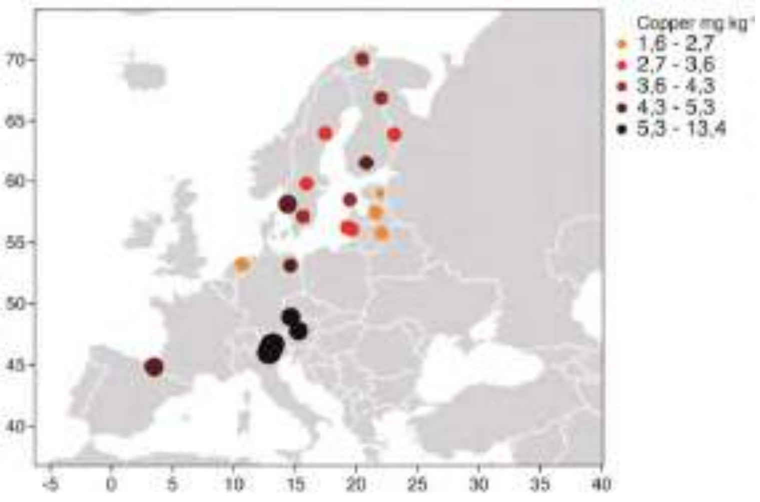


Lead	Depth (cm)	Mean	median	min	max	n sites
BD ng L^{-1}		3.42	1	0.01	40	31
TF ng L^{-1}		6.12	1.86	0.25	40.8	20
LF mg kg^{-1}		3.38	3.31	0.83	11.1	21
RW ng L^{-1}		0.68	0.49	0.04	3	18
SC mg kg^{-1}	0 – 10	21.0	17.6	0.5	59	26
	10 – 30	13.7	11.2	1.0	46	25
	30 – 200	9.3	4.8	1.0	34	23
	OH/litter	45.7	33.6	5.6	161	28

Copper

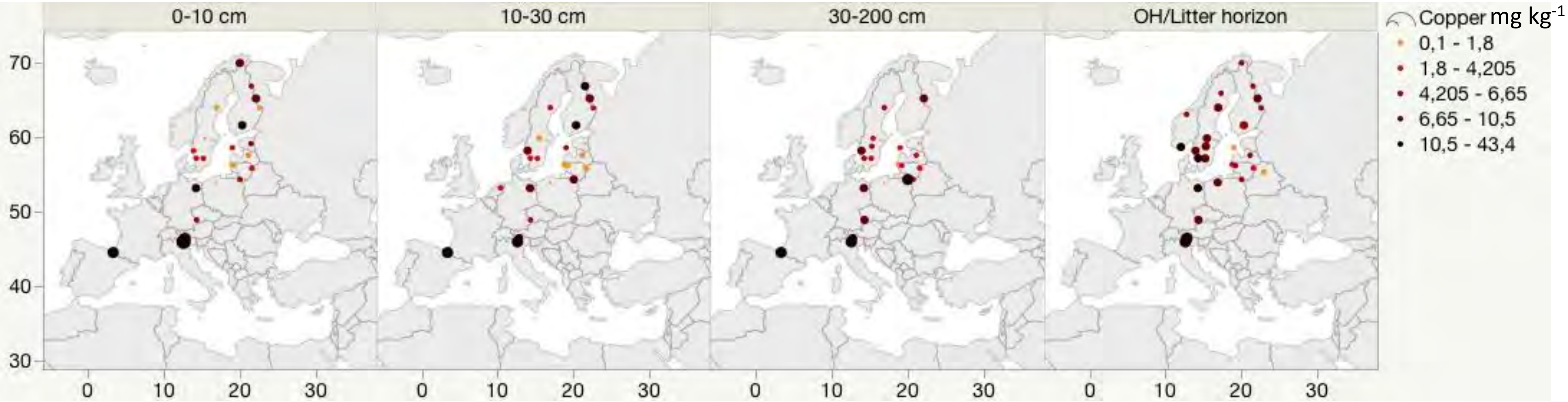


Litterfall



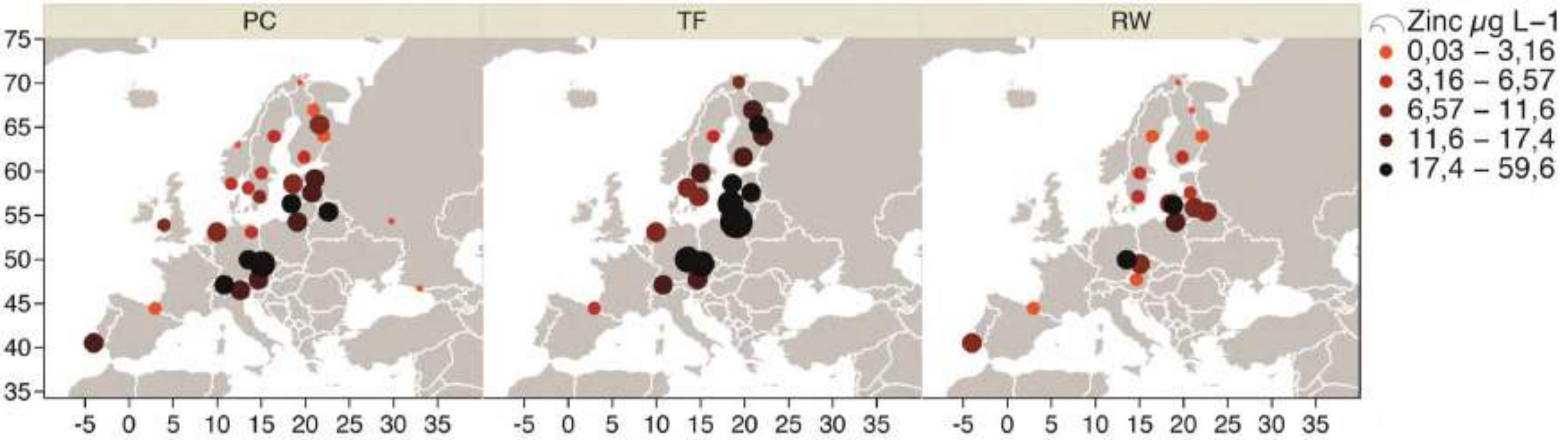
Cu Enrichment	mean	SD	n sites
RW/TF	0.24	0.15	13
TF/PC	2.7	1.7	17

Copper
Soil chemistry

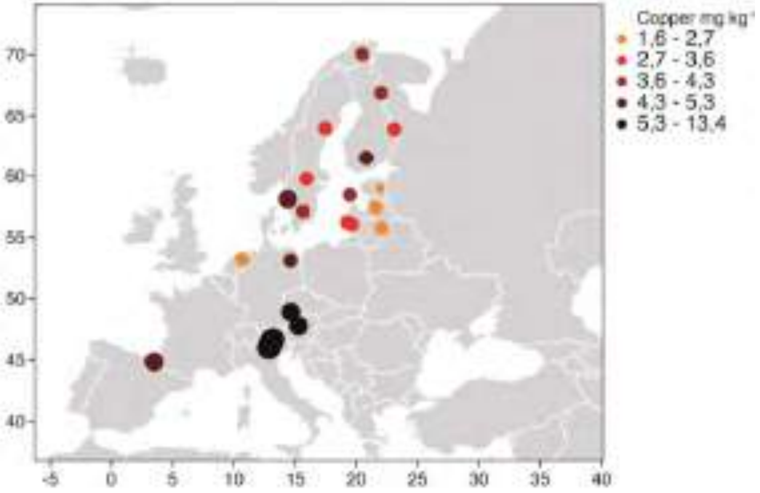


Copper	Depth (cm)	Mean	median	min	max	n sites
BD ng L^{-1}		2.10	1.34	0.40	11.7	24
TF ng L^{-1}		5.14	3.45	0.95	26.0	17
LF mg kg^{-1}		5.02	4.27	1.6	13.4	23
RW ng L^{-1}		1.13	0.66	0.1	3.5	19
SC mg kg^{-1}	0 – 10	7.1	4.5	0.4	43.4	26
	10 – 30	6.9	4.5	0.1	19.4	25
	30 – 200	6.6	4.4	0.2	33.7	23
	OH/litter	8.2	7.0	1.5	23	28

Zinc

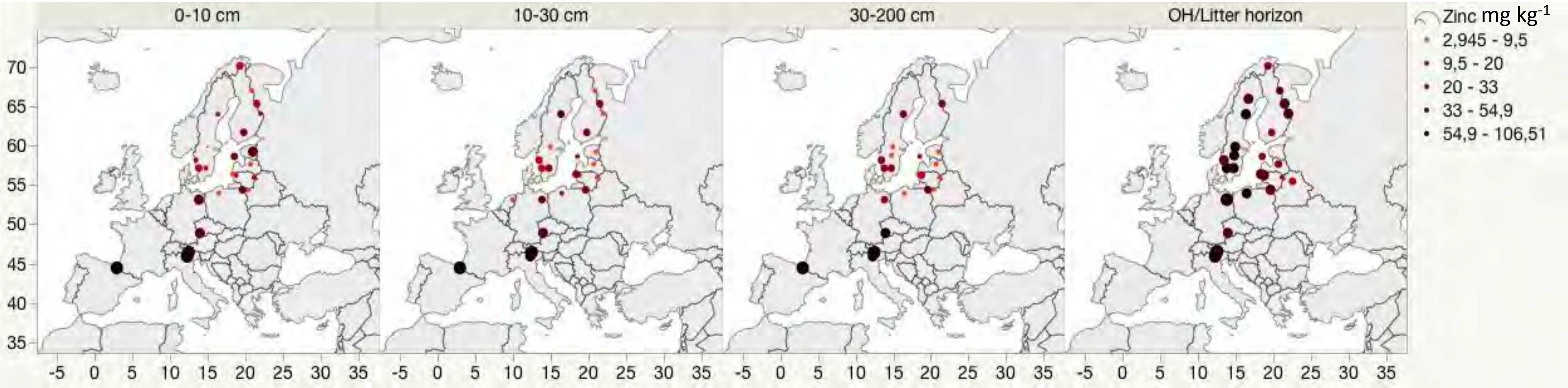


Litterfall



Zn Enrichment	mean	SD	n sites
RW/TF	0.29	0.21	14
TF/PC	2.67	1.92	19

Zinc
Soil chemistry



Zinc	Depth (cm)	Mean	median	min	max	n sites
BD ng L^{-1}		9.52	7.25	0.03	29.5	29
TF ng L^{-1}		19.2	16.3	5.6	60	19
LF mg kg^{-1}		56.0	53.2	21.6	132	24
RW ng L^{-1}		7.2	5.4	0.62	21	19
SC mg kg^{-1}	0 – 10	27.8	15.8	2.9	102	26
	10 – 30	26.8	20.5	4.0	93	25
	30 – 200	30.0	25	3.0	106	23
	OH/litter	48.9	46	13.2	101	26

Heavy metal concentrations in terrestrial compartments and runoff across European IM sites

Conclusions

- HM data from ICP IM sites important for evaluating responses from emissions and atmospheric transport of HM
- Uncertainty in data comparison between sites and regions
- Better resolution in spatial coverage of HM data; complement of data from compartments
- Others HM: Ni, Cr, Mo, V… (Sweden)
- More to come in ICP IM progress report autumn 2017…

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Heavy metal concentrations in terrestrial compartments and runoff across European IM sites

What about POPs?

What about POPs?

Variation and accumulation patterns of poly- and perfluoroalkyl substances (PFAS) in European perch *(Perca fluviatilis*) across a gradient of pristine Swedish lakes

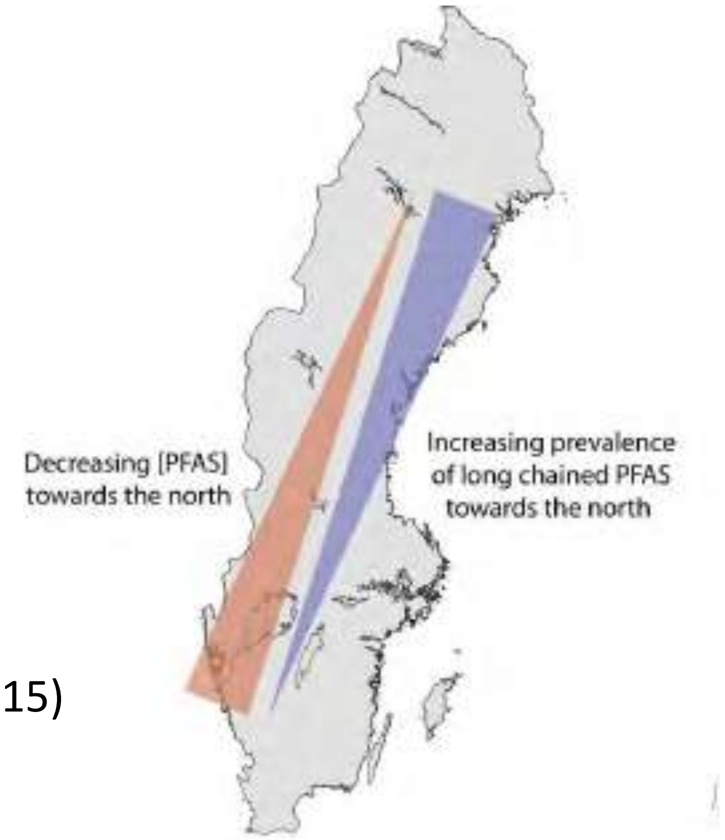
Åkerblom S. et al. Accepted for publication in *Science of the Total Environment*

(Not ICP IM or ICP Waters, but related….)

- 7 PFASs detected: 6:2 FTSA, PFOS, PFDA, PFUnDA, PFDoDA, PFTriDA, and PFTeDA

→ Increaing length of carbon chain

- **Σ**PFAS : mean ± SD: 0.99 ± 0.63 ng g^{-1} ww (min / max : 0.31 / 3.4 ng g^{-1} ww)
- Comparable background **Σ**PFAS levels from high mountain lakes in France ranging from 20.7 to 36.1 ng g^{-1} ww (Ahrens et al. 2010)
- PFOS in Sweden: 0.01 / 0.93 ng g^{-1} ww'
- PFOS in Resolute Bay (Nunavut, Canada): <0.001 – 2.0 ng g^{-1} ww (Lescord et al. 2015)








Environmental drivers of leaf litter decomposition in streams

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SUPSI

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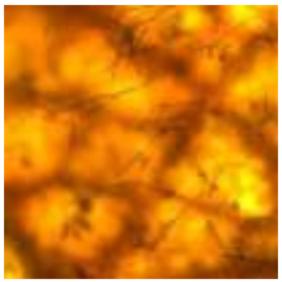
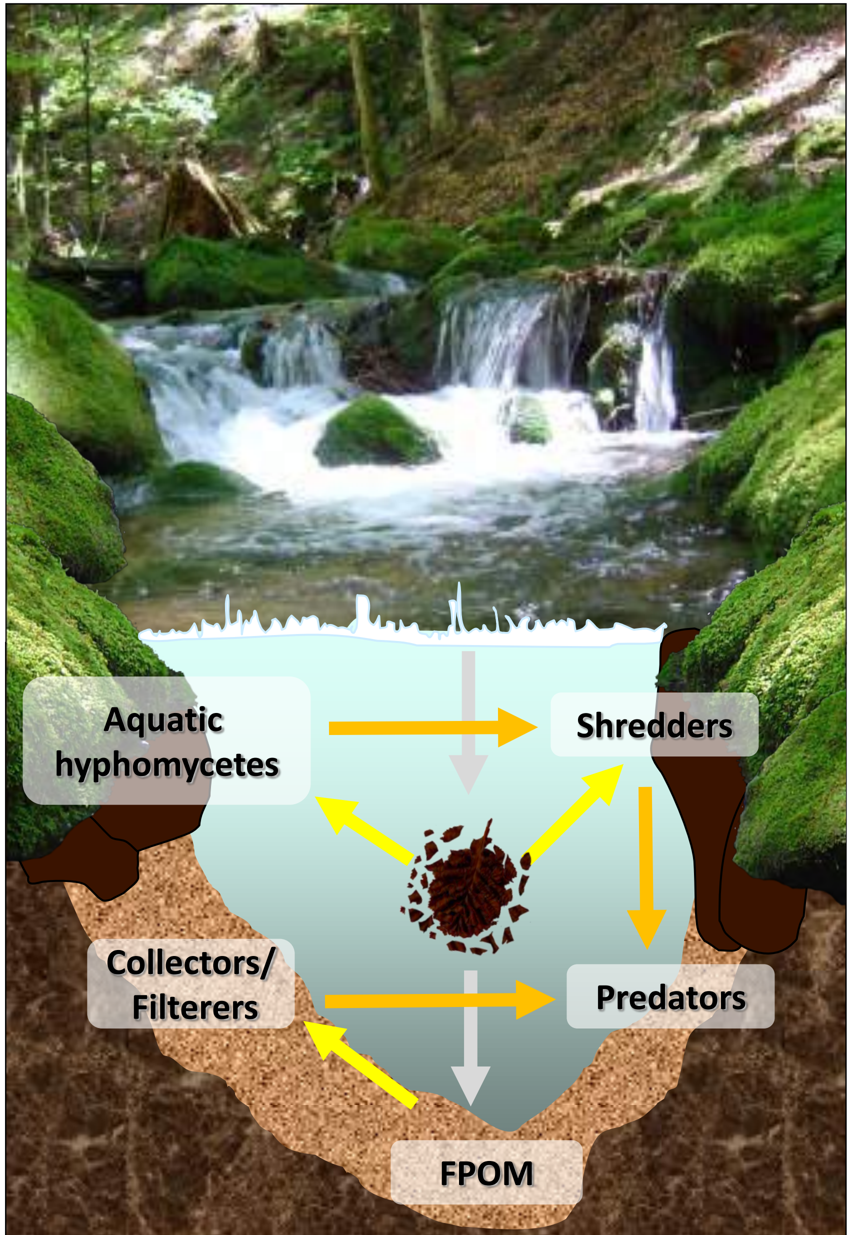
[2]Laboratory of Applied Microbiology

food webs of forested streams

Aquatic hyphomycetes



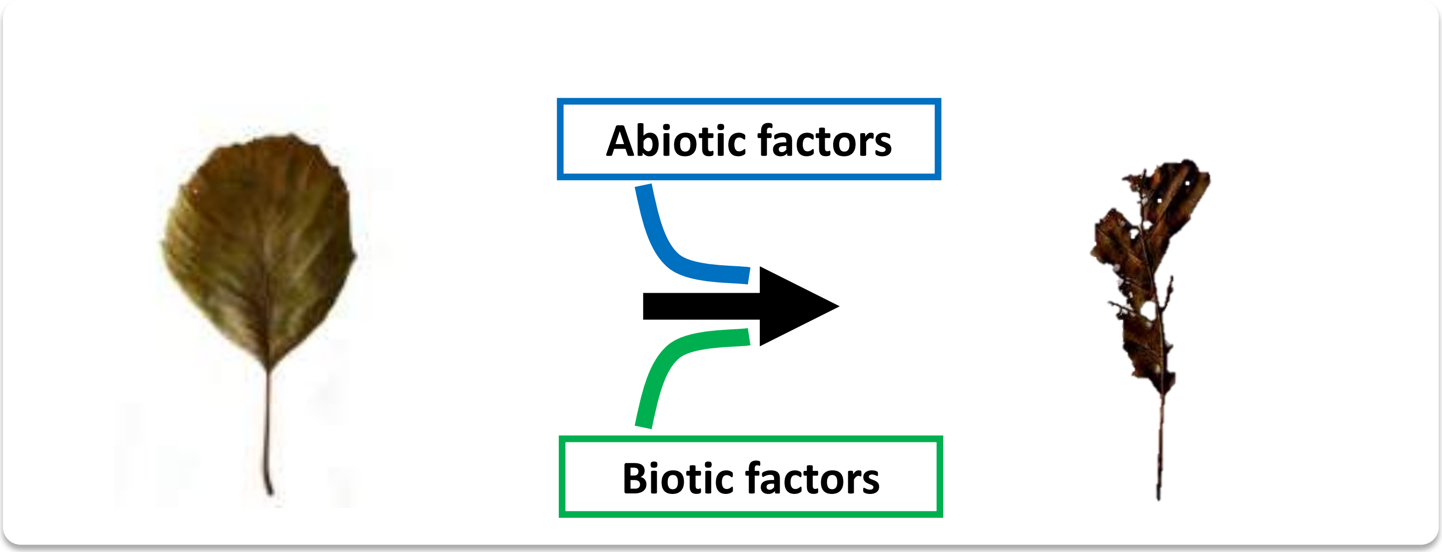
Collectors/Filterers

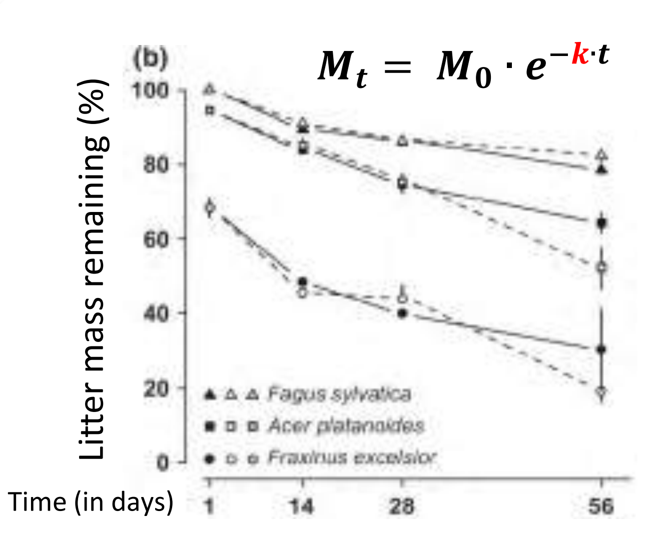


Shredders

Predators

leaf litter decomposition





Bruder et al. (2014) Freshwater Biology

Abiotic factors

> Temperature

> Dissolved chemicals

> Pollution

> Flow velocity

> ...

Biotic factors

> Litter characteristics

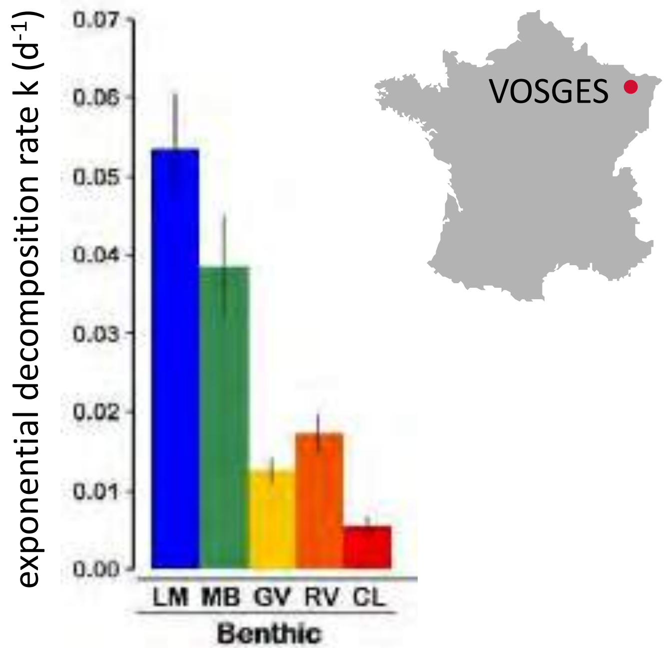
> Biodiversity

> Community composition

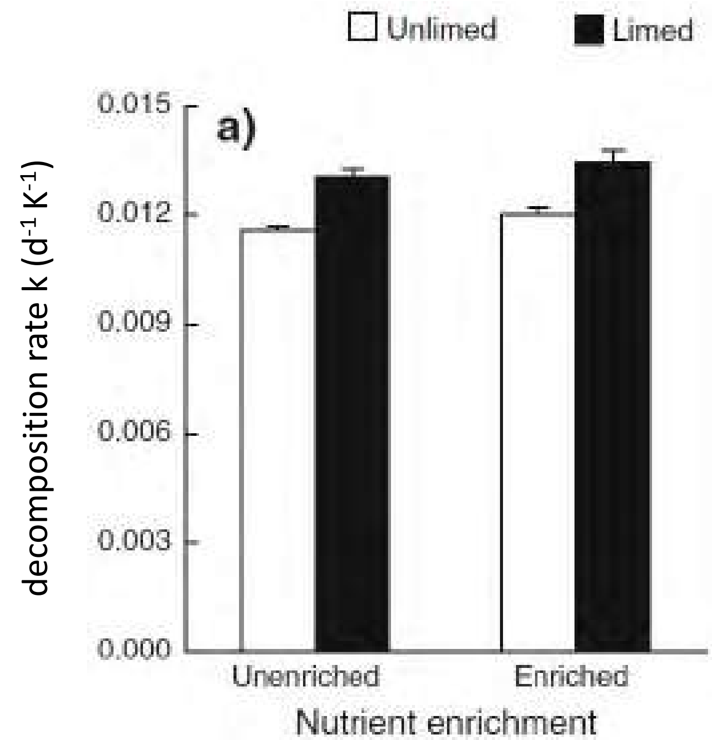
> ...

role of abiotic conditions

acidification



Stream	LM	MB	GV	RV	CL
pH	7.4	7.0	6.4	6.1	4.6



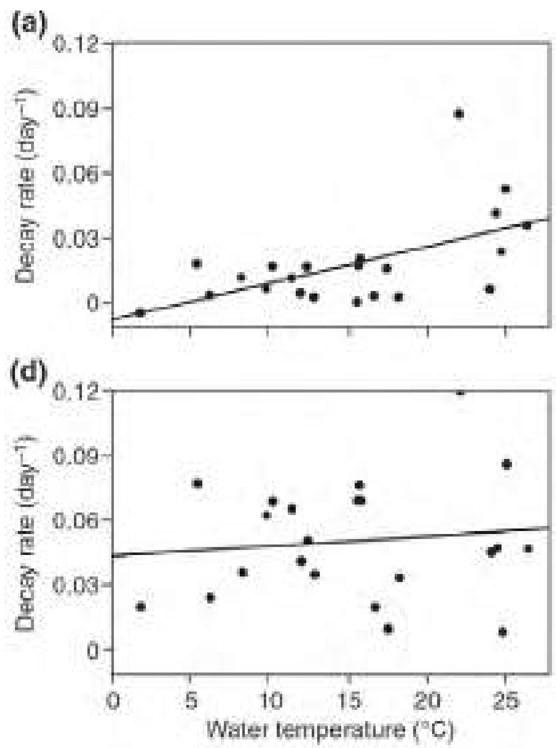
McKie et al. (2009) Oecologia

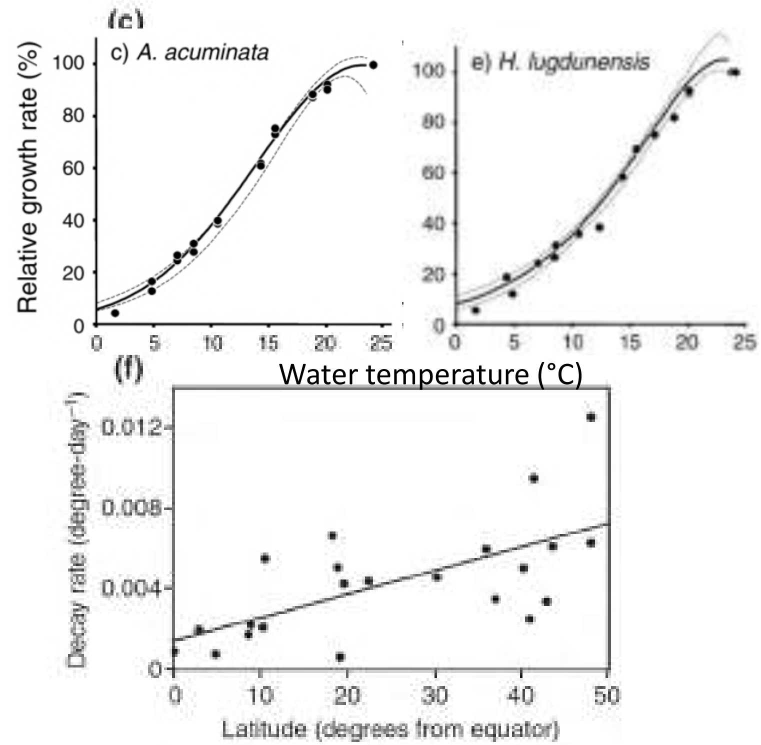
In this study, effects of acidification on fungal and shredder biomass was small
> but negative effects on their activity and in turn on decomposition

role of abiotic conditions

temperature and latitudinal gradient
(and decomposer groups)

+





Boyero et al. (2011) Ecology Letters

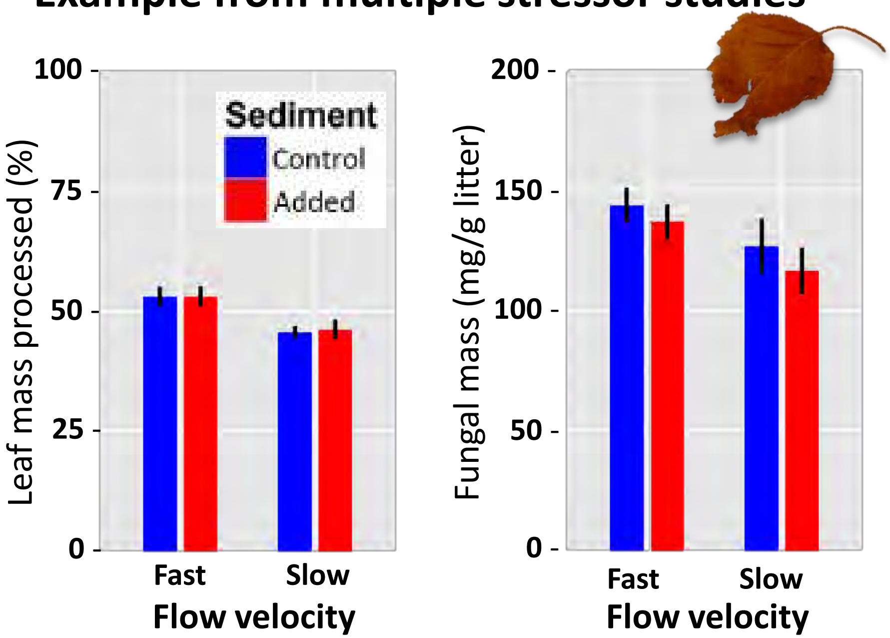
Dang et al. (2009) Ecology

Activity of fungi and shredders respond differently to temperature and latitude
> climate warming could change their relative importance for litter decomposition and affect the carbon cycle

role of abiotic conditions

flow velocity and fine sediment

Example from multiple stressor studies



Bruder et al. (2016) Functional Ecology

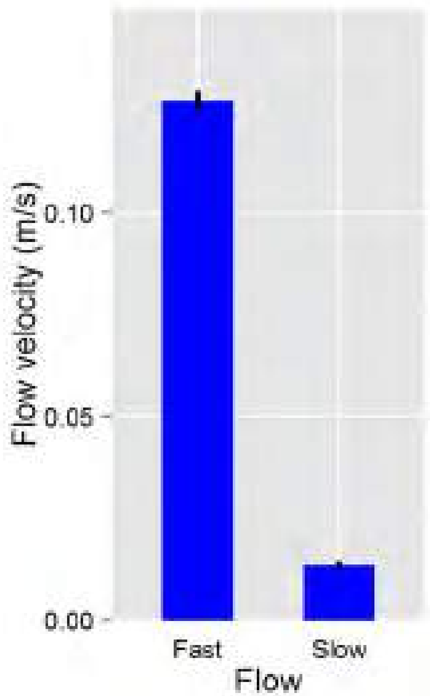
Outdoor/streamfed
N: 128
Area $0.045\ m^2$
Discharge: $2\ L{\cdot}min^{-1}$
Volume: 3 L
Sediment: 0.5 L
Res. Time: 75s

Slow flow velocity reduces litter decomposition rate and fungal biomass
> situations comparable to littoral zones of forested lakes?

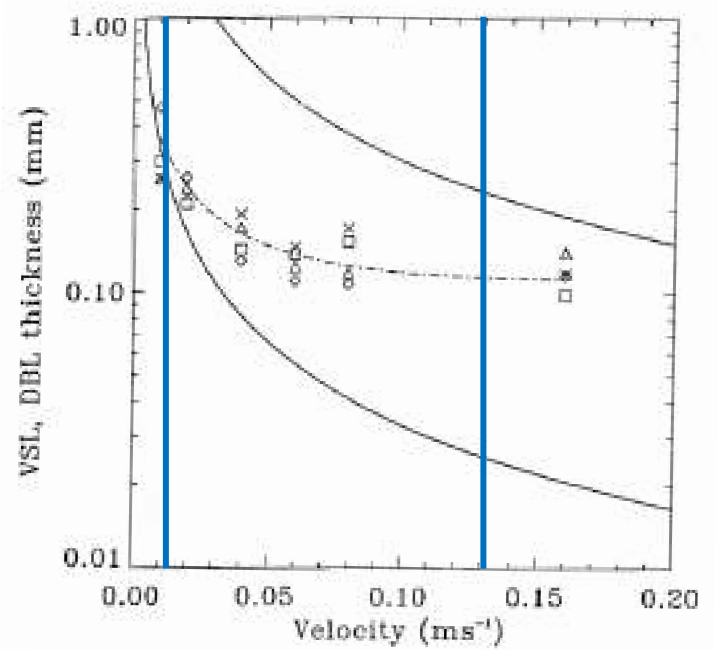
role of abiotic conditions

flow velocity and fine sediment

Measured flow velocity

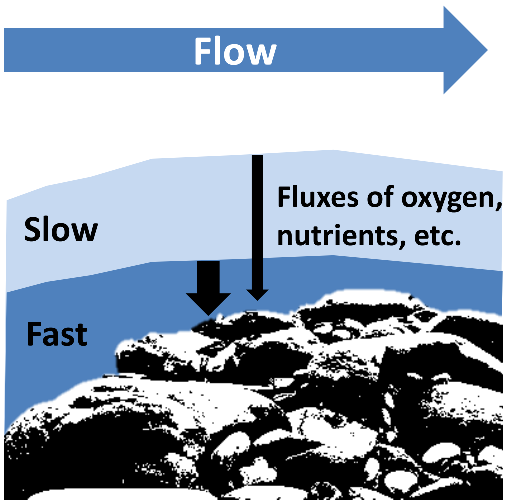


Flow velocity effects on boundary layer



mod. from Stevens & Hurd (1997) Hydrobiologia

Boundary layer effects on benthic habitat

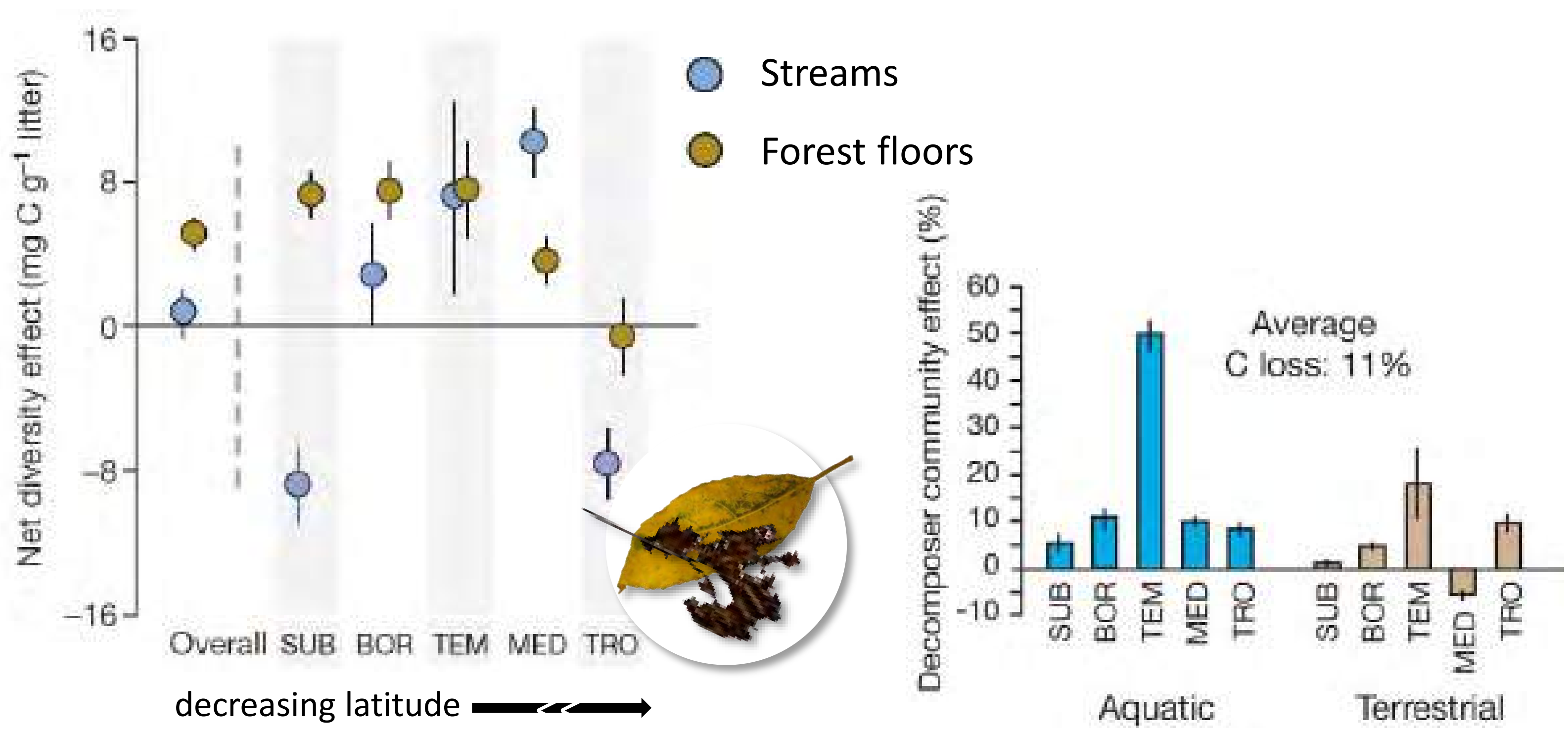


Fluxes = *f*(boundary layer thickness) = *f*(flow velocity)

Effects on physicochemical conditions in/on the sediment with consequences on organisms and biological processes

role of biodiversity

leaf litter diversity (and biome effects)

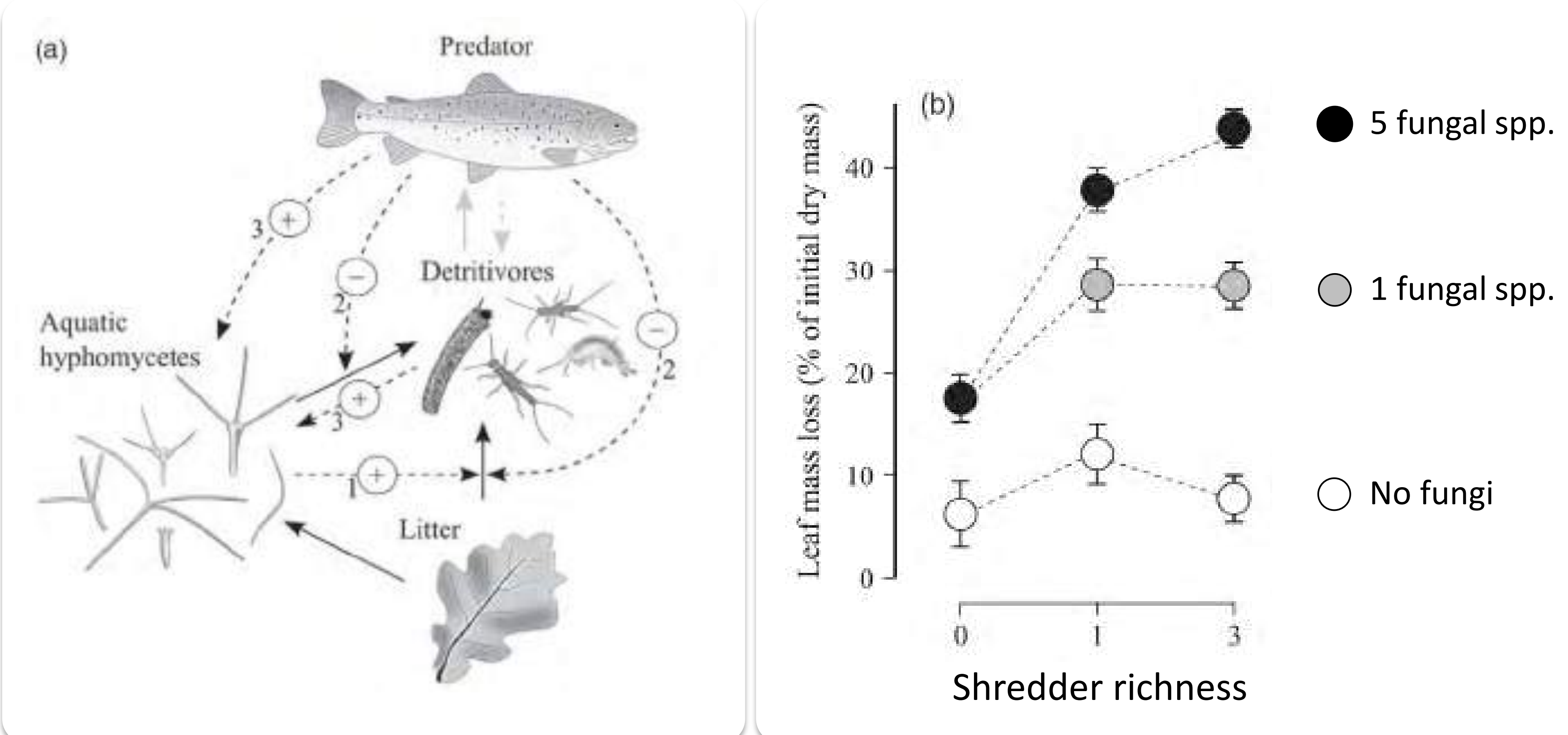


Species identity and environmental conditions dominate diversity effects

Handa et al. (2014) Nature

role of biodiversity

Decomposer diversity (and food-web complexity)



Both vertical and horizontal diversity influences litter decomposition rates

Jabiol et al. (2013) Journal of Animal Ecology

conclusions

Litter decomposition is sensitive to environmental conditions but:
> response depends on specific ecological and environmental situation
> can be different for the main decomposer groups (fungi *vs* shredders)
> depends on biodiversity *but* the picture is not very clear for aquatic situation

Part of ecological variation could be reduced using standardized substrate:
> for instance cotton strips (mainly cellulose)
> this approach is used in the ICP IM indicator *Microbial Decomposition*
but also in other global studies
(e.g. CELLDEX – testing decomposition in streams and riparian vegetation)
> results are transferable between studies using leaf litter and those using cotton

Thank you for your interest

and the Swiss Federal Office for the Environment (FOEN) for financial support to participate at the ICP IM TF Meeting

UNIVERSITY OF THE WITWATERSRAND
JOHANNESBURG

33rd ICP Waters & 25th ICP IM Task Force Meeting Uppsala, Sweden, 9-11 May 2017

Species sensitivity to acidification in highly endemic regions of South Africa

***Londiwe Khuzwayo**, Chris Curtis, Helen James and Kari Austnes*

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NILU
Norsk institutt for luftforskning
Norwegian Institute for Air Research

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

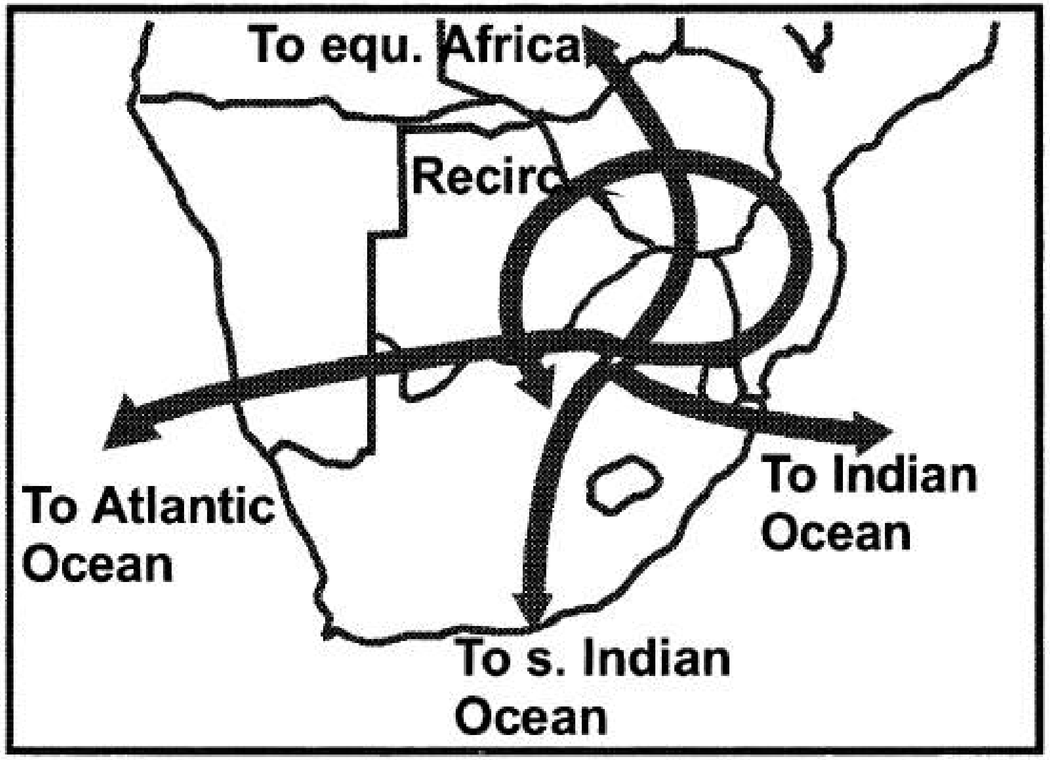
Introduction

- South Africa is a major consumer of coal and is among the twenty most carbon intensive economies in the world
- About 74% of the countries energy demand is met by coal resources
- Pressure on the energy sector over the past 18 years
  - Increase energy demands
    - economic growth
    - Free Basic Energy Policy (1998)
- Two new coal power stations (4 800 MW)
- 16 coal power stations and 75% of these are concentrated in the Highveld (HV) region of South Africa


Matimba power station (Limpopo)

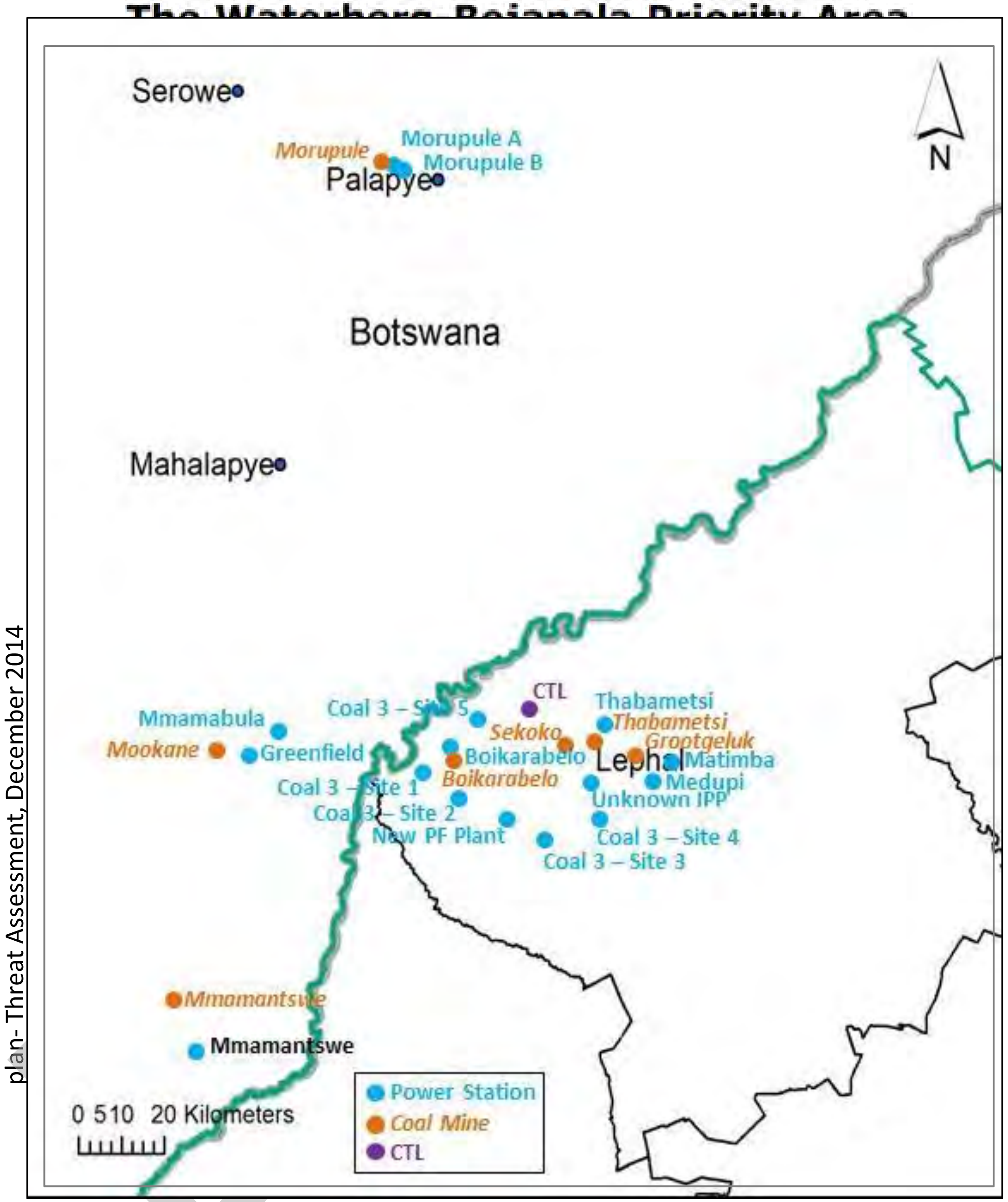

Medupi power station (Limpopo)

Main pathways transporting air in and out of the Highveld



Abbreviations: South (s.), Equatorial (equ.) and Recirculated (Recirc.)

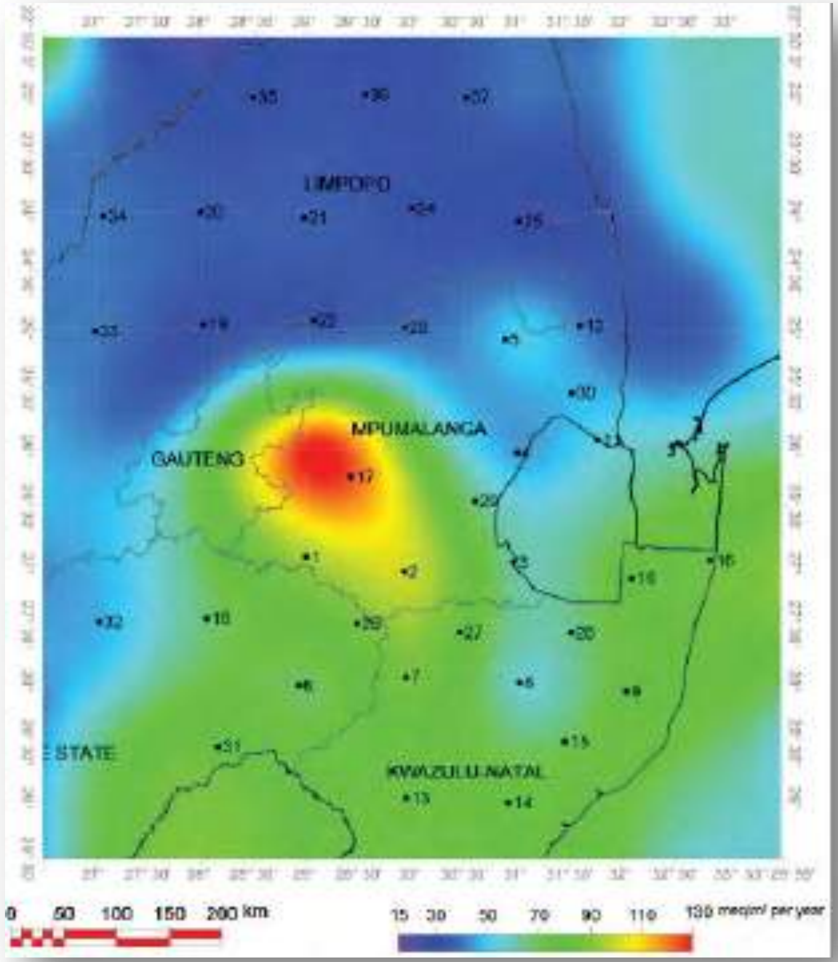
Source: Freiman, M. T. and Piketh, S.J. (2003) Air transportation into and out of the industrial Highveld Region of South Africa. American Meteorological Society 42.



Source: DEA, 2014. Waterberg-Bojanala Priority Area Air Quality Management plan- Threat Assessment, December 2014

Relative locations of the proposed energy-based and mining projects are indicated in blue and brown respectively while the proposed location for the coal-to-liquid (CTL) plant is shown in purple.

Total dry and wet acid deposition rate (meq/m^2/year)



Source: Josipovic, M., Annegarn, H.J., Kneen, M.A., Pienaar, J.J. and Piketh, S.J. (2011) Atmospheric dry and wet deposition of sulphur and nitrogen species and assessment of critical loads of acidic deposition exceedance in South Africa. South African Journal of Science 107, 01-10.

Key Hypothesis

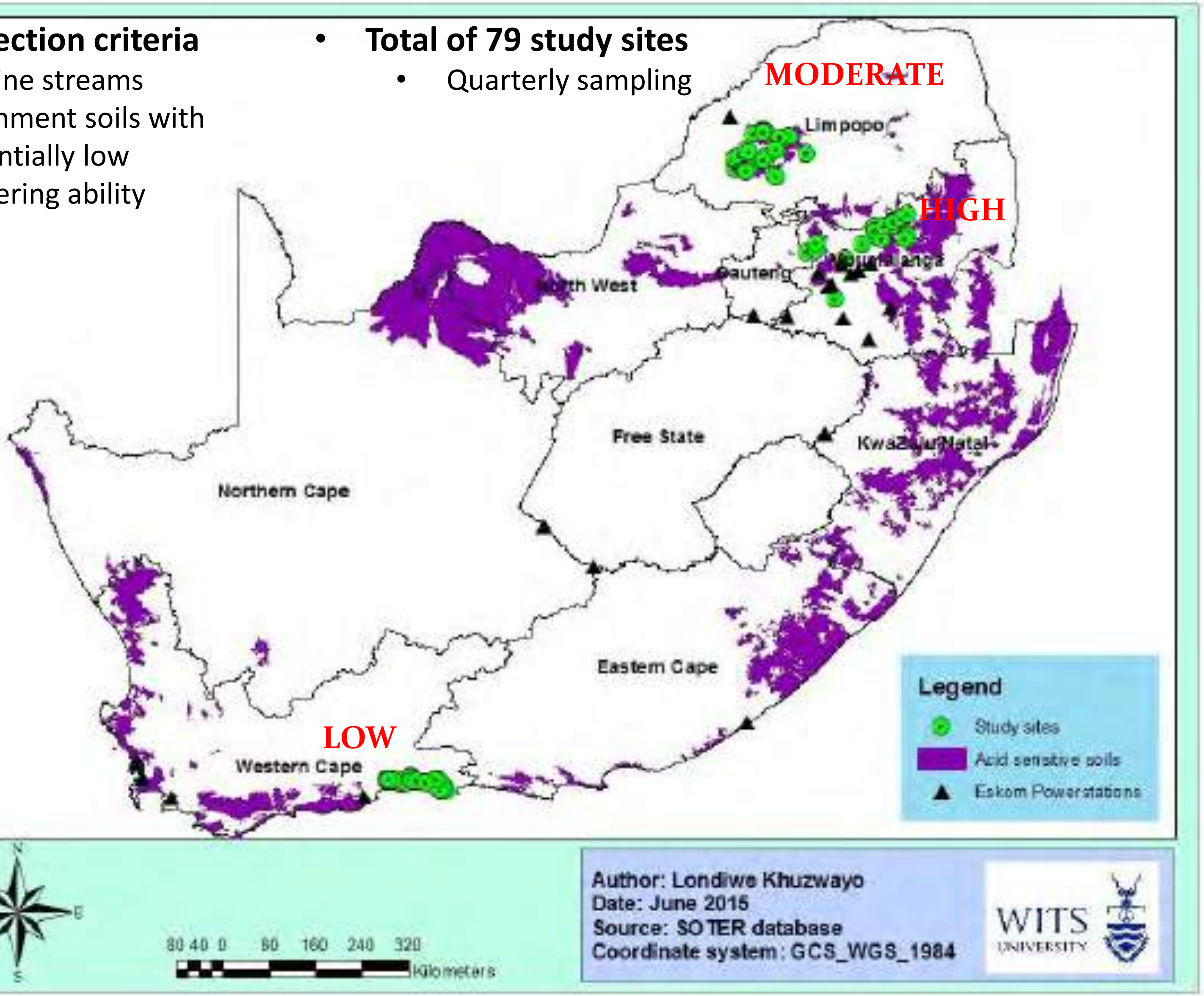
- Current levels of acid deposition exceed the critical load for acidification of acid sensitive streams
- Future point sources of S and N deposition pose a threat in acid loading to sensitive streams
- Anticipate climate change will exacerbate present-day acidification state

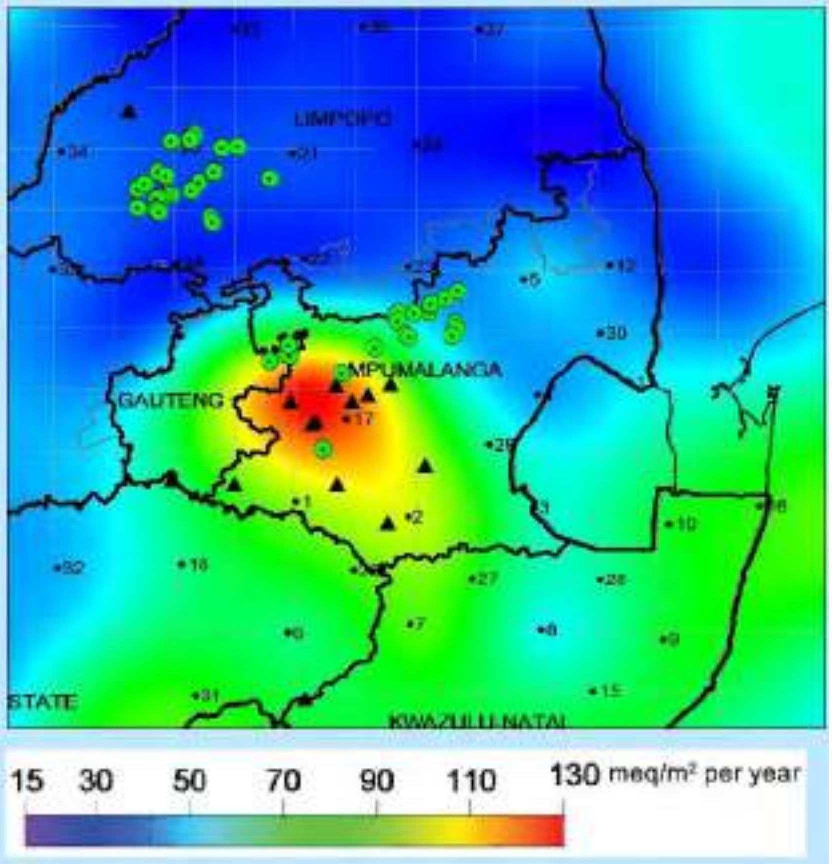
The aim of this study was to investigate differences in the aquatic ecosystem related to acidification by looking at water chemistry and macroinvertebrates.

Study Regions

Site selection criteria
- Pristine streams
- Catchment soils with potentially low buffering ability

- **Total of 79 study sites**
  - Quarterly sampling






Highveld (HV)
Waterberg (WB)
South-western Cape (SWC)

Methods

- Biotope – Stoney riffle
- SASS5 net (1mm mesh with 30cm square frame
- Kick sampling (2mins)

Preserved in 70% Ethanol

Sample emptied into a tray. Individual species picked Out and analysed under the microscope

Key focus groups

- Order
  - Ephemeroptera (Mayflies)
    - Baetidae
    - Caenidae
    - Heptageniidae
    - Leptophlebiidae
    - Oligoneuriidae
    - Prosopistomatidae
    - Teloganodidae
    - Tricorythidae
  - Diptera (Trueflies)
    - Simuliidae (Blackflies)
    - Chironomids (Non-biting midges)
  - Plecoptera (Stoneflies) - One of the key indicator sp. for clean / non-polluted waters in South Africa


Trichoptera (Caddisflies)

Distribution of some Mayfly species across all three study regions

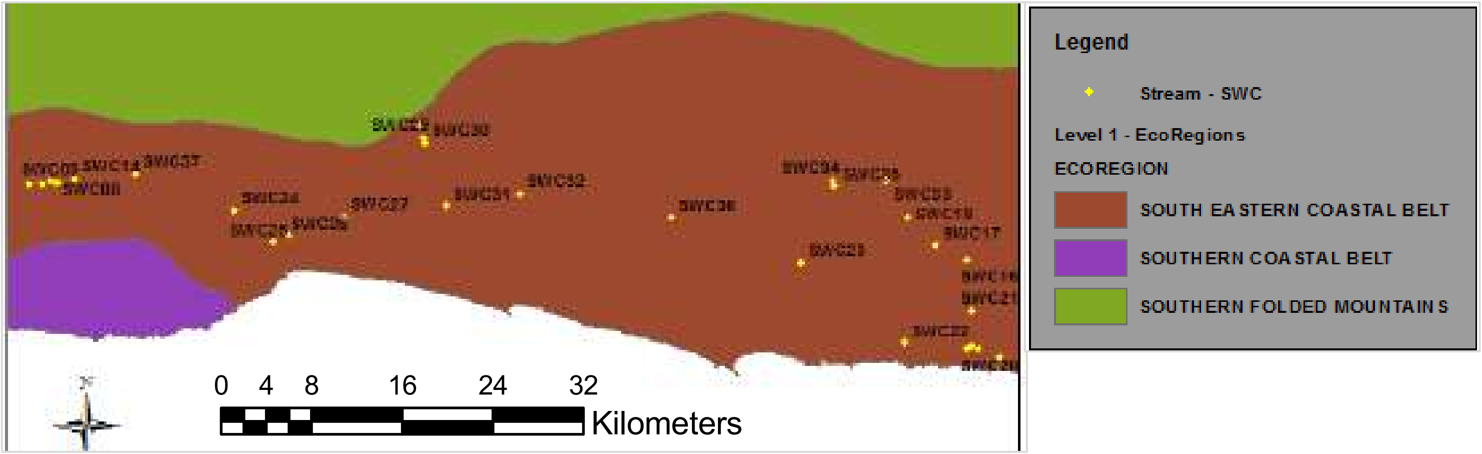
Order	Family	*Genus/ species name*	South-western Cape	Waterberg	Highveld
Ephemeroptera	Tricorythidae	*Tricorythus reticulatus*	Absent	Absent	Present
	Leptophlebiidae	*Adenophlebia auriculata*	Sparse	Absent	Sparse
		Adenophlebiodes bicolor	Absent	Sparse	Absent
		Aprionyx intermedius	Sparse	Absent	Absent
		Castonophlebia calida	Present	Sparse	Absent
		Choroterpes	Sparse	Absent	Absent
		Euthraulus sp.	Absent	Sparse	Present
	Baetidae	*Acanthiops varius*	Absent	Sparse	Sparse
		Afroptilum sudafricanum	Sparse	Sparse	Sparse
		Baetis harrisoni	Sparse	Sparse	Present
		Baetis sp. (Unknown)	Sparse	Sparse	Absent
		Bugilliesia margaretae	Absent	Sparse	Absent
		Cheleocloeon excisum	Sparse	Sparse	Sparse
		Cheleocloeon sp. (unknown)	Sparse	Sparse	Sparse
		Cloeodes sp. (unknown)	Sparse	Absent	Absent
		Cloeon sp. (unknown)	Absent	Sparse	Sparse
		Crassabwa flava	Sparse	Sparse	Sparse
		Dabulamanzia indusii	Sparse	Absent	Absent
		Demoreptus capensis	Sparse	Sparse	Absent
		Demoreptus monticola	Sparse	Absent	Absent
		Demoreptus sp. (unknown)	Absent	Sparse	Absent
		Demoulinia crassi	Absent	Sparse	Absent
		Labiobaetis vinosus	Sparse	Absent	Absent
		Pseudocloeon glaucum	Sparse	Sparse	Sparse
		Pseudocloeon latum	Sparse	Sparse	Sparse
		Pseudocloeon piscis	Sparse	Sparse	Sparse
		Pseudocloeon sp. (unknown)	Sparse	Sparse	Absent
		Pseudopannata maculosa	Absent	Sparse	Sparse
		Susua sp. (unknown)	Absent	Absent	Sparse

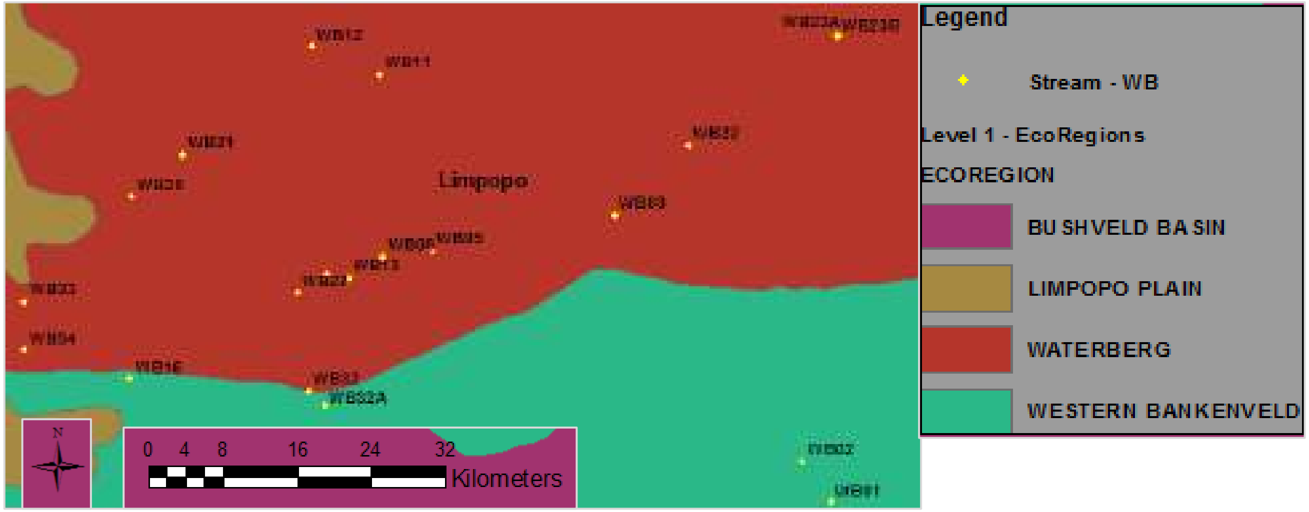
Present Found in 70% or more sites sampled in that region / season

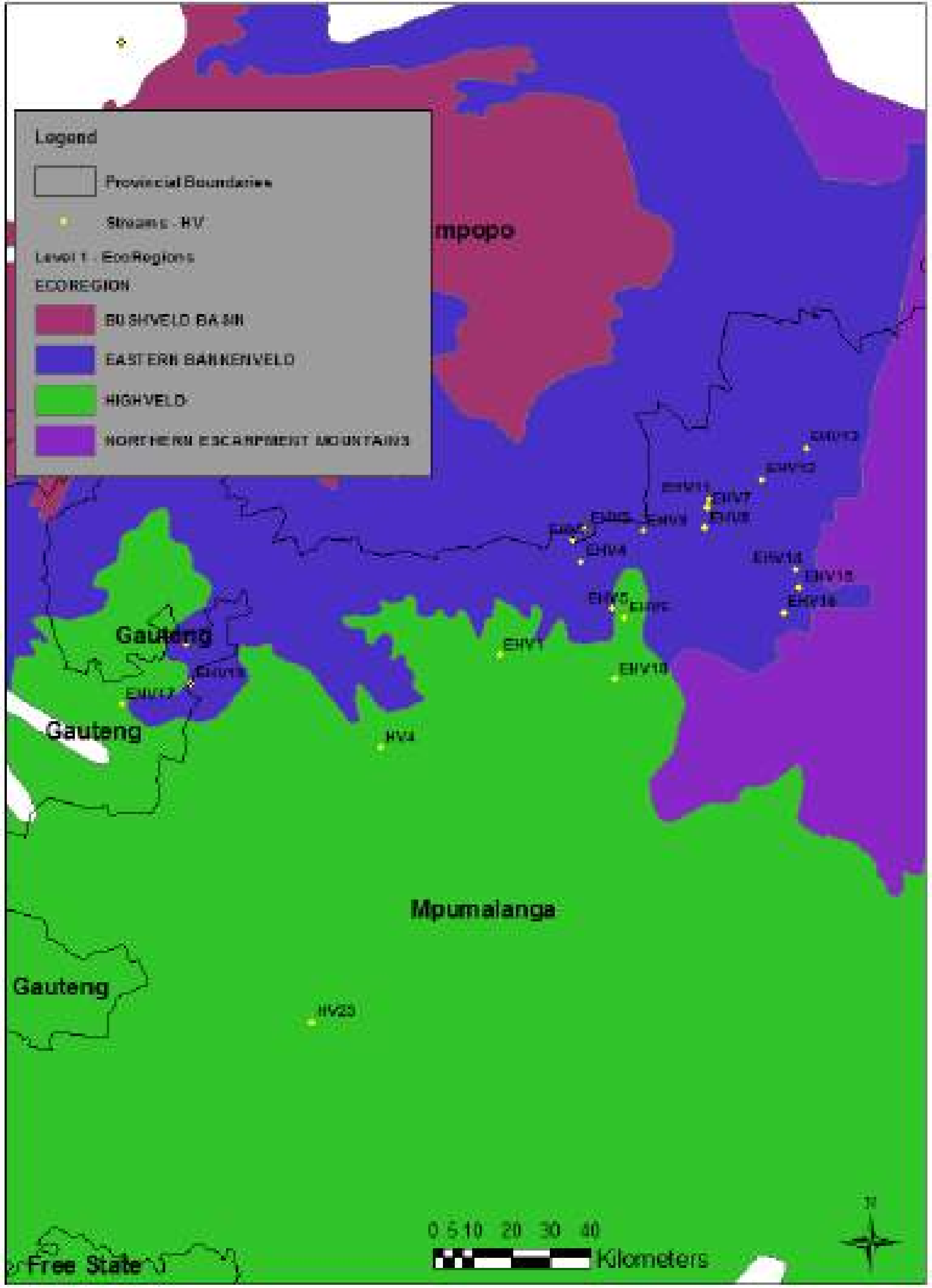
Absent Not found in any of the sites sampled in that region

Sparse Found in 40% or less sites in that region / season

EcoRegions


Legend
Stream - SWC
Level 1 - EcoRegions
ECOREGION
SOUTH EASTERN COASTAL BELT
SOUTHERN COASTAL BELT
SOUTHERN FOLDED MOUNTAINS
0 4 8 16 24 32
Kilometers


Limpopo
Legend
Stream - WB
Level 1 - EcoRegions
ECOREGION
BUSHVELD BASIN
LIMPOPO PLAIN
WATERBERG
WESTERN BANKENVELD
0 4 8 16 24 32
Kilometers


Legend
Provincial Boundaries
Streams - HV
Level 1 - EcoRegions
ECOREGION
BUSHVELD BASIN
EASTERN BANKENVELD
HIGHVELD
NORTHERN ESCARPMENT MOUNTAINS
mpopo
Gauteng
Gauteng
Mpumalanga
Gauteng
Free State
0 5 10 20 30 40
Kilometers

Highveld region

- The Highveld region had the least number of overall sampling site and Macroinvertebrate sites
- High pH values
- Historical data (1954 -1965) obtained from Albany museum
  - 10 Simuliidae spp. were described during that time of which four were identified in this project
  - Ephemeroptera was largely dominated by Baetidae spp. While samples collected during this project were mainly dominated by Tricorythus reticulatus and Euthraulus spp.
  - Neoperla is still the only genus found in this region with just one described sp., Neoperia spio
- These observations suggest that spp. composition has changed over the years and there has been a huge decline in Baetidae spp. for this region, which may be accounted to changes in land-use
- The high pH values in the mist of well documented deterioration of air quality suggests that the soils in this region have a high buffering ability

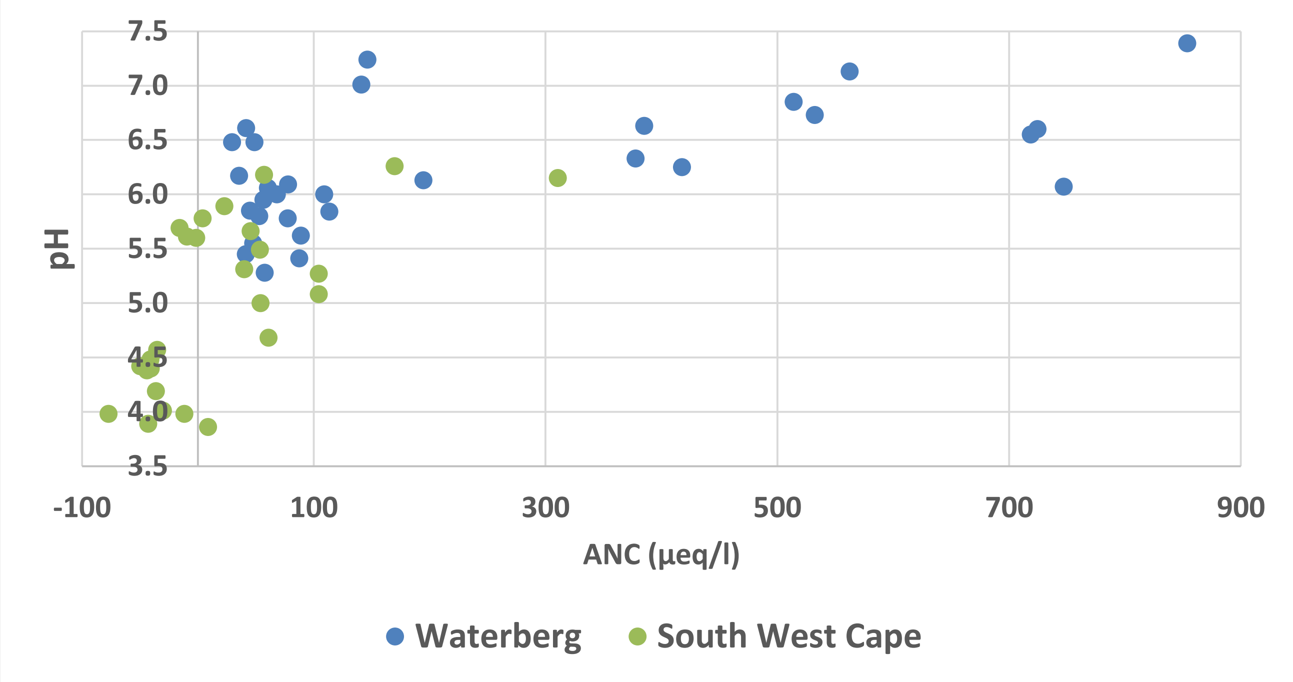
Waterberg region

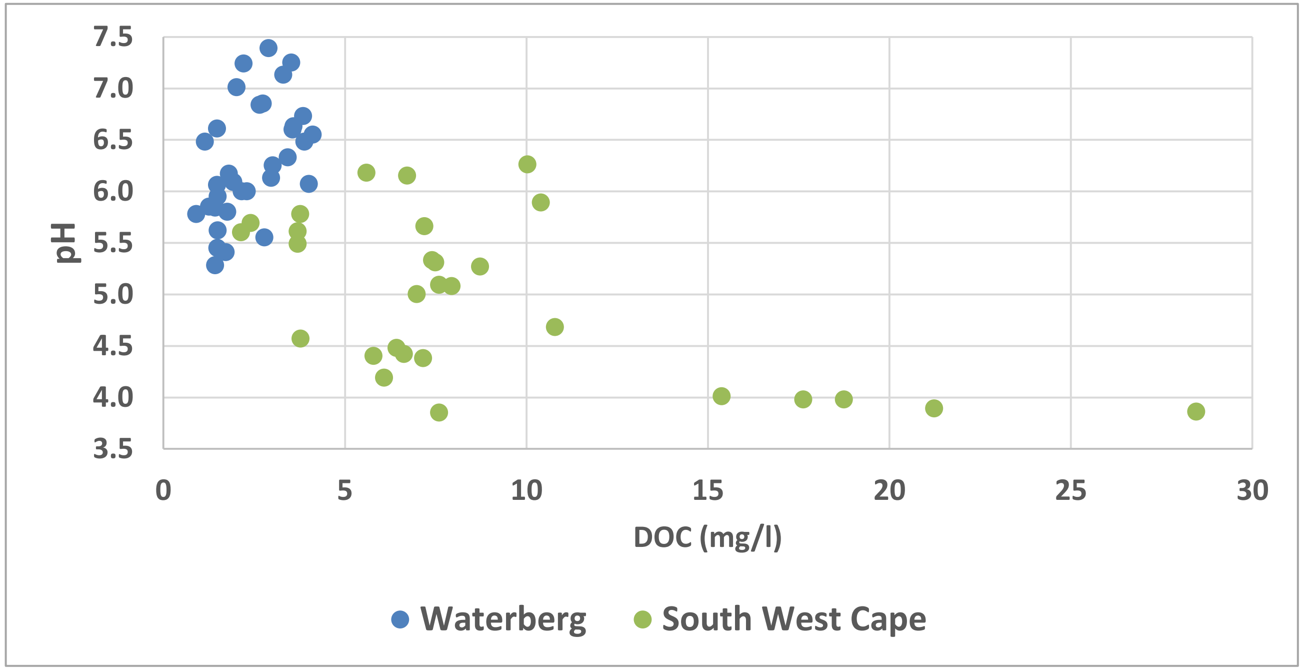
- Least studied area of the three regions
- Consists of acidic and basic streams
- Largely dominated by uncommon Mayfly species that are sparsely distributed

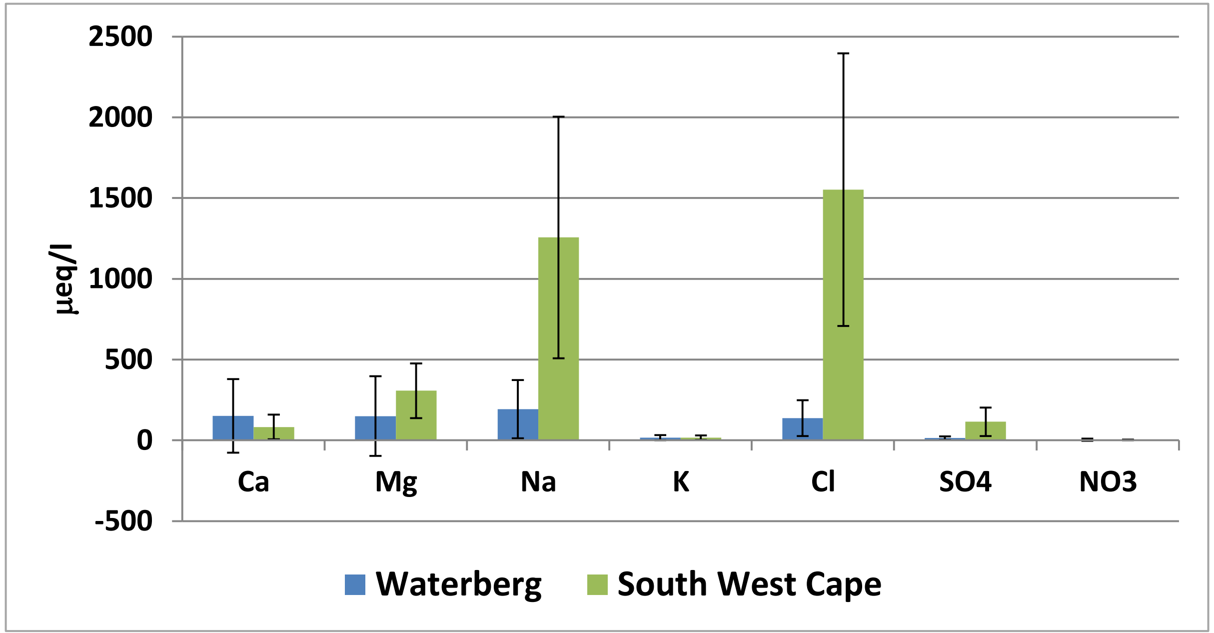
South-western Cape region

- Most studied area in aquatic sciences
- Naturally acidic streams
- High degree of diversity and endemism
  - World's 200 significant Freshwater Ecoregions

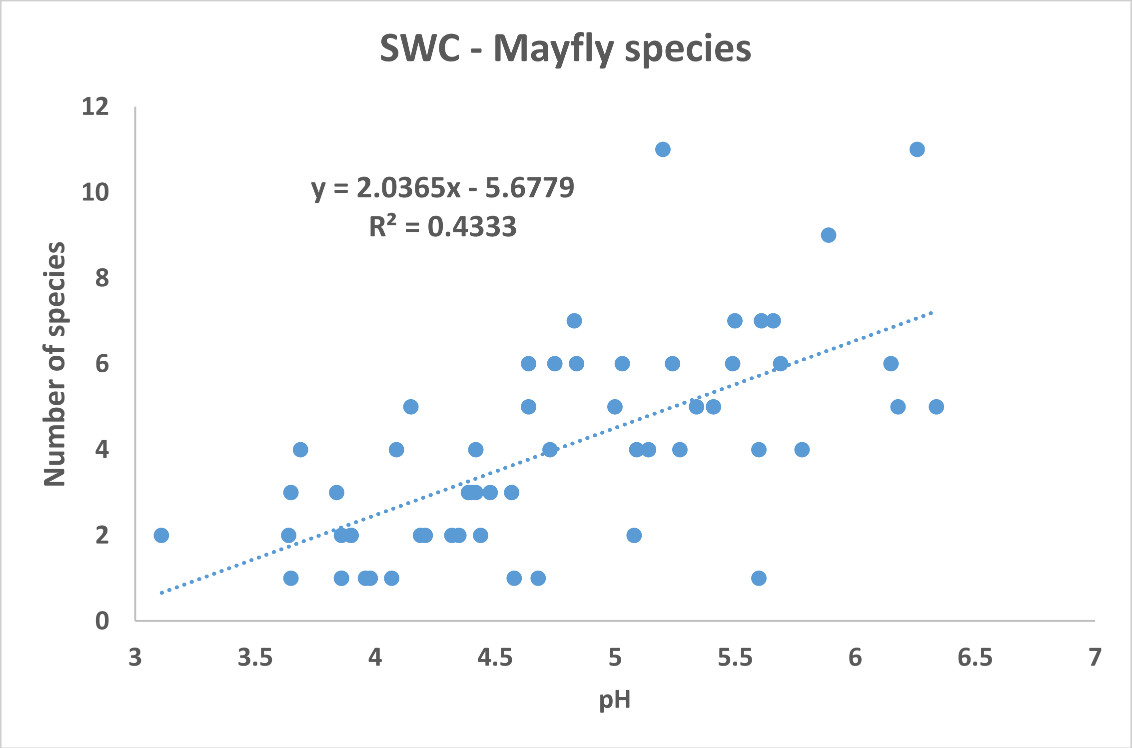
Chemistry results

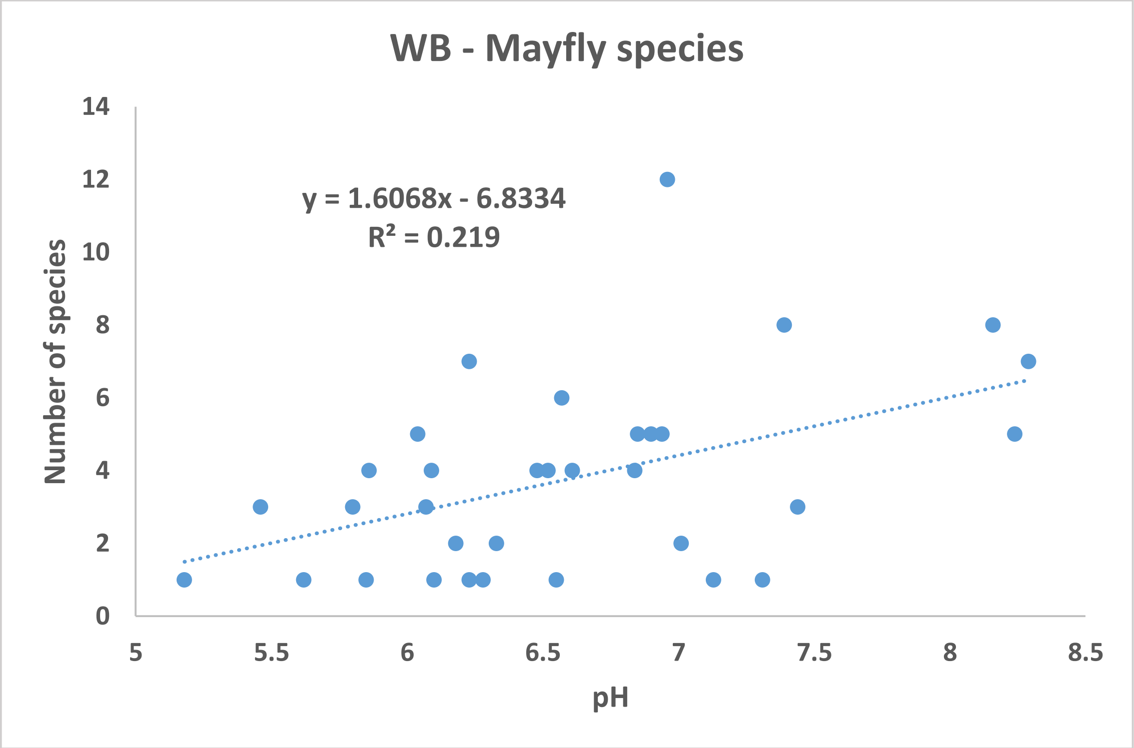






The effects of pH concentration on species numbers





Visit to Norway

- Chemistry
  - Q & A
  - Summarising and analyzing data
- Relationship between chemistry and biology
  - Individual species
  - Potential indices
- Critical loads

THANK YOU

South African
NATIONAL PARKS

NILU
Norsk institutt for luftforskning
Norwegian Institute for Air Research

ALBANY
MUSEUM

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

WITS
UNIVERSITY

The Research Council
of Norway

NIVA
Norwegian Institute for Water Research

1919
CZECH GEOLOGICAL SURVEY

NRF
National
Research
Foundation

UMGENI
WATER • AMANZI

The overall project addresses the theme “Environment” with a specific interest in the effects of air pollution on the aquatic ecosystem as well as predicting future scenarios of climate change and changes in sulphur and nitrogen emissions into the atmosphere.

South African indices

- There are several indices that are available in South Africa and are used to assess the integrity of the aquatic ecosystem
  - Index of habitat integrity (IHI)
  - Fish assemblage integrity index (FAII)
  - South African scoring system (SASS5)
  - Macro-invertebrate response assessment index (MIRAI)
  - Fish response assessment index (FRAI)
  - Riparian vegetation index (RVI)

- SASS5 and MIRAI are specific to macroinvertebrates and they assess the overall health of the aquatic ecosystem and identification is done at family level

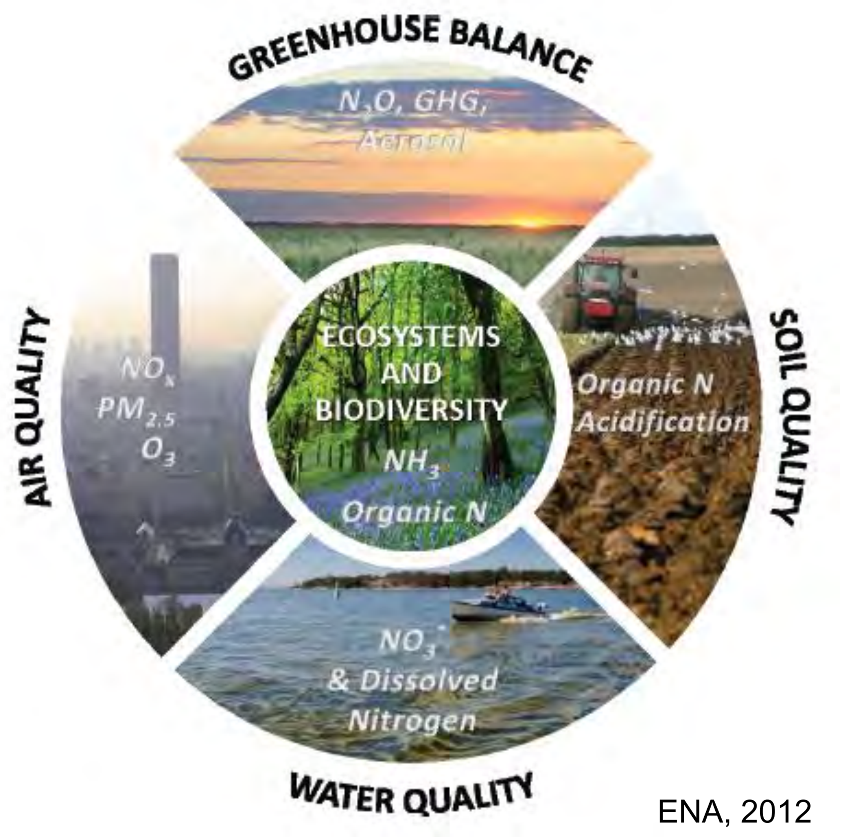
- In this study we tried to investigate the feasibility of establishing a South African scoring system specific to acidification using macroinvertebrates

F. Rokop

LONG-TERM NITROGEN DEPOSITION IMPACTS IN A TEMPERATE FOREST ECOSYSTEM IN AUSTRIA

THOMAS DIRNBÖCK **IKA DJUKIC** JOHANNES KOBLER
MICHAEL MIRTL

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt



ENA, 2012

REACTIVE NITROGEN HARMS THE ENVIRONMENT

- **Nitrogen is an essential nutrient** but today emissions from agriculture and fossil fuel burning provide ¾ of the N input into the biosphere (in Europe)
- **Ecosystem effects** include tree nutritional imbalances, NO_3 loss to the groundwater, N_2O emissions, soil acidification, and biodiversity loss
- The annual costs of reactive N in the environment in the EU amount to 70 - 380 billion € (ENA, 2012)

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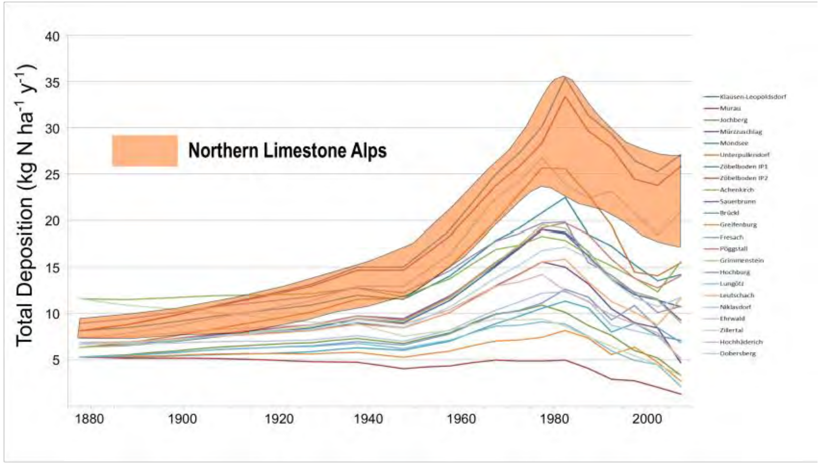
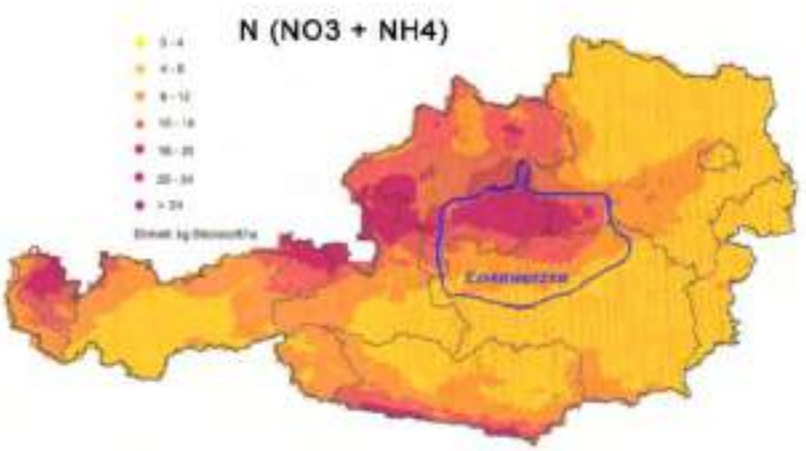
HIGHEST ATMOSPHERIC NITROGEN LOADS IN THE NORTHERN LIMESTONE ALPS



Total (dry and wet) N deposition since 1880

3-5 fold the preindustrial N deposition



Distribution of wet N deposition in Austria (Schneider 1998)

Highest N deposition in the humid Northern Limestone Alps due to precipitation and emission sources

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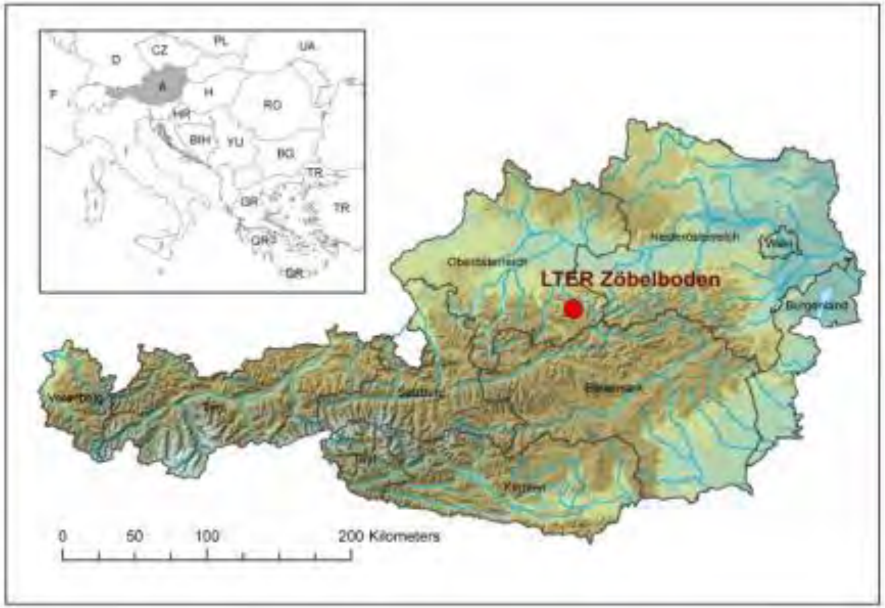
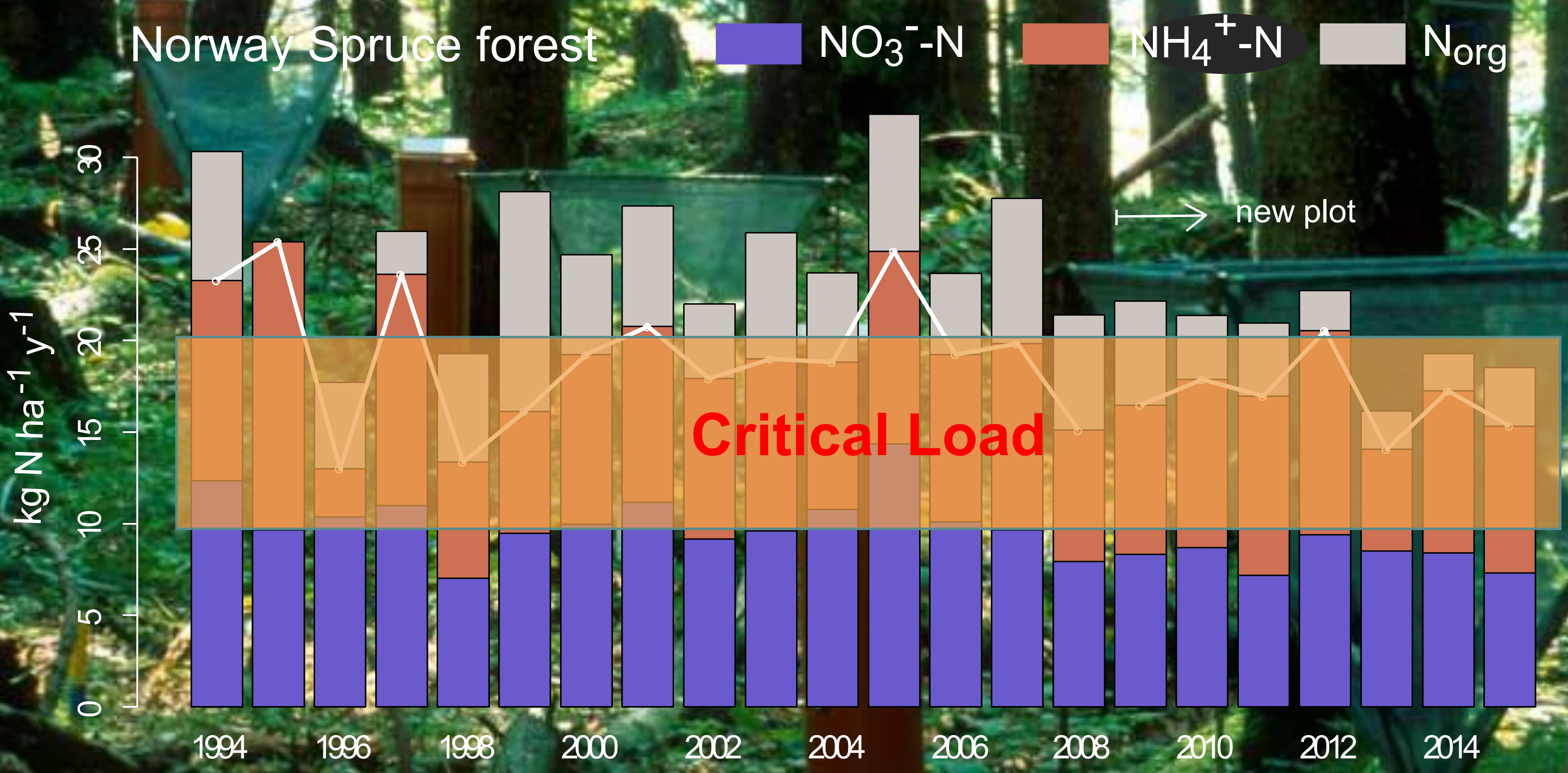
25 YEARS ECOSYSTEM MONITORING AT ZÖBELBODEN

- Forested, 90 ha Karst catchment (550 - 950 m a.s.l) in the Northern Limestone Alps
- Established in the year 1992 as the Austrian‘s contribution to ICP Integrated Monitoring (UN-ECE) of air pollution effects in Europe
- Today LTER Zöbelboden serves as a highly instrumented ecosystem monitoring and research site for the effects of air pollution and climate change including biodiversity

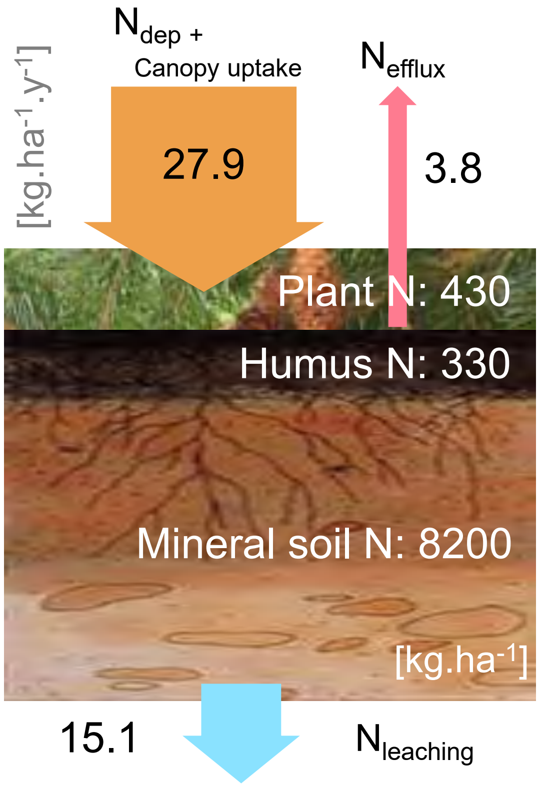




Canopy throughfall deposition

Additional Canopy Uptake: 8-10 kg N ha^{-1} y^{-1}

OPEN N CYCLE DUE TO CHRONIC N DEPOSITION



- Mull humus with low C:N ratio (17) and low microbial N immobilization
- From the total N deposition, 68% is lost to the groundwater (mostly NO_3^-) or as gaseous efflux (NO, N_2, N_2O)

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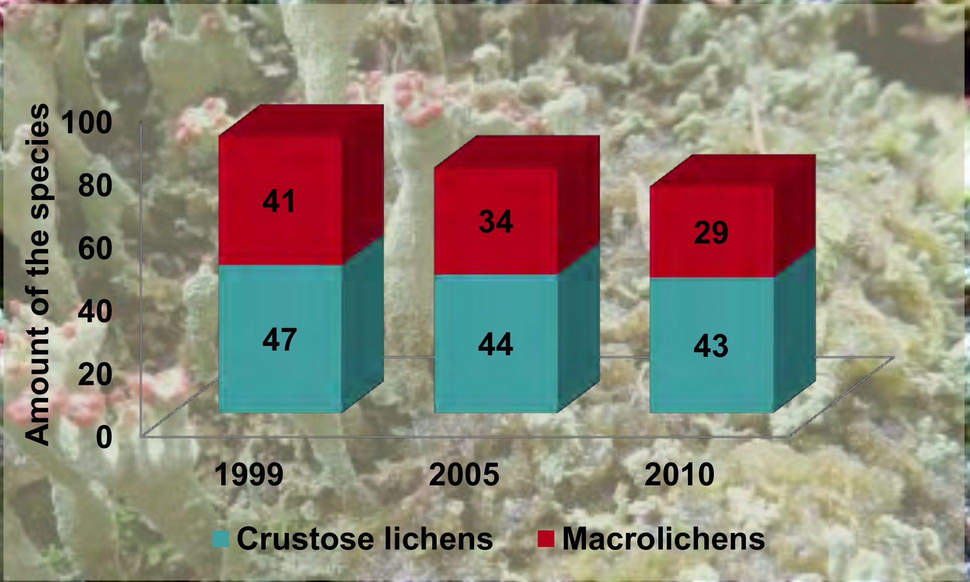
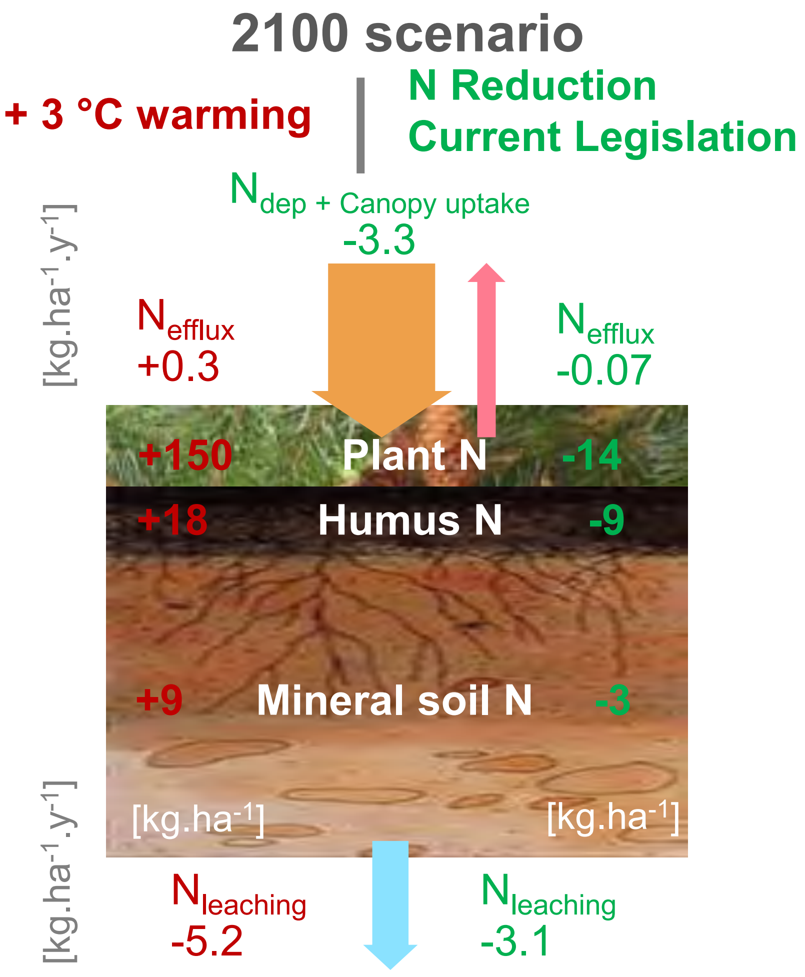
UNIVERSITÄT SALZBURG

HIGH N DEPOSITION NEGATIVELY AFFECTS BIODIVERSITY



R. Türk



FUTURE REDUCTION IN N DEPOSITION AND CLIMATE CHANGE MAY INCREASE ECOSYSTEM N RETENTION

- According to current legislation **N deposition will decrease by ~3 kg N ha^{-1} y^{-1} causing less N loss**
- Expected **climate warming** will particularly **increase immobilization of N in trees**
- Overall N retention is expected to increase rendering the system **significantly less leaky**

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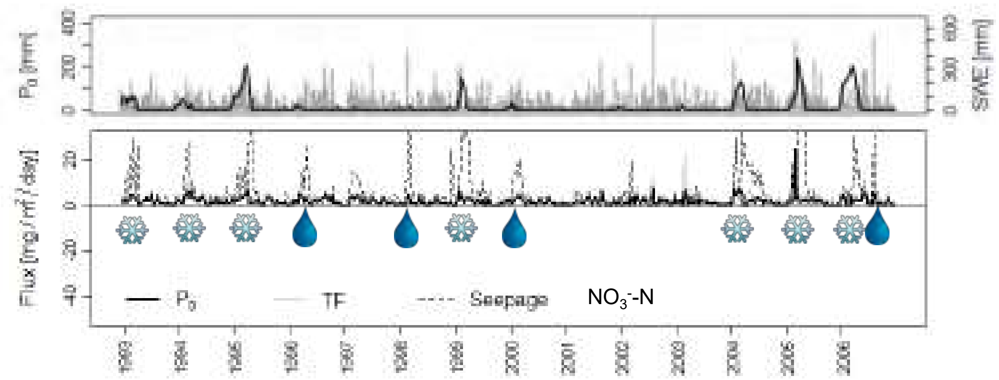
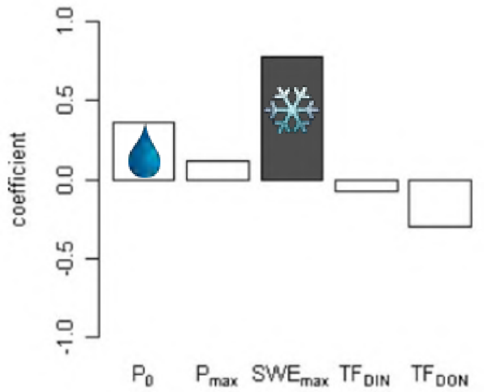
CLIMATE AND DISTURBANCE EVENTS MAY BE MORE IMPORTANT IN FUTURE

- Scenarios rarely capture changes in seasonal variation and extreme climate events
- Droughts, stormflows and snow dynamics may change in an unexpected way
- Forest disturbances are predicted to increase
- What can we learn from the measured N dynamics?

CLIMATE EVENTS DRIVE NITRATE LOSS TO THE GROUNDWATER AND NOT THE AVERAGE CLIMATE





Long-Term climate and Nitrate fluxes

Very high variation in NO_3-N seepage fluxes

Coefficients of determination of NO_3 leaching

Nitrate leaching is predominately controlled by snow melt and heavy rain events

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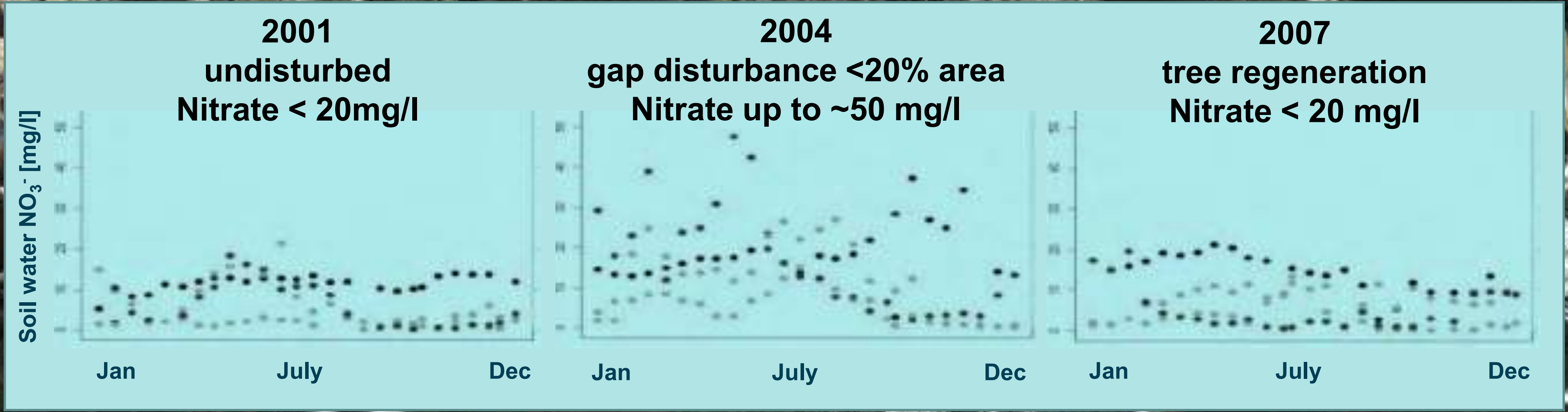
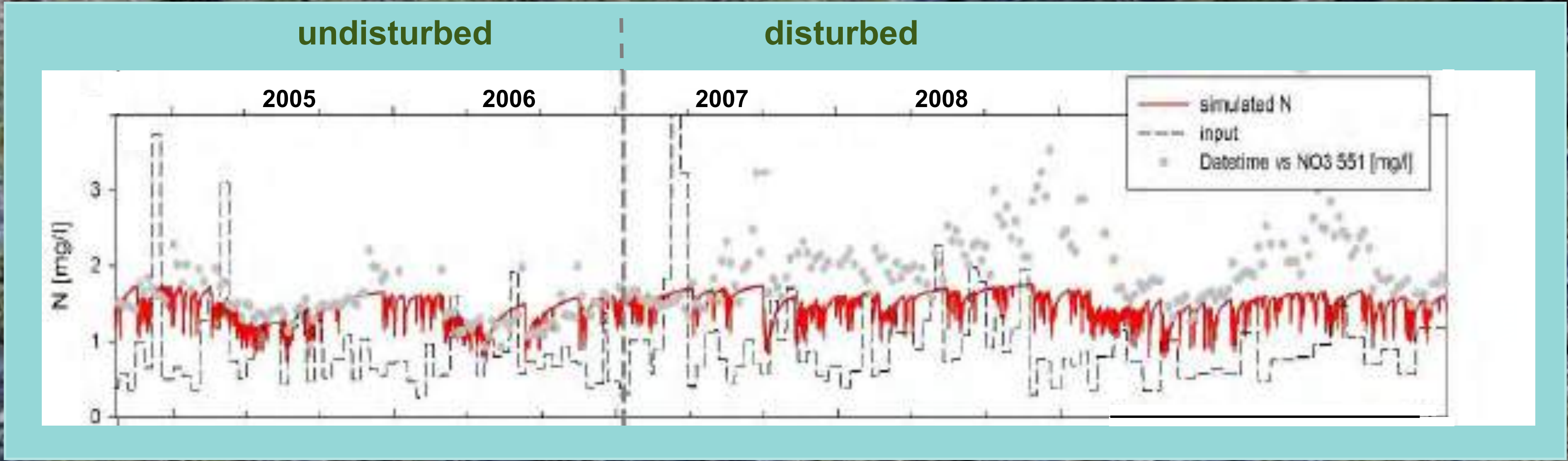
FOREST DISTURBANCE STRONGLY REDUCES N RETENTION CAUSING ELEVATED NITRATE LOSS





Catchment response to forest disturbance

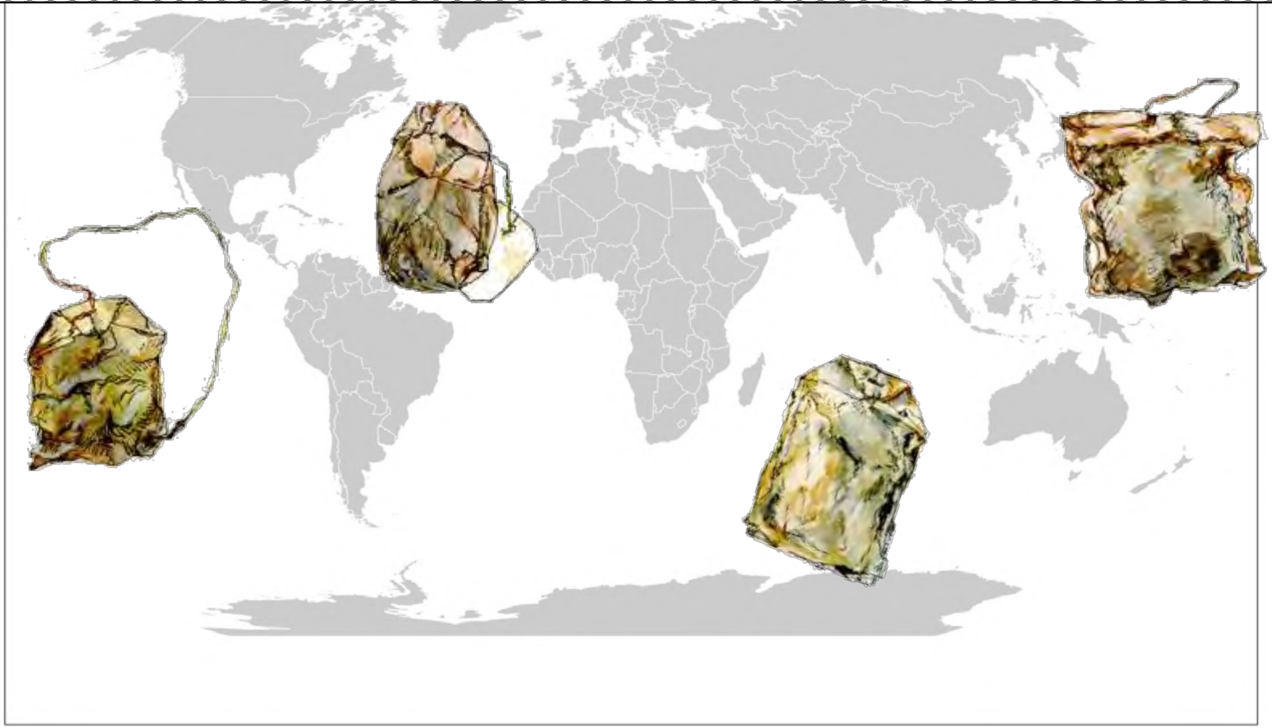
Windthrow at approx. 5-10% of the catchment

CONCLUSIONS AND OUTLOOK

- Long-term high N deposition in the Northern Limestone Alps has resulted in forest ecosystems with particularly **open Nitrogen cycles**
- Future **reduction in N deposition** according to current legislation **and climate change will cause higher N retention**
- **Future changes in climate events** may have a significant impact on how the ecosystem and the karst catchment will be able to retain Nitrogen
- The expected increase in **forest distrubances may additionally cause N pollution pulses** with long-lasting consequences on drinking water quality
- The ICP IM and LTER site **Zöbelboden will be part of LTER-CWN**, a network for the investigation of extreme climate events on C, N and water cycles in Austrian ecosystems

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

Global Litter Decomposition Study



Contact: Ika Djukic; ika.djukic@umweltbundesamt.at

TeaComposition H_2O – Global Aquatic Litter Decomposition Initiative

Contact: Stacey Trevathan-Tackett
s.trevathantackett@deakin.edu.au

Common Metric: Phytometer

Contact: Wilfahrt Peter
Peter.Wilfahrt@uni-bayreuth.de

ACKNOWLEDGEMENTS

RESEARCH PARTNER ORGANISATIONS:

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Gas supersaturation may cause effects on the biota comparable to acidification

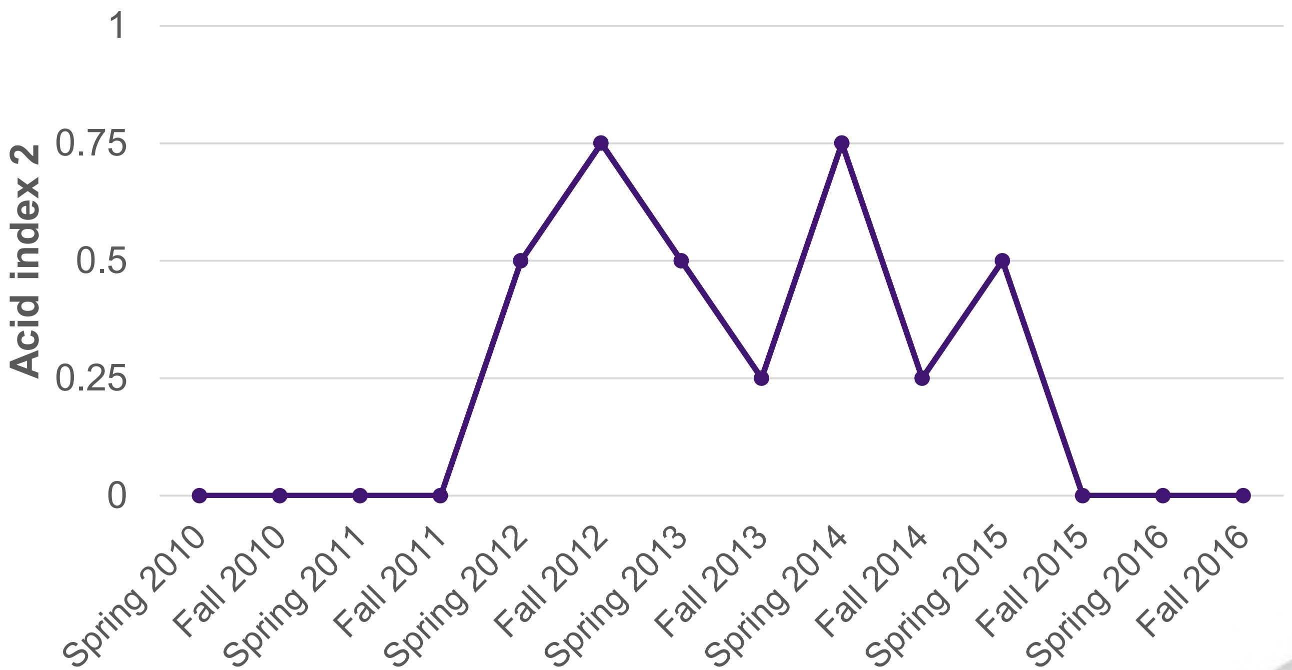
Gaute Velle, Ulrich Pulg, Sebastian Stranzl,

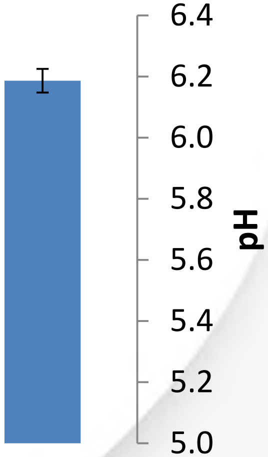
Sondre S. Kvalsheim, Godtfred A. Halvorsen

GAS SUPERSATURATION

BACKGROUND
MEASUREMENTS
CAUSES
BIOLOGICAL EFFECTS
CONCLUSIONS AND RELEVANCE

ACID INDEX 2 IN RIVER OTRA

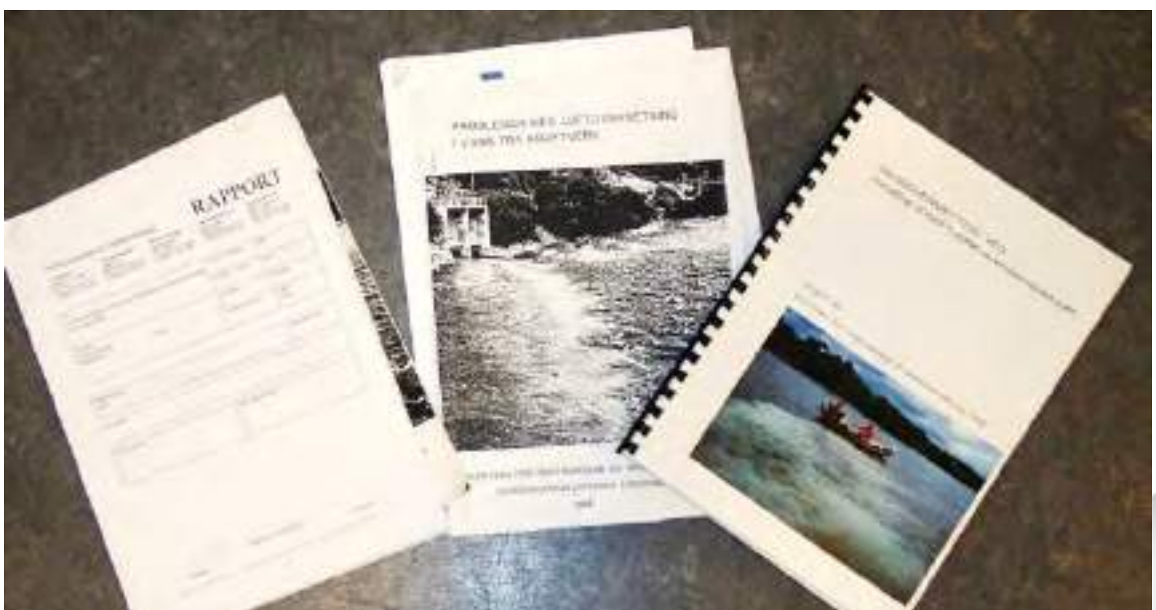




uni Research

By Brokke power plant


Bekkeinntak på kraftverkstunneler
Sluttrapport fra Bekkeinntakkomiteen 1986
PROSJEKTANSVARLIG: VASSDRAGSREGULANTENES FORENING


RAPPORT

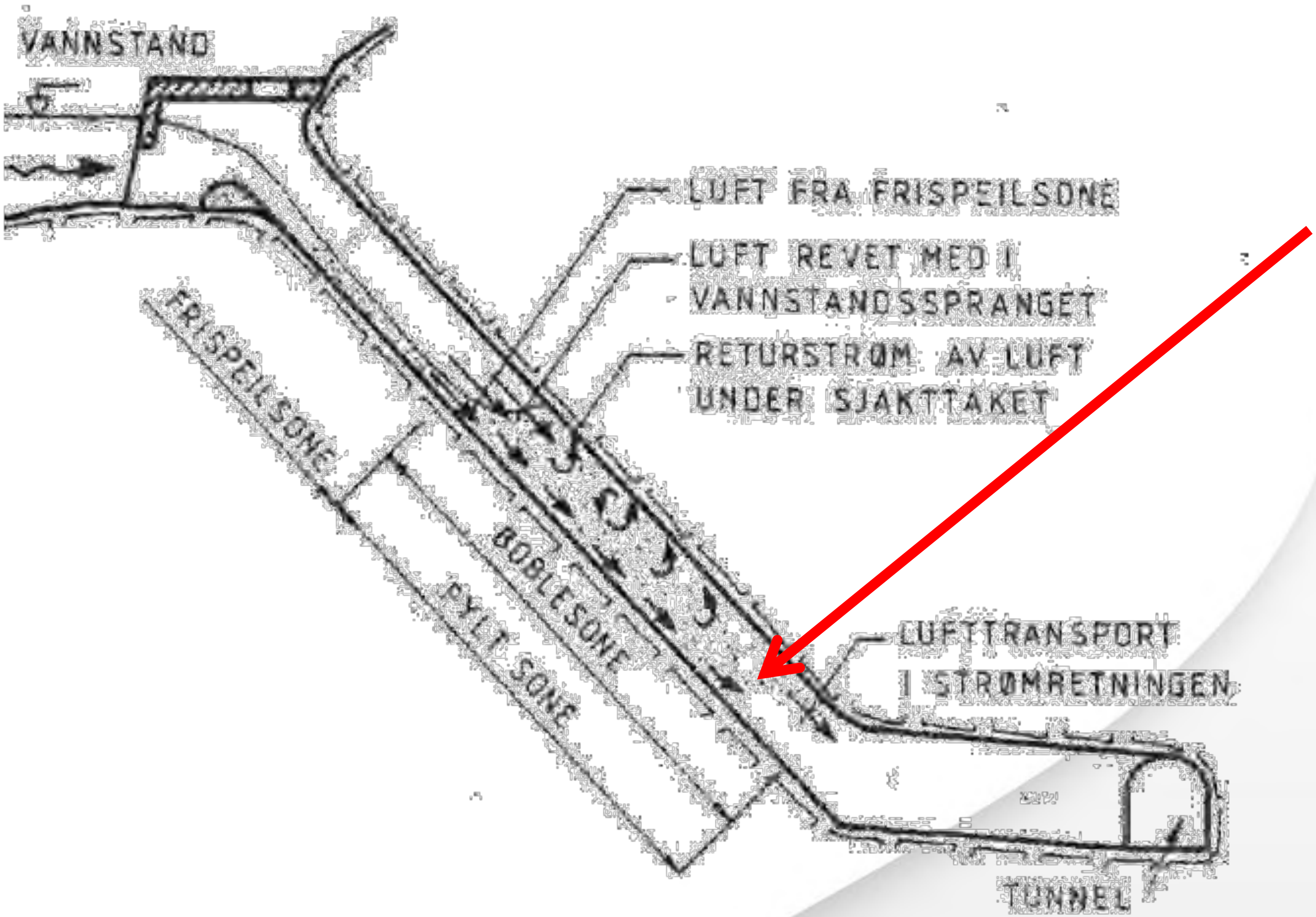
Gas supersaturation

Normal river water: 100 % Total Gas Pressure (TGP)

Carbonated bottle water: 120%-130% TGP

TGP may occur naturally: Water falls; temperature changes, photosynthesis

Man made: Gas + fluids + pressure + reduced pressure



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Lack of measuring equipment

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Gas saturation downstream from Brokke hydropower plant 2011-2016

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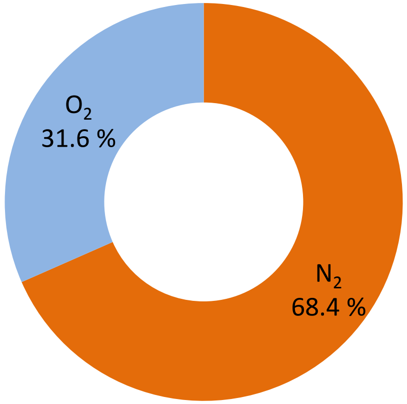
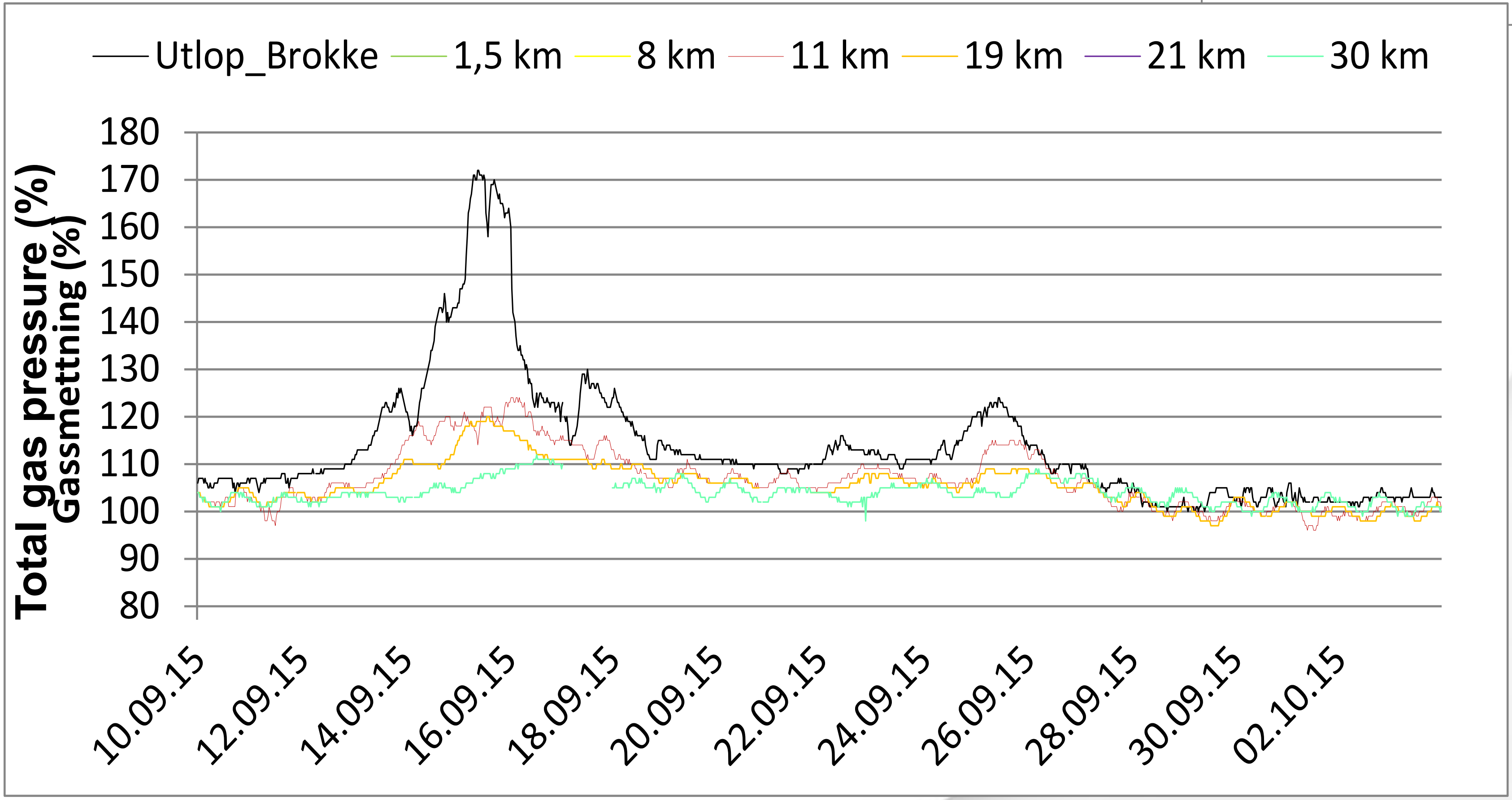
River Otra


O2
31.6 %
N2
68.4 %


Utlop_Brokke
1,5 km
8 km
11 km
19 km
21 km
30 km
Total gas pressure (%)
Gassmettning (%)
180
170
160
150
140
130
120
110
100
90
80
10.09.15
12.09.15
14.09.15
16.09.15
18.09.15
20.09.15
22.09.15
24.09.15
26.09.15
28.09.15
30.09.15
02.10.15

Wave characteristics, aeration, dilution

Maximum values

Cause

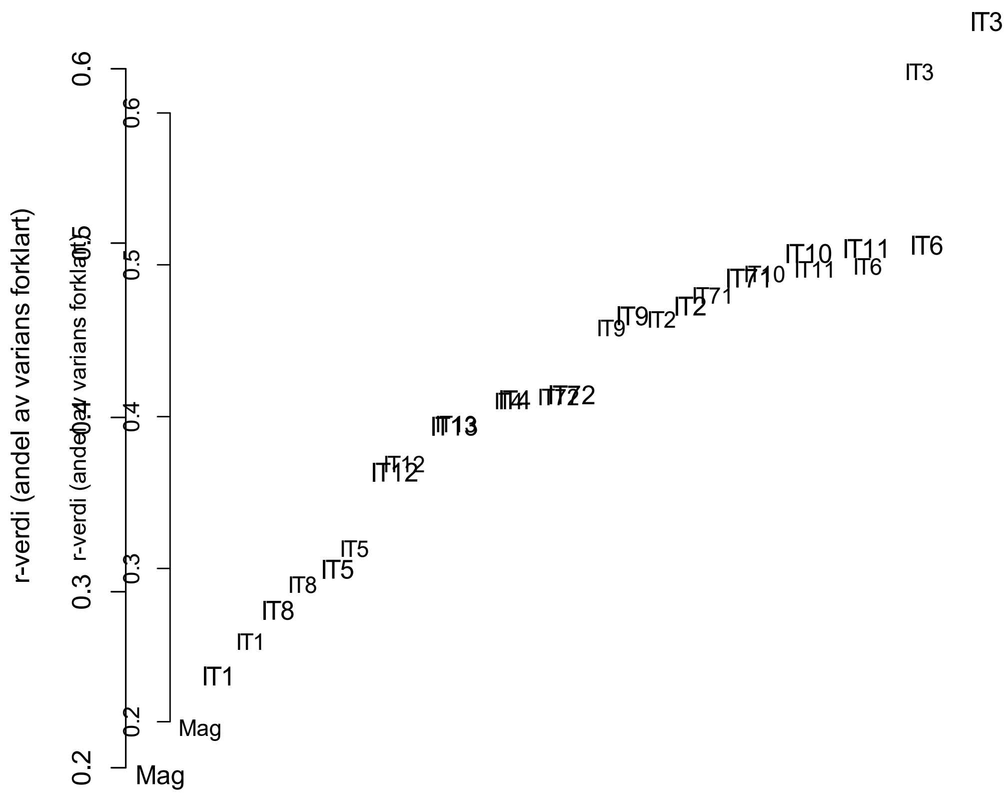


Fig. 1 R^2 verdier for lineære modeller

Nr	
3	Ljosåni
6	Lisleå
11	Faråna
10	Havestøylani
71	Flossi
2	Hisa
9	Hylesdalsan
72	Flossi liten
4	Gjesløy
13	Myklevatnet
12	Kvernani
5	Skiptesbekken
8	Kvinnåni
1	Holsbekken

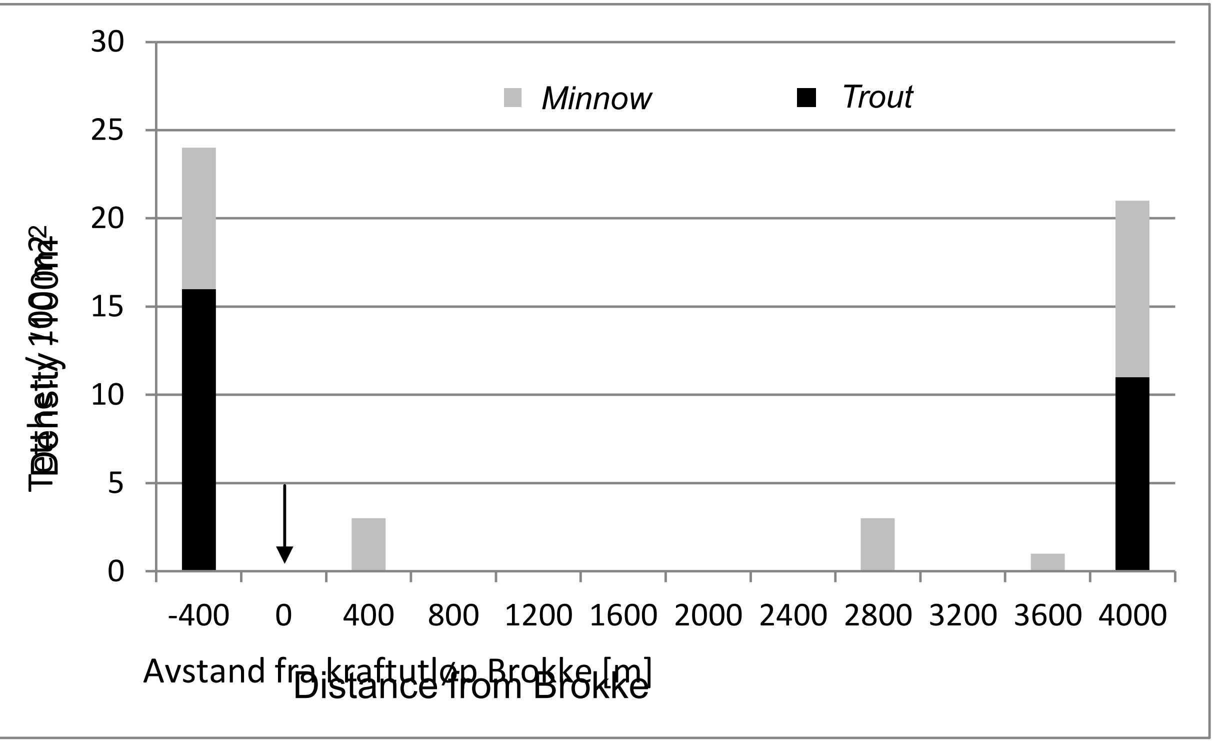
Tabell 1. Bekkeinntakene ordnet i

uni Research

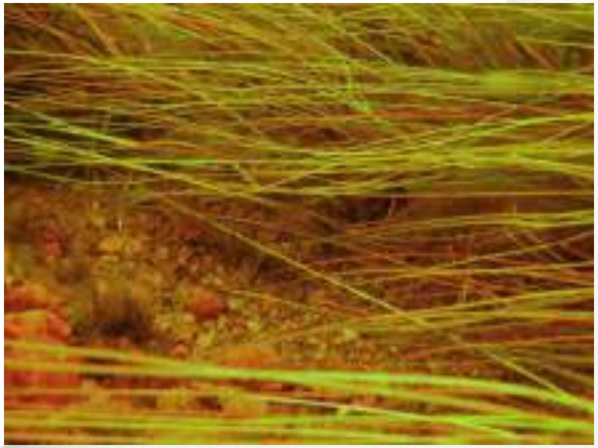
Cause

Effects on the biota

Electrofishing, Otra



Data fra el-fiske 30.-31. 10. 2012. Ørret ble bare funnet ovenfor kraftutløpet og i Rystadbassenget. Ørekyte fantes også innimellom men i svært lave tettheter og samtlige ble funnet ved bekkemunninger.



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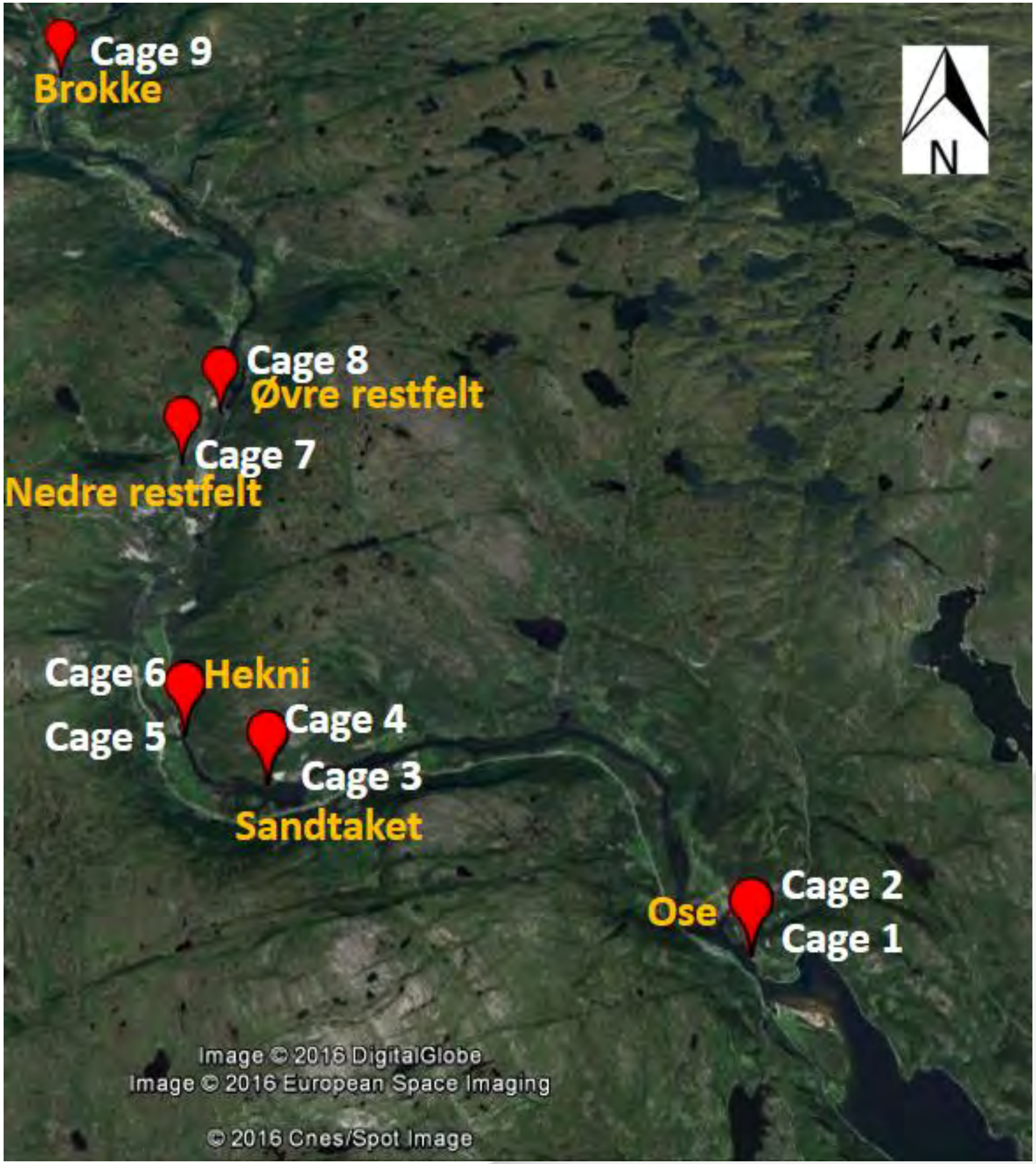
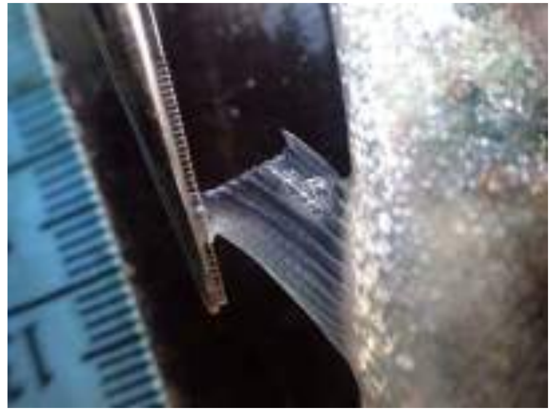
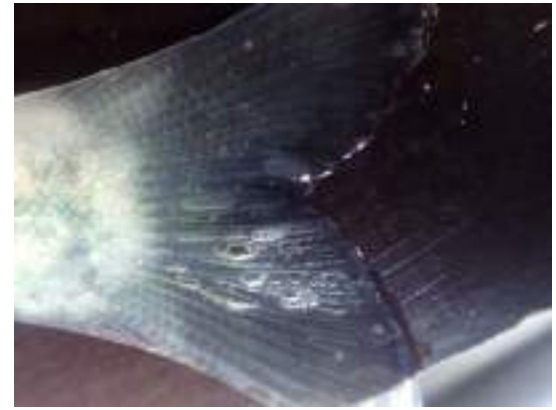
Cage experiments

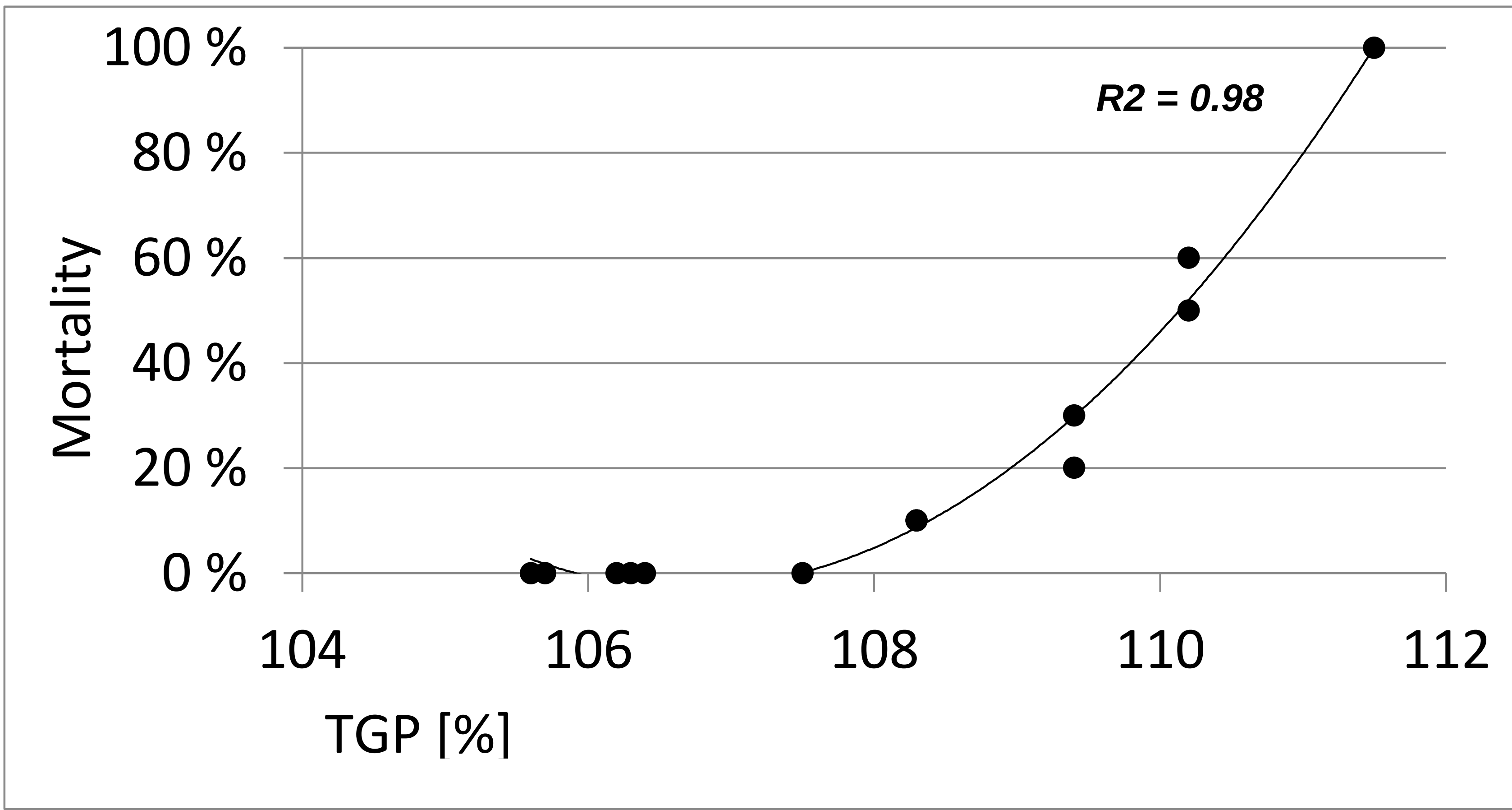


uni Research

Right gill arch 1 = metal analysis
Left gill arch 2 = histology
Right gills = check for gas bubbles
Fins = bubbles
Blood = Plasma cortisol

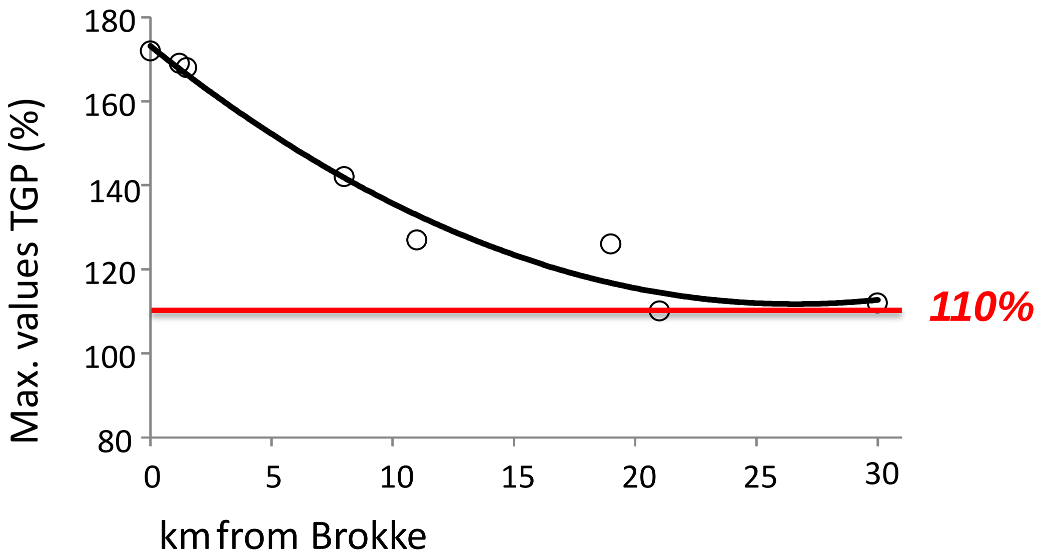






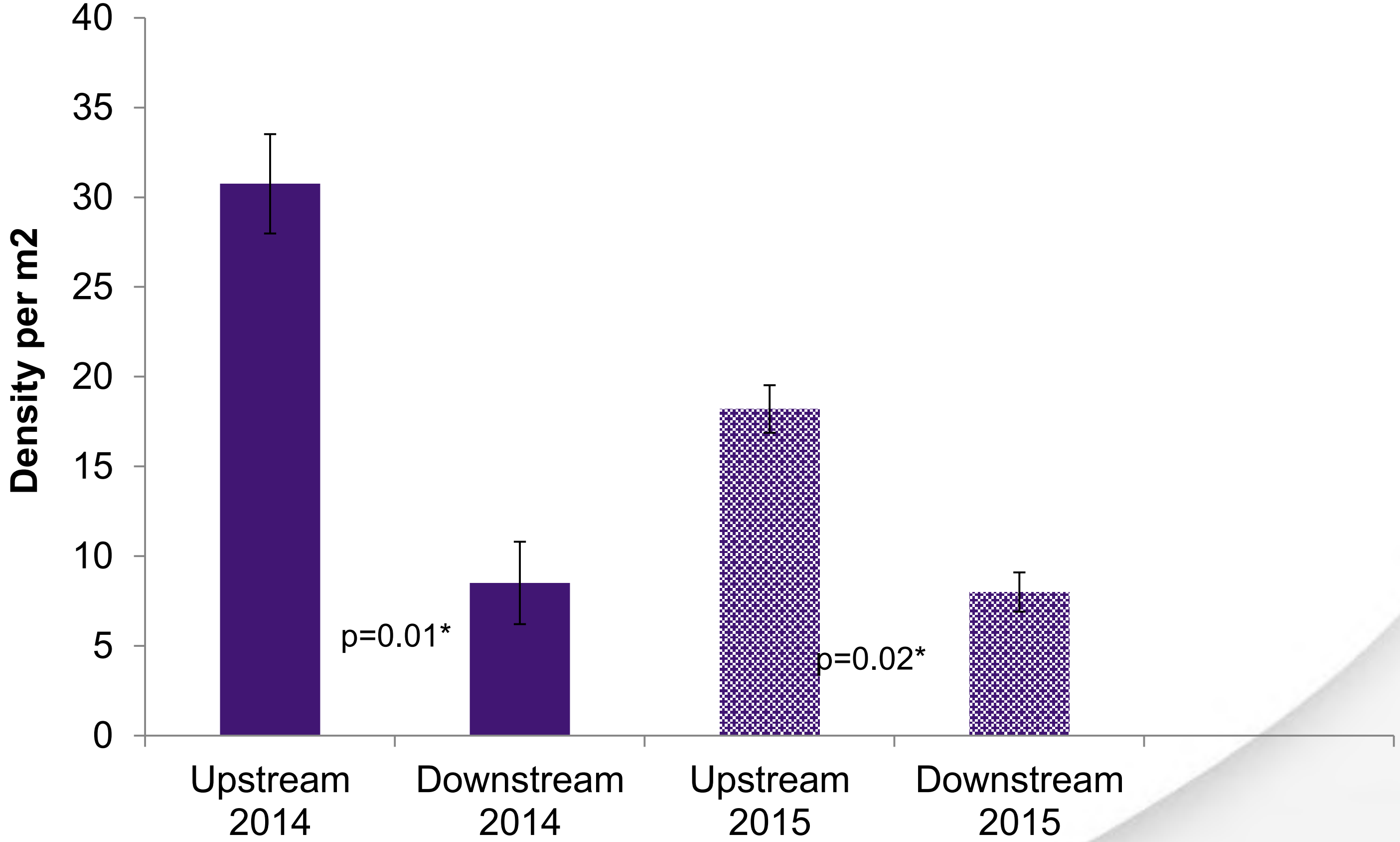
R2 = 0.98
Mortality
100 %
80 %
60 %
40 %
20 %
0 %
104
106
108
110
112
TGP [%]

LD50 = 110% gas supersaturation

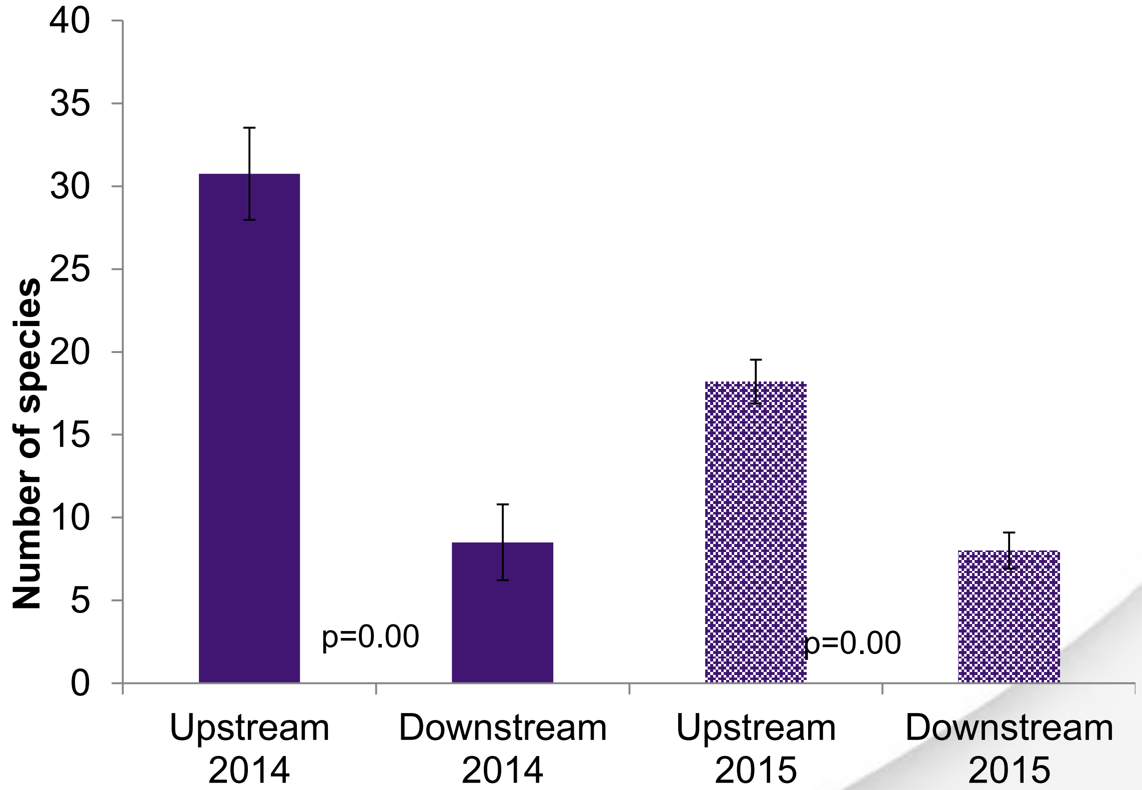


Effects on benthic invertebrates

Density of invertebrates



Diversity of invertebrates



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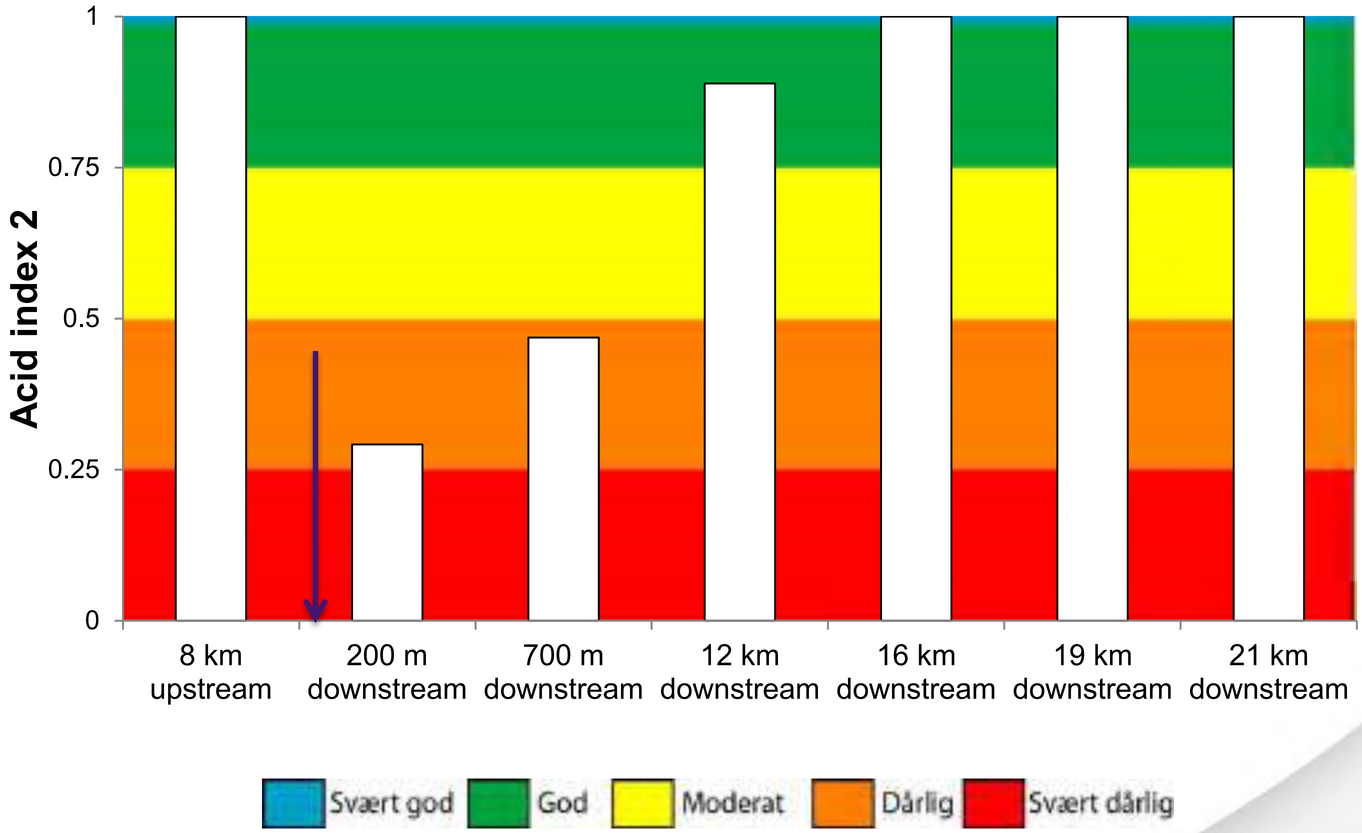
Average acidification index 2010-2015



uni Research

Fauna dominated by digging taxa

200 m upstream		700 m downstream		11 km downstream	
Taxon	**No./m²**	**Taxon**	**No./m²**	**Taxon**	**No./m²**
Chironomidae	6896	Nematoda	1513	Chironomidae	6299
Oligochaeta	1407	Oligochaeta	1299	Oligochaeta	842
Acari	1103	Acari	235	Nematoda	188
Oxyethira sp.	776	Chironomidae	145	Acari	168
Nematoda	458	Apatania sp.	51	Oxyethira sp.	84
Simuliidae	318	A. borealis	23	Ostracoda	64
Oecetis testacea	305	Simuliidae	13	Leptophlebia marginata	23
Lepidostoma hirtum	302	Tipula sp.	8	Pisidium sp.	22
Leuctra fusca/digitata	283	Nemoura cinerea	7	Empididae indet.	19
Pisidium sp.	240	Collembola	7	Simuliidae	15
Radix balthica	220	Empididae indet.	6	Apatania sp.	14
Amphinemura borealis	199	Pisidium sp.	6	Leuctra hippopus	13

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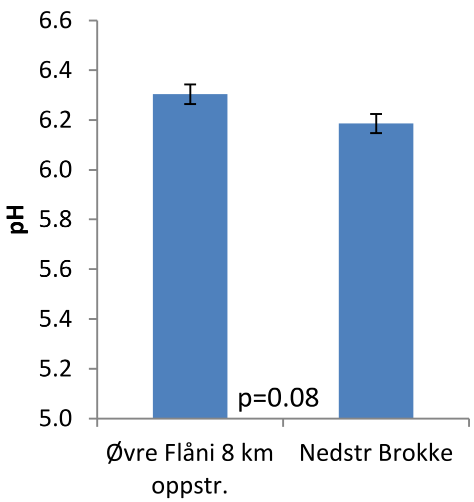
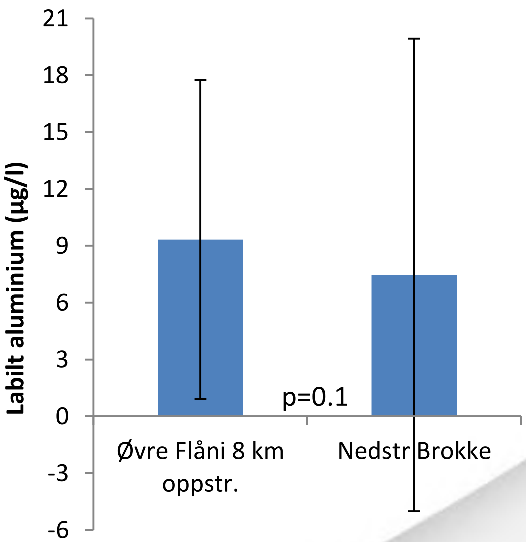
Possible causes

- Substrat

Possible causes

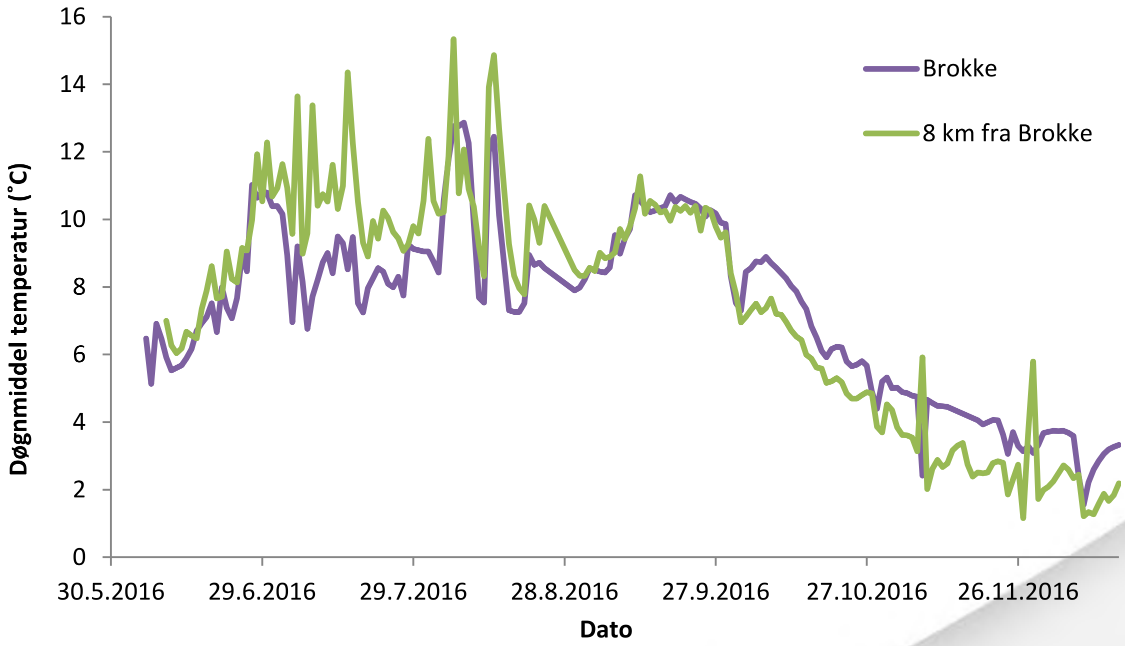
- Substrat
- Water chemistry/ organic load





Possible causes

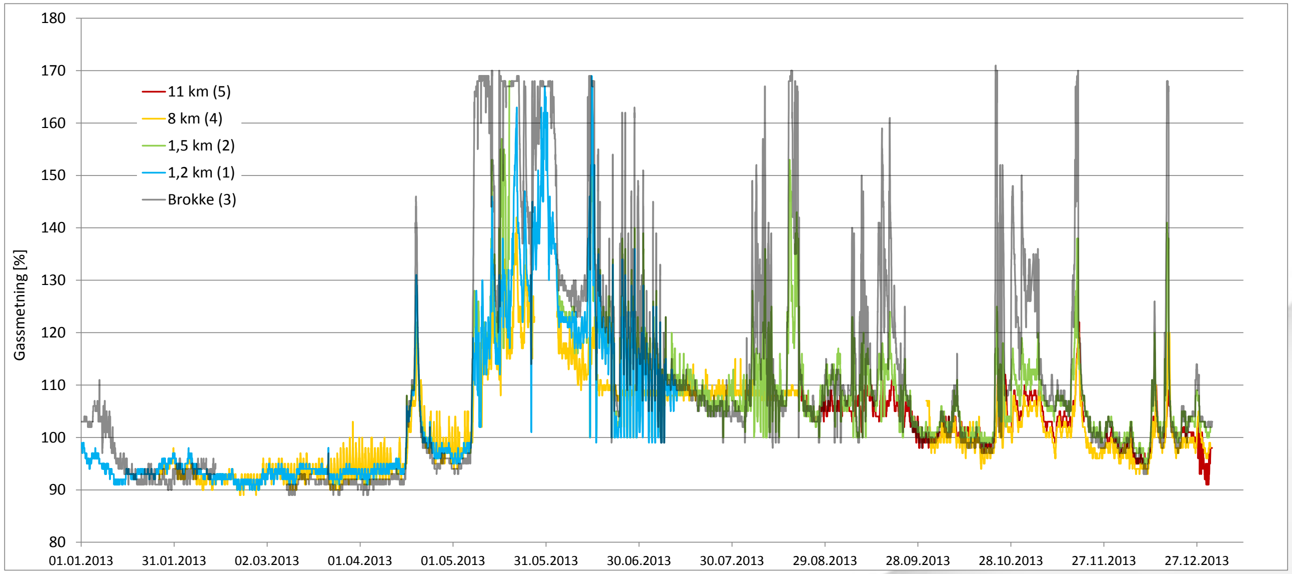
- Substrat
- Water chemistry/ organic load
- Temperature



uni Research

Possible causes

- Substrat
- Water chemistry/ organic load
- Temperature
- Gas supersaturation



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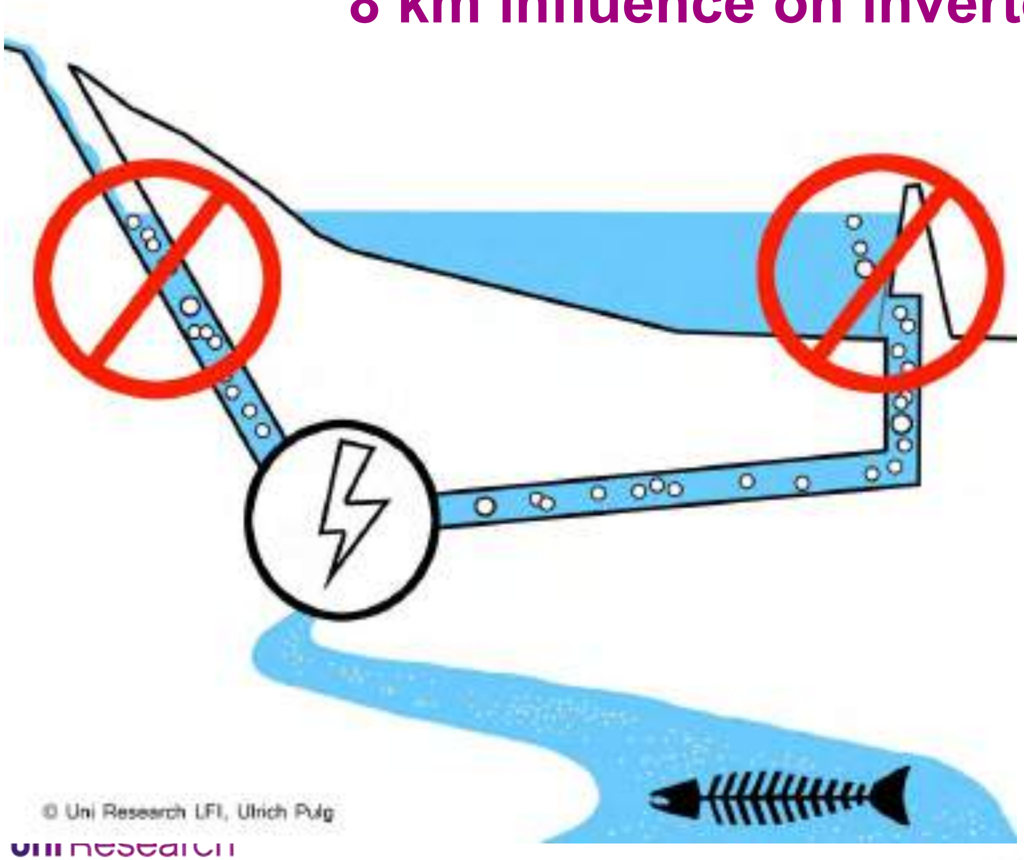
Summary Otra (2011-2016)

110% for > 20 km
100-110% for >30 km
4 km without fish
12 km increased fish mortality
8 km influence on invertebrates



Conclusions

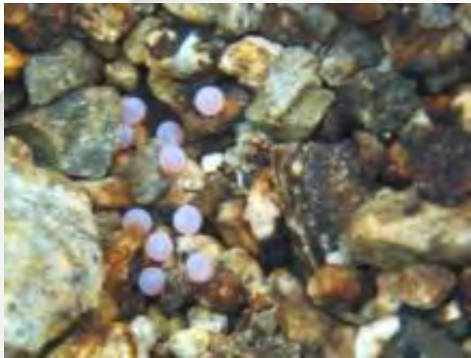
- **Supersaturation may severely influence the the biota**

Lack of knowledge

- Occurrence of supersaturation elsewhere
- Effects on benthic animals and zooplankton
- Sub-lethal doses and avoidance behaviour of fish
- *No regulations or awareness exists*

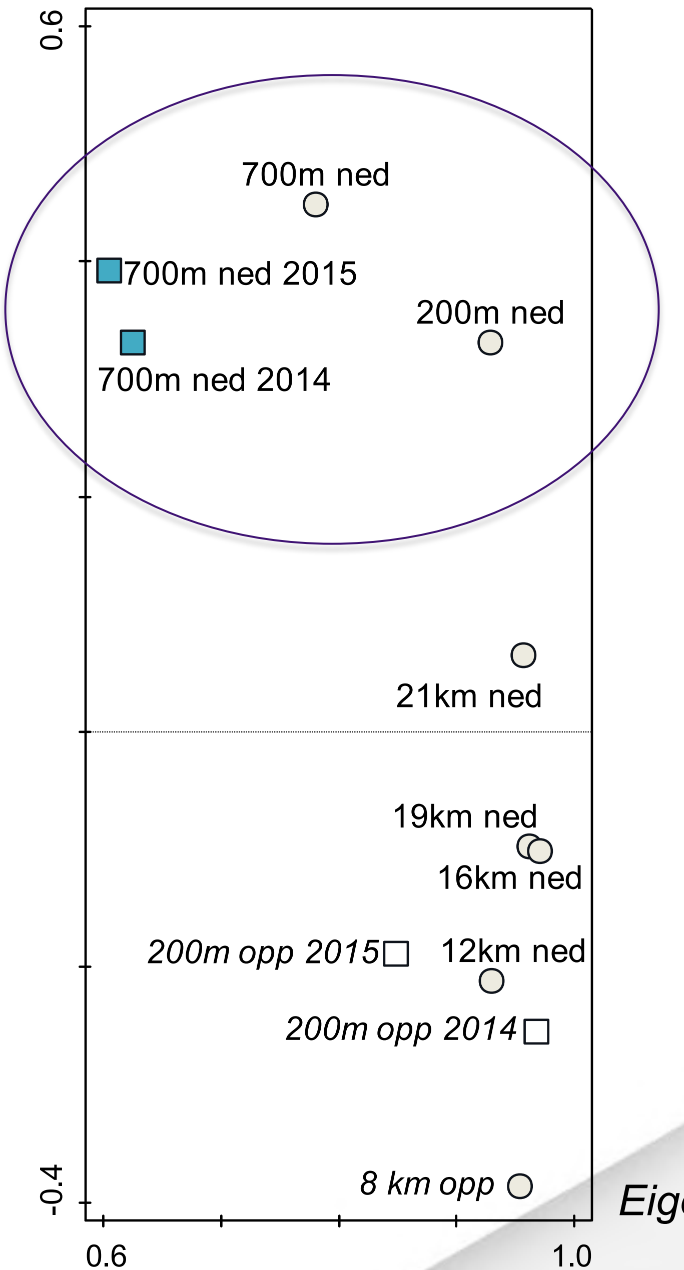
Relevance for ICP waters

- Biota may indicate acidification when the cause is supersaturation
- May occur downstream from dams and power plant outlets, also downstream of falls?



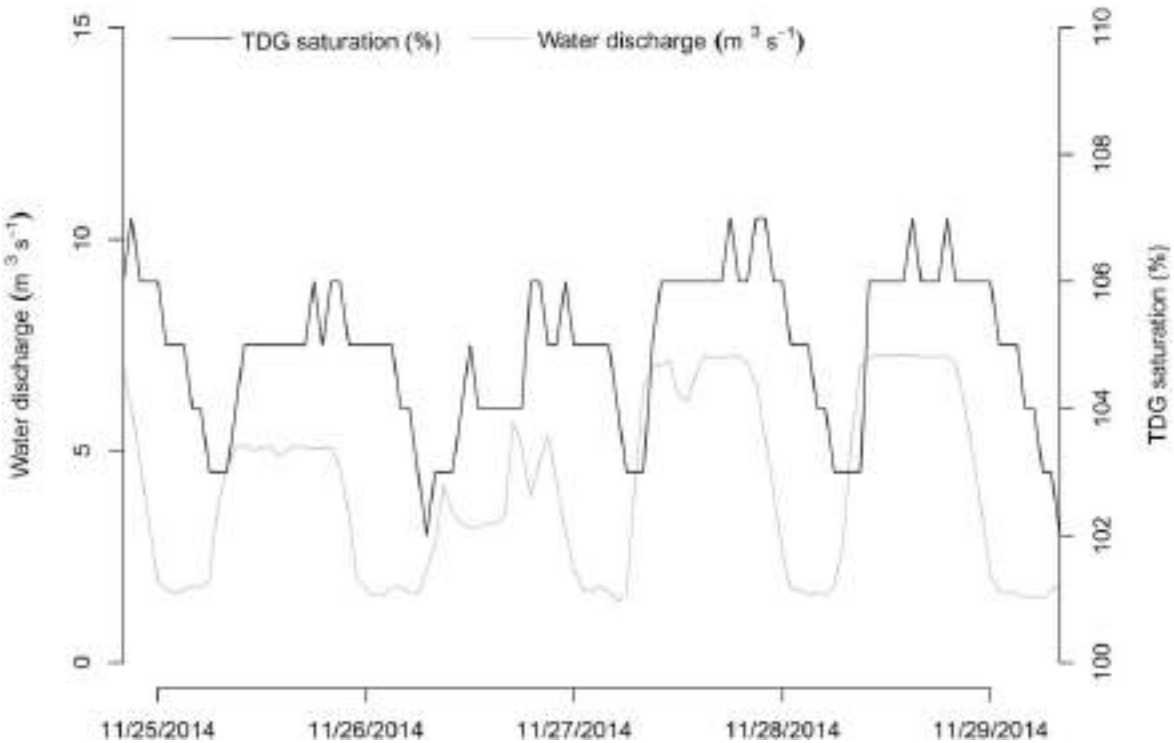

Thanks for your attention!

Species composition

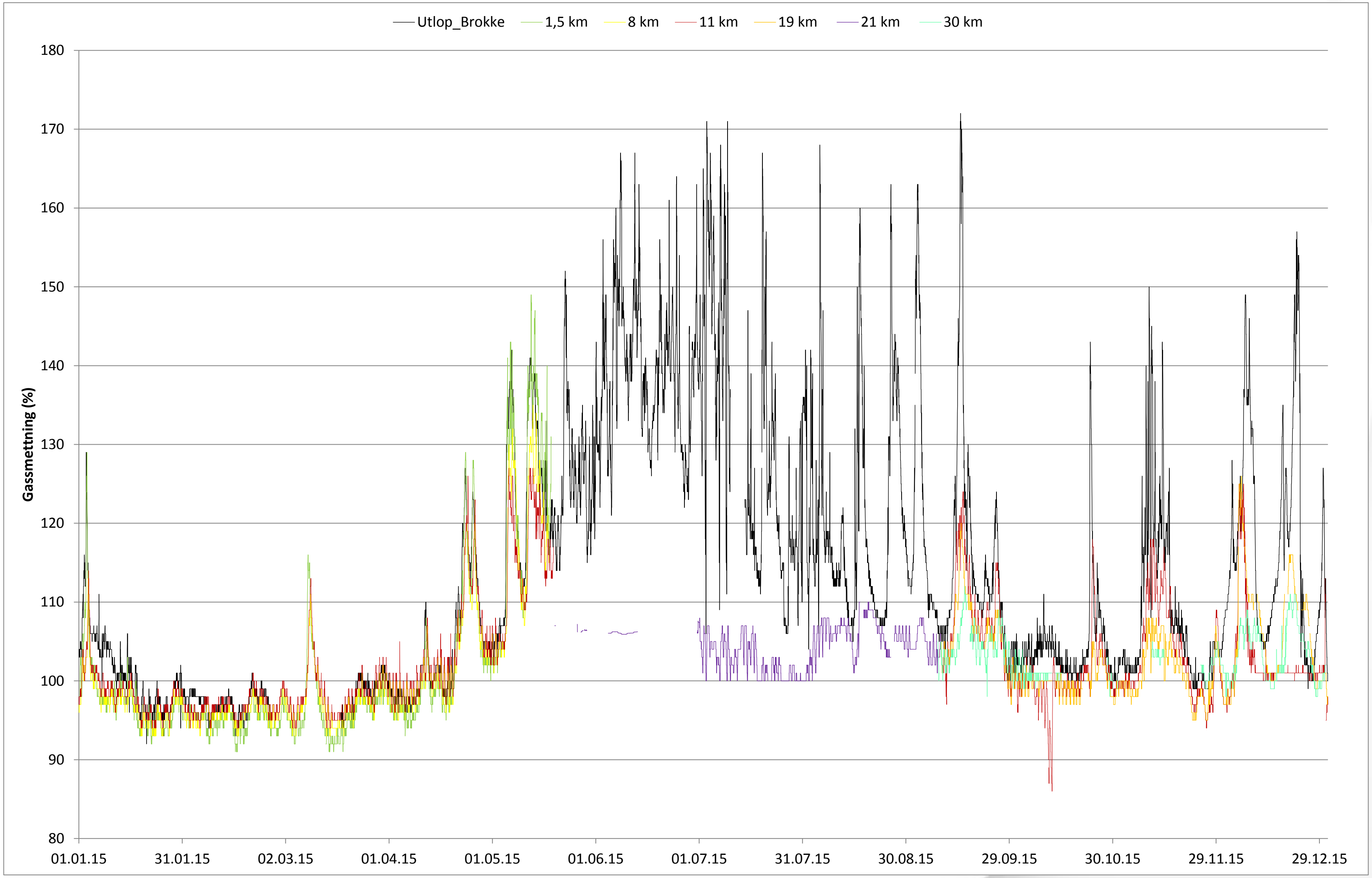


Eigenvalues: 0.77/ 0.08

uni Research

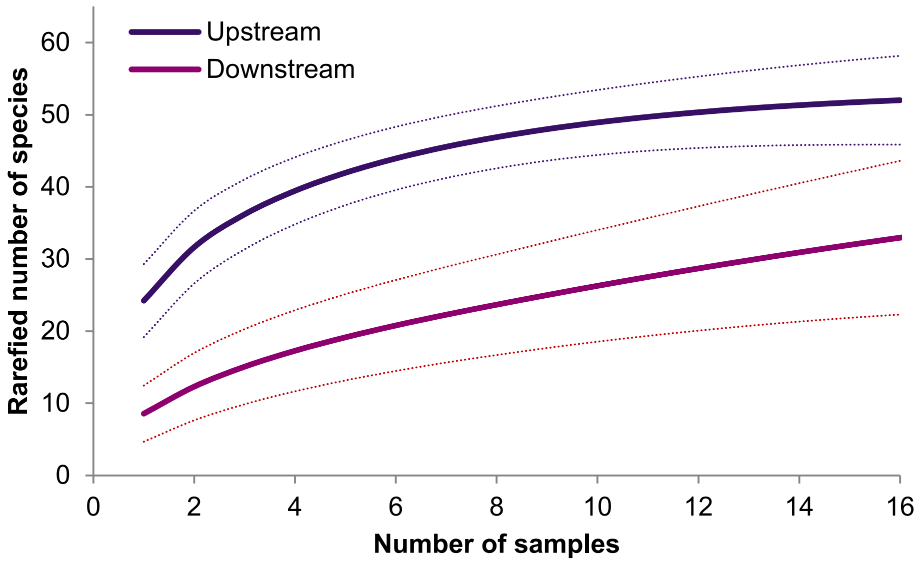


Pulg, Vollset, Velle, Stranzl. (2016). First observations of saturopeaking: Characteristics and implications. *Science of the Total Environment* 573: 1615-1621



uni Research

Accumulation curves for species richness

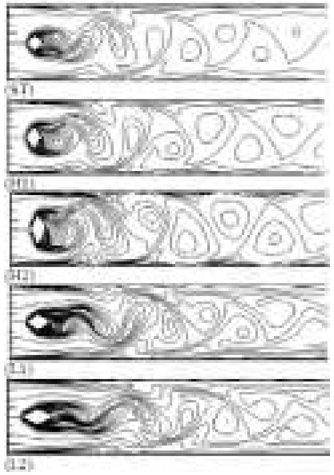


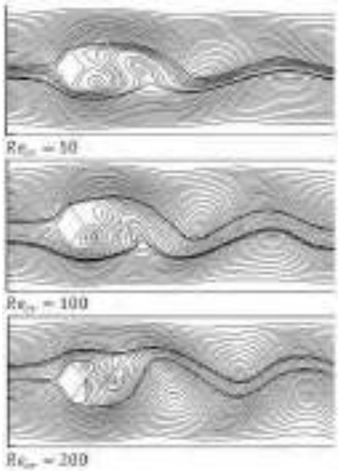
uni Research

Low Pressure / Variable Pressure Zones in Rivers

Mitigation measure: Pressure Variability due to form drag?

Form drag: Form drag occurs because localized flow separation can create a high pressure upstream from an object and a low pressure downstream in the objects wake (Wohl, 2015). The resulting pressure-gradient force oposes flow and creates viscos energy losses downstream of the object (Tritton, 1988; Roberson & Crowe, 1993).



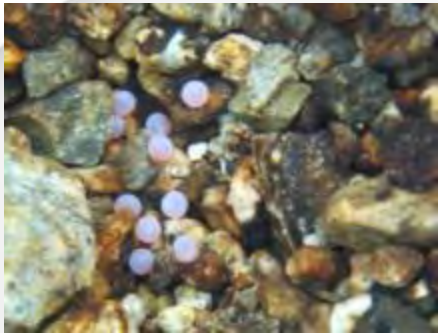


uni Research

Biological effects from gas supersaturation

Fish

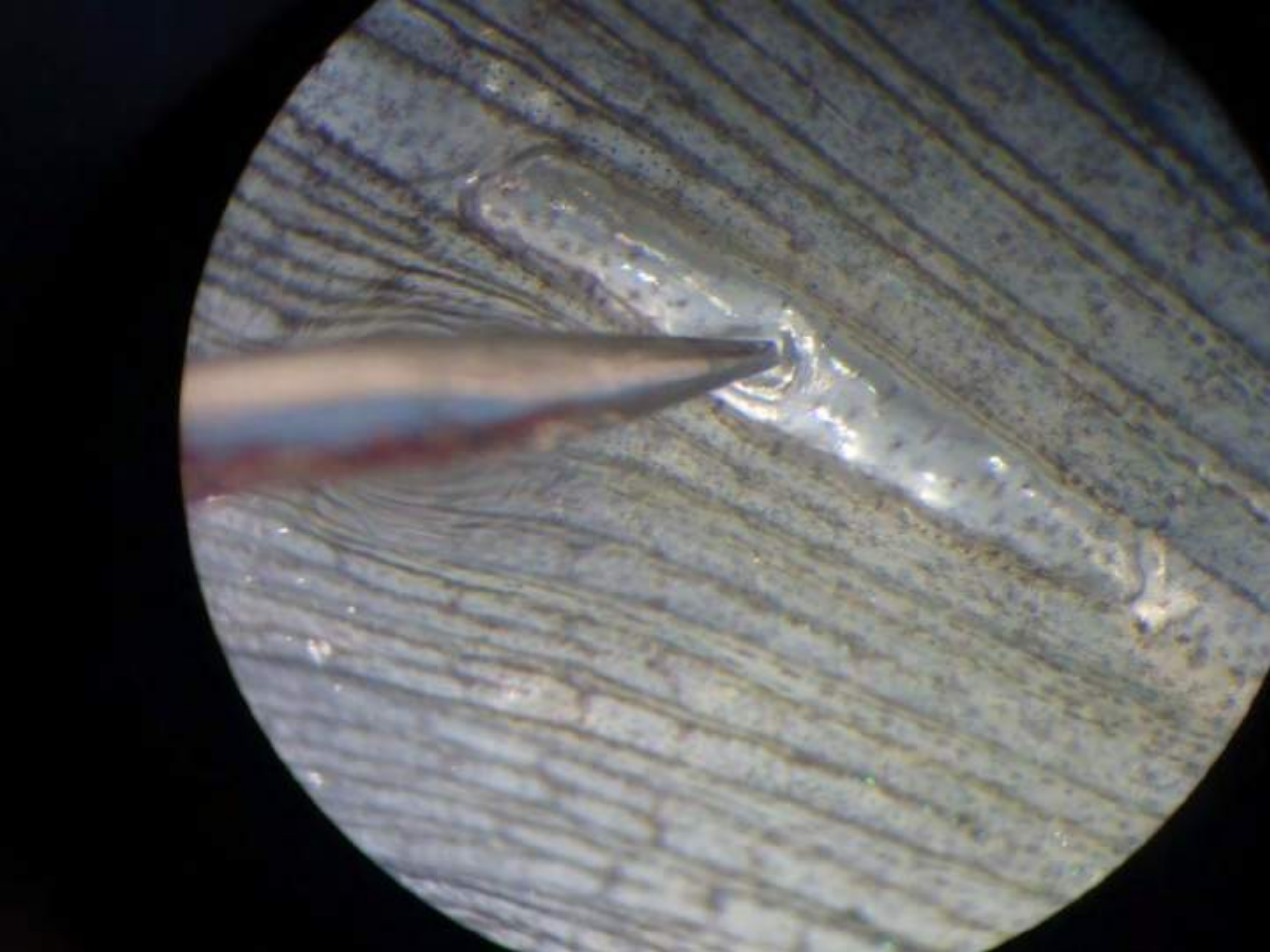
- Gas bubble desease
- Depending on species, life stage and depth
- Fish in hatcheries have increased mortality from 102-103 %
- Fish in rivers experience acute death from 110 %
- Immune system and behaviour influenced below 110%



Biological effects from gas supersaturation

Other groups

- Bullfrog 120% (*Rana catesbeiana*, Colt et al. 1984)
- Zooplankton 115% (*Daphnia magma*, (Nebeker et al. 1975).
- Crayfish: 120%-127% (*Orconectes limosus*, Nebeker et al. 1976)
- Stoneflies: 130% (*Acroneuria californica, A. pacifica, Pteronarcys californica*)
- Aquatic plants: no data– buoyancy effects? CO_2- boost?

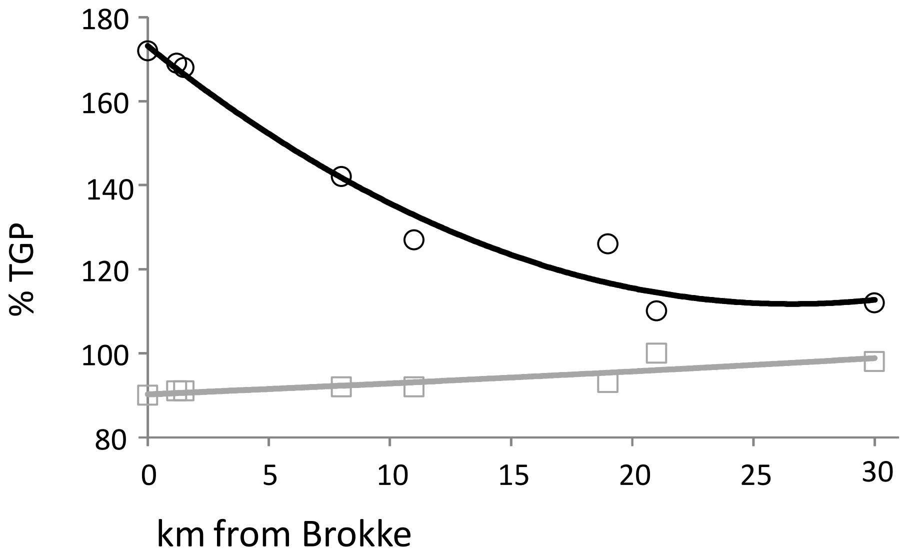


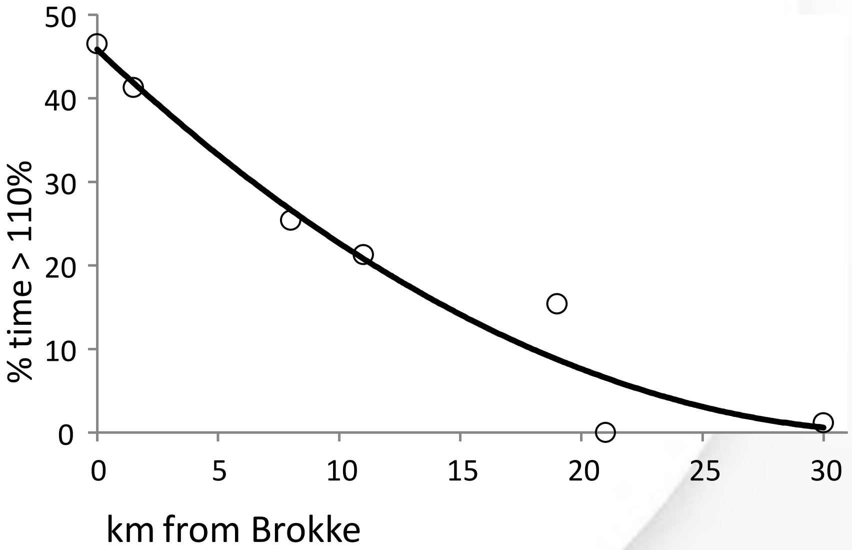
Tiltak mot gassovermetning

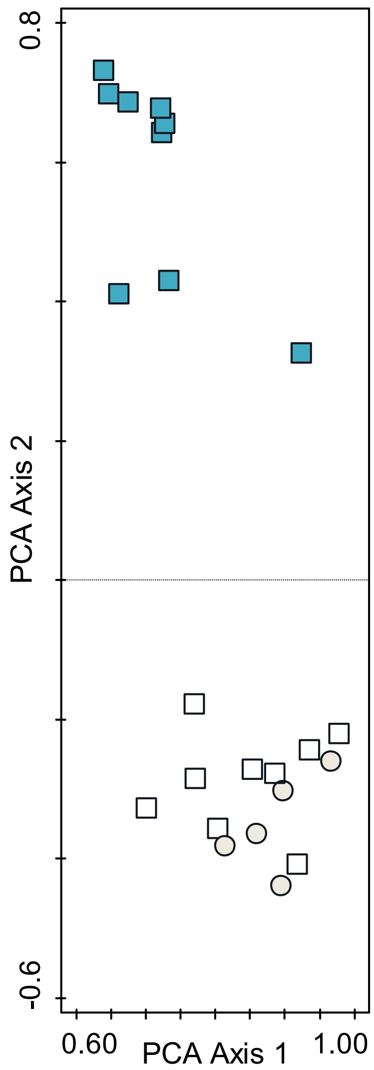
- Gjøre noe med kilden; Vanskelig å isolere hvilke inntak til Brokke som bidrar mest til overmetningen
- Opprettholde loggestasjoner som beskriver situasjonen med fravær/forekomst av gassovermetning – bestemme influensområde (rom & tid)
- Hvordan responderer fisk og bunndyr på eksponeringen – unnviklsesatferd?
- Kartlegge influensområdet nedstrøms Tjurrmodammen dvs. hvilke deler av blekas nåværende utbredelsesområde er påvirket – 2 km - 12 km
- Miljøbasert kjøring av Hekni dvs. planlegg stans i Hekni i perioder uten gassovermetning slik at restfeltet ikke får overmettet vann (Uni kan utrede når det er gassovermetning og anbefale konkrete kjøreregler)- allerede innført?
- Tiltak med å lufte ut gassovermettet. Mulighet for utgassing på fallstrekningen nedstrøms Brokke. Uni anbefaler dette og kan sammenfatte eksisterende data fra mange vassdrag og fra litteratur for å bestemme potensialet.

uni Research

Wave characteristics, aeration, dilution







uni Research

Co-analysis of coniferous forest state parameters and atmospheric deposition data series obtained by ICP IM and EMEP at European part of Russia

LRTAP
Long-range Transboundary Air Pollution

EMEP

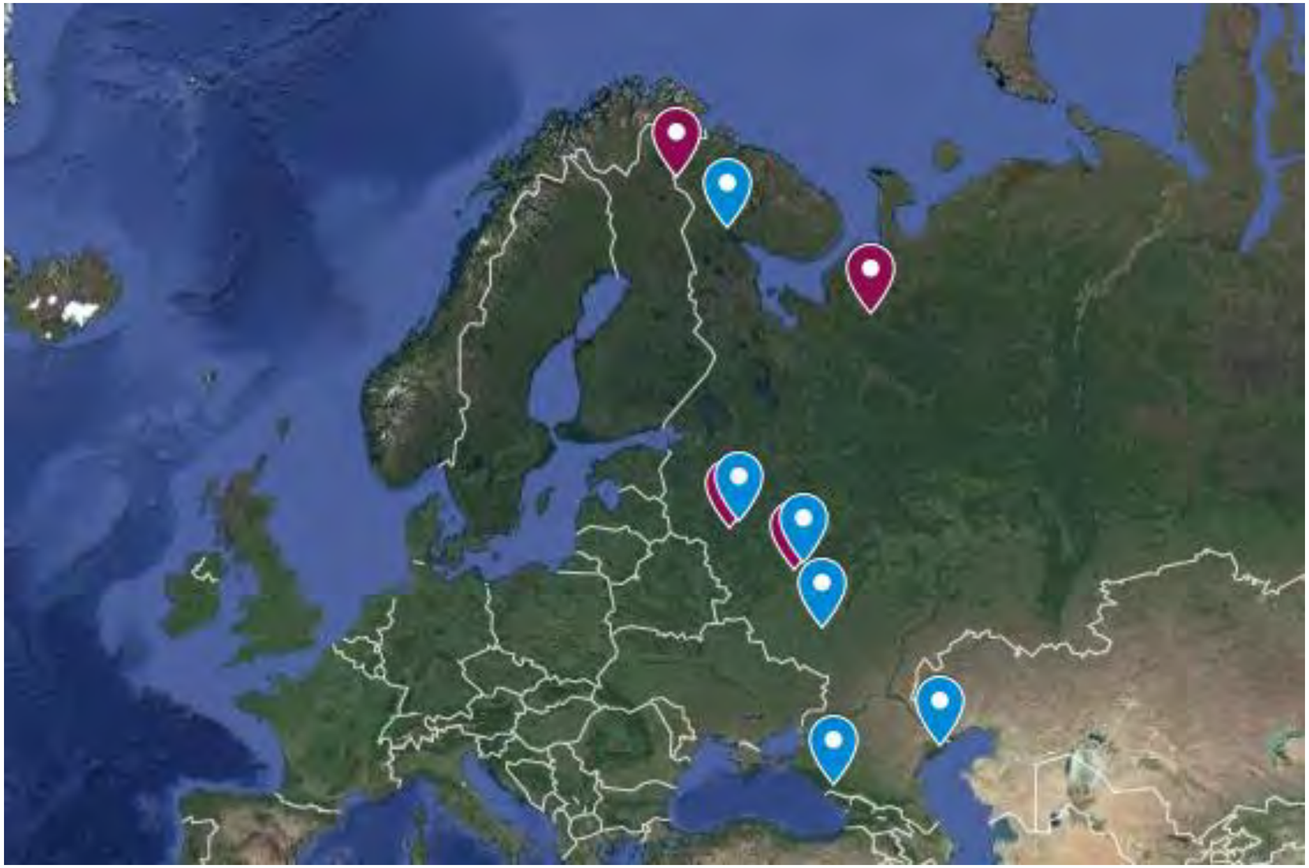
ICP IM

Pozdnyakova E.
Institute of Global Climate and Ecology of Roshydromet and RAS

IGCE
Institute of Global Climate and Ecology Roshydromet & RAS

katemukudori@mail.ru

ICP IM and EMEP Russian network



ICP IM station

EMEP station

ICP IM and EMEP research parameters

ICP IM

Coniferous stands	**Defoliation (%)** **Depigmentation (%)**
Annual sampling	
Analysis were carried out by visual assessment	

EMEP

Concentration in precipitation	K^{+} Na^{+} Ca^{2+} Mg^{2+} NH_4^{+} NO_3^{-} NO_3^{-} SO_4^{2-} Cl^{-}
Daily sampling	
Analysis were carried out by methods of ion and liquid chromatography	

Stands
White Sea Biological Station

fir-wood	pinery

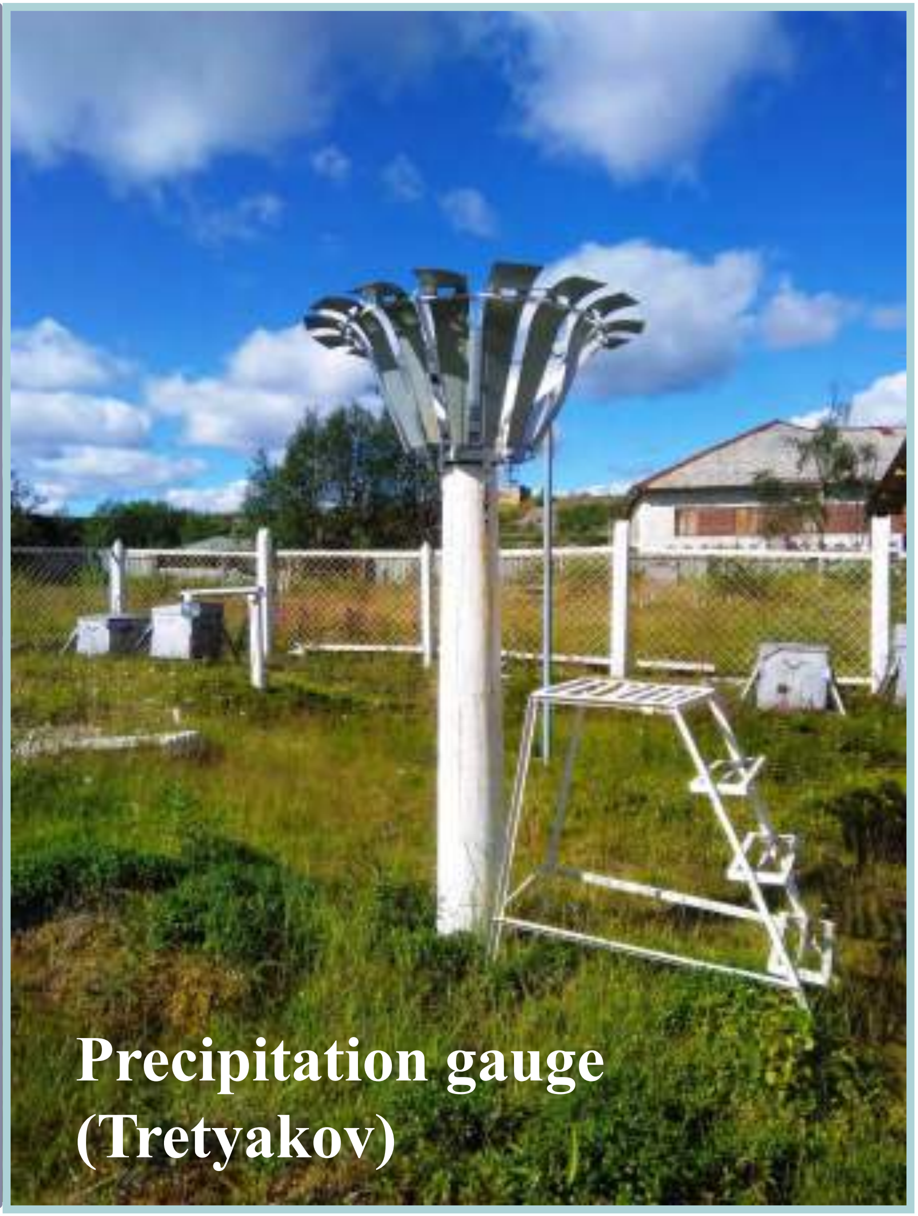
Stands
Oka-Terrace Biosphere Reserve

fir-wood	pinery
	

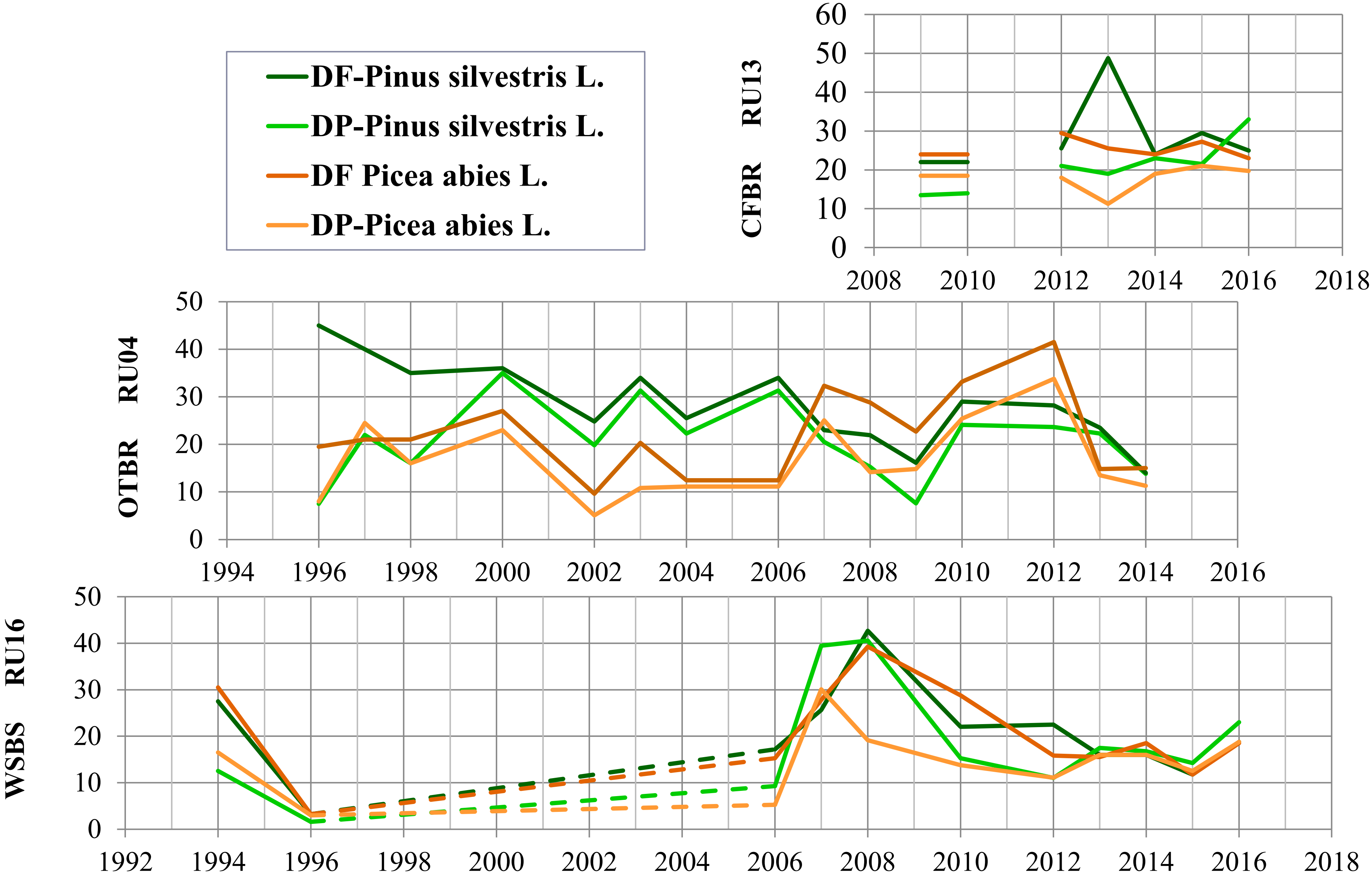
Stands
Central-Forest Biosphere Reserve

fir-wood	pinery
	

EMEP station



Interannual fluctuations of defoliation(%) and depigmentation(%) in stands of Scots pine (Pínus sylvéstris) and spruce (Pícea ábies) .



Defoliation and depigmentation in pine and spruce stands changed unidirectionally for RU16 and RU04

Correlation coefficients (p = 0.05)			
RU04		RU16	
R(DF&DP)	R(DF&DP)	R(DF&DP)	R(DF&DP)
Picea abies	Pinus sylvestris	Picea abies	Pinus sylvestris
0,861	0,698	0,649	0,748

There is no the same correlations for RU13

CFBR **Tab. 1 Coefficients of correlations between the parameters of coniferous stands and total wet deposition of pollutants for current(C) and previous(P) year. (p = 0.05)**

Stands	Parameter	SO4(S)	NO_3(N)	NH4(N)	Na	Mg	Ca	Cl	K
Pinus sylvestris L.	DF			-0.63C; 0.63P;					-0.63C;
Picea abies L.	DF						0.58C;		
Pinus sylvestris L.	DP	-0.94C; -0.73P;			-0.68C; -0.60P;	- 0.73C;		-0.64C; -0.66P;	-0.73C; -0.63P;
Picea abies L.	DP			-0.59P;					

Tab. 2 Coefficients of correlations between the parameters of coniferous stands and concentration pollutant in precipitation for current(C) and previous(P) year. (p = 0.05)

Stands	Parameter	SO4(S)	NO_3 (N)	NH4(N)	Na	Mg	Ca	Cl	K
Pinus sylvestris L.	DF	-0.69P;	0.67C;						-0.61C;
Picea abies L.	DF	-0.65C;							
Pinus sylvestris L.	DP		0.55P;	0.73P;			0.59C;	-0.58P;	
Picea abies L.	DP	0.58P;		0.74C;					

OTBR Tab. 3 Coefficients of correlations between the parameters of coniferous stands and total wet deposition of pollutants for current(C) and previous(P) year. (p = 0.05)

Stands	Parameter	SO4(S)	NO_3(N)	NH4(N)	Na	Mg	Ca	Cl	K
Pinus sylvestris L.	DF		-0,49P;	0,46C;		-0,59P;	-0,49P;	-0,54P;	-0,46P;
Picea abies L.	DF		-0,49P;					0,42C;	
Pinus sylvestris L.	DP			0,44C;	-0,55P;	-0,63P;		-0,62P;	-0,47P;
Picea abies L.	DP								

Tab. 4 Coefficients of correlations between the parameters of coniferous stands and concentration pollutant in precipitation for current(C) and previous(P) year. (p = 0.05)

Stands	Parameter	SO4(S)	NO_3 (N)	NH4(N)	Na	Mg	Ca	Cl	K
Pinus sylvestris L.	DF			0,60P					
Picea abies L.	DF						-0,54C;	0,53C;	
Pinus sylvestris L.	DP			0,66P	-0,46P;			-0,52P;	
Picea abies L.	DP								

WSBS & Pinega

Tab. 5 Coefficients of correlations between the parameters of coniferous stands and total wet deposition of pollutants for current(C) and previous(P) year. (p = 0.05)

Stands	Parameter	SO4(S)	NO_3(N)	NH4(N)	Na	Mg	Ca	Cl	K
Pinus sylvestris L.	DF				0,87C; 0,55P;	0,87P;	0,52P;	0,74C; 0,55P;	0,73P;
Picea abies L.	DF			-0,59P;	0,79C; 0,69P;	0,72P;		0,70C; 0,63P;	0,59P;
Pinus sylvestris L.	DP	0,71C;	0,52C; -0,51P;	-0,79P;	0,92C;	0,68C; 0,53P;	0,52P;	0,92C;	0,65C;
Picea abies L.	DP	0,72C; -0,59P;	0,48C; - 0,70P;		0,71C;	0,86C;	0,53C;	0,87C;	0,84C;

Tab. 6 Coefficients of correlations between the parameters of coniferous stands and concentration pollutant in precipitation for current(C) and previous(P) year. (p = 0.05)

Stands	Parametr	SO4(S)	NO_3 (N)	NH4(N)	Na	Mg	Ca	Cl	K
Pinus sylvestris L.	DF	0,51C;			0,73C; 0,64P;	0,93P;		0,89C; 0,52P;	0,75 P;
Picea abies L.	DF	0,61C;		-0,61P;	0,86P;	0,76P;	-0,55C;	0,83C; 0,64P;	0,62 P;
Pinus sylvestris L.	DP		-0,48P;	-0,67P;	0,65C; 0,55 P;	0,74P;	0,75 P;	0,94C; 0	0,73 P;
Picea abies L.	DP			-0,54P;			0,88P;	0,75C;	

WSBS & Janiskoski

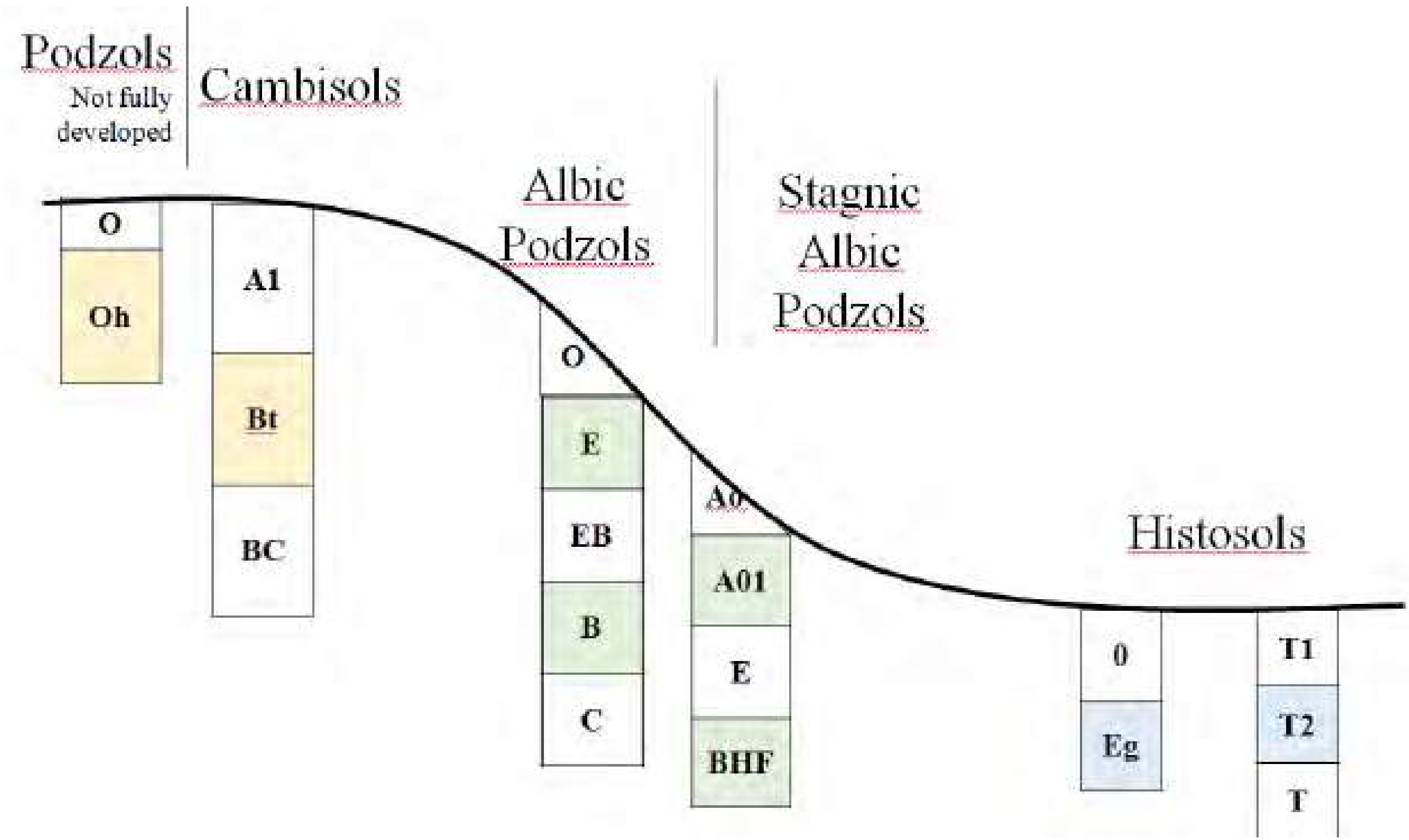
Table. 7 Coefficients of correlations between the parameters of coniferous stands and total wet deposition of pollutants for current(C) and previous(P) year. (p = 0.05)

Stands	Parameter	SO4(S)	NO_3(N)	NH4(N)	Na	К	Ca
Pinus sylvestris L.	DF	0,59 C;		0,61C;	0,79C;	0,69C;	0,69C;
Picea abies L.	DF		-0,65 C; -0,48 P;		0,63C; 0,72 P;	0,46C; 0,57P;	0,50C; 0,59P;
Pinus sylvestris L.	DP			0,62 C;	0,83C;	0,77C;	0,80C;
Picea abies L.	DP				0,48C;	0,53C;	0,58C;

Table. 8 Coefficients of correlations between the parameters of coniferous stands and concentration pollutant in precipitation for current(C) and previous(P) year. (p = 0.05)

Stands	Parameter	SO4(S)	NO_3 (N)	NH4(N)	Na	К	Ca
Pinus sylvestris L.	DF		-0,63C; -0,48 P;	0,62C;	0,57C; 0,66 P;	0,65C;	062C; 0,48 P;
Picea abies L.	DF		-0,79C;		0,91 P;	0,75 P;	0,76 P;
Pinus sylvestris L.	DP		-0,58C;	0,63C;	0,77C; 0,62 P;	0,74C;	0,71C;
Picea abies L.	DP	0,47 P;	-0,59C;		0,53 C;		

The distribution of soils at White Sea Biological Station



Conclusions

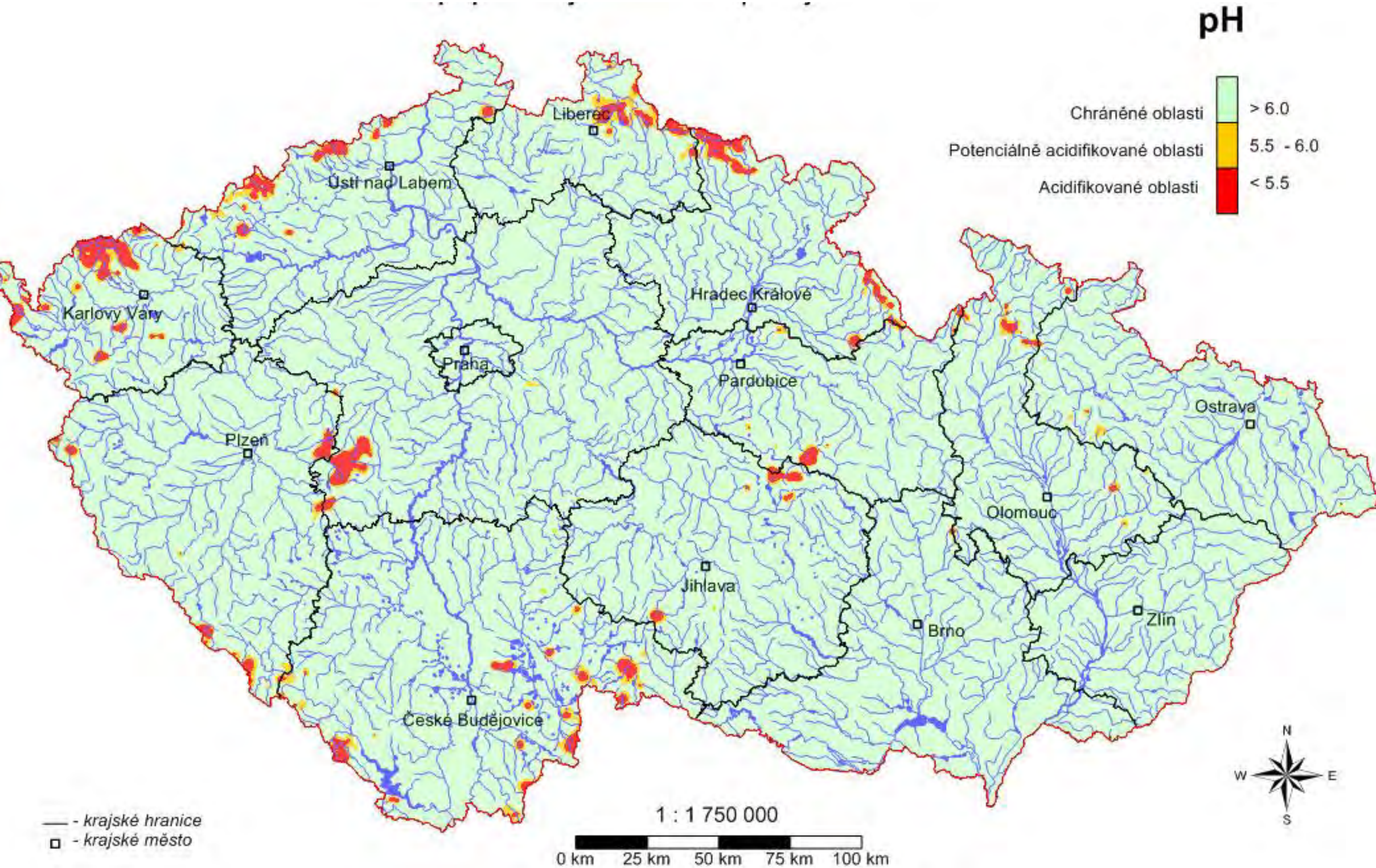
- Defoliation and depigmentation of pine and spruce changed unidirectionally for RU16 and RU04
- For all territories, discovered the significant correlations between the state of the forest and annual fluctuations of pollutants
- Coniferous forests of the North are more sensitive to fluctuations in pollutants
- Nitrogen compounds act as fertilizers for the territories of the far North
- We assume that the results of this research, could be used for verification models of the atmospheric pollutants transport for Northern area


Thank you

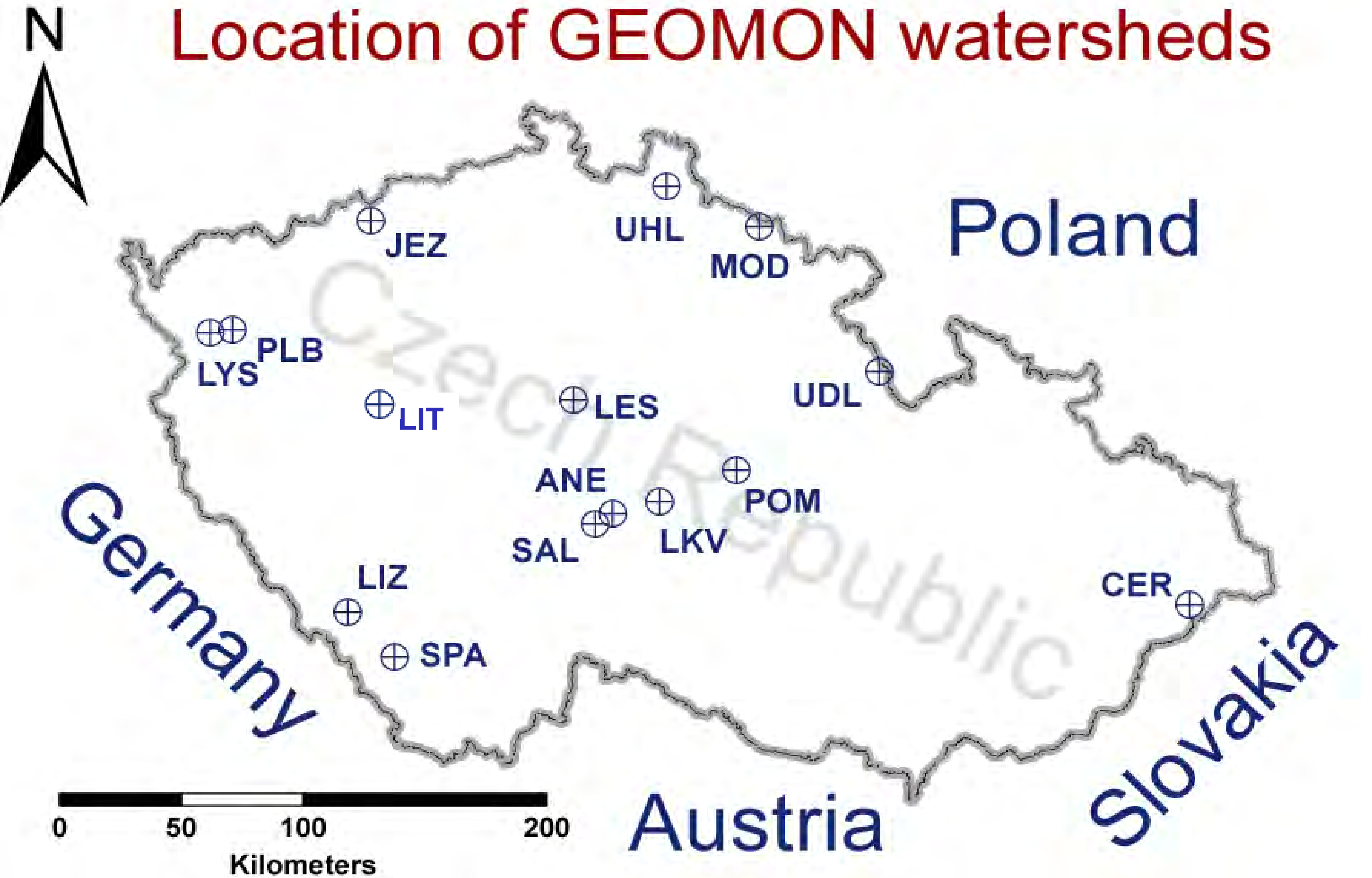
Recovery of benthic algal assemblages from acidification: how long does it take, and is there a link to eutrophication?

Susi Schneider[1], Filip Oulehle[2], Pavel Krám[2], Jakub Hruška[2]
[1]Norwegian Institute for Water Research, Norway
[2]Czech Geological Survey, Praha, Czech Republic

Acidified surface waters in the Czech Republic



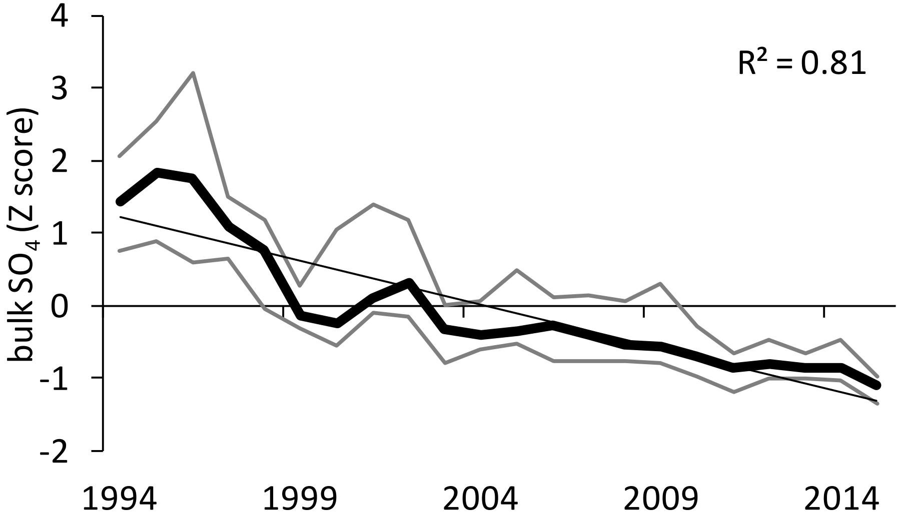
Location of GEOMON watersheds



GEOMON

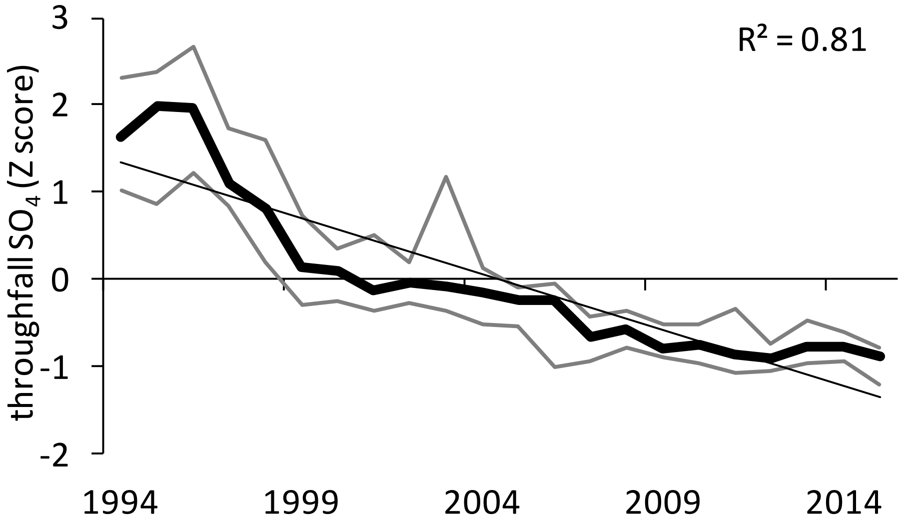
Oulehle et al. (2017) *Biogeochemistry* 132:251–272

S deposition (1994 - 2015)



14 kg S ha^{-1} yr^{-1}

3.7 kg S ha^{-1} yr^{-1}

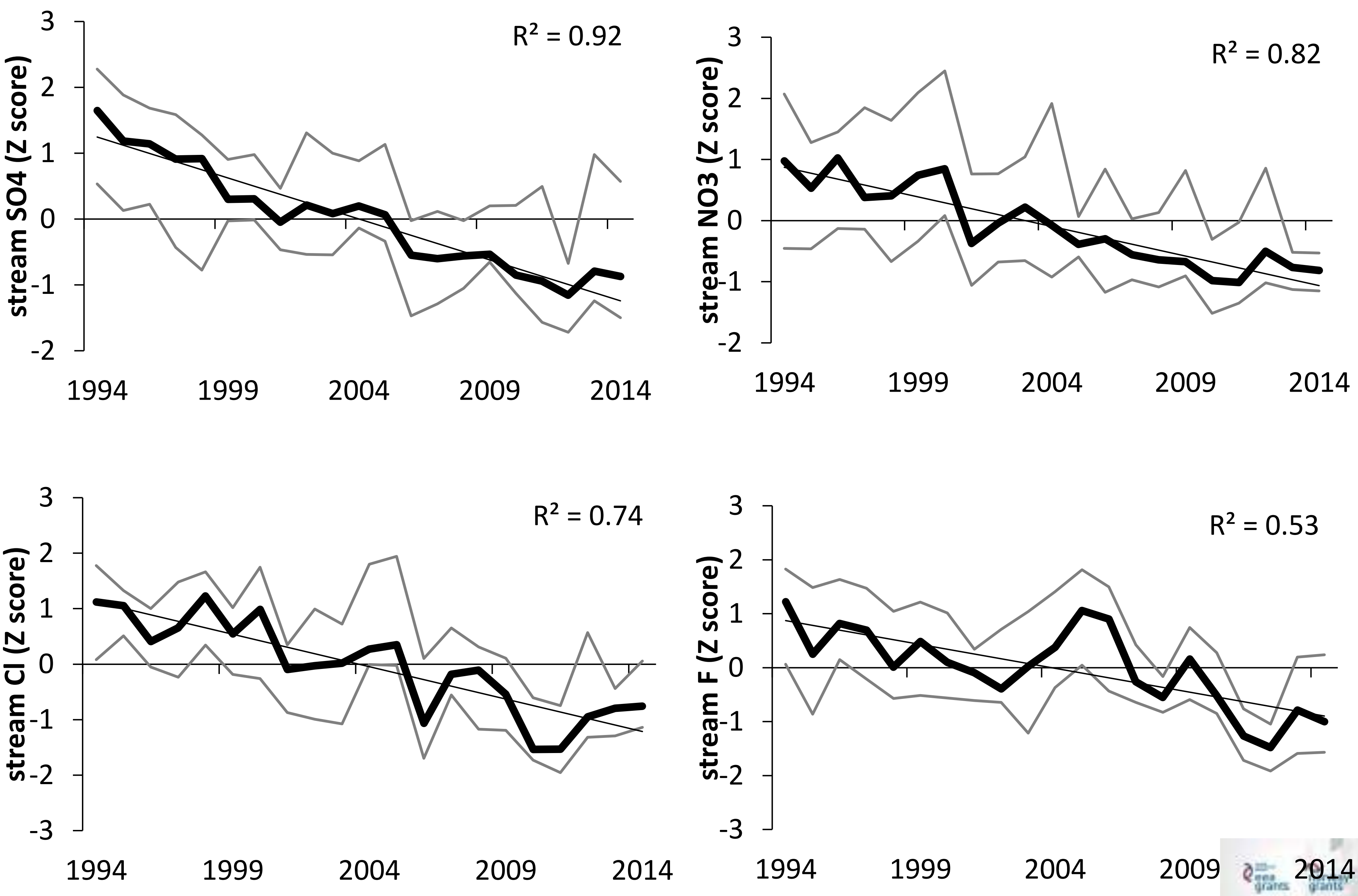


36 kg S ha^{-1} yr^{-1}

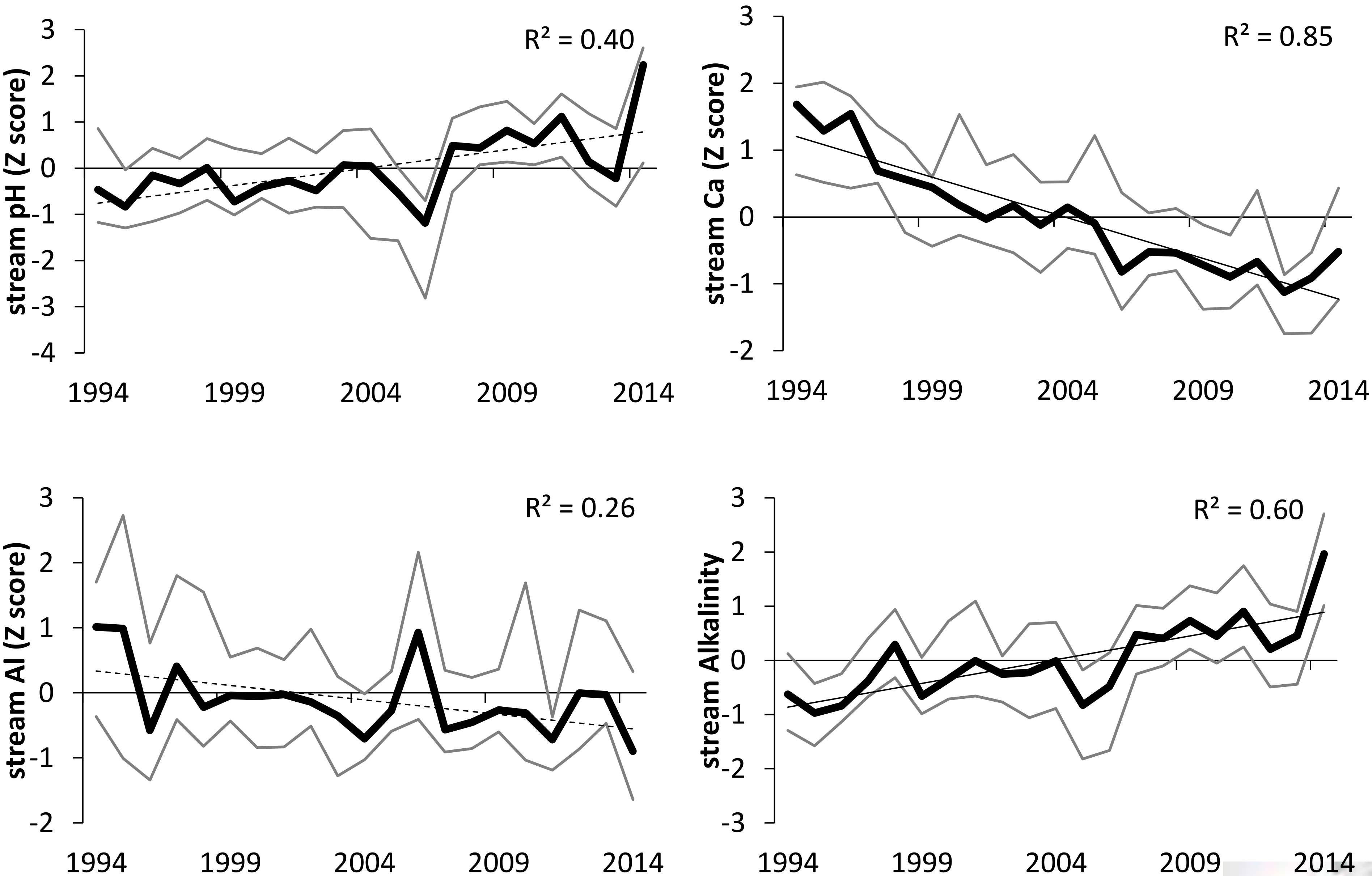
9.7 kg S ha^{-1} yr^{-1}

Dry deposition still important

GEOMON Runoff (anions)

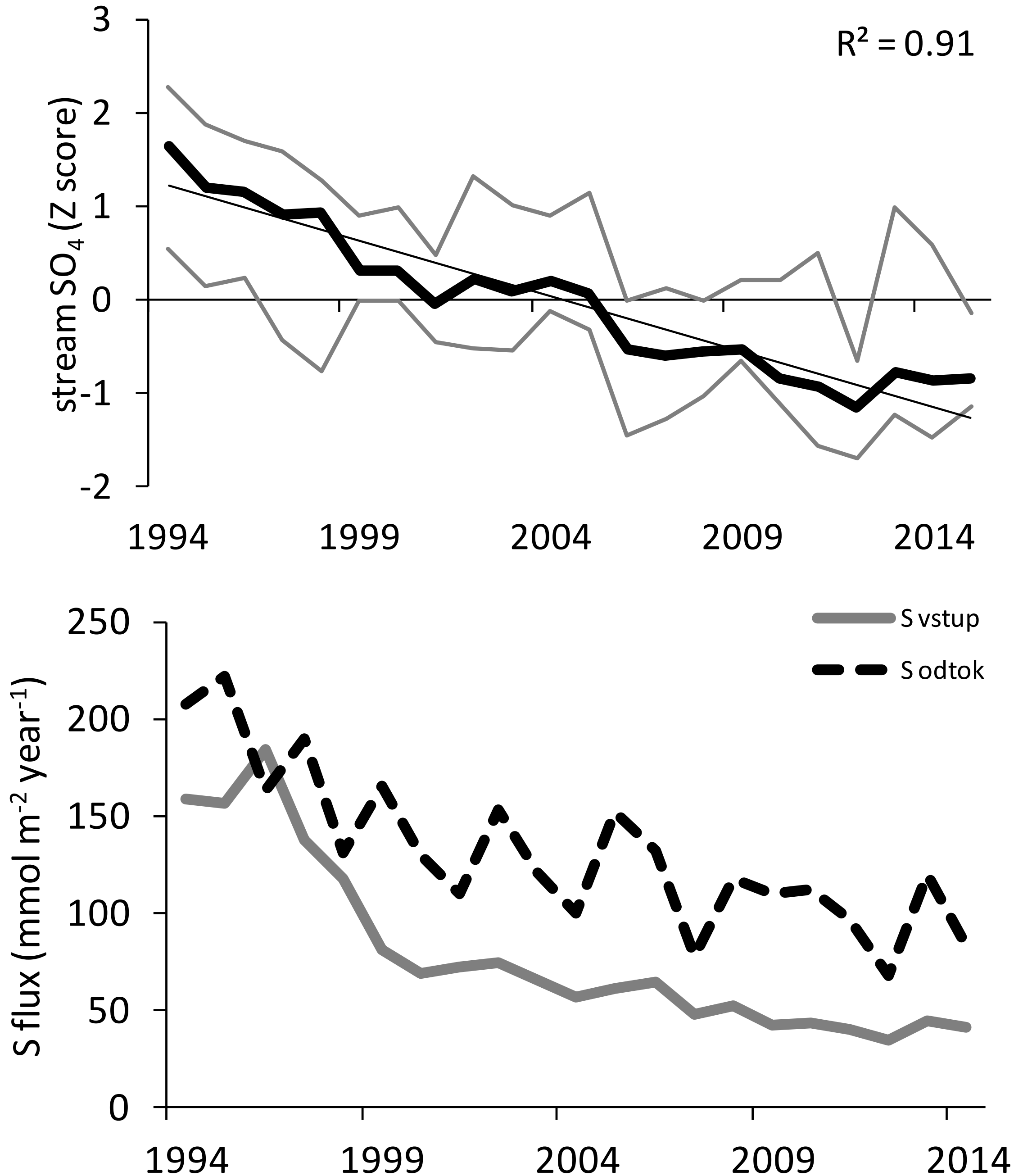


GEOMON Runoff (cations, alk)



GEOMON

S budget



eea grants norway grants

Susi Schneider

	ANE	CER	JEZ	LES	LIT	LIZ	LKV	LYS	MOD	NAZ	PLB	POM	SAL	UDL	UHL
cyanobacteria															
Calothrix elenkinii											xx				
Calothrix fusca											x				
Chamaesiphon confervicola		x							x						
Chamaesiphon incrustans												x			
Chamaesiphon polonicus			<1					<1							
Chroococcus spp.														x	
Heteroleibleinia spp.		xx				x						x	x		
Hydrococcus cesati											x				
Hydrococcus sp.													<1	<1	
Leptolyngbya spp.	<1		x										x		
Oscillatoria spp.		x							x						
Phormidium autumnale						<1			1						
Phormidium favosum		<1													
Phormidium inundatum															<1
Phormidium spp.												x	x	x	
Pleurocapsa minor										xxx	5				
Pseudanabaena spp.									xx					x	
Pseudanabaena starmachii															x
Scytonema spp.												<1			
unidentified coccoid cyanobacteria	xxx														
green algae															
Actinotaenium cruciferum									x					x	
Closterium spp.		x		x			xx								x
Cosmarium spp.									xx						
Gongrosira spp.		2	<1		<1										
Hormidium flaccidum										5	10	x			
Hormidium rivulare					xx				<1						
Microspora palustris var minor			x		10			15							x
Microspora tumidula										x					
Microthamnion strictissimum					x			x							
Mougeotia a (6 -12u)					xx			xx						x	
Mougeotia d/e (27-36u)							x								
Oedogonium b (13-18u)		<1													
Oedogonium c (23-28u)										x			x		
Oedogonium d (29-32u)		xx													
Oedogonium e (35-43u)			x												
Spirogyra a (20-42u,1K,L)							<1								
Staurastrum spp.		x												x	x
Stigeoclonium spp.	x							15						x	
unidentified coccoid green algae					<1			<1							
Ulothrix tenerrima				xx											
Ulothrix zonata		x													
Zygogonium sp3 (16-20u)															x
chrysophytes															
Epipyxis spp.					x										
red algae															
Audouinella chalybaea		<1													
Audouinella pygmaea						x	x		x						x
Batrachospermum confusum															1
Batrachospermum spp.	xx														
unidentified red algae				x						x		x	x	x	
xanthophytes															
Vaucheria spp.			<1				<1								
AIP	n.d.	7.13	*6.5*	n.d.	*5.8*	*7.2*	*7*	*5.7*	6.75	*7.1*	*7*	*7.3*	*7.1*	n.d.	*5.5*
PIT	7.76	14.3	15.5	*20*	5.15	22.4	23	5.2	13.1	6.87	5.49	11.1	8.3	3.95	15.3
algal taxon richness	4	11	6	3	7	3	5	6	8	5	5	6	6	9	8
taxon richness cyanobacteria	2	4	2	0	0	2	0	1	4	1	4	4	4	4	2
taxon richness green algae	1	6	3	2	6	0	3	5	3	3	1	1	1	4	4

Oedogonium e (35-43u)			x												
Spirogyra a (20-42u,1K,L)							<1								
Staurastrum spp.		x												x	x
Stigeoclonium spp.	x							15						x	
unidentified coccoid green algae					<1			<1							
Ulothrix tenerrima				xx											
Ulothrix zonata		x													
Zygogonium sp3 (16-20u)															x
chrysophytes															
Epipyxis spp.					x										
red algae															
Audouinella chalybaea		<1													
Audouinella pygmaea						x	x		x						x
Batrachospermum confusum															1
Batrachospermum spp.	xx														
unidentified red algae				x						x		x	x	x	
xanthophytes															
Vaucheria spp.			<1				<1								
AIP	n.d.	7.13	*6.5*	n.d.	*5.8*	*7.2*	*7*	*5.7*	6.75	*7.1*	*7*	*7.3*	*7.1*	n.d.	*5.5*
PIT	7.76	14.3	15.5	*20*	5.15	22.4	23	5.2	13.1	6.87	5.49	11.1	8.3	3.95	15.3
algal taxon richness	4	11	6	3	7	3	5	6	8	5	5	6	6	9	8
taxon richness cyanobacteria	2	4	2	0	0	2	0	1	4	1	4	4	4	4	2
taxon richness green algae	1	6	3	2	6	0	3	5	3	3	1	1	1	4	4

AIP – Acidification Index Periphyton 5,2 (UHL) – 7,3 (POM)

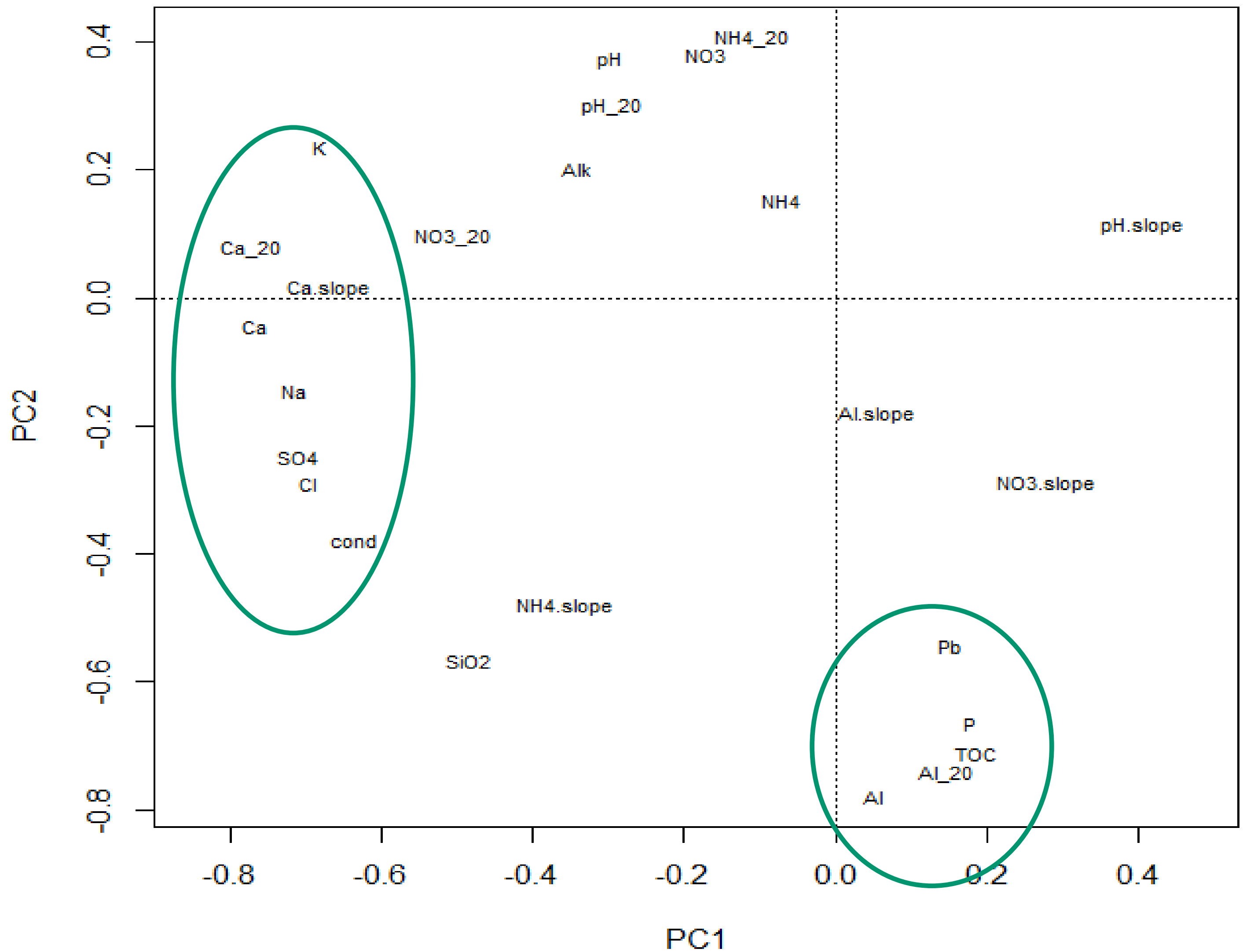
PIT – Periphyton Index of Trophic Status 3,95 (UDL) – 23,0 (LKV)

Main component analysis – streamwater chemistry

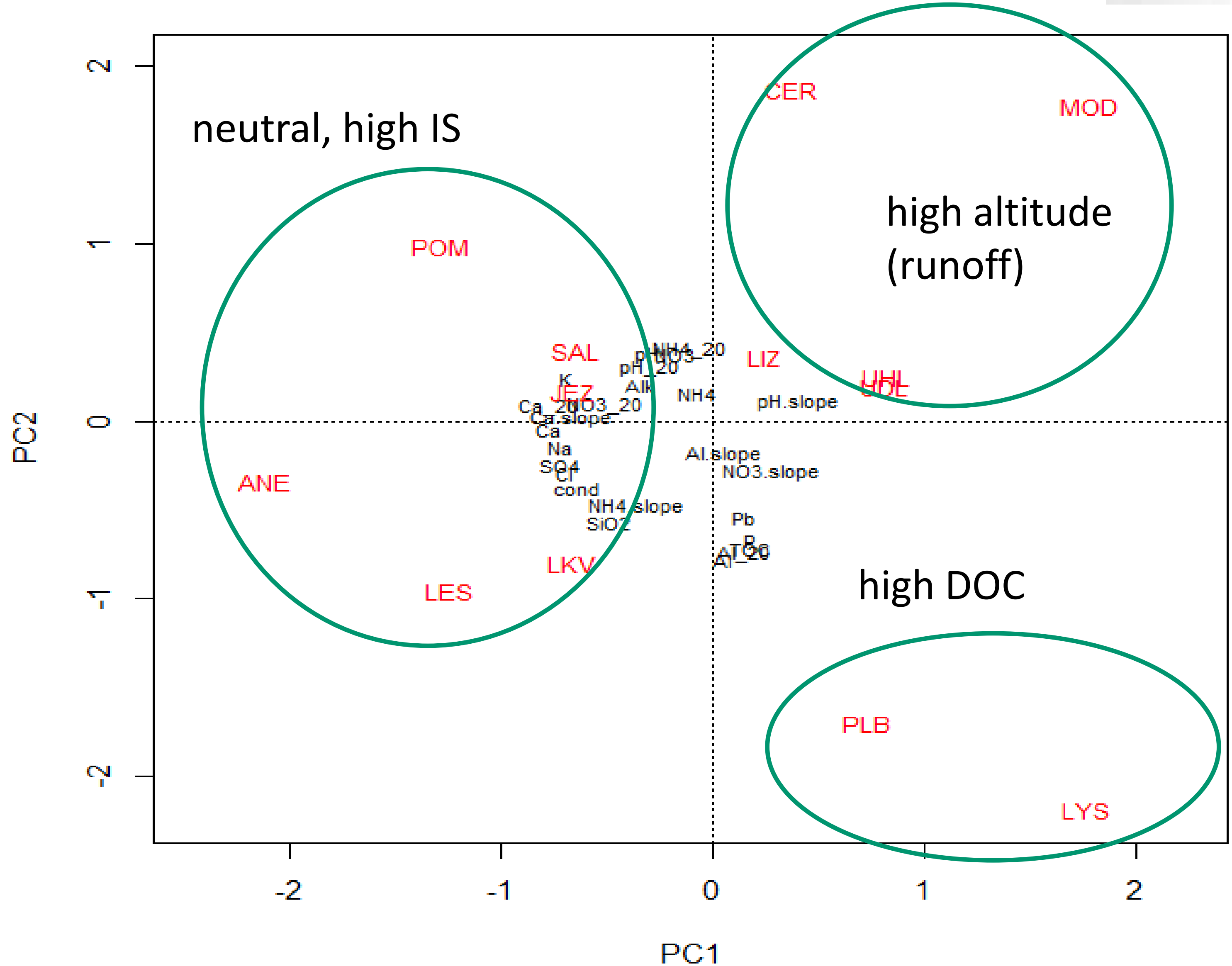
		PC1	PC2	PC3
	Eigenvalue	7,64	5,88	4,86
	Proportion Explained	0,31	0,24	0,19
	Cumulative Proportion	0,31	0,54	0,74
2015	pH	-0,30	0,37	-0,66
	Na	-0,71	-0,14	0,30
	K	-0,68	0,24	0,11
	NH4	-0,07	0,15	-0,16
	Ca	-0,77	-0,04	0,22
	Cl	-0,69	-0,29	0,02
	NO3	-0,17	0,38	-0,50
	SO4	-0,71	-0,25	0,19
	SiO2	-0,48	-0,57	-0,26
	Al	0,05	-0,78	-0,01
	Alk	-0,34	0,20	-0,70
	cond	-0,64	-0,38	-0,18
	DOC	0,19	-0,71	-0,23
	Pb	0,15	-0,54	-0,48
	P	0,18	-0,67	-0,13
1995-2014	pH_20	-0,29	0,30	-0,66
	pH.slope	0,40	0,11	0,08
	NH4_20	-0,11	0,41	-0,36
	NH4.slope	-0,36	-0,48	-0,35
	Ca_20	-0,77	0,08	0,28
	Ca.slope	-0,67	0,02	0,37
	NO3_20	-0,50	0,10	-0,31
	NO3.slope	0,28	-0,29	-0,27
	Al_20	0,15	-0,74	0,10
	Al.slope	0,06	-0,18	-0,70

PC1 – ionic strenght
PC2 – DOC
PC3 – acidity

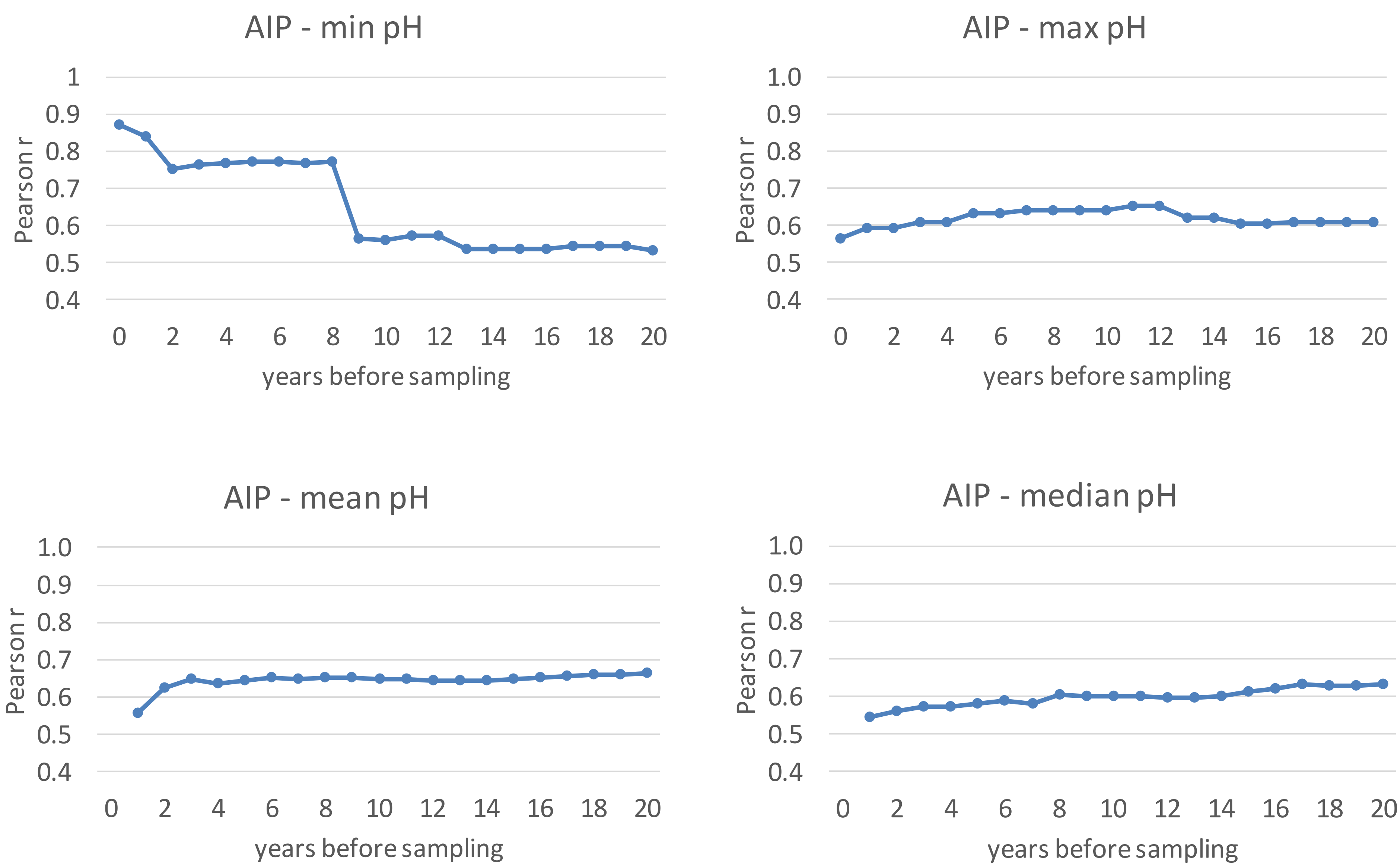
All together -74% of variability



NH4_20
NO3
pH
pH_20
K
Alk
NH4
pH.slope
Ca_20
NO3_20
Ca.slope
Ca
Na
Al.slope
SO4
Cl
NO3.slope
cond
NH4.slope
SiO2
Pb
P
TOC
Al_20
Al
PC1
PC2

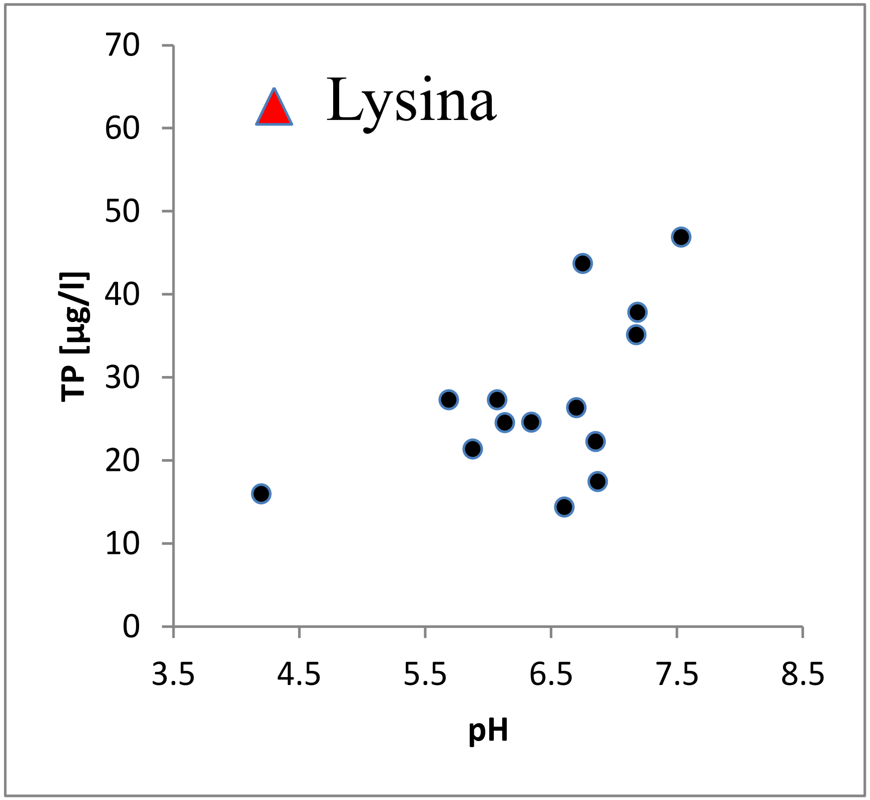

neutral, high IS
high altitude
(runoff)
high DOC
CER
MOD
POM
SAL
LIZ
UHL
ANE
LKV
LES
PLB
LYS
NH4_20
pH_20
Alk
NH4
pH.slope
K
NO3_20
Ca.slope
Ca
Na
SO4
Cl
cond
NH4.slope
SiO2
Al.slope
NO3.slope
Pb
PC1
PC2
-2
-1
0
1
2

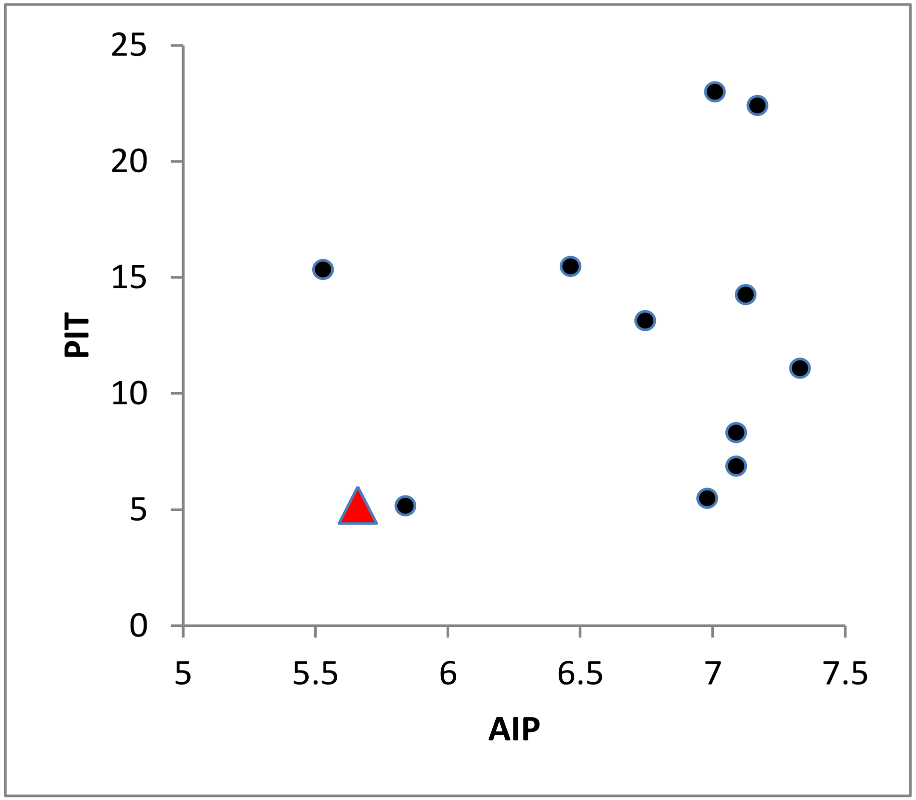
Correlation coefficients (Pearson r) between AIP (acidification index periphyton) of algal assemblages and pH, calculated for the time intervals before the algal sampling



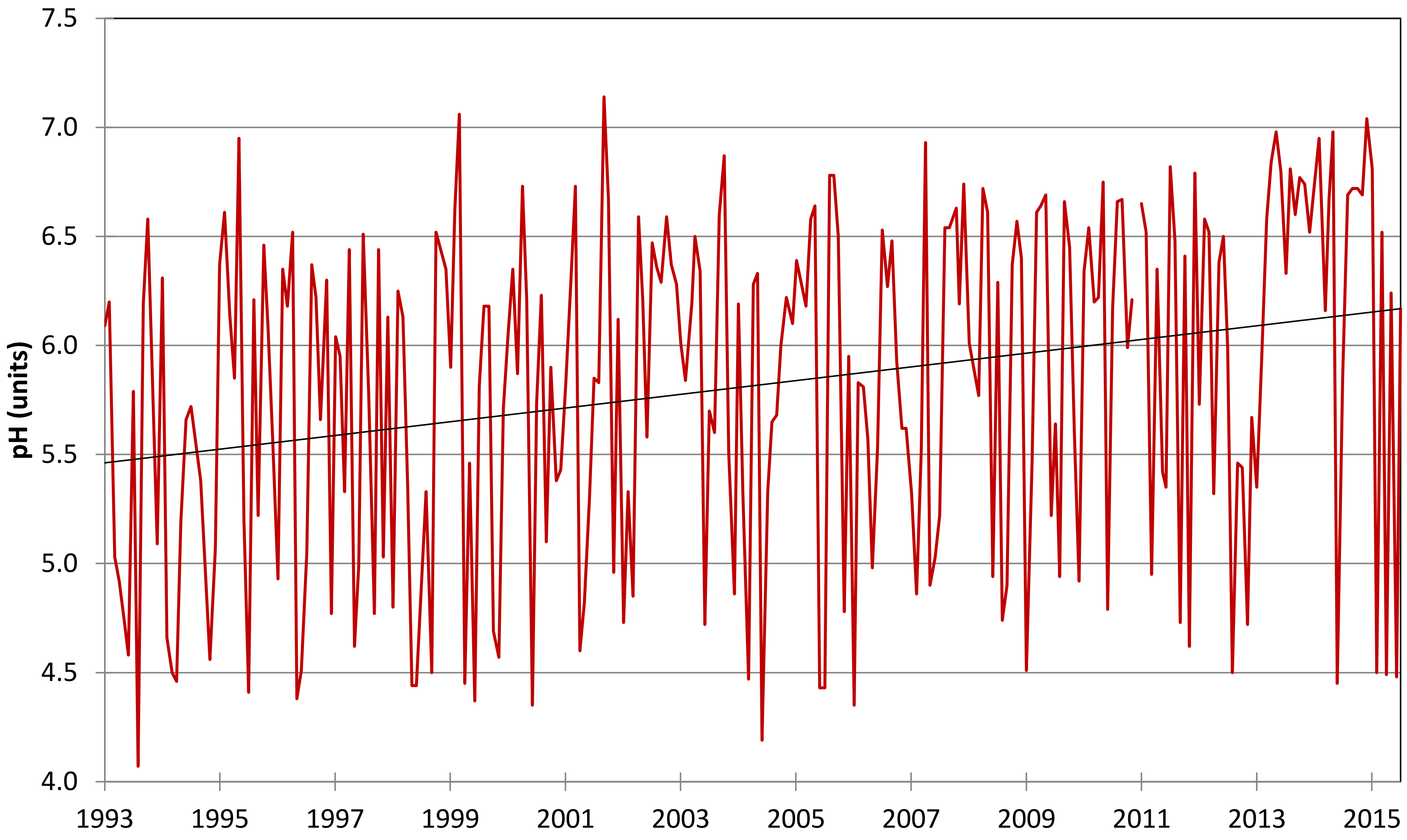
		AIP	PIT	taxon richness cyano-bacteria	taxon richness green algae	total algal taxon richness
catchment characteristics	catchment area	-0,03	0,39	0,05	0,25	0,37
	mean elevation	-0,18	0,04	0,37	0,27	0,46
	min_elevation	-0,31	-0,17	0,35	0,25	0,42
	max_elevation	-0,08	0,17	0,35	0,25	0,46
	Avg Temp	0,28	0,05	-0,41	-0,30	-0,50
	forested area	0,03	0,20	0,10	0,31	0,40
	longitude (X_WGS)	0,28	0,20	0,45	0,24	**0,64**
	latitude (Y_WGS)	-0,50	-0,16	0,11	0,25	0,32
2015	pH	**0,75**	0,13	**0,66**	**-0,66**	-0,08
	Na	0,36	0,39	-0,29	**-0,52**	**-0,57**
	K	0,48	0,11	0,07	-0,35	-0,18
	NH4	-0,50	0,13	-0,05	0,15	0,19
	Ca	0,50	0,40	-0,25	-0,44	-0,45
	Cl	0,40	-0,05	-0,32	-0,48	**-0,66**
	NO3	0,35	-0,08	**0,64**	-0,44	0,06
	SO4	0,22	0,29	**-0,52**	-0,25	-0,51
	SiO2	0,33	0,02	-0,15	**-0,72**	**-0,77**
	Al	**-0,65**	-0,45	**-0,59**	0,22	-0,32
	Alk	**0,66**	0,16	**0,56**	**-0,67**	-0,17
	cond	0,43	0,09	-0,26	-0,51	**-0,62**
	DOC	-0,33	**-0,55**	-0,24	0,04	-0,28
	Pb	-0,47	-0,43	0,04	-0,09	-0,16
	P	-0,14	-0,43	-0,08	-0,14	-0,31
1995-2014	pH_20	**0,79**	-0,06	**0,61**	-0,55	-0,06
	pH.slope	-0,34	0,11	-0,02	0,34	0,28
	NH4_20	0,28	-0,14	**0,61**	-0,18	0,32
	NH4.slope	0,24	-0,19	-0,19	**-0,61**	**-0,66**
	Ca_20	0,37	0,37	-0,41	-0,26	-0,35
	Ca.slope	0,05	0,02	-0,40	-0,10	-0,28
	NO3_20	0,29	-0,29	0,25	-0,42	-0,19
	NO3.slope	0,15	0,12	-0,02	-0,08	-0,16
	Al_20	**-0,63**	-0,35	-0,54	0,04	-0,40
	Al.slope	0,38	-0,20	0,40	-0,41	-0,15
PCA	PC1	-0,56	-0,15	0,25	0,51	0,49
	PC2	0,39	0,30	**0,57**	0,11	**0,56**
	PC3	-0,39	0,33	**-0,62**	0,51	0,08

Stream chemistry, PIT (nutrient) and AIP (acidification) indices





Uhlířská (ICP Waters) - lowest AIP



Conclusions

- acidification more important that eutrophication
- episodes more important than long-term averages
- expected results, but not much documented

Schneider et al. (in review, Hydrobiologia)

Soil modelling study VSD+

Maria Holmberg
Finnish Environment Centre SYKE, Helsinki

Joint TFM ICP IM & ICP Waters

Uppsala 9–11.5.2017

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Acknowledgements

Collaboration on model application: Thomas Dirnböck, Max Posch, Julian Aherne, Kari Austnes, Jelena Beloica, Alessandra de Marco, Francesca Fornasier, Martyn Futter, Tomasz Pecka, Ed Rowe, Thomas Scheuschner, Salar Valinia.

Model development: Luc Bonten, Janet Mol, Max Posch, Gert Jan Reinds, Wieger Wamelink

Data provision and organisation: Lars Lundin, Martin Forsius, Sirpa Kleemola, Jussi Vuorenmaa, Burkhard Beudert, Nicholas Clarke, Natalie Cools, Ulf Grandin, Juha Heikkinen, Pavel Krám, Antti-Jussi Lindroos, Tiina Nieminen, Jørn-Frode Nordbakken, Maija Salemaa, Hubert Schulte-Bisping, Volkmar Timmermann, Milán Váňa.

We acknowledge the support of Swedish EPA and our institutes and those of our collaborators as well as support of the eLTER project (EU/H2020 grant agreement No. 654359).

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Outline

Background, rationale

Modelling setup

Site locations 40 sites

Calibrations 14 sites

Simulations 10 sites

Next tasks

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On-going pressures

Climate change

- Warming: earlier start of growth, later end of growth
- Seasonal or annual drought
- Heavy rainfall events, drought spells

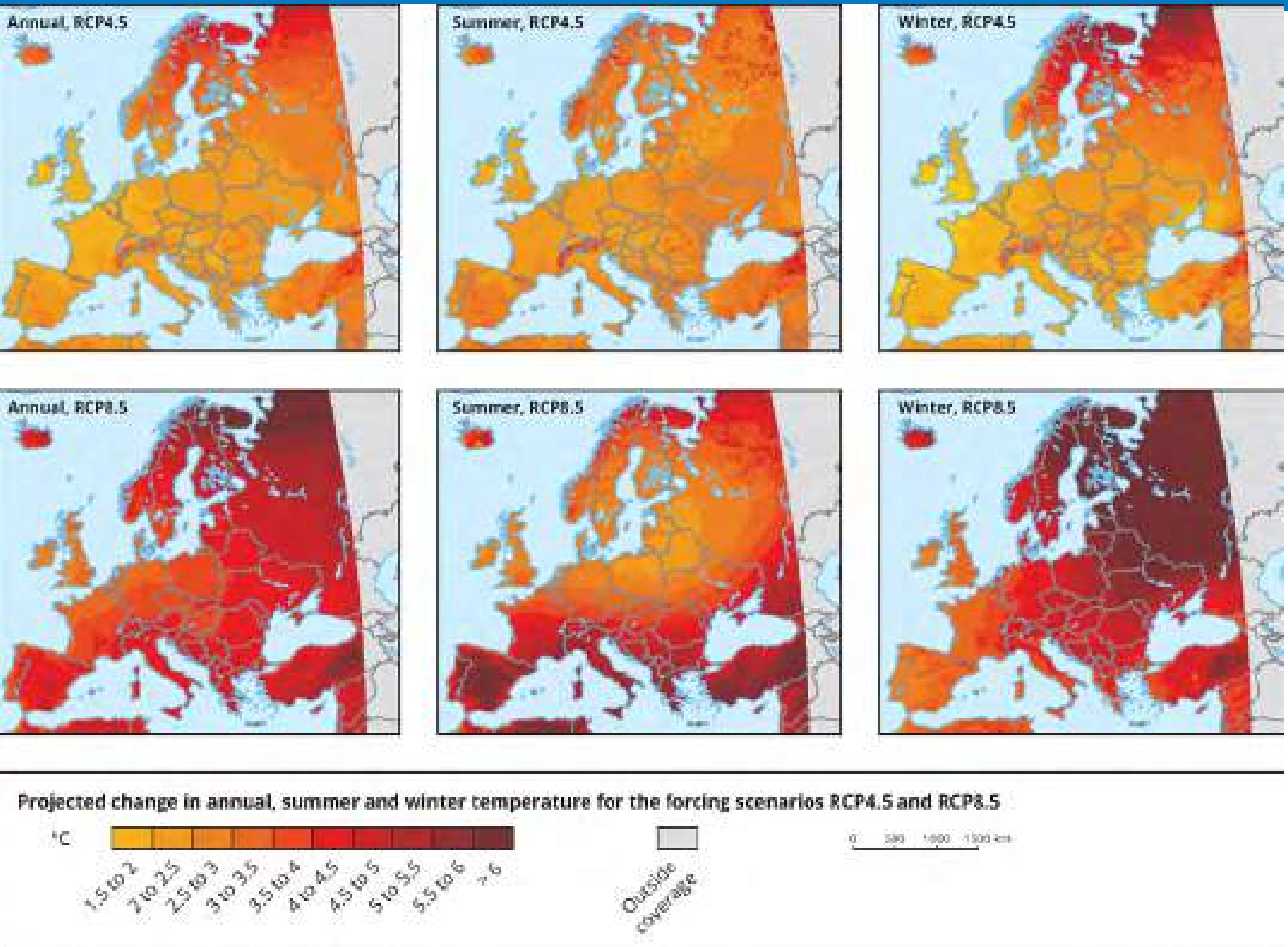
Air pollution

- Sulphur shows decreasing trends
- Nitrogen stable or some increase

Management

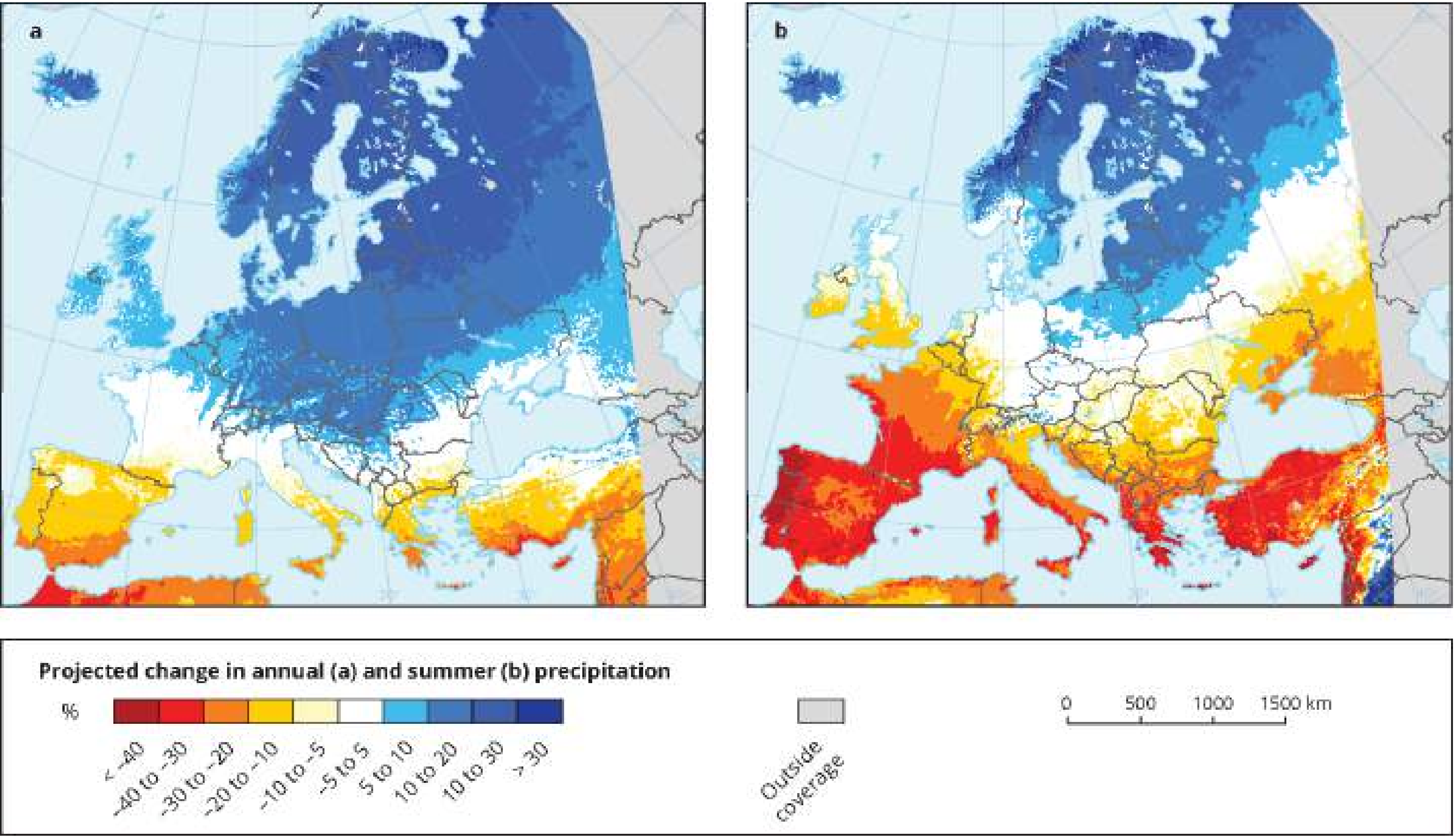
- Increased use of bioenergy, e.g. to mitigate climate change
- Decreased motivation for protection of biodiversity

Spatial variation in future climate: Temp.



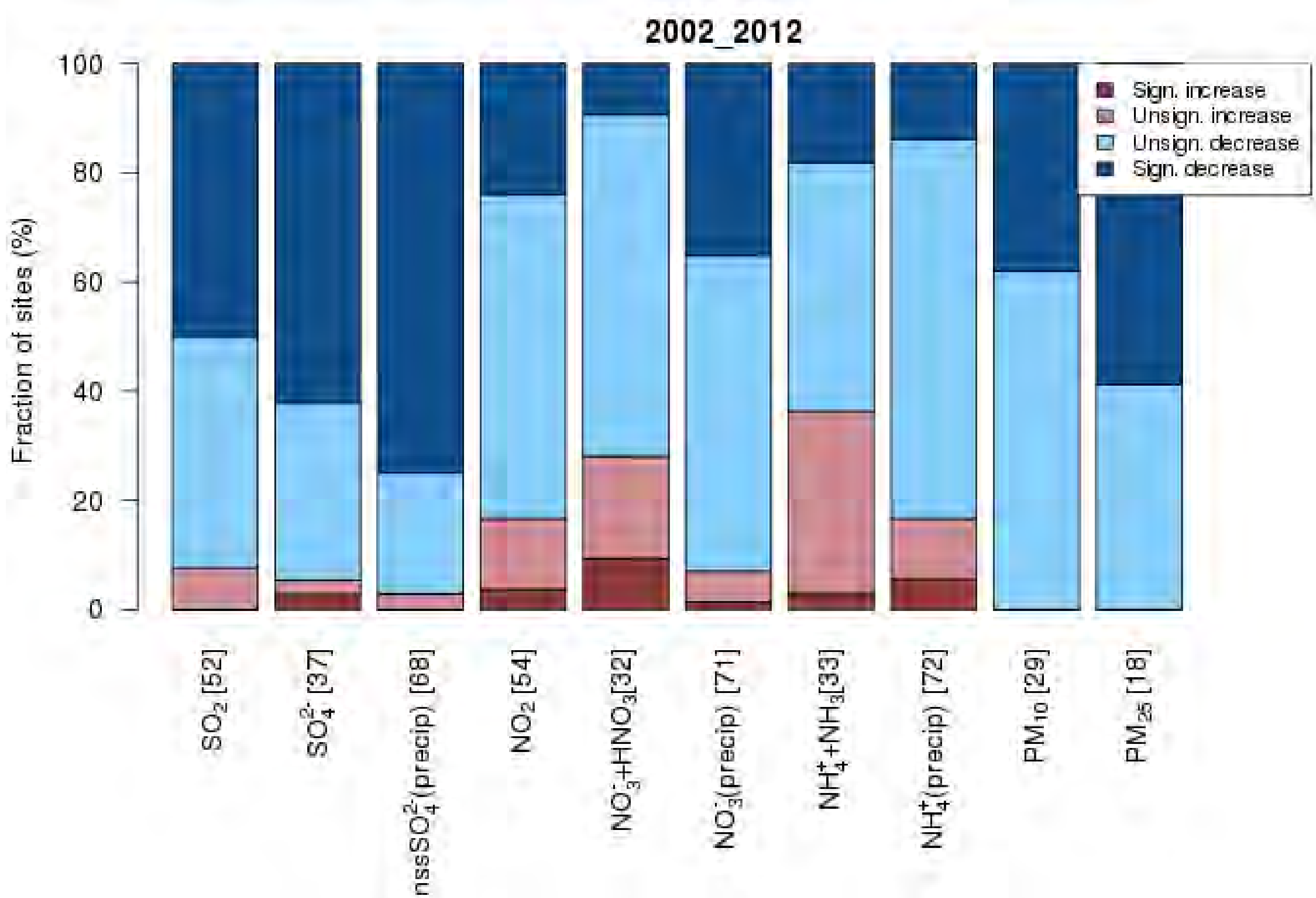
Projected changes in annual (left), summer (middle) and winter (right) near-surface air temperature (°C) in the period 2071-2100,
compared to the baseline period 1971-2000 for the forcing scenarios RCP 4.5 (top) and RCP 8.5 (bottom). Model simulations are based on the multi-model ensemble average of RCM simulations from the EURO-CORDEX initiative. http://www.euro-cordex.net/

Spatial variation in future climate: Prec.



Projected changes in annual (left) and summer (right) precipitation (%) in the period 2071-2100 compared to the baseline period 1971-2000 for the forcing scenario RCP 8.5. Model simulations are based on the multi-model ensemble average of RCM simulations from the EURO-CORDEX initiative.http://www.euro-cordex.net/

Deposition trends: S decreased, N remains concern



EMEP Task Force on Measurement and Modelling Trend Report, Final Draft:
http://www.nilu.no/projects/ccc/tfmm/utrecht_2016/TFMM_TrendAR_20160513.pdf

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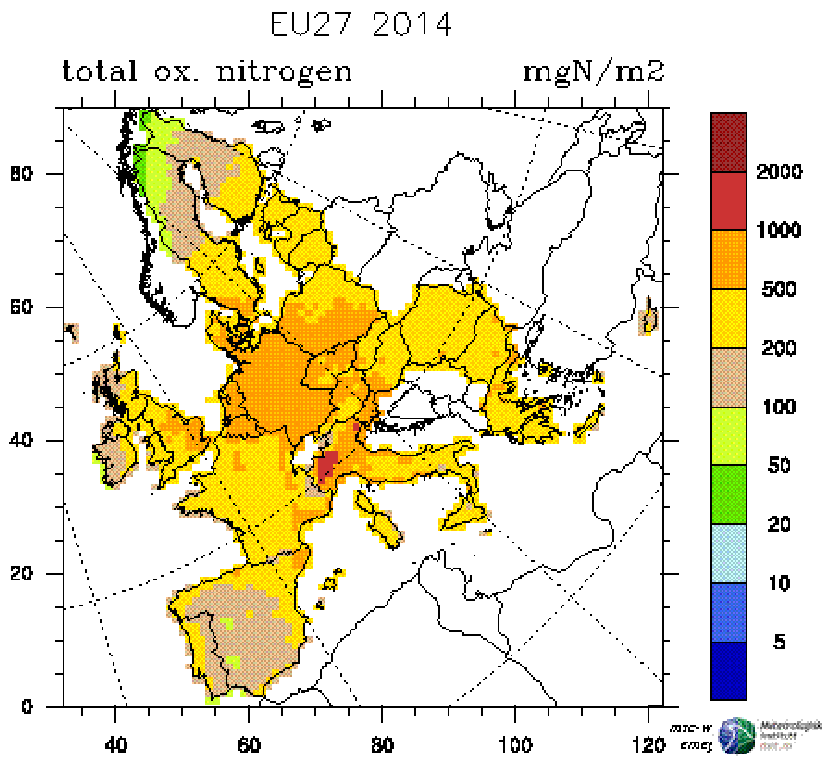
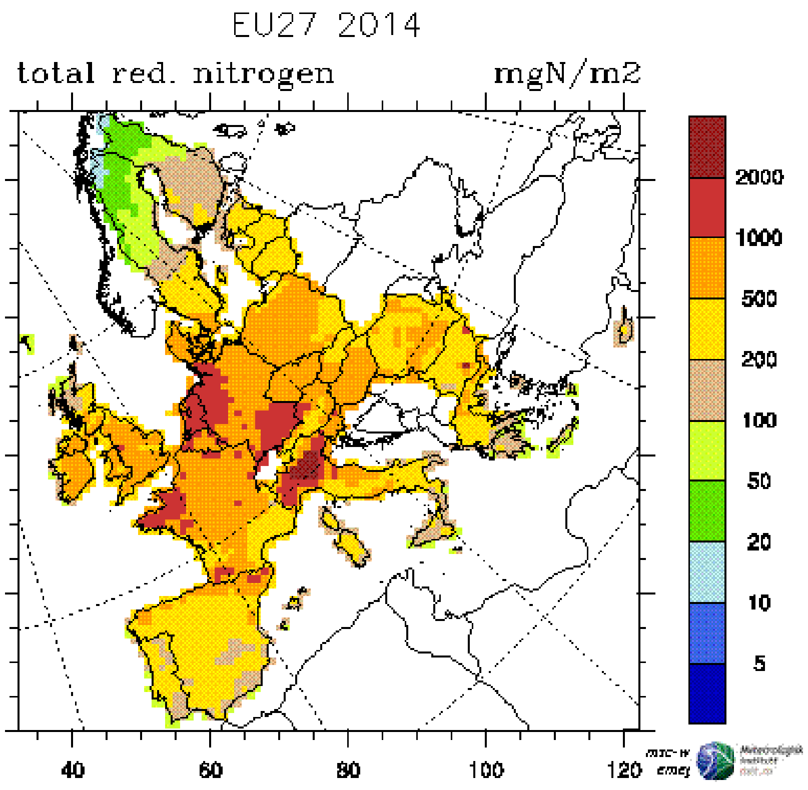
Spatial variation in N deposition





EMEP SR 2015 http://www.emep.int/mscw/

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Soil and habitat responses

Air pollution, climate change, management

- Affect vegetation on the species and habitat levels
- Varies with region, latitude, policy
- Understanding soil dynamics will help evaluate vegetation response

Overall aim to test VSD+ model chain to evaluate habitat responses

- Part I: Soil abiotic responses (Maria Holmberg et al.)
- Part II: Habitat responses (Thomas Dirnböck et al.)

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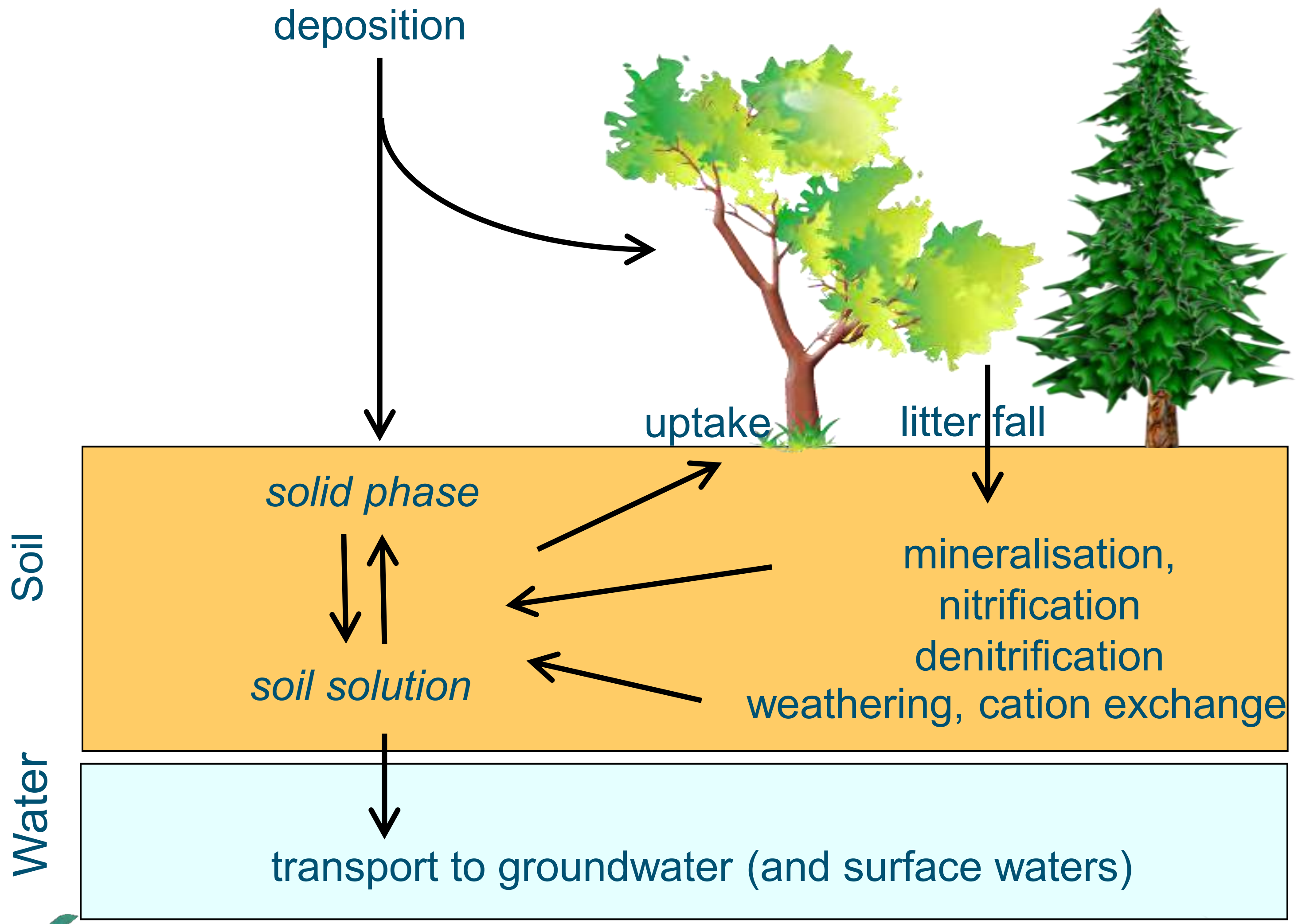
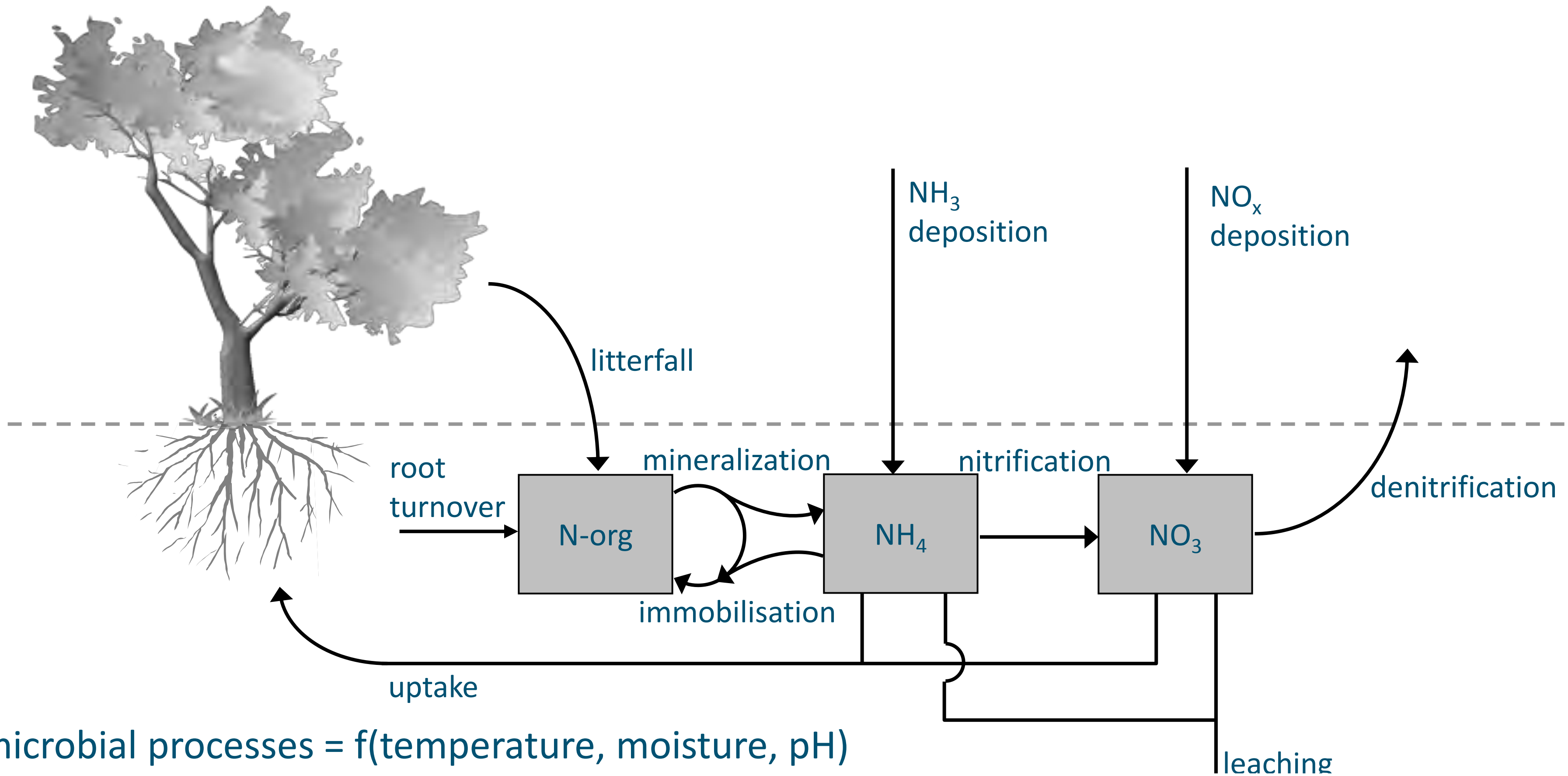
VSD+



http://wge-cce.org/Methods_Data/The_VSD_suite_of_models

N processes in VSD+



microbial processes = f(temperature, moisture, pH)

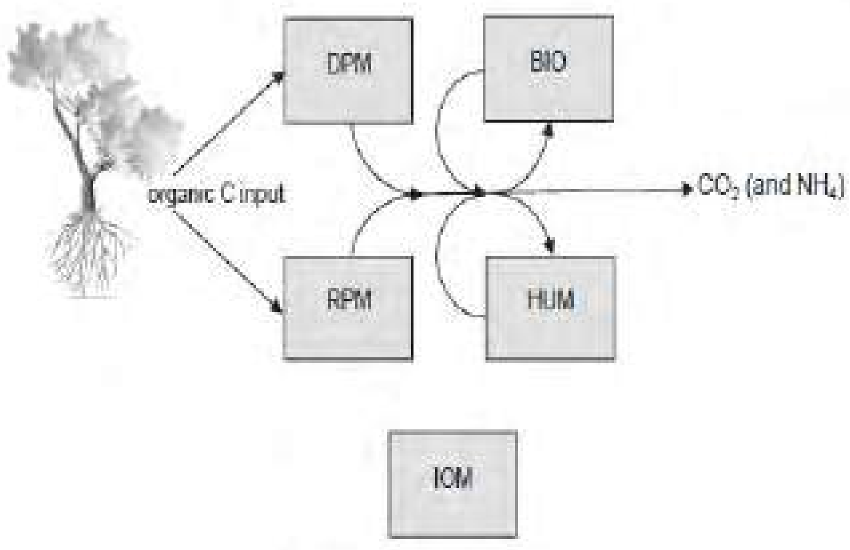
Bonten et al. 2016. Env Soft 79:75-84.
http://dx.doi.org/10.1016/j.envsoft.2016.01.009

RothC 26.3 model in VSD+

Carbon pools

1. Decomposable plant material
2. Resistant plant material
3. Microbial biomass
4. Humified organic matter
5. *Inert organic matter*

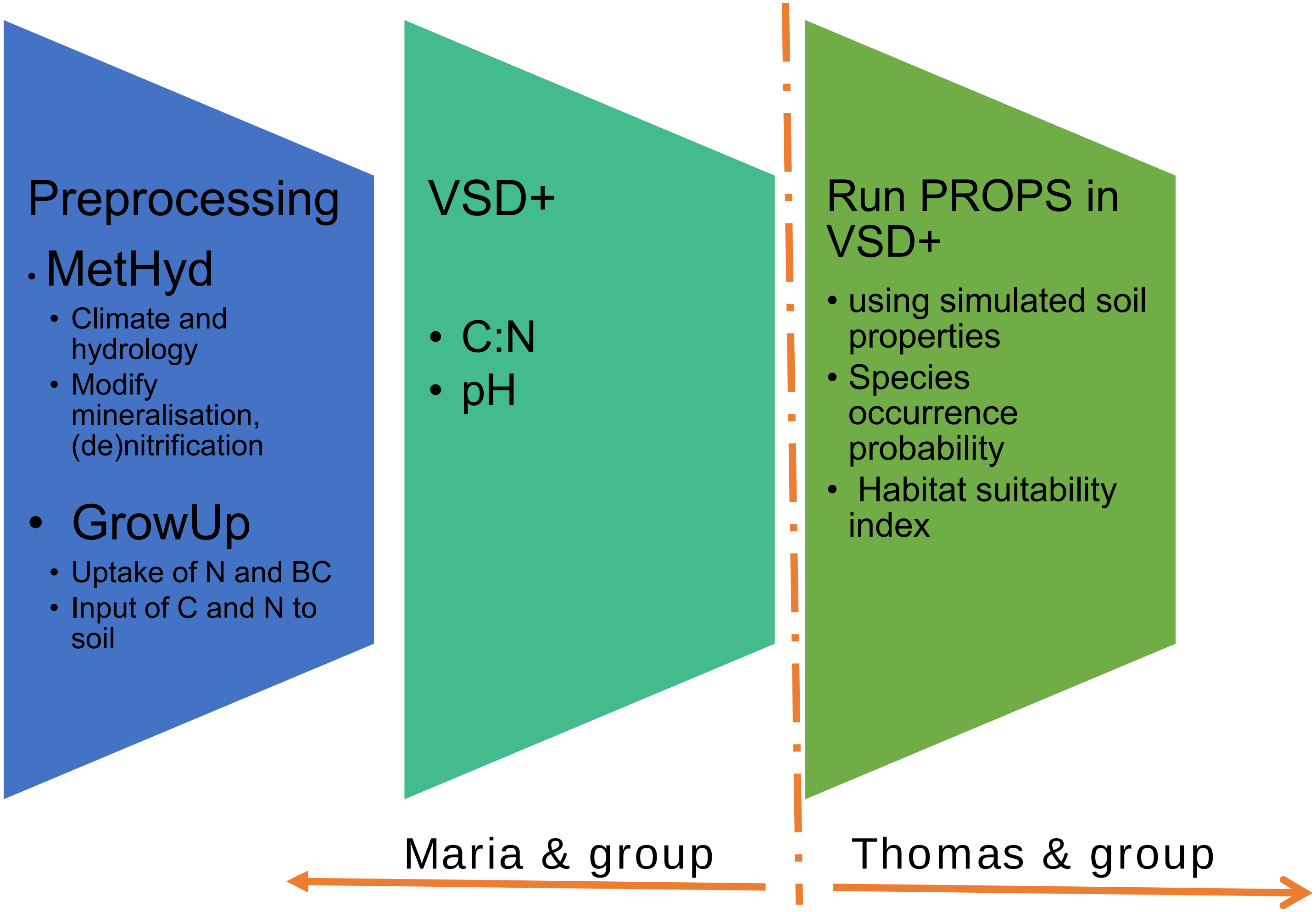
First-order processes for turnover of pools 1-4. Temperature, soil moisture and soil cover modify rates.



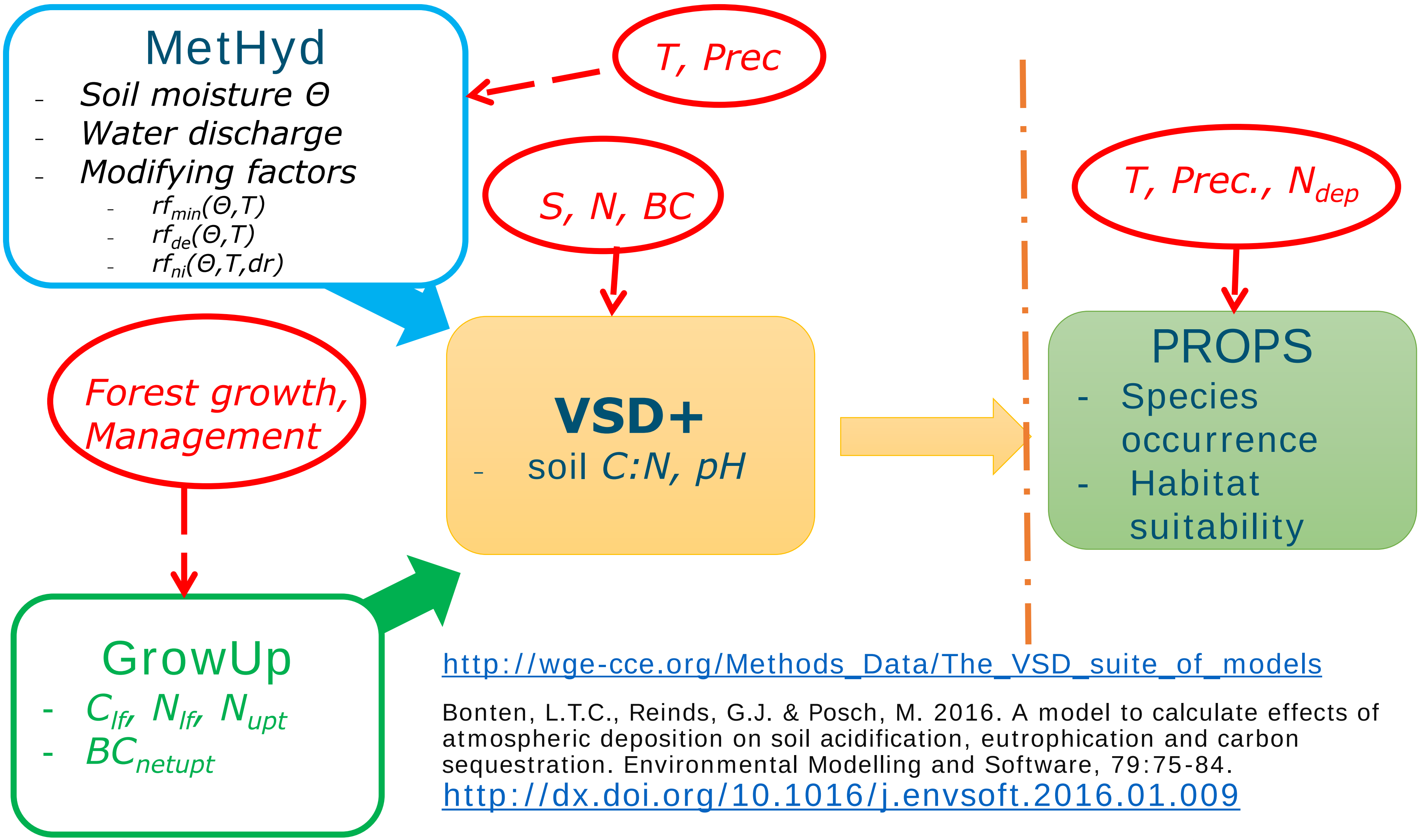
Bonten et al. 2016. Env Soft 79:75-84.
http://dx.doi.org/10.1016/j.envsoft.2016.01.009
Coleman & Jenkinson 2104
http://rothamsted.ac.uk/sites/default/files/users/kcoleman/RothC_guide_DOS.pdf

VSD+ model chain

http://wge-cce.org/Methods_Data/The_VSD_suite_of_models



VSD+ model chain



http://wge-cce.org/Methods_Data/The_VSD_suite_of_models

Bonten, L.T.C., Reinds, G.J. & Posch, M. 2016. A model to calculate effects of atmospheric deposition on soil acidification, eutrophication and carbon sequestration. Environmental Modelling and Software, 79:75-84. http://dx.doi.org/10.1016/j.envsoft.2016.01.009

Objectives – soil modelling

Study impacts of N deposition and climate warming on soil conditions

Run VSD+ with deposition and climate scenarios

- Primary input
  - S, N dep
  - annual precip., annual temperature
  - Forest growth
- Primary output
  - Soil pH, (BS), C:N
- Key variables delivered to vegetation response analysis
  - N dep, temperature, precipitation
  - Soil pH, C:N

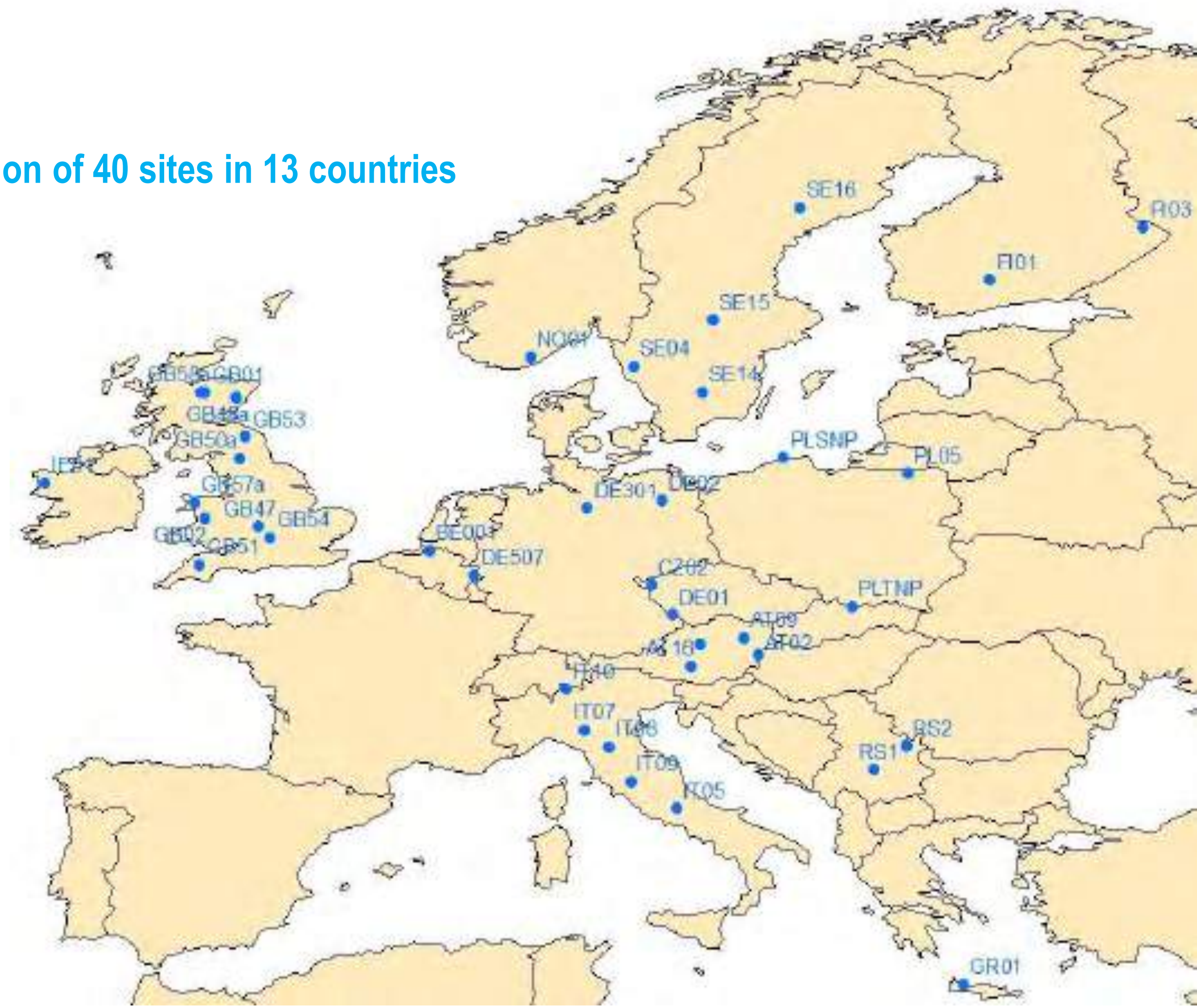
Illustrate regional variability in response

- Analyze cross-site differences

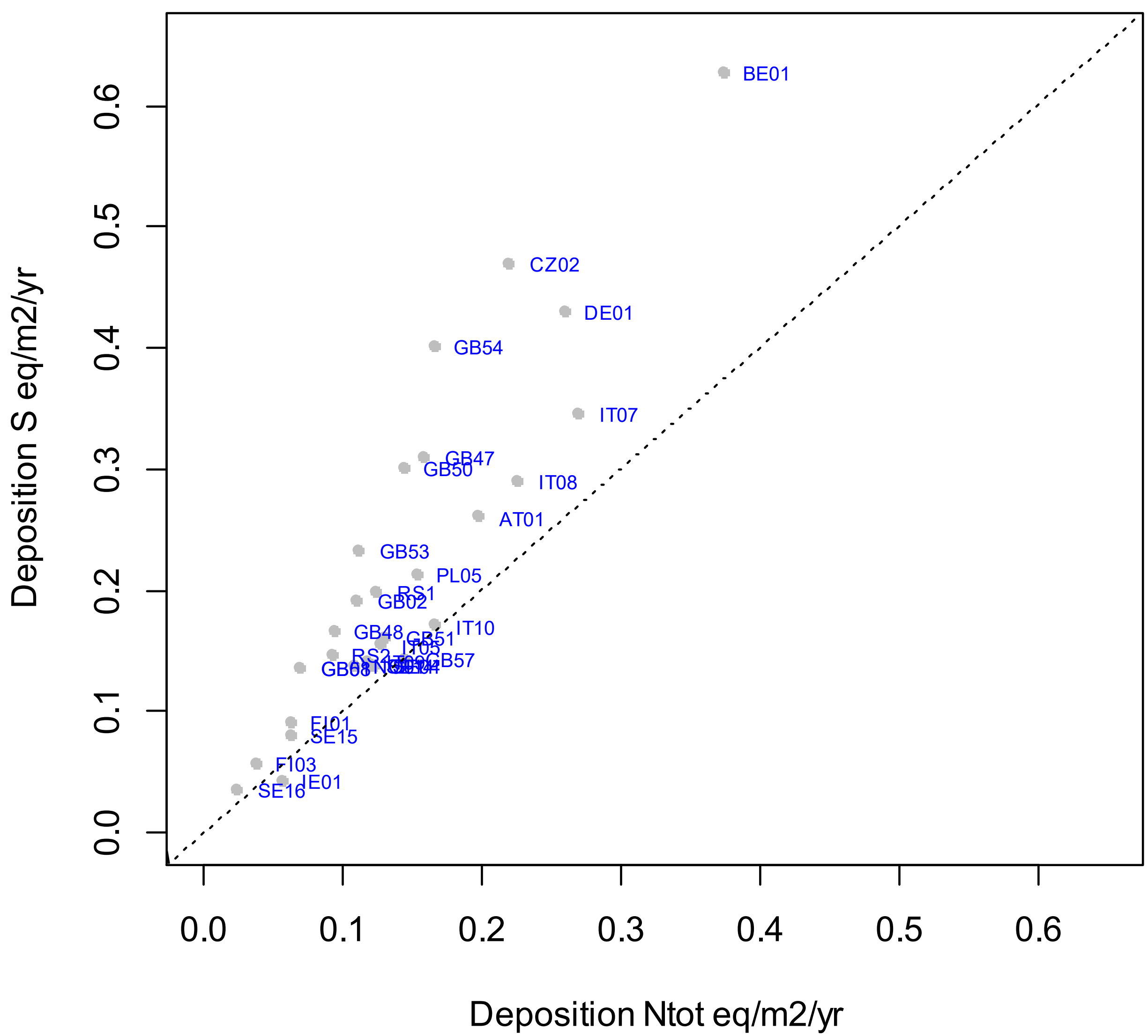
Work towards manuscript to special issue in STOTEN on theme ”Detecting and explaining natural and anthropogenic changes by making use of large extent, long-term ecological research facilities of the international long-term ecosystem research (ILTER) network”. (dl July 2017)

Potential participation of 40 sites in 13 countries

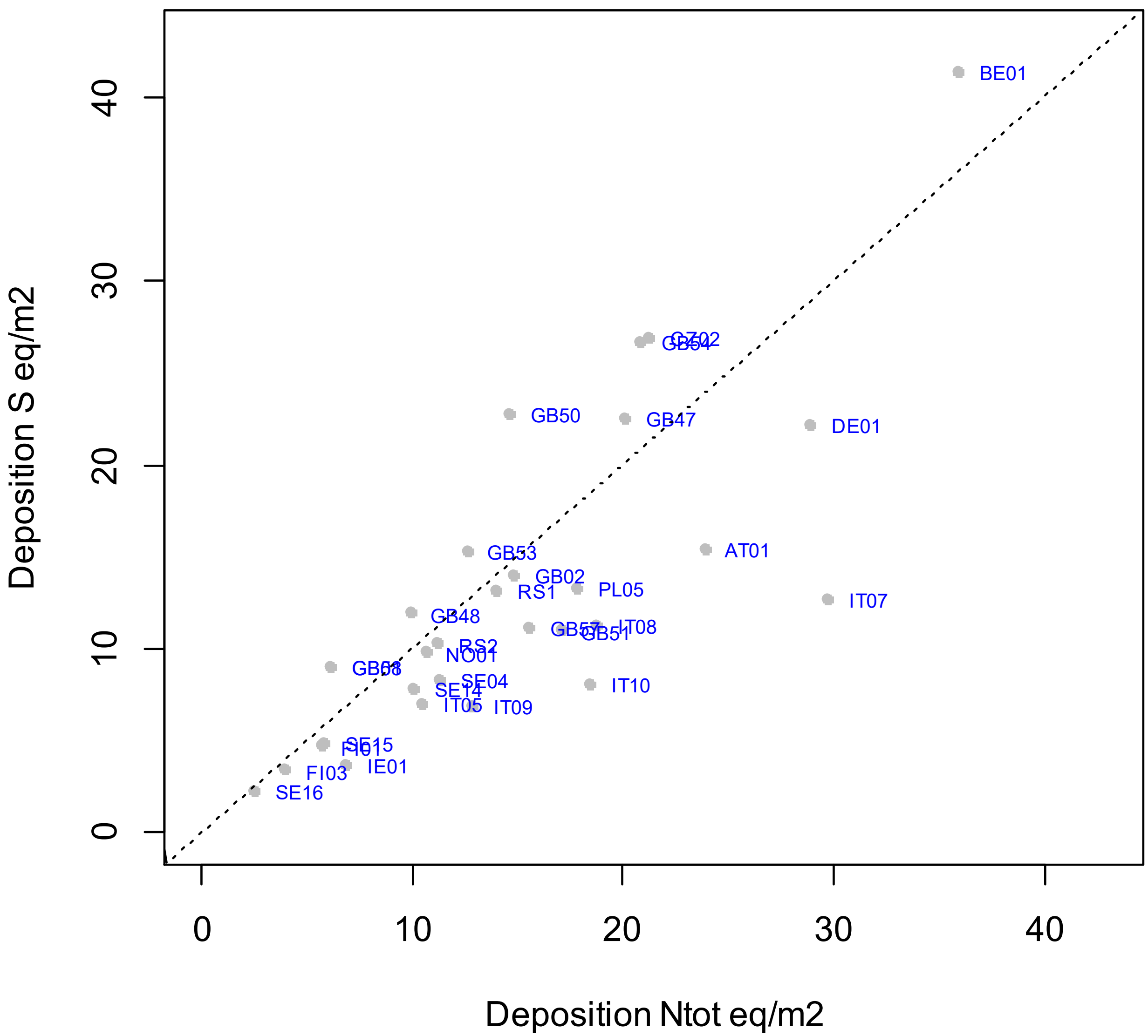
13 countries	40 sites
Austria	5
Belgium	1
Czech Republic	1
Germany	4
Greece	1
Finland	2
UK	10
Ireland	1
Italy	5
Norway	1
Poland	3
Serbia	2
Sweden	4



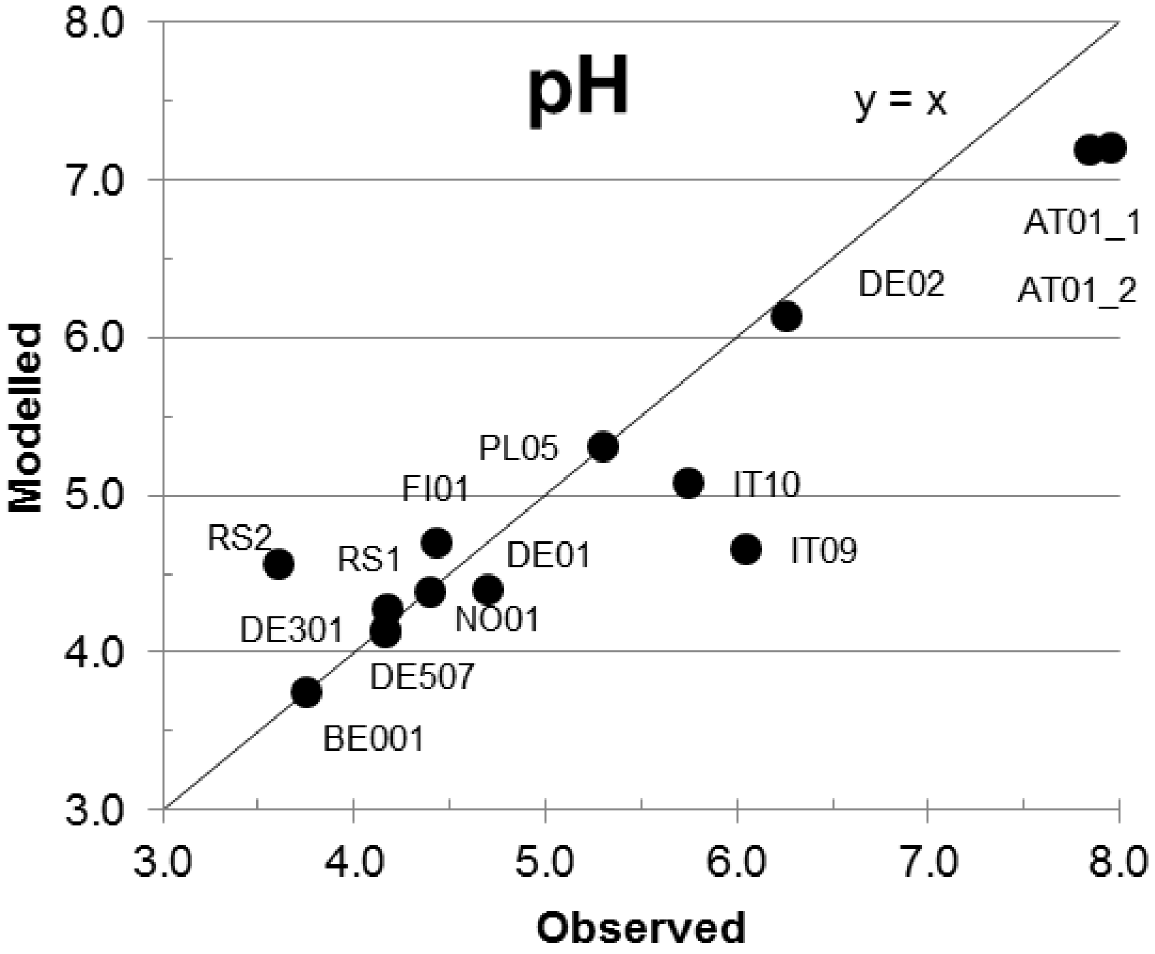
Peak deposition to forest



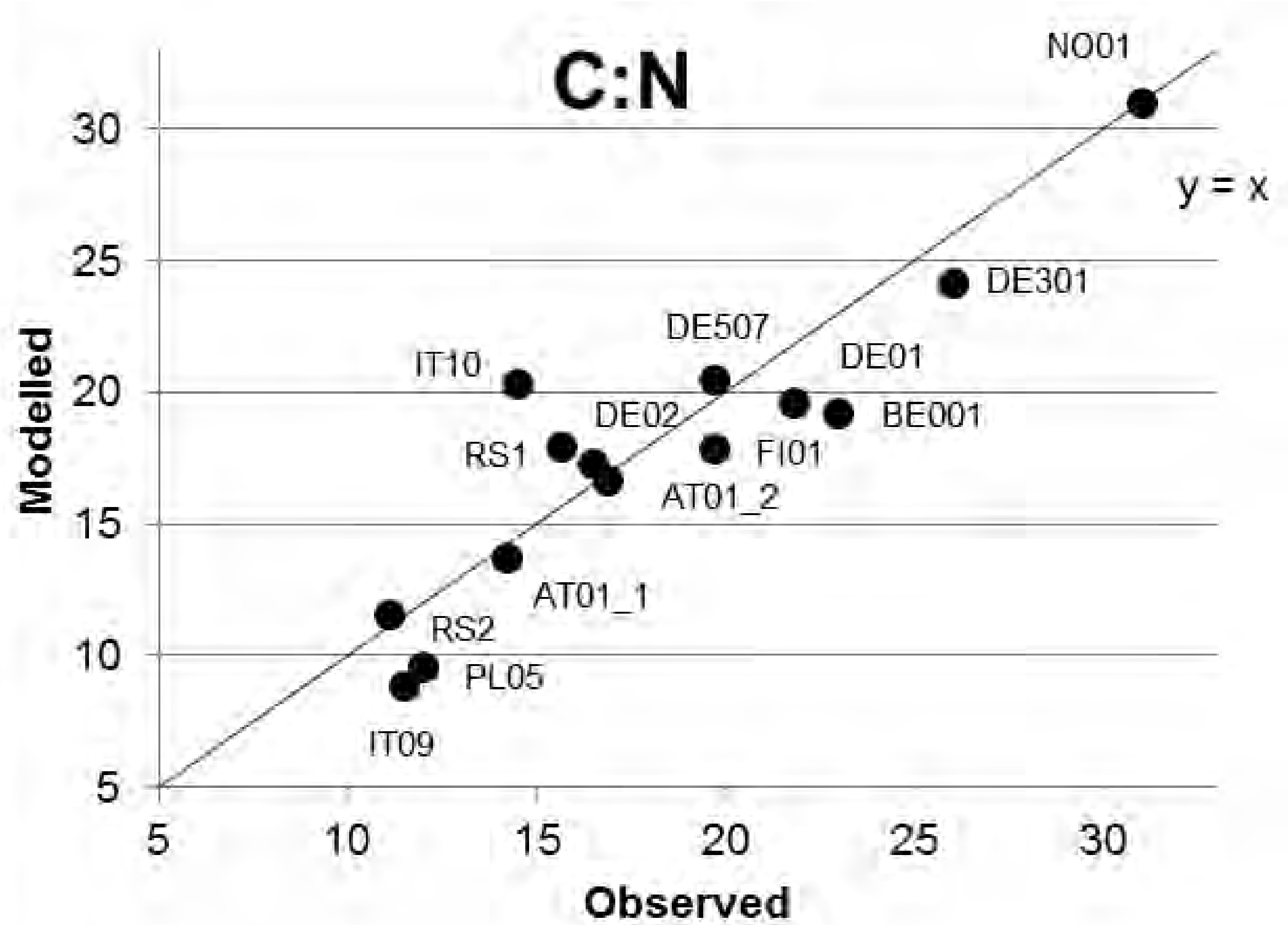
Cumulative forest deposition 1880 - 2100



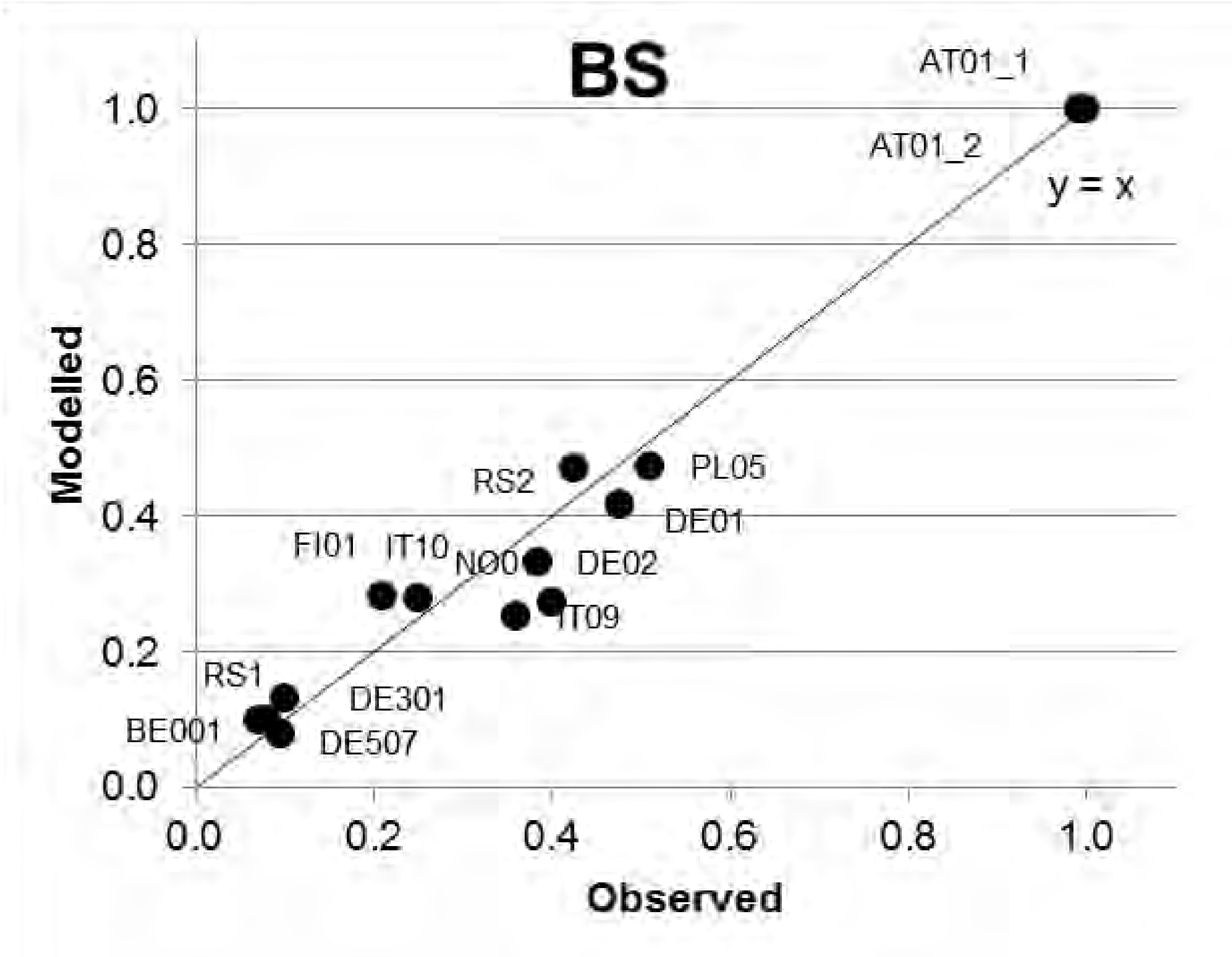
Comparison of modelled to observed values of soil solution pH at 14 sites.

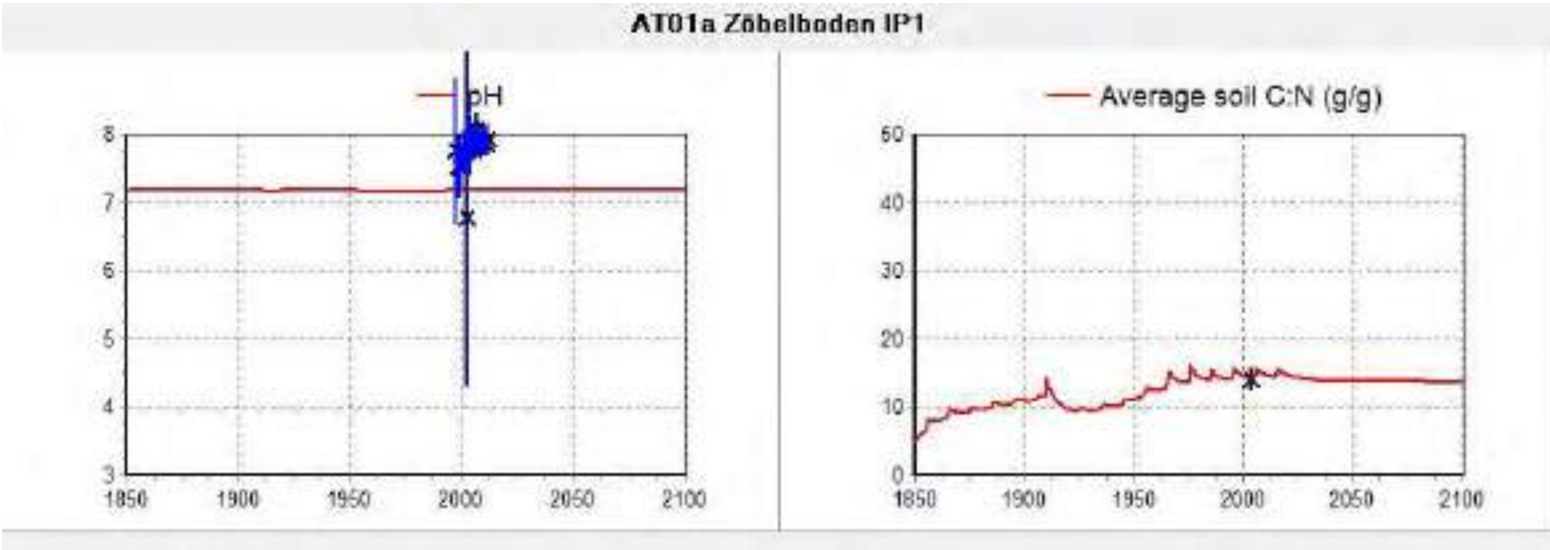


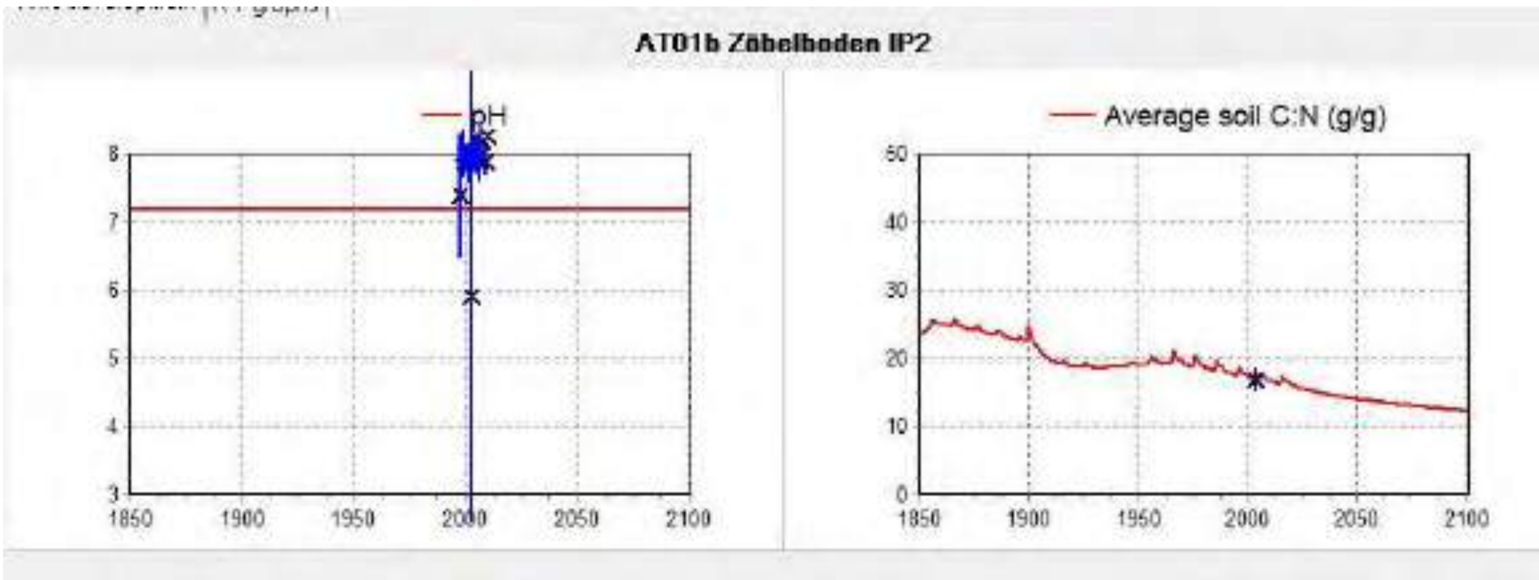
Comparison of modelled to observed values of soil C:N at 14 sites.



Comparison of modelled to observed values of soil BS at 14 sites.







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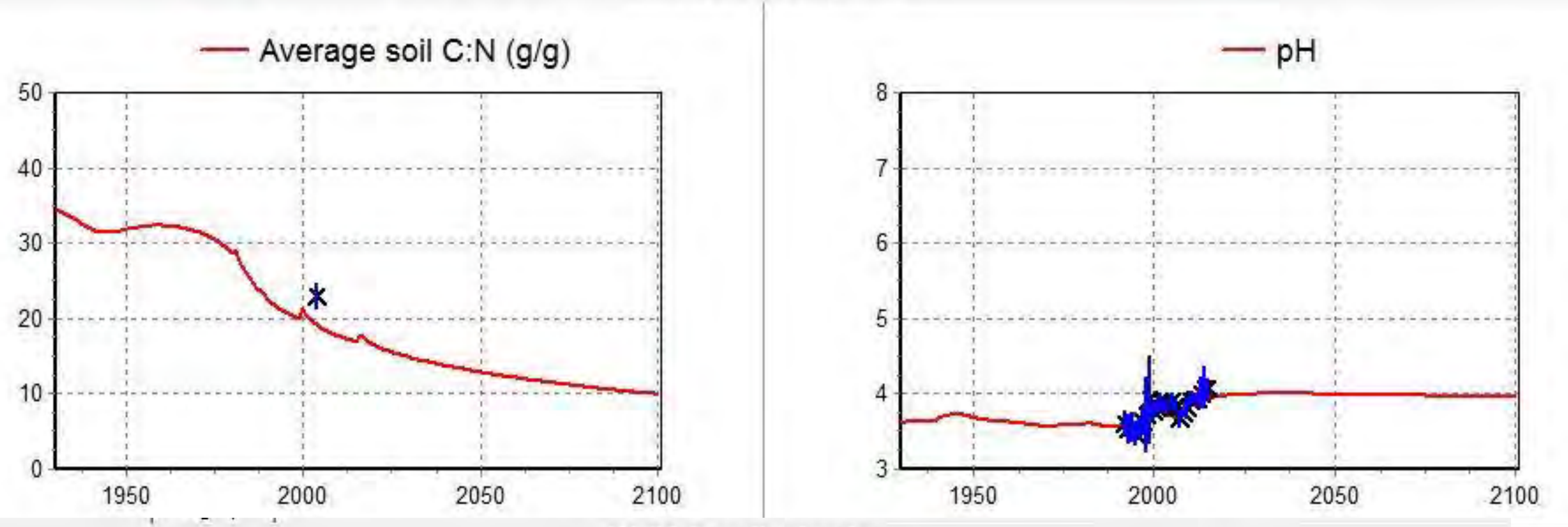
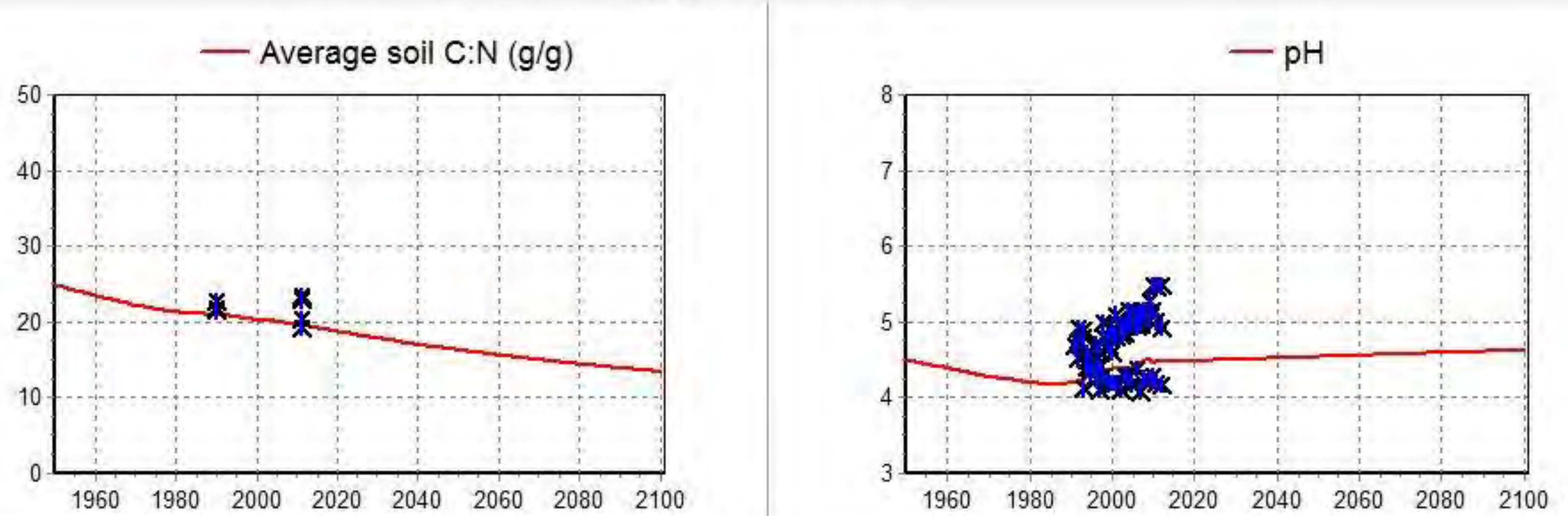
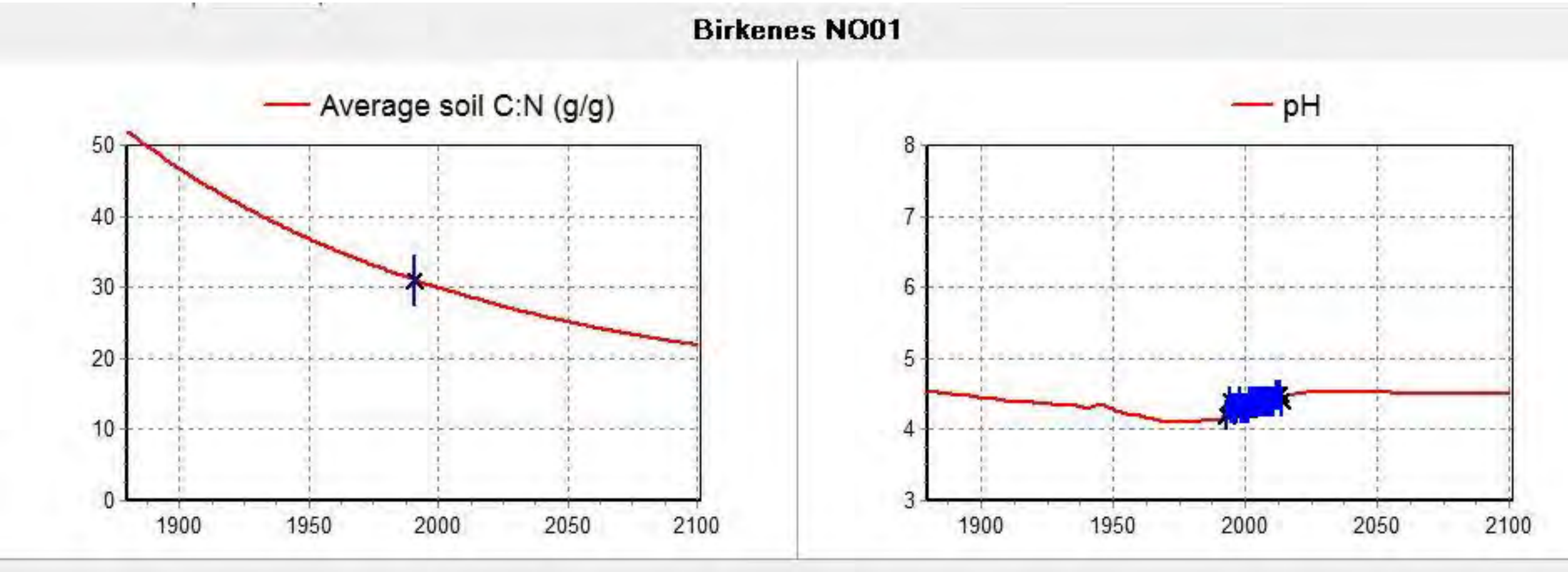
BE01 Brasschaat



DE01 Forellenbach




Birkenes NO01
Average soil C:N (g/g)
pH
0
10
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30
40
50
3
4
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6
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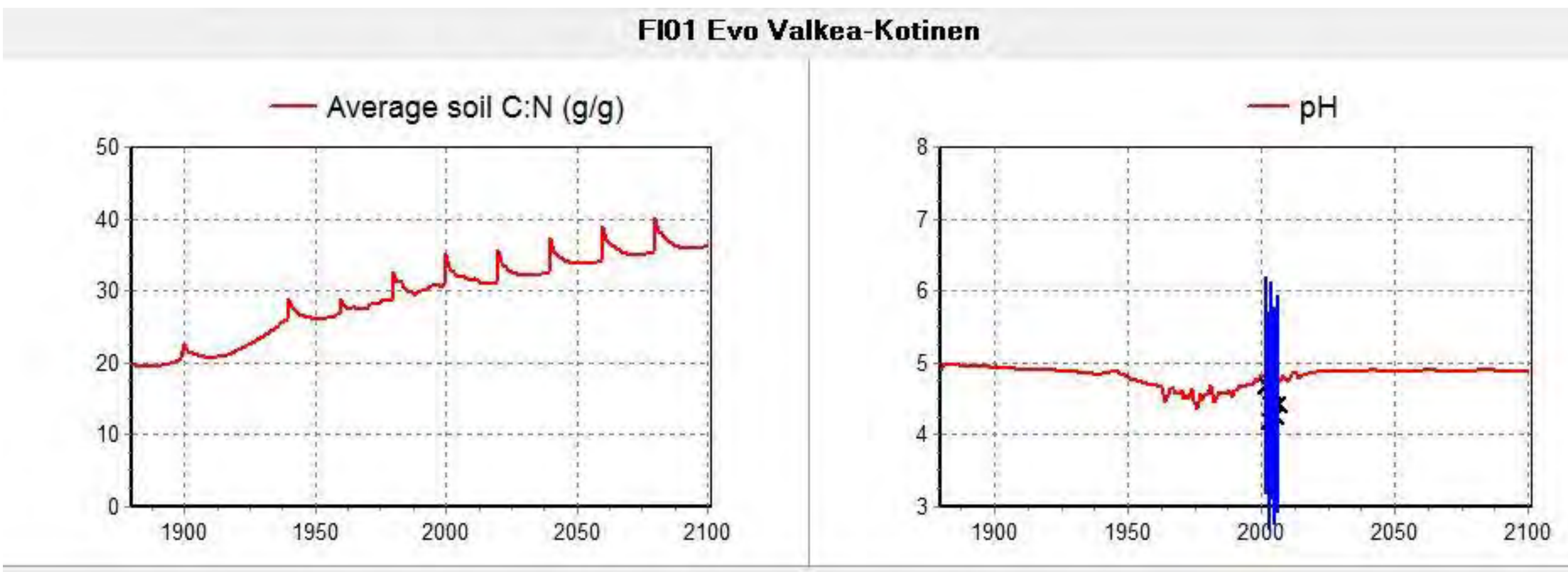
8
1900
1950
2000
2050
2100


FI01 Evo Valkea-Kotinen
Average soil C:N (g/g)
pH
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1900
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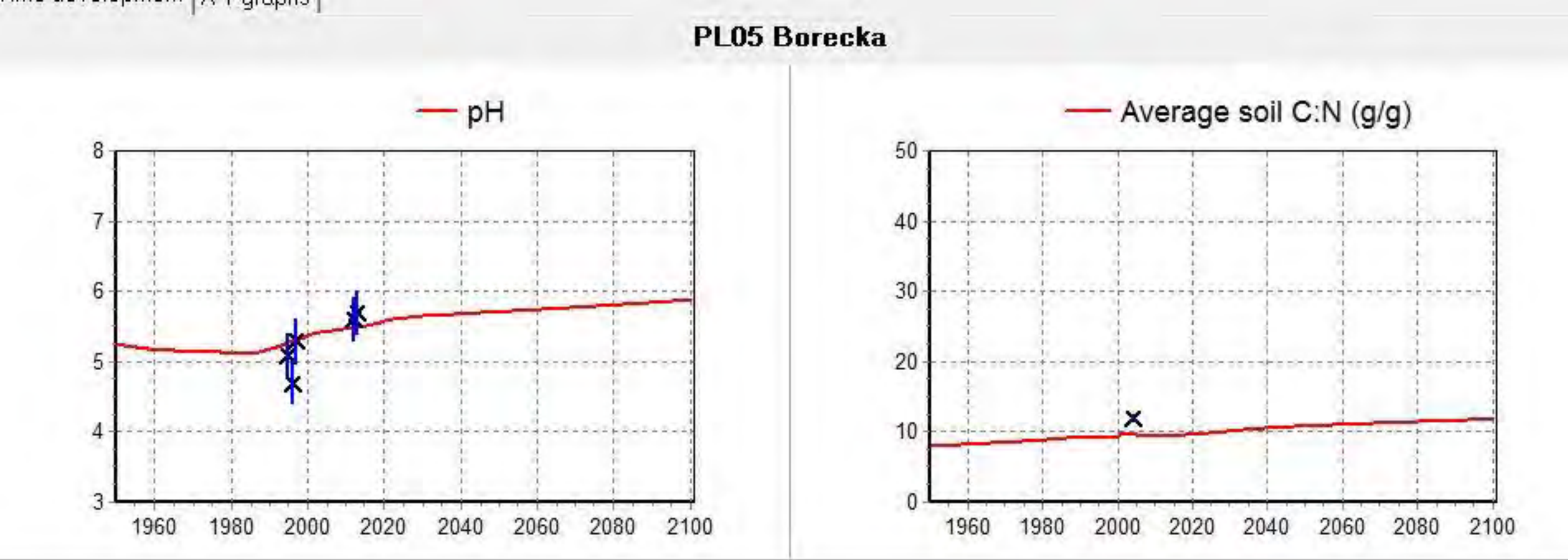
X-Y graphs
PL05 Borecka
pH
8
7
6
5
4
3
1960
1980
2000
2020
2040
2060
2080
2100
Average soil C:N (g/g)
50
40
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1980
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2020
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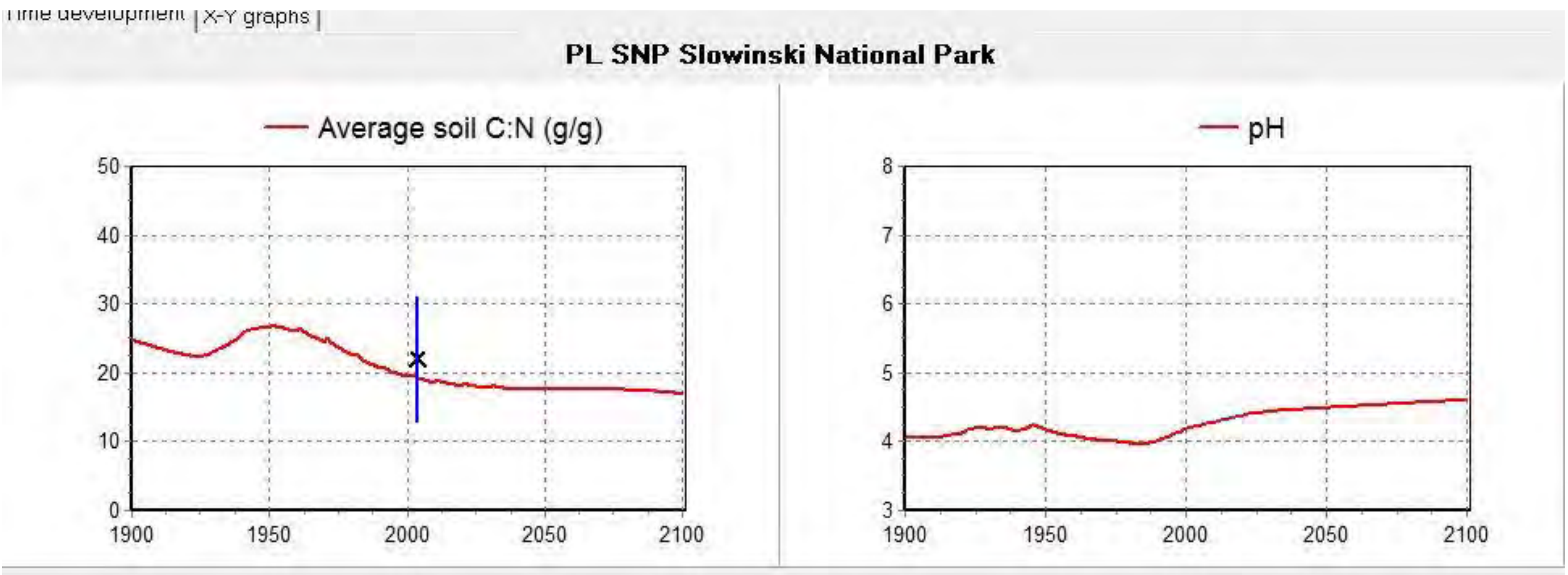
2060
2080
2100


Time development
X-Y graphs
PL SNP Slowinski National Park
Average soil C:N (g/g)
50
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pH
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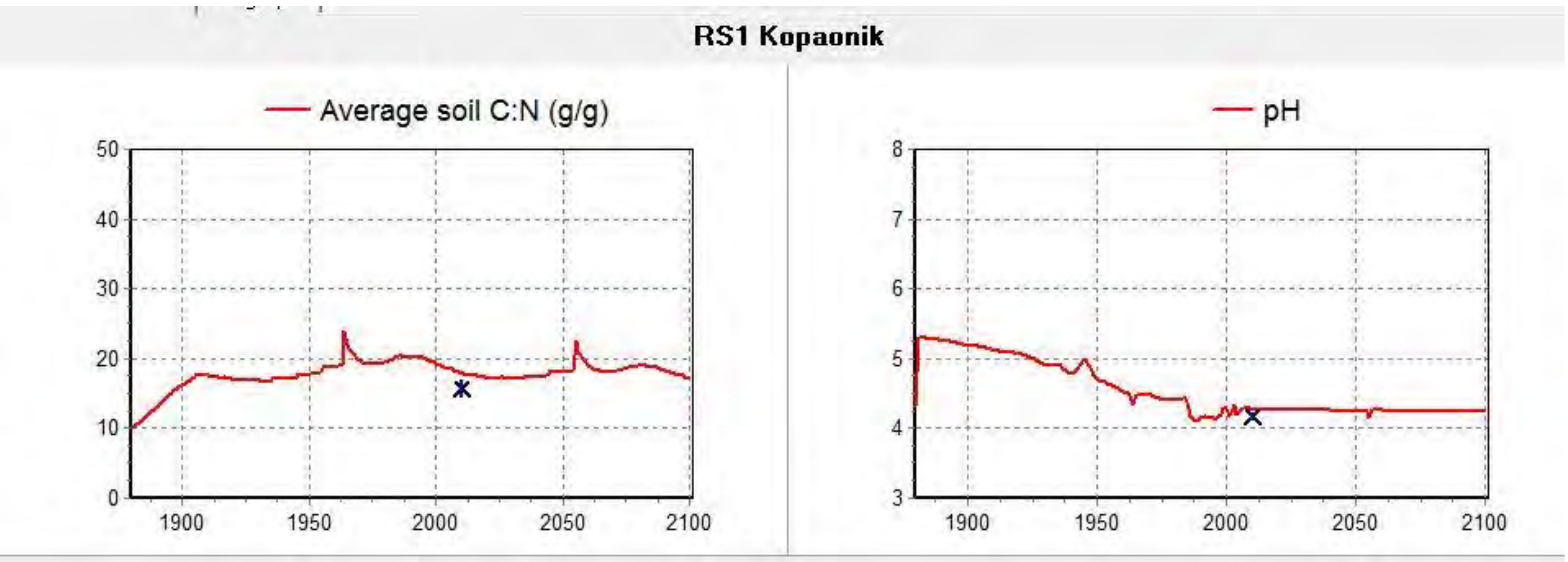

RS1 Kopaonik
Average soil C:N (g/g)
pH
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10
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4
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6
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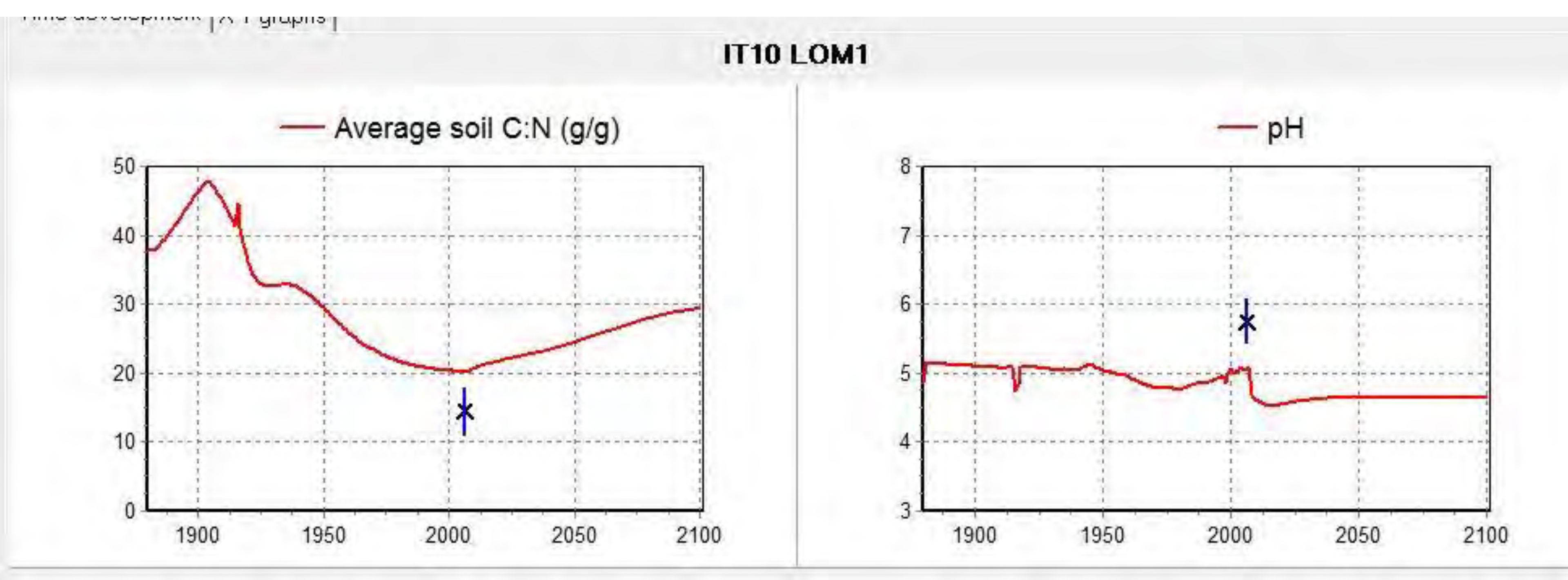
8
1900
1950
2000
2050
2100



IT10 LOM1
Average soil C:N (g/g)
pH
0
10
20
30
40
50
3
4
5
6
7
8
1900
1950
2000
2050
2100

Next and future tasks

Ndep
- Simulate with deposition scenarios

T, P
- Simulate with climate scenarios

BS, C:N
- Evaluate soil abiotic results

Thank you for your interest

maria.holmberg@ymparisto.fi

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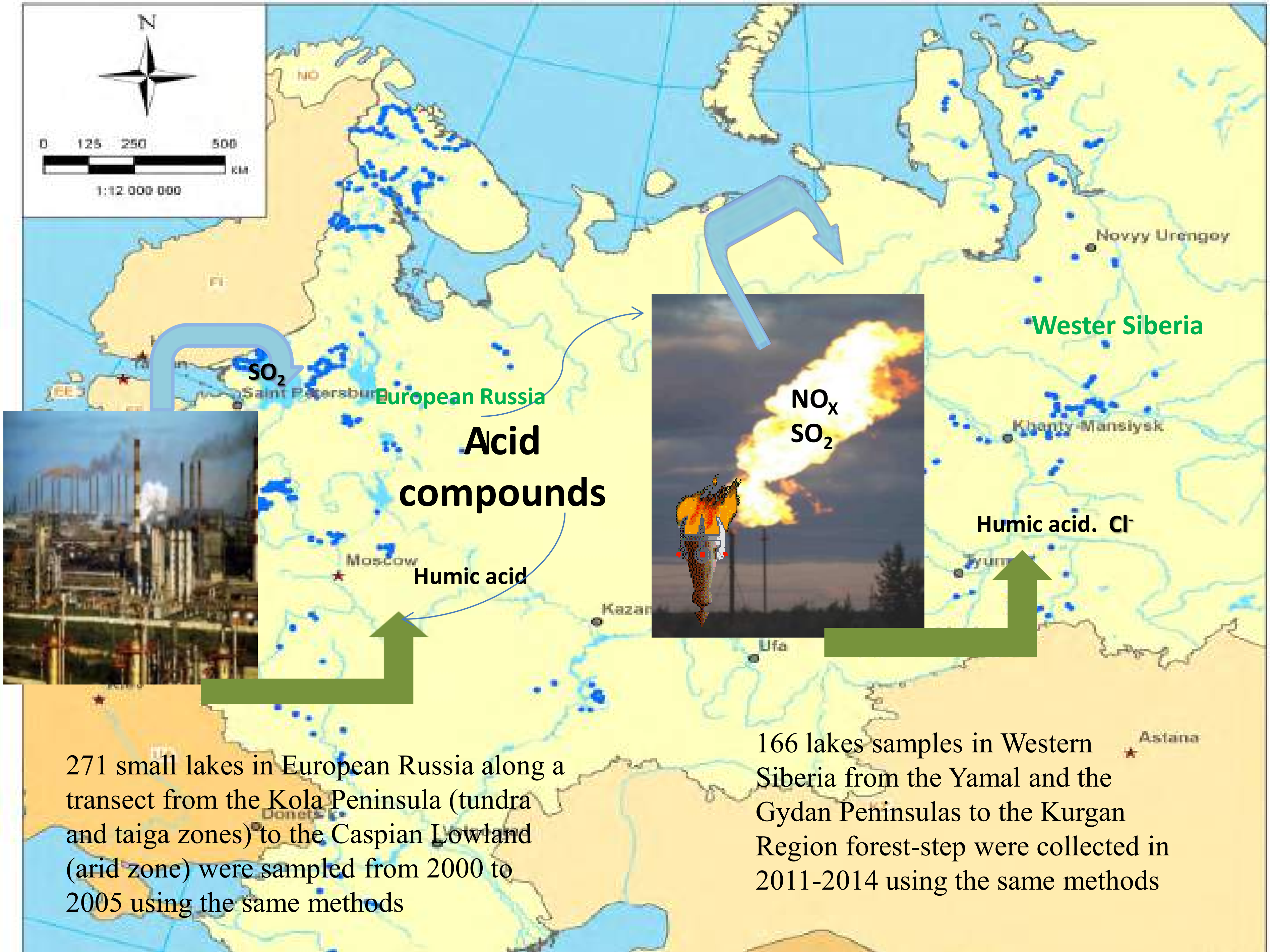
State University of Tyumen

Water acidification and critical loads: case study European Russia and Western Siberia

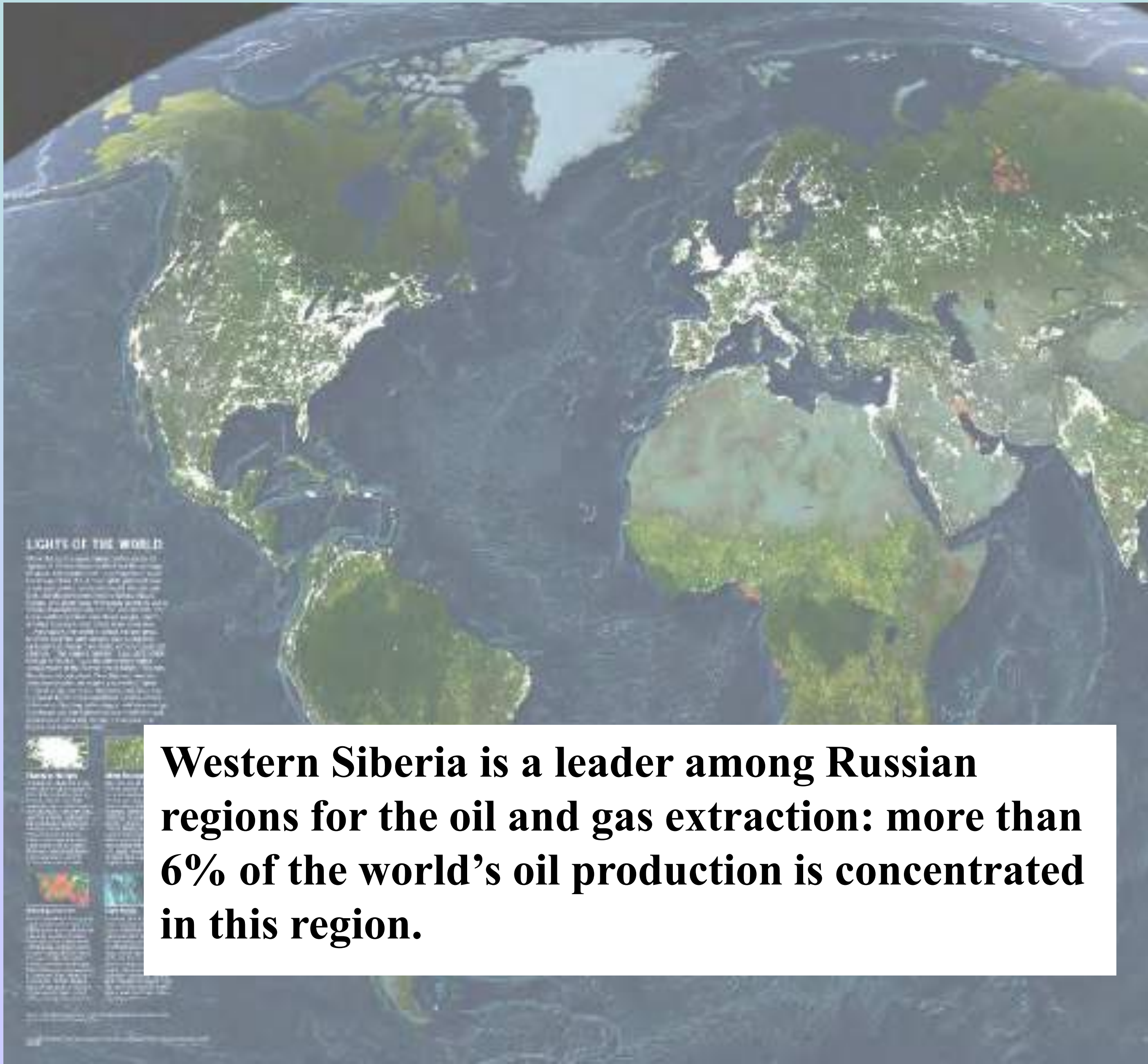
Moiseenko T.I.. Dinu M.I..
Kremleva T.A.. Gashkina N.A.
Khoroshavin V.Yu.



271 small lakes in European Russia along a transect from the Kola Peninsula (tundra and taiga zones) to the Caspian Lowland (arid zone) were sampled from 2000 to 2005 using the same methods

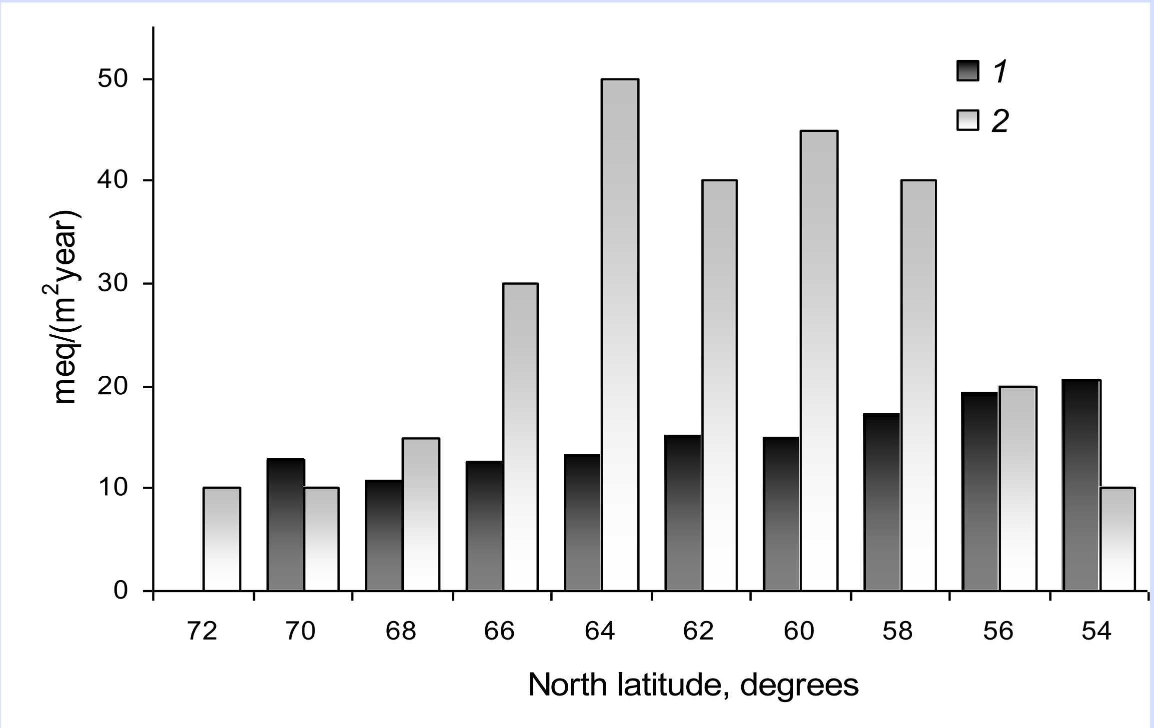
166 lakes samples in Western Siberia from the Yamal and the Gydan Peninsulas to the Kurgan Region forest-step were collected in 2011-2014 using the same methods

Gas flaring during of oil production in Western Siberia leads to air pollution by oxides of nitrogen, sulfur, chlorine.



Western Siberia is a leader among Russian regions for the oil and gas extraction: more than 6% of the world's oil production is concentrated in this region.

Deposition



Deposition of strong acids (meq/m^2year) by the latitudinal gradient **in European territory of Russia - 1** (EMEP, 2000) and **in Western Siberia - 2** (Semenov, 2002)

pH of precipitation

Region	pH of precipitation	
	Min	Max
North and North-West of ER	3.1 3.4	6.2 6.3
Center of ER	3.2	7.0
South of ER	3.1	7.1
Urals and the Urals region	4.0	7.2
Center of Western Siberia northern coast and north-eastern seas	3.6	7.0

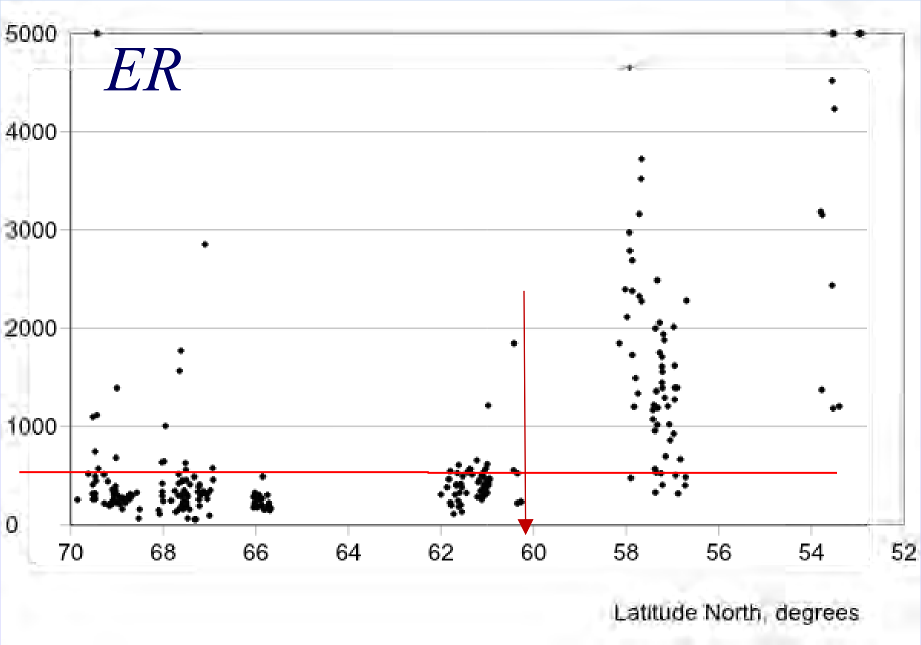
Protasov et al., 2000

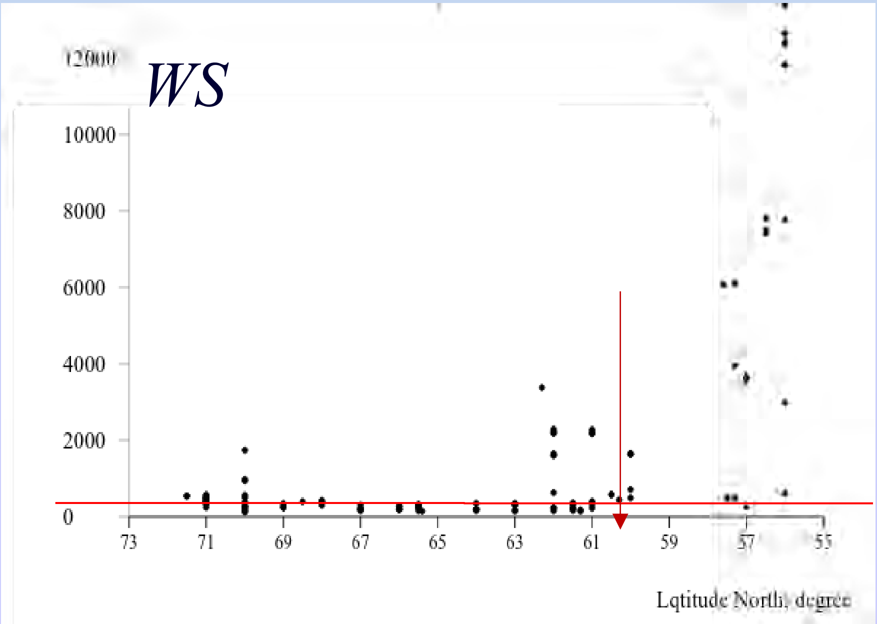
Buffer capacity

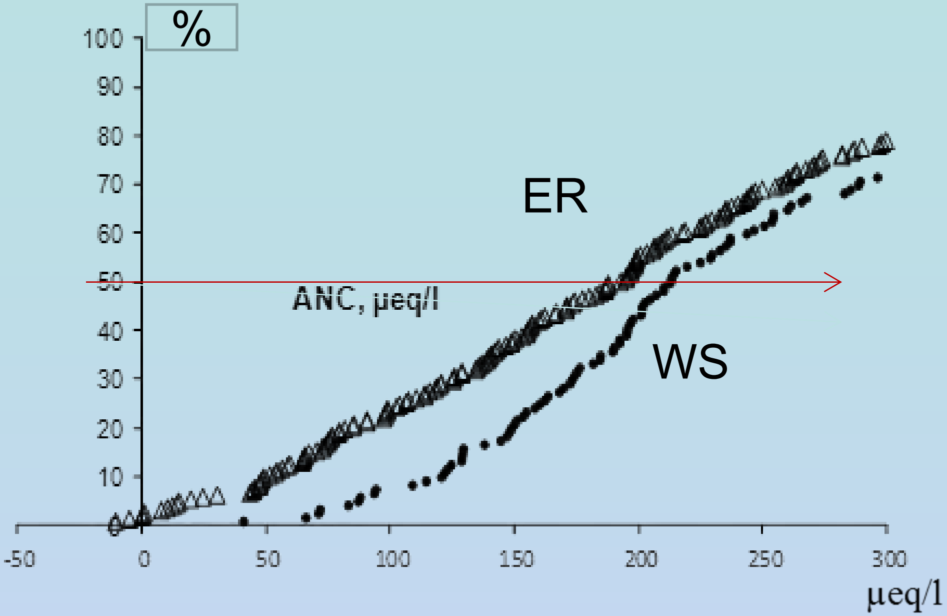
The main feature of both regions is **an increase of cations and alkalinity concentrations** in water towards the south: for ER - 55-60 °, for WS - 55-60 ° North latitude. The lakes of forest-steppe zones in ER and WS are highly resistant to acidification. Therefore, further discussion of these lakes was excluded.

Buffer capacity of northern and middle taiga region of ER and WS connect with the features of geology.

Concentration of cations (Ca+Mg+K+Na), μeq/l, in smalls lakes



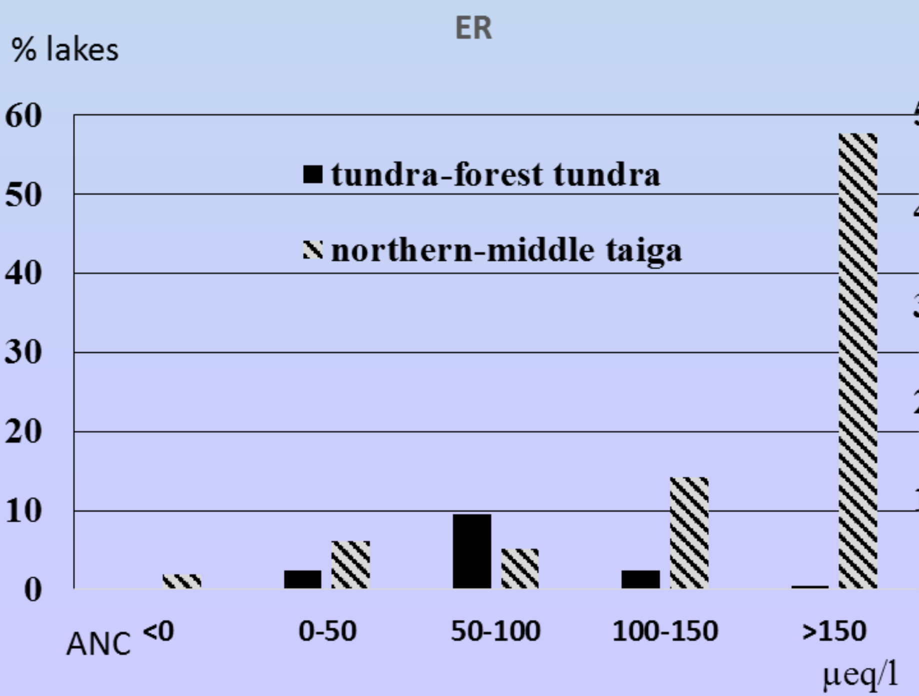


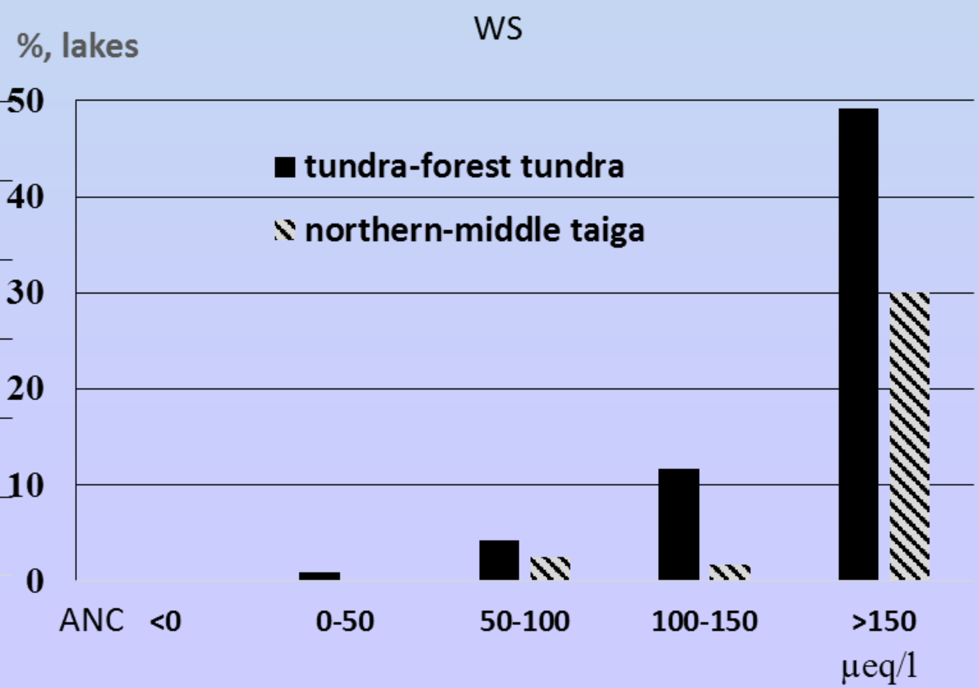


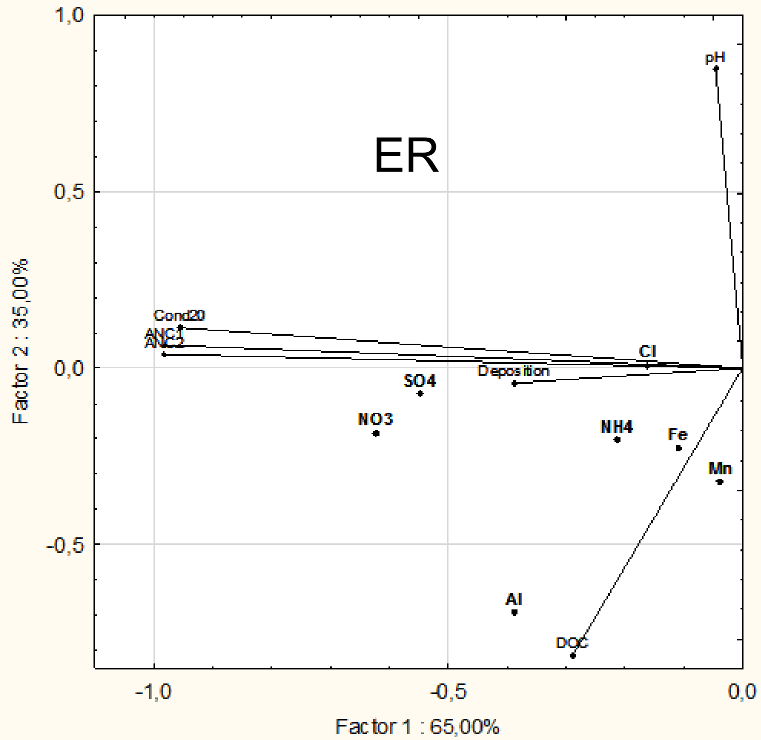
The acid neutralizing capacity of water (ANC, μeq/l) is used to estimate the anthropogenic acidification as a difference between cations and anions of strong acids (Henriksen et. al., 1992)

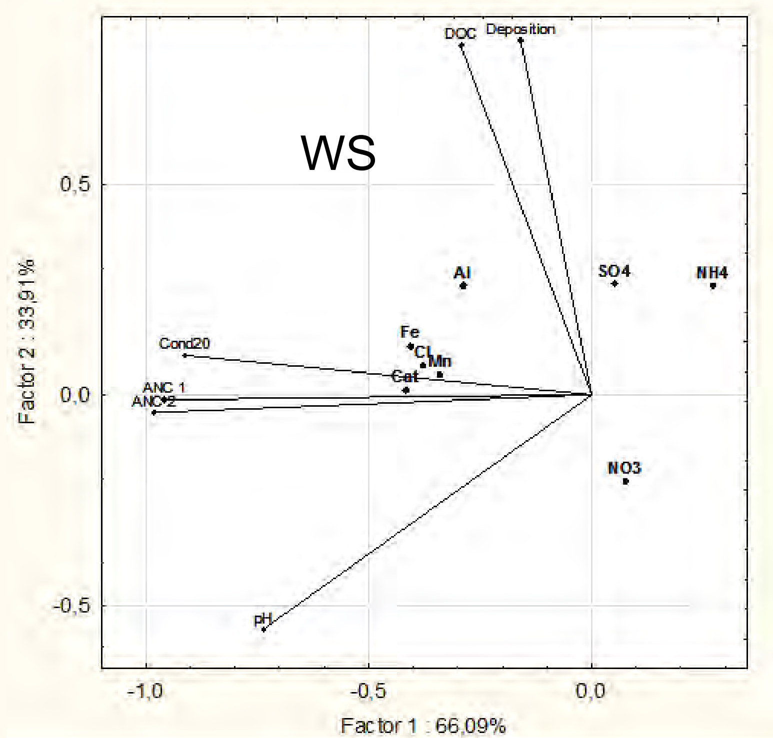
1. $ANC1=Ca^{2+}+Mg^{2+}+Na^{+}+K^{+}-SO_4^{2-}-NO_3^{-}$

2. $ANC2=HCO_3^{-}+A^{n-}-H^{+}-Al^{3+}$







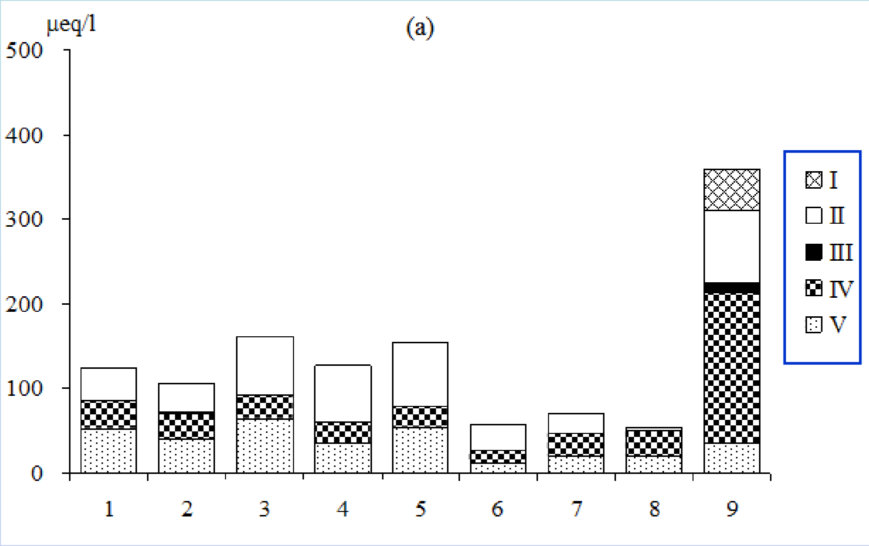


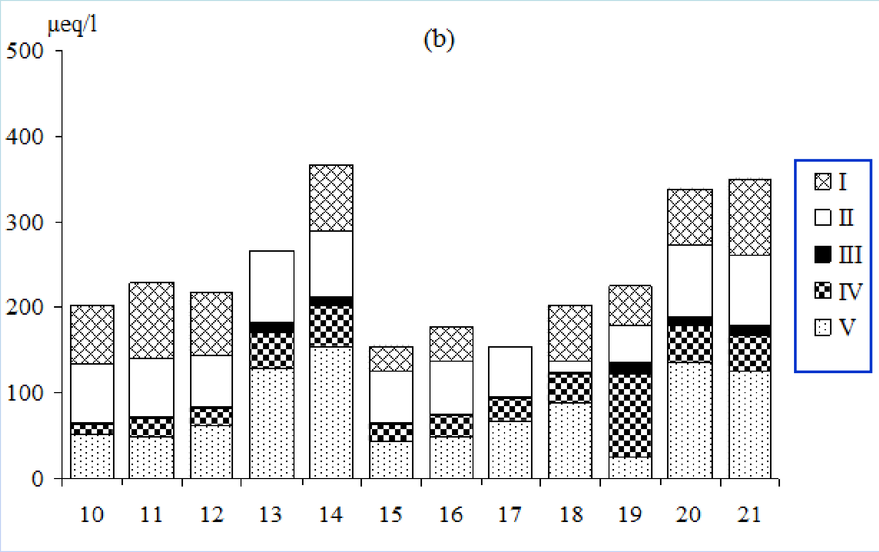
According to the results : **ANC 1 and ANC 2 are very close** that means the reliable of analyzes.

In **ER** lakes SO4, Cl and NO3mostly have an affinity for Cond. This is due to increased population density and industrial at the same time with increase cations and buffer capacity of water, The direct connection of the deposition and pH (lake ER) confirms the greatest acid deposition in an areas with steady geological formations to acidification.

In the water **WS** Cl have an affinity for Cond because increased salt content of watersheds toward the South. WS is located on the site of paleo area and Quaternary rocks: contain a amount of chloride. SO4 have an affinity for Deposition despite the higher sulfate concentrations in waters ER. The nitrate is inert to the selected axes because has the technological and natural origin.

The anionic composition (I – Alk. II - A^{n-}. III – NO_3^-. IV – SO_4^{2-}. V – Cl^-) of the water lakes with **pH <5** on the ER (a) (1 - in the tundra, 2-8 - in the northern taiga, 9 - in the middle taiga) and WS (b) (10-12 in the tundra, 13-14 - in the northern taiga, 15-21 - in the middle taiga).





Water acidification due to anthropogenic sulfate is characterized of ER.
In the acidic lakes of WS the water contained: chlorides, nitrates and sulfates.
Chlorides (lakes 13. 14. 20. 21) are dominated in majority lakes, but in same lake sulfates are dominated (lake 19).
Concentration of nitrates in water WS are higher in compared to the waters of ER.

NO^-_3

i) *Delivery with the marsh waters, wetland and marsh is widely developed in the WS*

(Nорг = 49.7·DOC – 114. (r=0.87. n=120);

i) *the gas flaring forms the nitrogen oxides;*

Cl^-

i) *WS is located on the site of paleosee area and Quaternary rocks contain a amount of chloride (Arkhipov et al.. 1987).*

ii) *The chlorides are present in the waters of WS as part of pollution of the oil and gas fields development (Kiriushin et al.. 2013).*

Organic compound (A^-)

Natural humus acids enters with the marsh waters.

Natural humus are characterized by a dual nature: weak and strong acids

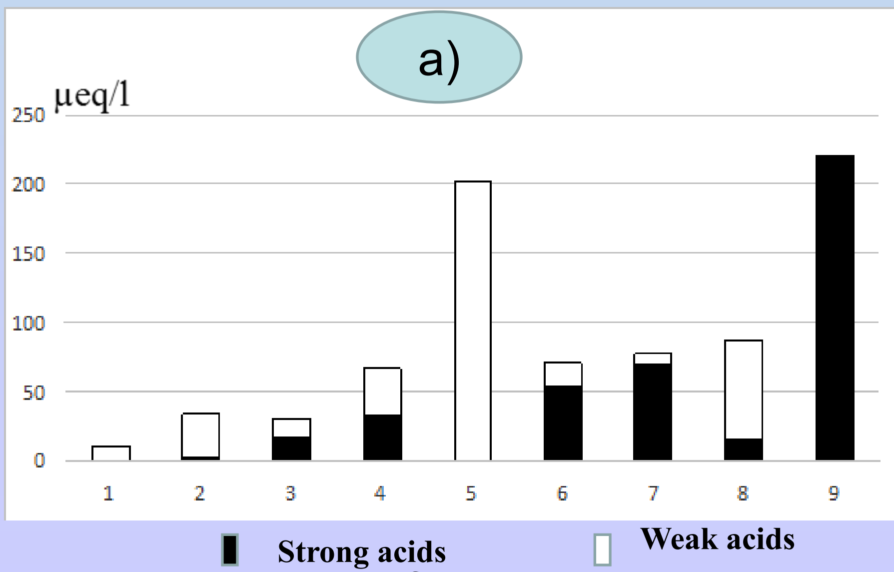
(Evans, Monteith et al.. 2008)

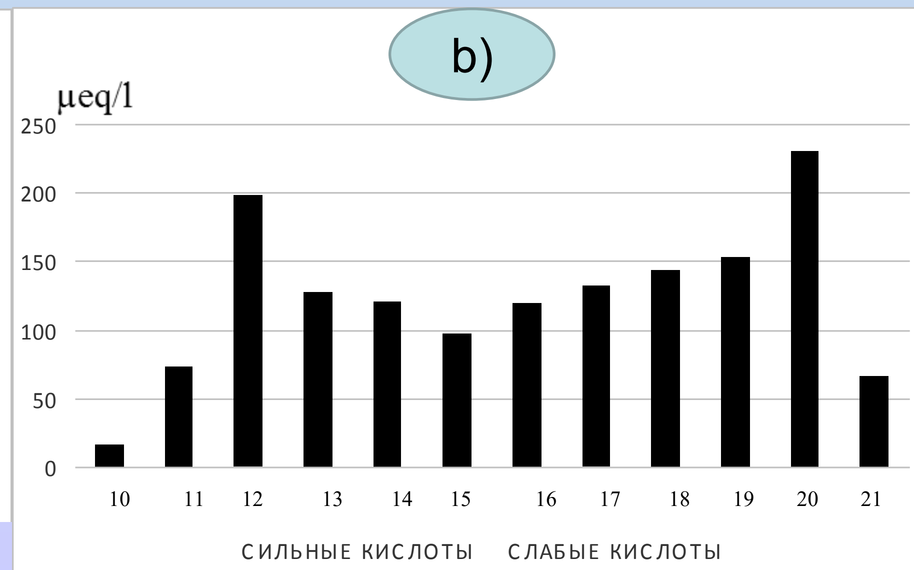
We calculated part of strong and week acids in water for acidify lakes in ER and WS based on method (Evans, Monteith, et.al. 2008). We used date about material balance of water chemical composition in each lake. The calculation algorithm takes into account the whole structure of the cationic and anionic groups including carbonates and bicarbonates.

$$OrgA_{strong} = Ca^{2+} + Mg^{2+} + Na^{+} + NH_4^{+} + K^{+} + Al_{inorg} - SO_4^{2-} - Cl^{-} - NO_3^{-} - Alk$$

$$OrgA_{weak} = A^{n-} - OrgA_{strong}$$

(Evans, Monteith et al.. 2008)





*The proportion of weak and strong organic acids in natural waters ER **(a)**: 1 - in the tundra. 2-8 - in the northern taiga. 9 - in the middle taiga and WS **(b)**: 10-12 in the tundra. 13-14 - in the northern taiga. 15-21 - in the middle taiga*

In table:

Black color without parentheses is the average ANC classics:

1. $ANC1=Ca^{2+}+Mg^{2+}+Na^{+}+K^{+}-SO_4^{2-}-NO_3^{-}$

2. $ANC2=HCO_3^{-}+A^{n-}-H^{+}-Al^{3+}$

Red color with parenthese is the average ANC* with used of organic weak and strong acids

1. $ANC^{*}1=Ca^{2+}+Mg^{2+}+Na^{+}+K^{+}-SO_4^{2-}-NO_3^{-} - A_{strong}^{n-}$

2. $ANC^{*}2=HCO_3^{-}+A_{weak}^{n-}-H^{+}-Al^{3+} - Fe^{3+} - A_{strong}^{n-}$

RESULTS FOR DISCUSSION

pH	Color, °Pt-Co scale					
	<10	10-30	30-60	60-100	>100	*n*
European Russia, 220 lakes, ANC*, µeq/l						
4-5	-5.0 (-20)	7 (25)	-	4 (-7)	130 (-9)	*10*
5-6	43 (31)	270 (187)	250 (149)	310 (279)	410 (222)	*34*
6-7	69 (54)	220 (176)	235 (168)	235 (131)	260 (108)	*141*
7-8	234 (233)	380 (335)	-	400 (305)	373 (269)	*35*
Western Siberia, 120 lakes, ANC*, µeq/l						
4-5	40 (-5)	62 (3.5)	140 (5.3)	175 (6.2)	250 (6.2)	*18*
5-6	150 (4.8)	170 (4.0)	230 (10)	300 (11)	350 (15)	*54*
6-7	300 (10)	375 (9.7)	350 (6.5)	-	400 (5.5)	*35*
7-8	472 (153)	1142 (8)	1100 (220)	1450 (75)	1560 (606)	*13*

Critical Loads and its exiding

$$CL = ([BC_o^*] - [ANC_{limit}])\, Q - BC_d^*$$

$$BC_o^* = [BC^*]_t - F\,\Delta([SO_4^*] + [NO_3]) = [BC^*]_t - F\,(([SO_4^*]_t + [NO_3]_t) - ([SO_4^*]_o + [NO_3]_o))$$

$$F = \sin(\pi/2)\,[BC]_t / S$$

$$[SO_4]_0^* = 15 + 0.16[BC_t)^*$$ (Henriksen et al., 1992)

European Russia

$$\mathbf{BC_o = [BC]_t - F\,(([SO_4]_t - [SO_4]_o)}$$

Zones of tundra, forest-tundra and northern taiga (Kola Peninsula):
$[SO_4^*]_o = 15.3 + 0.02\,[BC^*]_t$. $r = 0.71$. $p<0.001$;
Zone of the middle taiga (Karelia):
$[SO_4^*]_o = 15.4 + 0.11\,[BC^*]_t$. $r=0.64$. $p<0.001$;
Zone of mixed forests:
$[SO_4^*]_o = 15.2 + 0.05\,[BC^*]_t$. $r=0.68$. $p<0.001$.

S is 400 μeq / l for the tundra and taiga zones.
S is 1100 μeq / l for mixed ER forests.

$$\mathbf{CL_{ex} = CL - SO_{4\,dep}^* - NO_{3dep} + BC_{dep}^*}$$

Western Siberia

$$\mathbf{BC_o = [BC]_t - F\,(([SO_4]_t - [SO_4]_o) + ([NO_3]_t - [NO_3]_o) + ([Cl]_t - [Cl_{Na}]))}$$

$$\mathbf{[NO_3]_o = 0.118\,[A^{n-}]_t.}$$

(Cl_{Na} is compensated by Na)

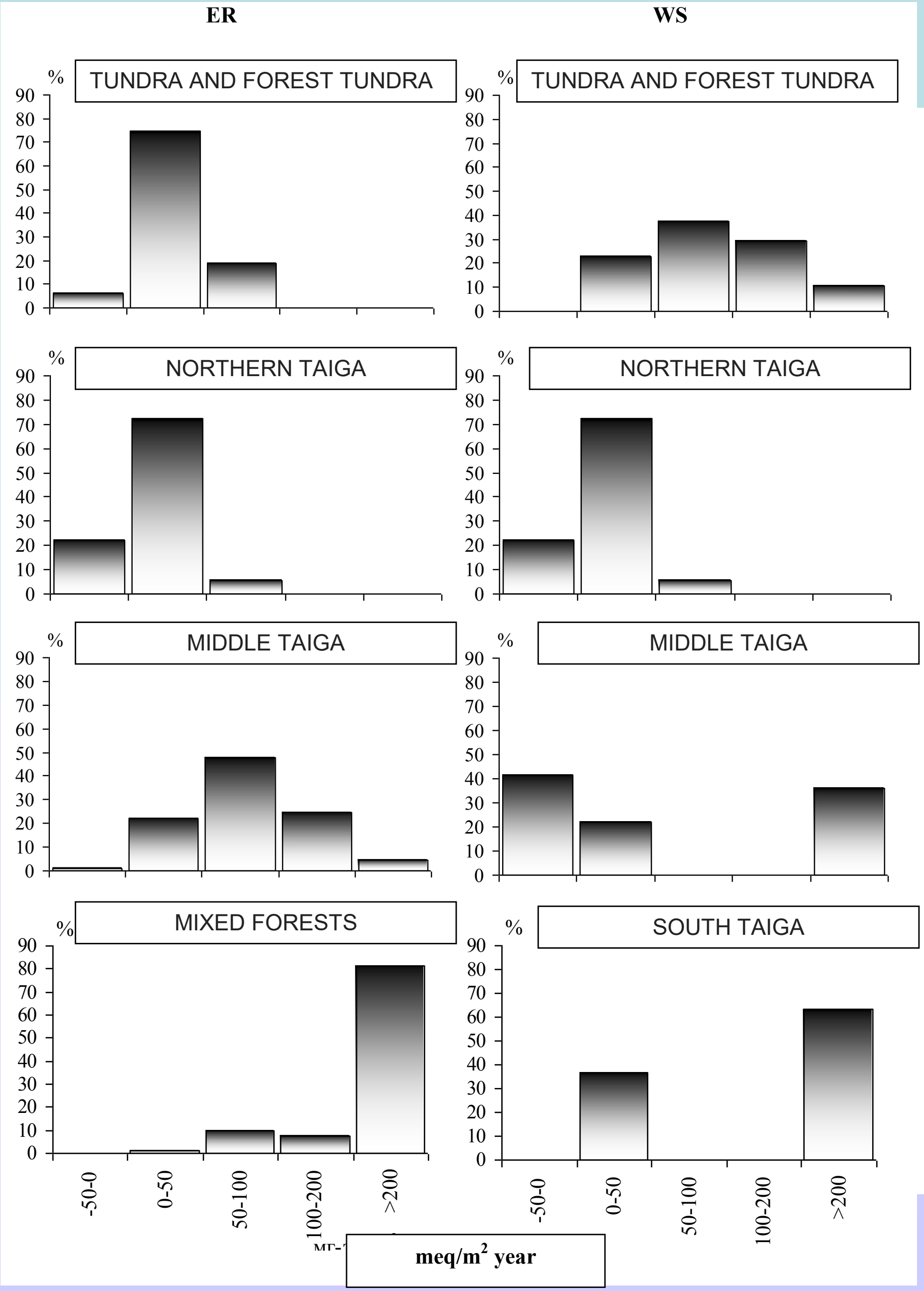
Zones of tundra, forest-tundra and northern taiga:
$[SO_4]_o = 2.67 + 0.021\,[BC]_t$. $r = 0.72$. $p<0.001$;
Zone of the middle taiga:
$[SO_4]_o = 16.9 + 0.015\,[BC]_t$. $r=0.76$. $p<0.001$;
Zone of southern taiga:
$[SO_4]_o = 12.4 + 0.002\,[BC]_t$. $r=0.69$. $p<0.005$.

S is 500 μeq / l for the tundra and northern taiga zones.
S is 1250 μeq / l for the middle taiga
S is 3000 μeq / l for the southern taiga.

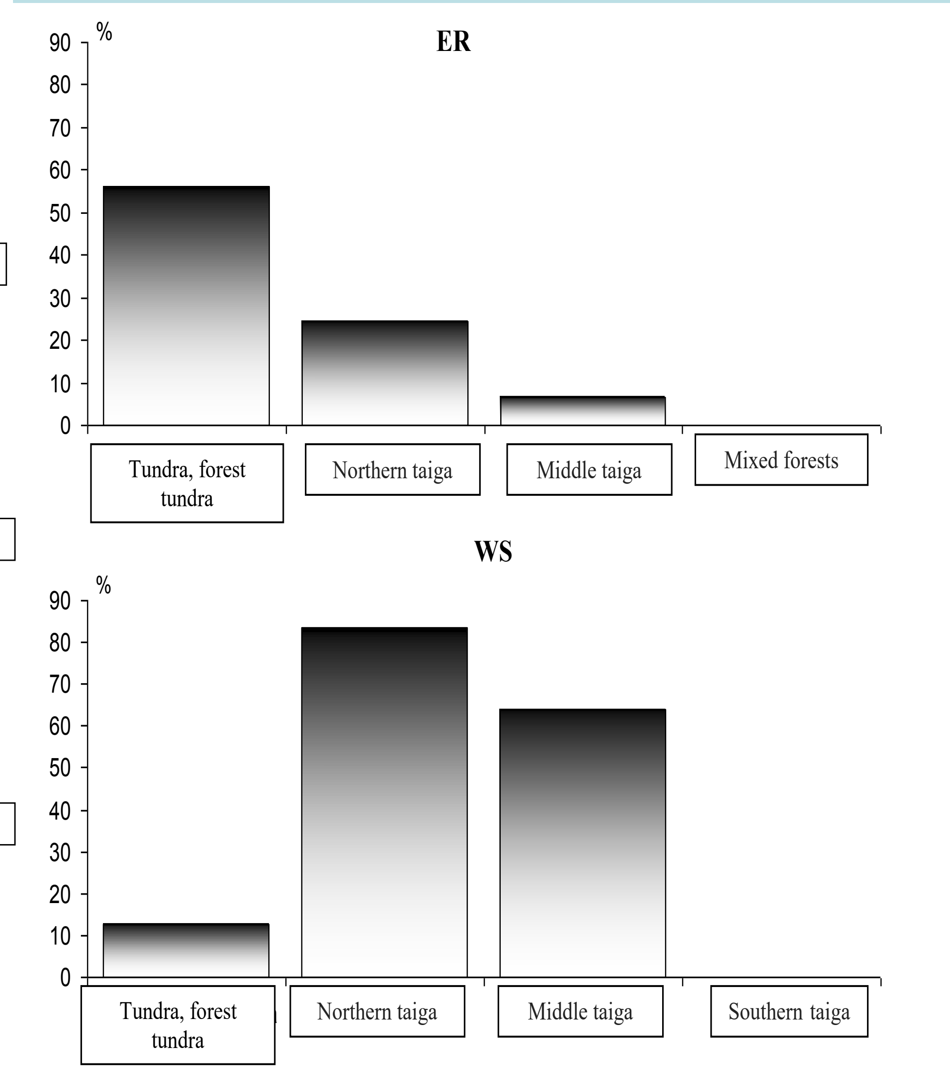
$$\mathbf{CL_{ex} = CL - SO_{4dep} - NO_{3dep} - Cl_{dep} + BC_{dep}.}$$

Thus, the necessary date for estimating the flow of cations into water systems ensuring neutralization of anthropogenic acids have been determined. Taking into account the complete and correctly obtained hydro-chemical information. ANClimit was adopted as 50, μeq/l

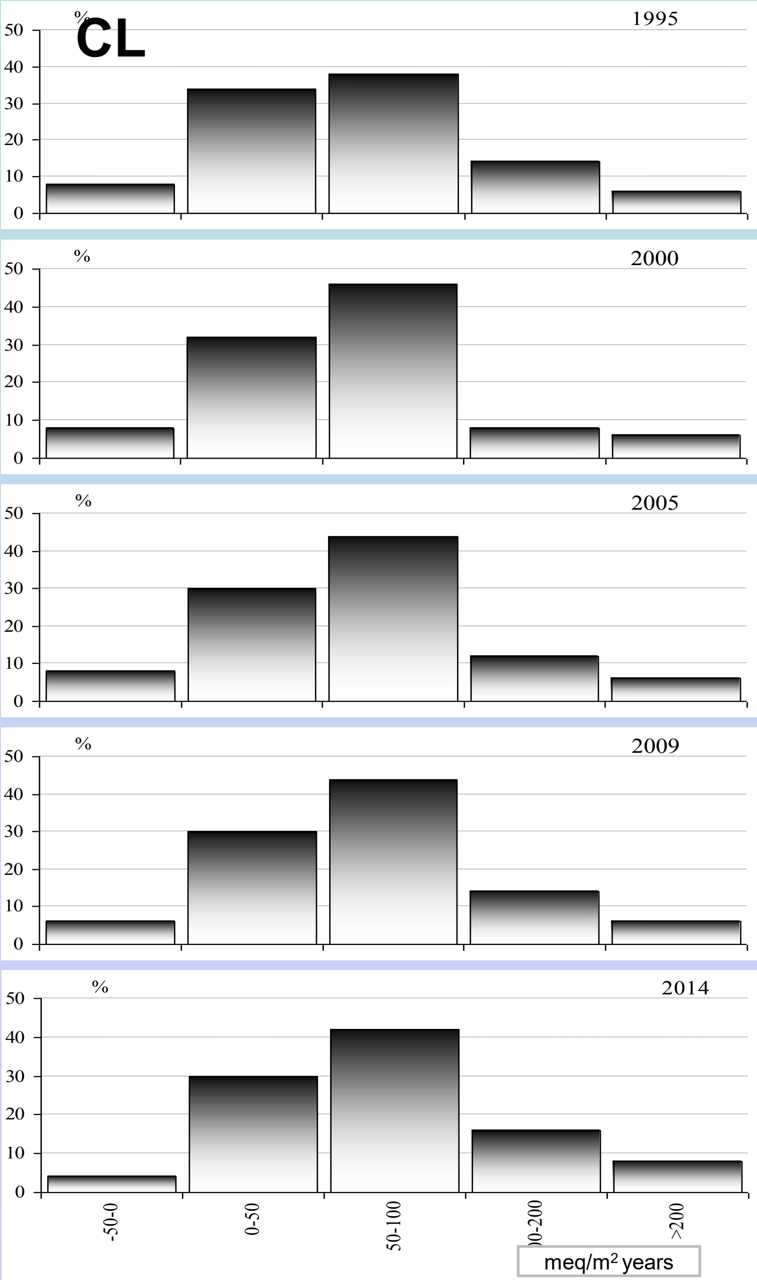
CL

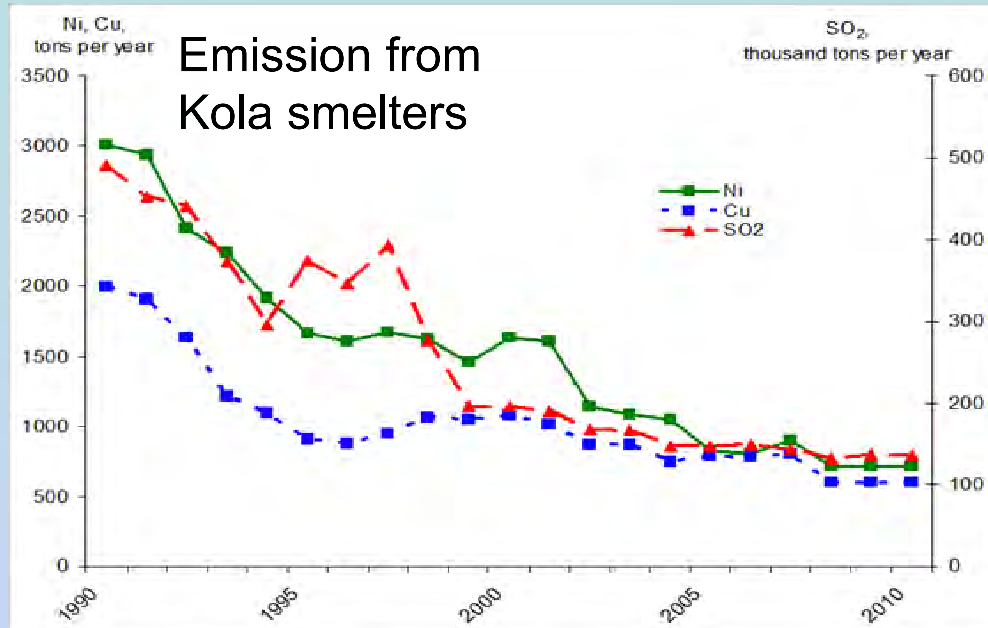

ER
WS
TUNDRA AND FOREST TUNDRA
NORTHERN TAIGA
MIDDLE TAIGA
MIXED FORESTS
SOUTH TAIGA
%
-50-0
0-50
50-100
100-200
>200
meq/m2 year

CLex


ER
%
Tundra, forest tundra
Northern taiga
Middle taiga
Mixed forests
WS
%
Tundra, forest tundra
Northern taiga
Middle taiga
Southern taiga

Long-term trends - recovery (Kola region)





Clex

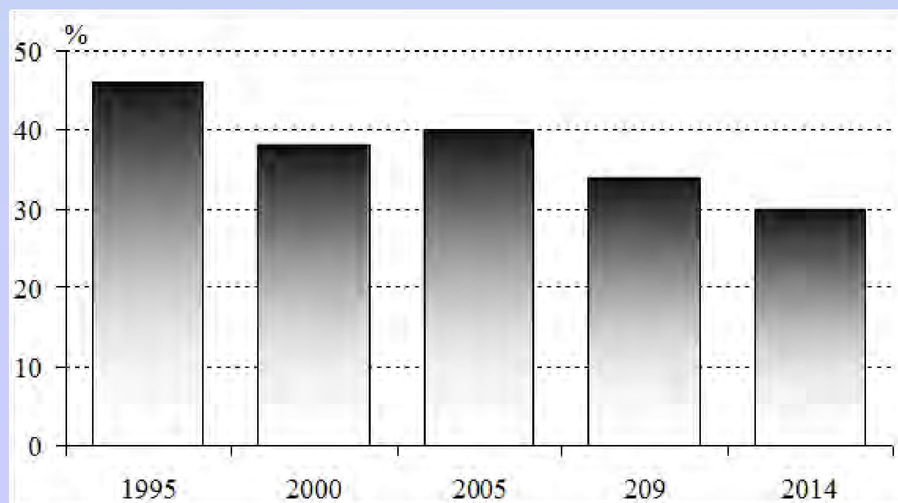
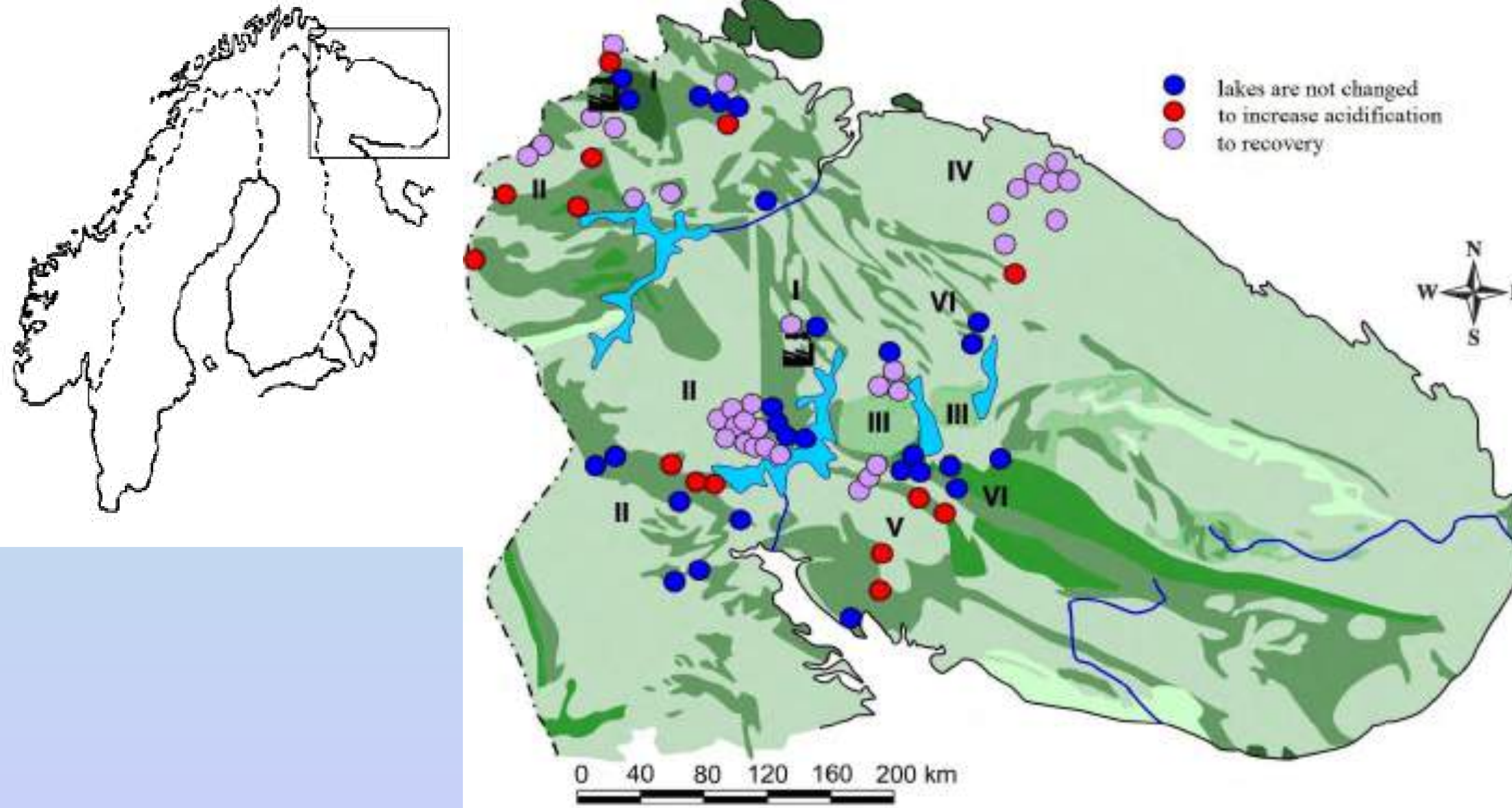


Рис. 12.6



*Water chemistry responses are **not** always proportionate to reductions in sulfate flow. Exists three scenarios of changes water chemistry: i) further water acidification is progressing. ii) pH and alkalinity levels remain the same; iii) lake water chemistry recovers.*

ISSN 0016-7029, Geochemistry International, 2016, Vol. 54, No. 12, pp. 1079–1093. © Pleiades Publishing, Ltd., 2016.
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Character of Spatiotemporal Variations in the Chemical Composition of Lake Water under the Influence of Emission from Copper–Nickel Plants: Prediction of Acidification

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Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Moscow, 119991 Russia *e-mail: ngashkina@gmail.com
Received July 28, 2015; accepted December 15, 2015

Abstract In this paper, we analyze the influence of variations in the emission of sulfur dioxide and solid substances by the Pechenganikel and Severonikel copper–nickel plants in Murmansk oblast on the chemical composition of lake water and development of acidification. The dynamics of ~100 lakes examined in 1990, 1995, 2000, 2005, and 2009 and response of the chemical composition of the lake waters on the impact of acidifying substances was explored depending on the magnitude of load (distance from the plants), geologically controlled vulnerability of the lake catchments to acid precipitation, and the size of the lakes. Possible further changes in the sulfate concentration and pH values of lake waters were estimated for scenarios assuming an increase or a decrease in sulfur dioxide emission from the plants. It was shown that, in the zone of maximum and high load, a 20% change in sulfur dioxide emission will result in a mean change in sulfate concentration of ±8 μeq/L (which is comparable with the regional background) and a change in pH value of ±0.1 in acid-sensitive lakes and will have almost no effect on these parameters in lakes insensitive to acid precipitation.

Keywords: lakes, anthropogenic sulfates, vulnerability, acidification, load variations, dynamics, prediction
DOI: 10.1134/S001670291612003X


Thanks for
attentions !

Relationship between critical load exceedances and empirical impact indicators at ICP Integrated Monitoring sites

Update 2017: preliminary results

Maria Holmberg, Jussi Vuorenmaa, Maximilian Posch
Sirpa Kleemola + NFCs…

Joint ICP Waters & ICP IM Task Force meeting,
Uppsala, Sweden, 11.5.2015

LRTAP Long-range Transboundary Air Pollution

eLTER H2020

SYKE

Previous study at ICP IM sites

- *Is there a link between modelled critical thresholds and empirical results for acidification parameters and nutrient nitrogen at IM sites?*
- Vuorenmaa & Holmberg (2010, 19th AR) and Holmberg et al. (2013, *Ecol Ind*) concluded that:
  - Empirical impact indicators as derived from observations in ICP IM catchments were in good agreement with exceedances of critical loads of acidification and eutrophication
  - Data from the ICP IM thus provided evidence of a connection between modelled critical loads and empirical monitoring results for acidification parameters and nutrient nitrogen.
  - The collected empirical data of the ICP IM allow testing/validation of the key concepts in the CL calculations.
  - Increases confidence in the regional scale CLs mapping approach used in the integrated assessment modelling.

SYKE

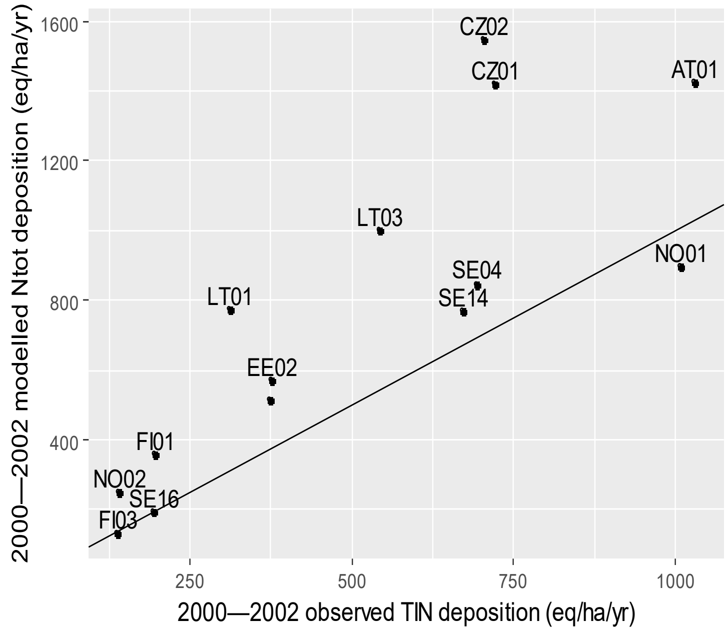
Material and methods

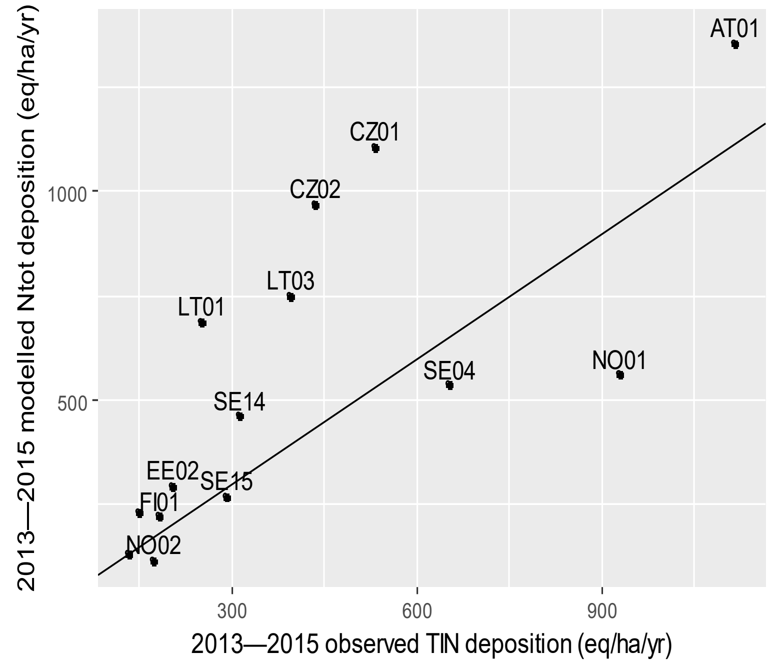
- Previous study with modelled N deposition data of 2000 and empirical TIN data of 2000-2002 **was revisited with new data on modelled N deposition (2010) and empirical TIN RW (2013-2015)**.
- Critical loads for eutrophication, their exceedances and concentrations and fluxes of total inorganic nitrogen (TIN = NO_3+ NH_4) in runoff were determined for a selection of 14 sites: AT01, CZ01, CZ02, EE02, FI01, FI03, LT01, LT03, NO01, NO02, SE04, SE14, SE15, SE16.
- The exceedances (ExCLnutN) were calculated as differences between the level of total N deposition (Ntot = NO_3+ NH_4) and the mass balance critical loads of nitrogen (CLnutN).

SYKE

N in deposition #1.

Comparison of modelled to observed N input to the sites in two study periods. The line is drawn at slope 1:1.

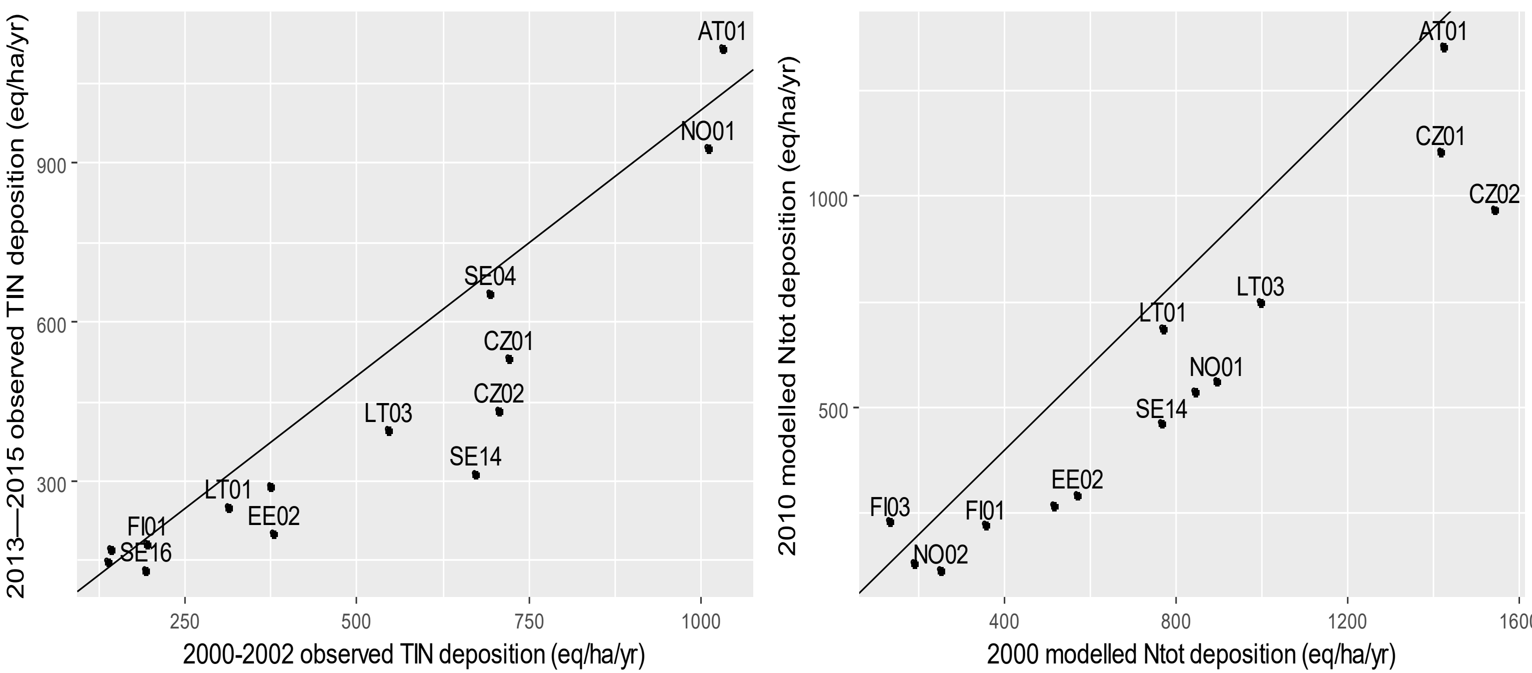




For most sites, the modelled N deposition > observed flux in bulk deposition

N in deposition #2.

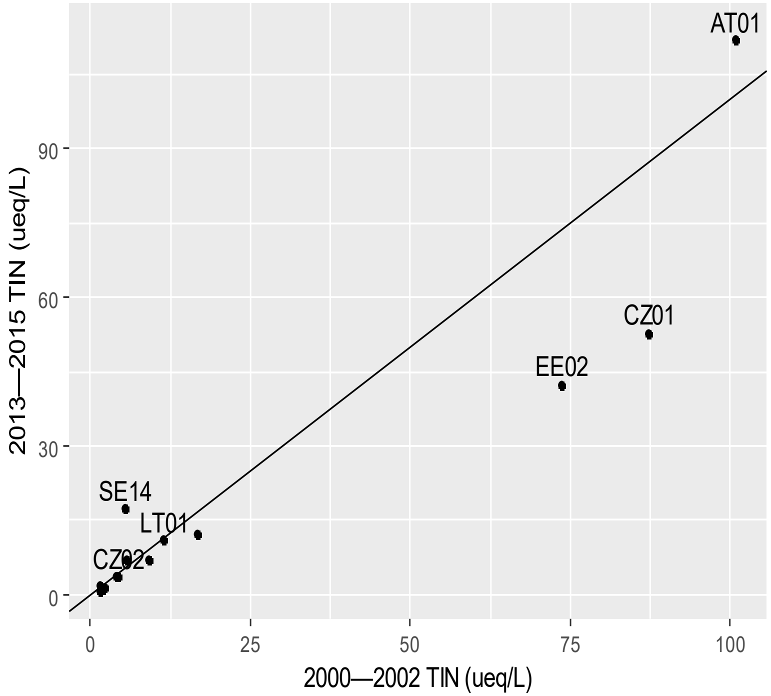
Comparison of N input (observed and modelled) to the sites for the period 2013–2015 (y-axis) versus period 2000–2002 (x-axis)

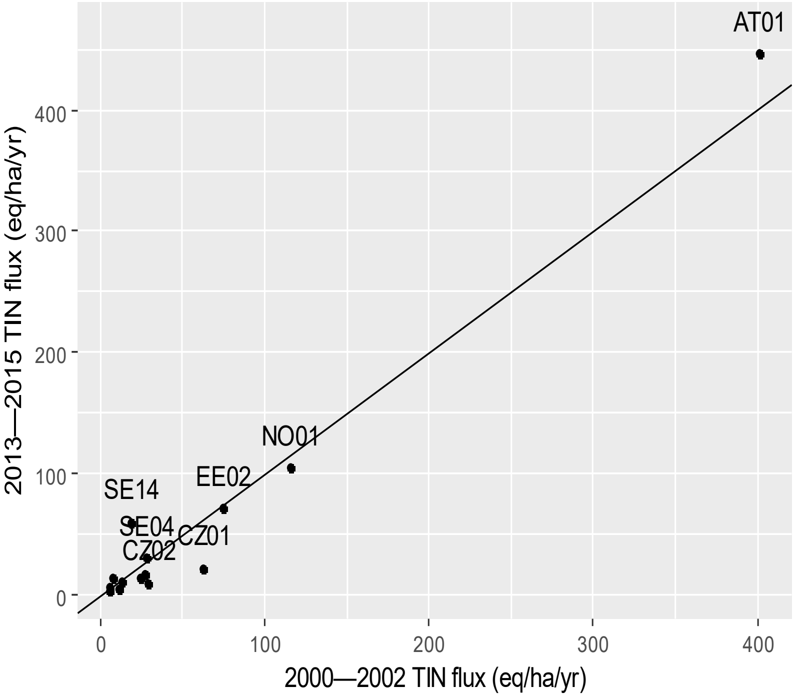


Both the observed and the modelled estimates for N input to the sites have decreased for almost all sites between the two observation periods.

N in runoff #1

Observed concentration (left) and flux (right) of TIN in runoff, averages for period 2013-2015 (y-axis) compared to those for 2000-2002 (x-axis).





TIN concentrations and fluxes in runoff decreased at most sites between the two observation periods.

Summary table: 2000 & 2000-2002 vs. 2010 & 2013-2015

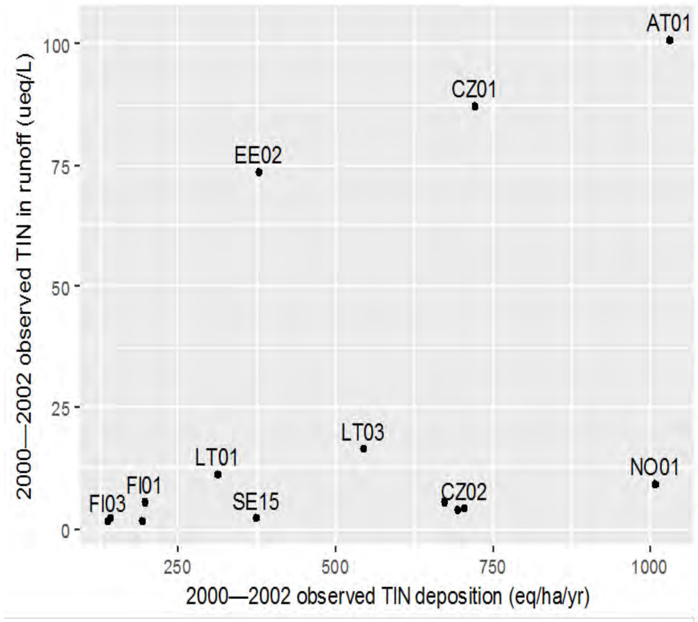
			2000-2002	2000-2002	2000	2000	2013-2015	2013-2015	2010	2010
Country	IM Site code	Site	TIN conc. (µeq L^{-1})	TIN flux (eq ha^{-1} yr^{-1})	Ntot dep. (eq ha^{-1} yr^{-1}) (modelled)	ExCLnutN (eq ha^{-1} yr^{-1})	TIN conc. (µeq L^{-1})	TIN flux (eq $ha^{-1} yr^{-1}$)	Ntot dep. (eq ha^{-1} yr^{-1}) (modelled)	ExCLnutN (eq ha^{-1} yr^{-1})
Austria	AT01	Zöbelboden IP1	100.8	401.3	1424	1117	111.8	446	1355	1049
Czech Republic	CZ01	Anenske Povodi	87.2	62.5	1417	1114	52.8	22.3	1107	804
	CZ02	Lysina	4.2	29.4	1545	1172	3.52	10.2	968	595
Germany	DE01	Forellenbach	102.8	1373.0	1616	1140	46.1	354	1481	1011
Estonia	EE02	Vilsandi	45.4	70.6	570	189	42.3	71.1	292	-45
Finland	FI01	Valkea-Kotinen	5.7	13.4	357	56	7	11.7	220	-141
	FI03	Hietajärvi	1.6	5.7	130	-108	1.86	6.2	228	-982
Lithuania	LT01	Aukstaitija	11.3	7.4	770	465	11	13.7	685	378
	LT03	Zemaitija	16.6	27.4	997	699	12.2	16.8	750	428
Norway	NO01	Birkenes	9.2	115.9	896	442	6.91	105	560	108
	NO02	Kårvatn	2.2	36.5	249	-408	1.31	13.5	113	-530
Sweden	SE04	Gårdsjön	3.7	27.0	845	660	3.72	31.1	535	152
	SE14	Aneboda	5.5	19.1	767	534	17.3	60.2	460	226
	SE15	Kindla	2.0	11.0	514	210	1.13	5.4	268	-36
	SE16	Gammtratten	1.6	5.7	191	-99	0.69	3.3	128	-161

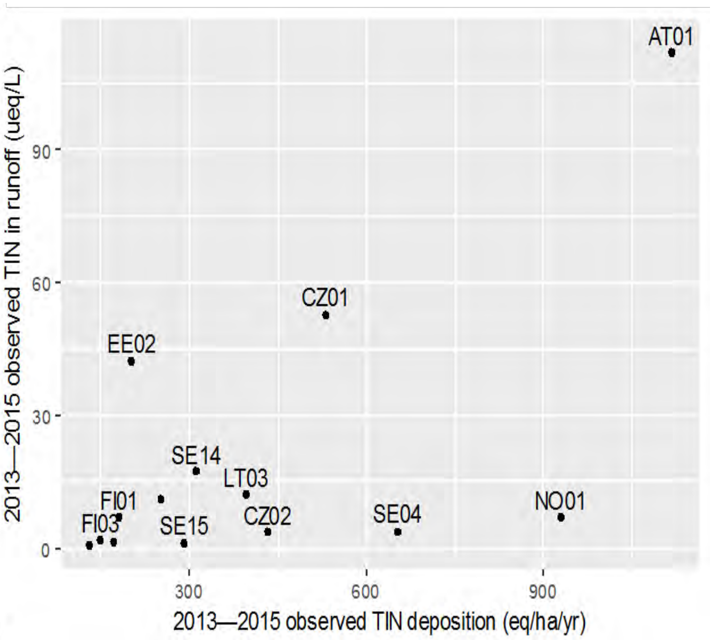
No change or increased, decreased

SYKE

N in runoff #2

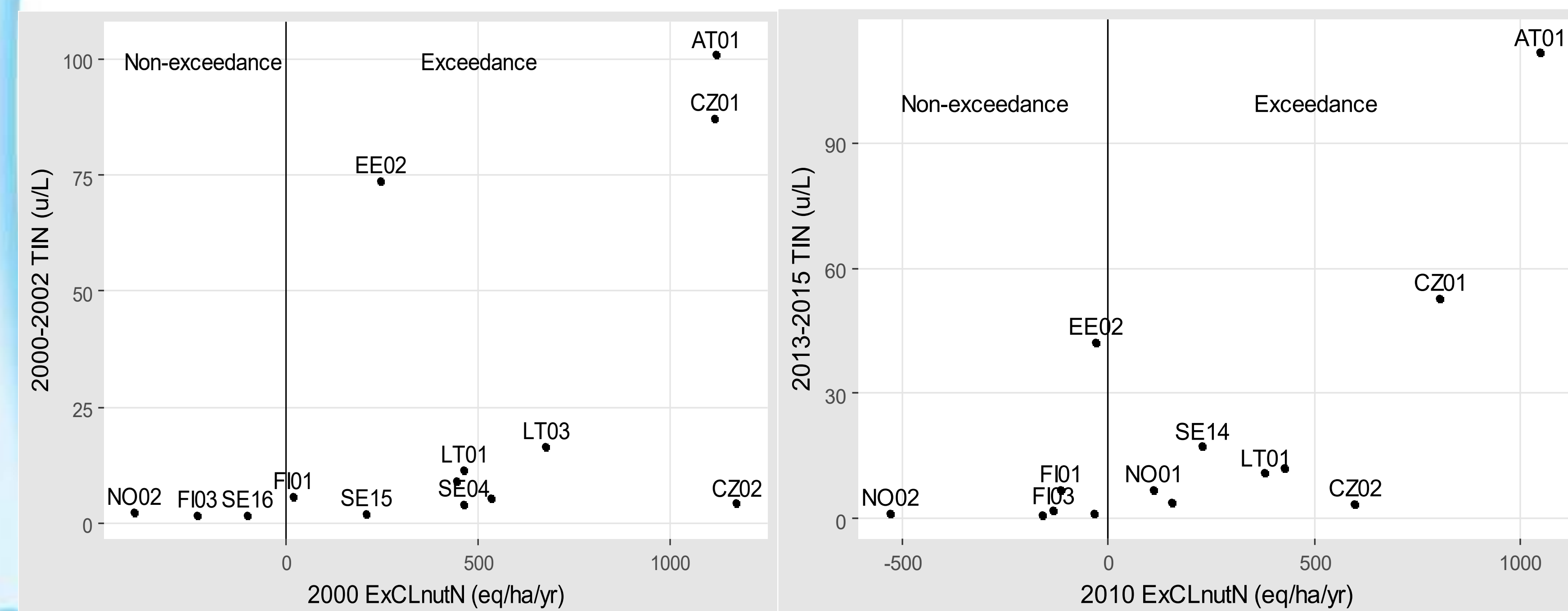
The observed concentration of TIN in runoff (y-axis) versus the observed deposition flux of TIN (x-axis). Period 2000 – 2002 in left panel, period 2013 – 2015 in right panel.





In general, concentrations of TIN in output increase with increasing TIN deposition

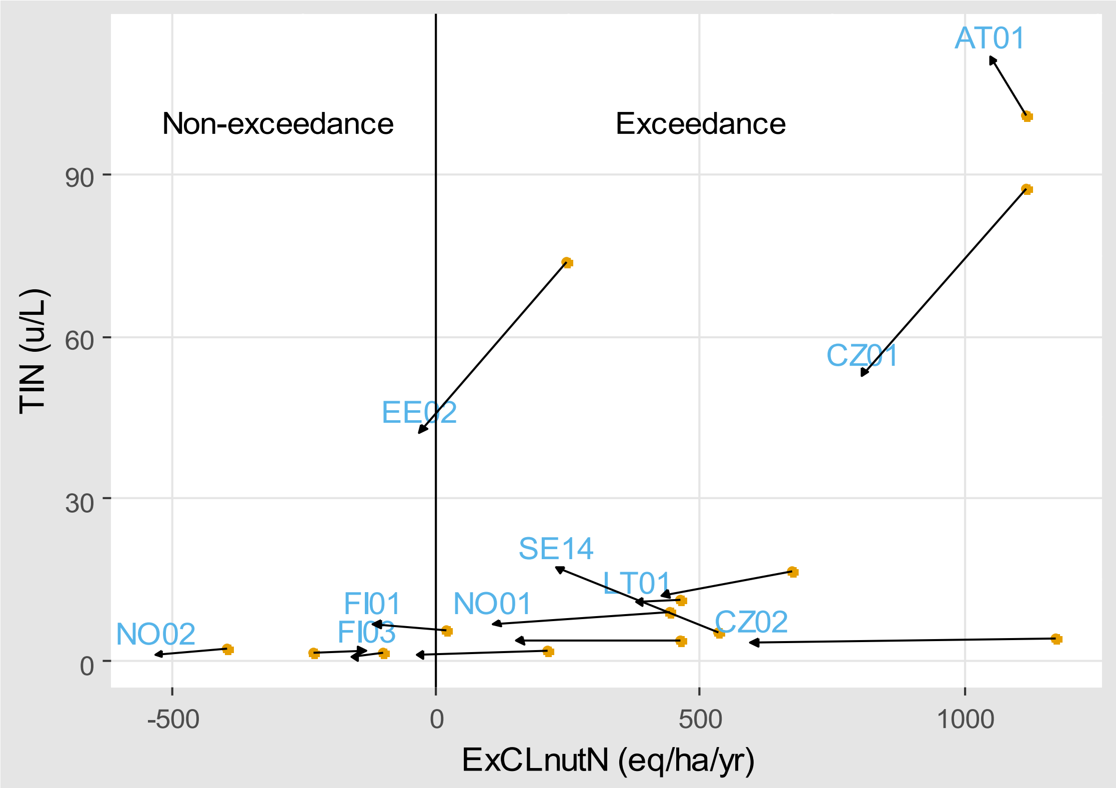
Observed concentration of TIN in runoff (y-axis), average for periods 2000–2002 (left) and 2013–2015 (right), versus the calculated exceedance of critical loads of nutrient N (x-axis), using modelled deposition values for 2000 (left) and 2010 (right).



CLnutN exceeded -> higher TIN concentrations in runoff

The observed concentration of TIN in runoff (y-axis) versus the calculated exceedance of critical loads of nutrient N (x-axis), using modelled deposition values.

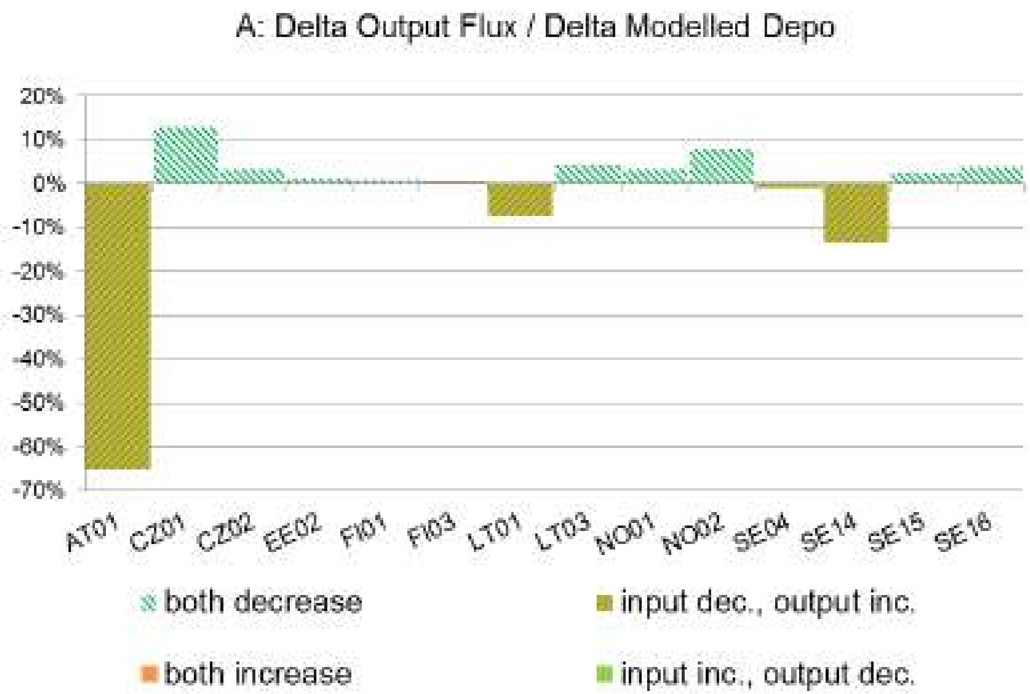
The arrows begin at the locations of the data points for the period 2000-2002 and end at the locations of the data points for the period 2013–2015.



Shift towards less exceedance and lower TIN concentrations in runoff

Comparison of changes in TIN flux in runoff, relative to the change in deposition.

Changes calculated as differences between the values for 2013 – 2015 and those for 2000 – 2002. Relative changes (%) as change in flux divided by change in modelled deposition. This comparison reflects also differences in meteorological and hydrological conditions and forest disturbance regimes for the two periods.



To summarize...

- We still conclude that there is a link between modelled critical thresholds and empirical results for nutrient N

- Improvement visible
  - N in deposition (modelled & measured) and output decreased rather than increased between the two observation periods 2000-2002 and 2013-2015
  - A shift towards less exceedance (ExCLnutN)

- Work will continue
  - A scientific paper in 2019, plans to extend empirical indicators to include vegetation indicators
  - Work is also related to the EU/H2020 project eLTER

SYKE

Thank you

Valkea-Kotinen IM catchment (FI01)
Photo: Jorma Keskitalo

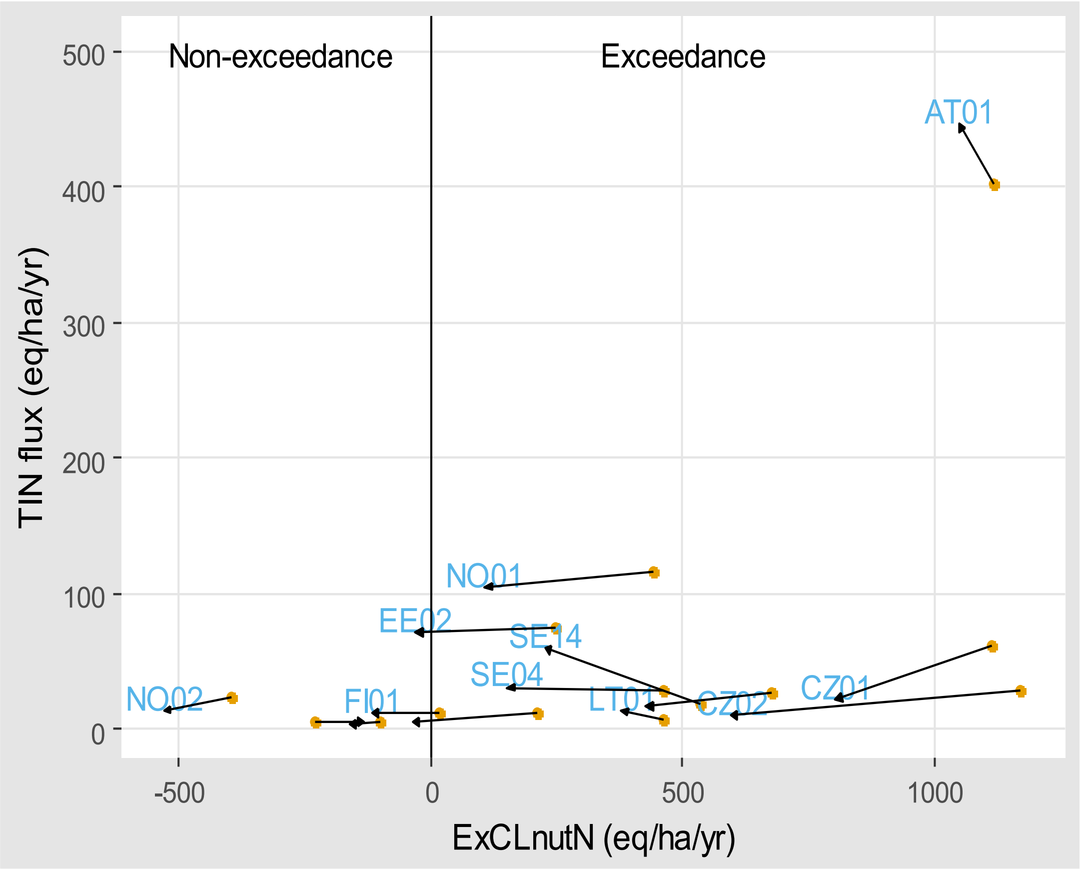


Figure 5b. The observed flux of TIN in runoff (y-axis) versus the calculated exceedance of critical loads of nutrient N (x-axis), using modelled deposition values. The arrows begin at the locations of the data points for the period 2000–2002 and end at the locations of the data points for the period 2013–2015.

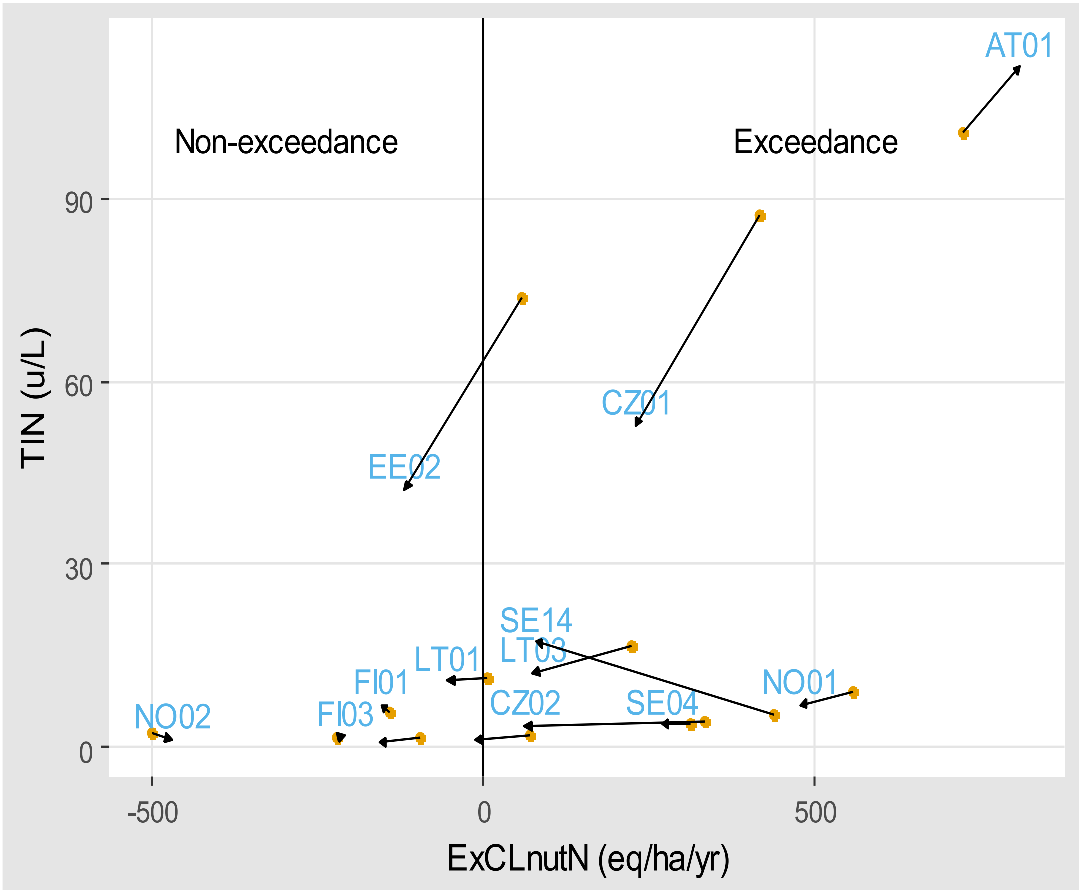


Figure 5c. The observed concentration of TIN in runoff (y-axis) versus the calculated exceedance of critical loads of nutrient N (x-axis), using observed input fluxes for deposition values. The arrows begin at the locations of the data points for the period 2000–2002 and end at the locations of the data points for the period 2013–2015.

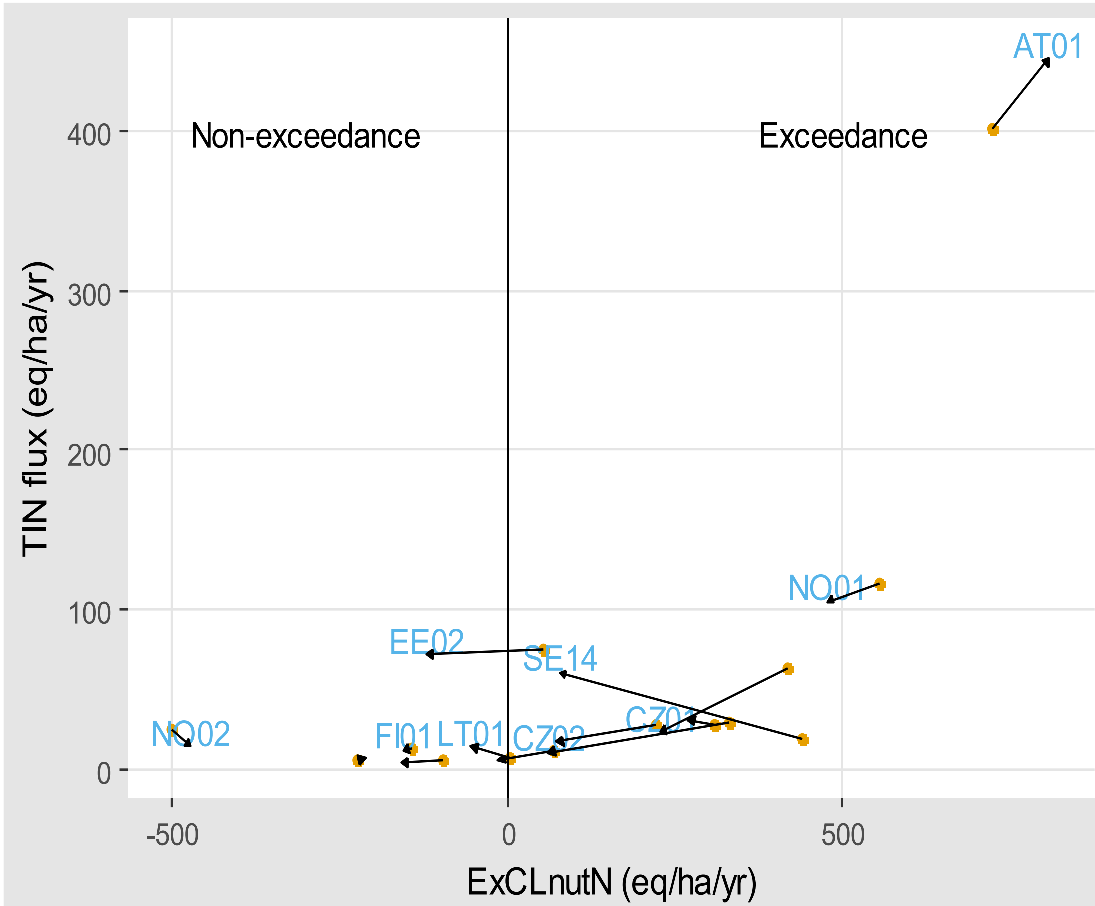
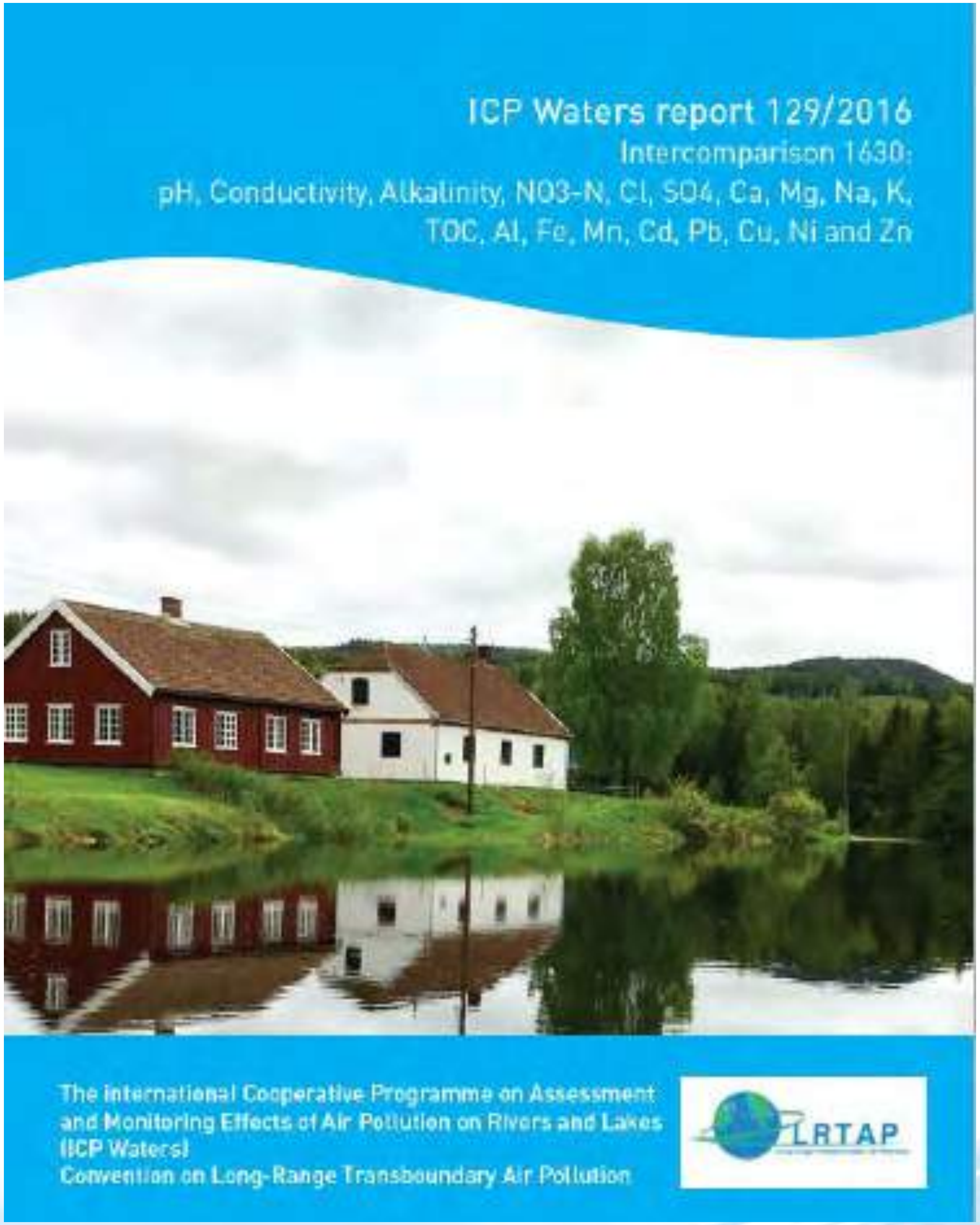


Figure 5d. The observed flux of TIN in runoff (y-axis) versus the calculated exceedance of critical loads of nutrient N (x-axis), using observed input fluxes for deposition values. The arrows begin at the locations of the data points for the period 2000–2002 and end at the locations of the data points for the period 2013–2015.

Intercomparison 1630

pH, conductivity, alkalinity, nitrate, TOC, major ions and trace metals


ICP Waters report 129/2016
Intercomparison 1630:
pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K,
TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni and Zn
The International Cooperative Programme on Assessment and Monitoring Effects of Air Pollution on Rivers and Lakes (ICP Waters)
Convention on Long-Range Transboundary Air Pollution
LRTAP

Intercomp number 30

Participation in intercomparison 1630

- 89 laboratories were invited to participate
- 35 laboratories from 20 countries accepted the invitation and submitted results for one or more parameters

Participation

Country	No. of labs.	Country	No. of labs.
Austria	1	Netherlands	1
Canada	1	Norway	1
Czech Republic	1	Poland	2
Estonia	1	Russia	6
Finland	2	Serbia	1
France	1	Spain	1
Germany	6	Sweden	1
Ireland	2	Switzerland	1
Italy	1	UK	3
Lithuania	1	USA	1

Preparation of the samples

- Water (50 L) was collected from Hakadal Verk (north of Oslo)
- Filtered (0,45 µm), stored at room temperature and left to equilibrate with atmosphere
- pH was lowered with addition of HCl and H_2SO_4 (sample set AB). Sample A diluted with MQ water.
- Sample set CD was spiked with metals and conserved (0.33 % HNO_3)

Results

				Acceptable Limit	Acceptable results (%)				
Variable	Sample pair	Sample 1	Sample 2	%	1630	1529	1428	1327	1226
pH	AB	6.00	6.04	3.3	56	64	68	52	59
Conductivity.	AB	4.08	4.59	10	77	89	93	78	72
Alkalinity.	AB	0.042	0.046	20	46	75	26	63	48
Nitrate + nitrite-nitrogen.	AB	276	309	20	71	88	14	0	52
Chloride.	AB	2.45	2.81	20	87	97	93	78	79
Sulphate.	AB	8.07	9.2	20	90	97	87	77	80
Calcium.	AB	3.9	4.42	20	93	97	97	85	75
Magnesium.	AB	0.41	0.47	20	89	100	87	82	74
Sodium.	AB	1.87	2.14	20	96	97	97	91	84
Potassium.	AB	0.43	0.49	20	86	97	97	70	81
Total organic carbon.	AB	4.09	4.65	20	81	70	82	78	76
Aluminium.	CD	255	270	20	78	89	78	89	79
Iron.	CD	186	190	20	91	81	74	72	70
Manganese.	CD	48	51.7	20	91	84	88	78	89
Cadmium.	CD	6.87	7.73	20	90	100	84	85	84
Lead.	CD	7.23	8.34	20	86	77	80	71	77
Copper.	CD	24.6	28	20	86	93	88	84	86
Nickel.	CD	10.2	11.5	20	90	97	92	83	78
Zinc.	CD	34.4	38.1	20	81	83	79	60	61
Total					81	88	80	73	74

Units: Conductivity: mS/m
Alkalinity: mmol/l
Nitrate+nitrite-N: µg N/l

Cl. SO4. Ca. Mg. Na. K. TOC: mg/l
Al. Fe. Mn. Cd. Pb. Cu. Ni. Zn: µg/l

pH

Analytical variable and method	Sample	TRUE Value		No. lab.		Avg/Std.av.	
	pair	S. 1	S. 2	Total	Omm.	Sample 1	
pH	AB	6.00	6.04	32	0	6.04	0.25
Electrometry				25	0	6.04	0.24
Stirring				4	0	5.89	0.17
Equilibration				2	0	6.37	
Other method				1	0	6.05	
Alkalinity	AB	0.042	0.046	24	8	0.041	0.007
Gran plot titration				9	1	0.044	0.008
End point titration				8	3	0.039	0.005
End point				2	2	0.079	
Other method				2	1	0.040	
Colorimetry				1	1	2.400	
End point 5.4				1	0	0.036	
End point 5.6				1	0	0.042	

Conclusions

- Accuracy in determination of major ions was very good(> 85 % had target accuracy < 20 %)
- Accuracy for trace metals and Fe was good (> 80 % had target accuracy better than 20 %)
- Accuracy for NO3, TOC and Al was fair (70-80% had target accuracy < 20 %)
- Accuracy for pH and alkalinity was poor (56 % or less had target accuracy better than 0.2 units and 20 %, respectively)

Intercomparison test 1731

- Will include phosphorous
- Free for labs within UN-ECE and EECCA that deliver results to national monitoring programs. Others have to pay a minor fee

Plan for Intercomp 1731

- 24 May : Deadline for registration in the database
- Week 24: Samples delivered to the participants
- 5 September: Deadline for reporting results in the database
- Week 46: Report available
- Interested parties can contact carlos.escudero@niva.no

CONVENTION ON
LONG-RANGE TRANSBOUNDARY AIR POLLUTION

International Cooperative Programme on
Integrated Monitoring of Air Pollution Effects on Ecosystems
25th ICP IM Task Force Meeting & Workshop

Organiser and Location

Swedish University of Agricultural Sciences, SLU

Uppsala

Swedish responsible

Swedish Environmental Protection Agency

Thursday 11 May

II. ICP IM Task Force meeting

Swedish University of Agricultural Sciences

ICP IM Task Force
Explanatory notes to the agenda

1. Opening of the meeting

2. Approval of minutes of the 24th ICP IM TF in Asker, Norway, 2016

Swedish University of Agricultural Sciences

ICP IM Task Force
Explanatory notes to the agenda

3. Report from Chairman and Programme Centre

Presented at the Working Group on Effects 2016

WGE chairman reported from EB
CLRTAP Strategy reviewed 2016
Monitoring specially mentioned
Emphasis on policy oriented messages and further actions by Parties
Joint report presented and accepted
Outreach to EECCA and SEE and translations
The Assessment report Report was presented in Brussels and Batumi

ICP IM Task Force
Explanatory notes to the agenda

Item 3 continues
Highlights in joint report

World Health Assembly resolution road map

Economic losses ozone impacts on wheat yield revealed Parties presented measures for emission reductions

Climate warming may increase the vulnerability of ecosystems

Excess N may have negative effects ; reductions policy relevant

Hg in fish over recommended values for humans

CH_4 on hemispheric scale to reduce ozone damage

Climate measures include reductions of methane and nitrous oxide

CCE meets problems with financing

ICP IM Task Force
Explanatory notes to the agenda

Item 3 continues

Two year workplan
A joint workplan together EMEP and WGE, currently 2016-2017
Next period: 2018 - 2019

Changed meeting structure;
EMEP and WGE together in September 2017
EB somewhat back to earlier scghedule but several meetings and a meeting in December 2017

EMEP and WGE homepages should have a common portal. But, now probably WGE homepage under UN ECE.

LRTAP
Long-range Transboundary Air Pollution

Item 4
Highlights from ICPs at WGE 2016

Forests – Database and evaluations priority; data used in publications

Waters – biodiversity would improve, in line with chemical recovery

Materials – trends in air pollution, corrosion and soiling showing a 50% decrease in corrosion since 1987 but in recent years poor further improvements

Vegetation – report on revised ozone risk assessment methods for vegetation; report analysis of tropospheric ozone – TOAR

IM – nitrogen still accumulates in the ecosystems and output is very low compared to input. S released from catchment soils. HM still accumulating in ecosystems.

Item 4 continues
Highlights from ICPs

MandM – Call for calculating biodiversity critical loads and by updating the acidification and eutrophication critical loads

TF Health – WHO AIRQ+ software to quantify the health impacts of air pollution

JEG – dynamic modelling in particular with respect to nutrient nitrogen biological response, aquatic biodiversity and climate

Updating of scientific and technical knowledge

The Joint report highlighted impacts of air pollution on human health.
Updated scientific and technical knowledge as presented above.
Reports with stronger connections to societal needs and also with direct response to the Convention requests.

LRTAP
Long-range Transboundary Air Pollution

Joint EMEP SB and WGE Bureau meeting

Item 5 Update scientific knowledge etc.

Joint thematic sessions three issues:
the linkages between climate change and air pollution; benzo(a)pyrene and wood burning; and ozone. Contribution of methane, black carbon and other climate change forcers.

Co-operation AMAP, Climate and Clean Air Coalition, EANET, etc.

CCE is financially problematic and the Netherlands intend to stop 2018.

Election WGE; Ms. Isaura Rabago (Spain) new Chair for a two-year term. Re-elected vice chairs Mr. Jesper Bak (Denmark), Ms. Gudrun Schuetze (Germany), Ms. Sabine Augustin (Switzerland), Mr. Thomas Dirnböck (Austria) and Mr. Nebojsa Redzic (Serbia).

Next WGE, No. 36, is scheduled for 11-15 September 2017.

wge Working Group on Effects of the Convention on Long-range Transboundary Air Pollution

Swedish University of Agricultural Sciences SLU

Joint EMEP SB and WGE Bureau meeting

Item 6

The ICP review concludes the importance of continuing monitoring and enhances the co-operation between ICPs as well as between WGE and EMEP.

CLRTAP launched a summary report, Towards Cleaner Air

Next Workplan is for 2 years with content reported by May 20.

WGE homepage; a page under UN ECE; "unece-wge.org"

HTAP, consider interactions between air pollution and climate including ozone, atmospheric compounds, Hg, ozone and POPs.

LRTAP
Long-range Transboundary Air Pollution

Item 7

7. CLRTAP Workplan

Workplan 2016-2017

WGE 2017 joint EMEP and WGE meeting

ICPs present the obligations and monitoring work content for the leading countries and the PCs.

Mandates to be presented related to the CLRTAP strategy and an update of the MoU.

LRTAP
Long-range Transboundary Air Pollution

Item 7

7. CLRTAP Workplan

ICP IM Mandates

There is a template for revised mandate for a WGE ICP/TF/Centre

Lead country: Sweden
ICP IM PC at SYKE, Finland

Determination and prediction of the state of ecosystems and their long-term changes with respect to the regional variation and impact of selected air pollutants, with special attention to effects on biota.

LRTAP
Long-range Transboundary Air Pollution

ICP Integrated Monitoring

Ecosystem investigation

Monitor state and changes with causative explanations
Develop and validate models
Detect changes by biomonitoring

Cause-effect approach
Cross-media flux approach

wge Working Group on Effects of the Convention on Long-range Transboundary Air Pollution

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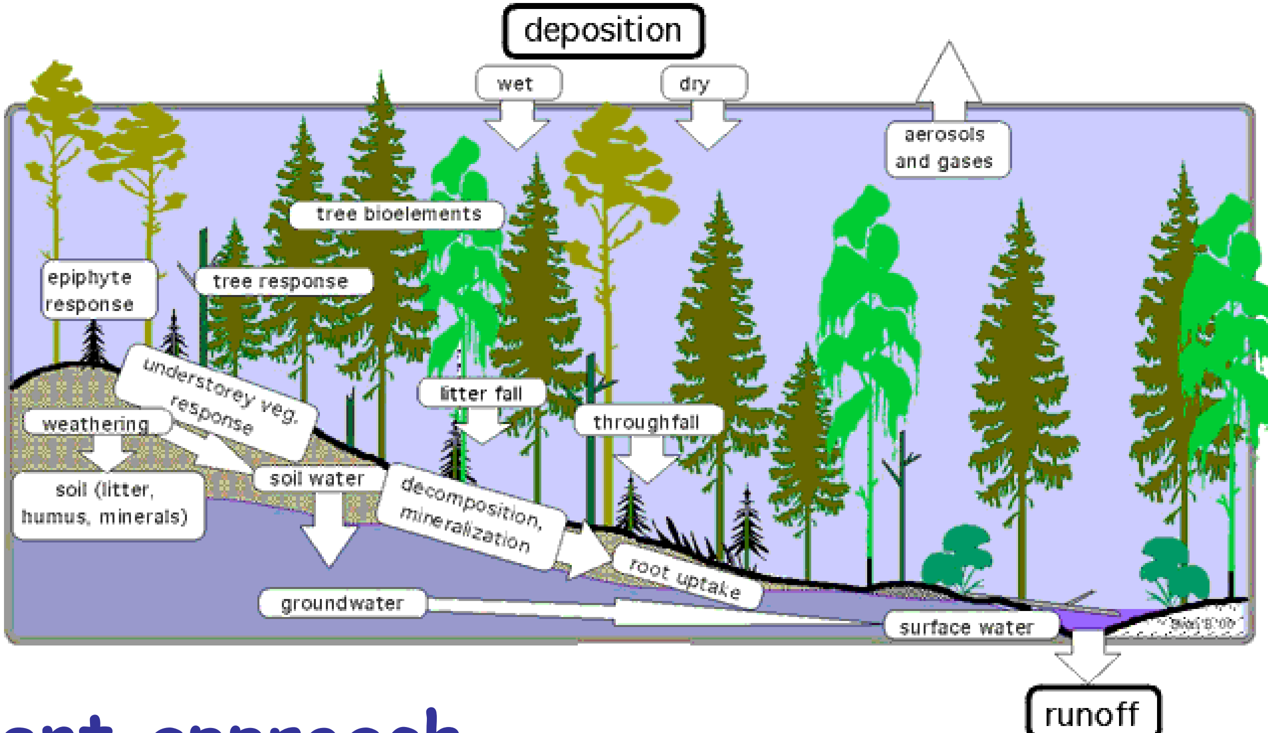
LRTAP
Long-range Transboundary Air Pollution

Integrated Monitoring



Catchment approach
Budget calculations
Process oriented

wge Working Group on Effects of the Convention on Long-range Transboundary Air Pollution

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Item 8 - ICP IM activities 2016

The ICP IM activities in 2016/2017 included work on S and N in-/output budgets for IM sites, dynamic vegetation modelling, the Annual ICP IM Report No 25 and common items such as outreach and common activities (ECE/EB.AIR/WG.1/2016/8).

Representatives have participated in a number of international meetings.

Database update (later item 10)

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Long-range Transboundary Air Pollution

Item 9

Reports from WGE and other ICPs

Possibly

Heleen de Wit, ICP Waters; Recent activities of ICP Waters

wge Working Group on Effects of the Convention on Long-range Transboundary Air Pollution

Swedish University of Agricultural Sciences SLU

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Long-range Transboundary Air Pollution

Item 10

Database

Item 11

Reports 2017

26th ICP IM Annual Report

Progress Report on connections between calculated CL exceedances and observed impacts of N. ICP IM PC.

Progress Report on concentrations of heavy metals in important forest ecosystem compartments (Sweden and ICP IM PC)

Report on mercury in the aquatic environment; Joint Report together with ICP Waters with ICP IM contribution

Comparison of activities across continents and regions; outreach and hemispheric view will relate to HTAP, EECCA, SEE and LTER as regards ICP IM

Item 11

Reports 2017

Common activities

Contributions to WGE/EMEP Joint report with policy relevant results

Revised Mandates

Technical reporting

Swedish University of Agricultural Sciences SLU

Item 12

Technical Reports and deliverables

The Joint report should present important results with policy relevance to May 20, 2017.

Medium term workplan for ICP IM has plans for the year 2018 and 2019 which will be covered under item 15; technical report submitted June 1, 2017,

Co-operation between WGE and EMEP with a joint meeting 11-14 September 2017,

Preparations of the 36th session of WGE, ordinary ICP activities will be given a short overview with main focus on common items and thematic scientific reporting, especially policy relevance of the ICP results

Item 14

Co-operation with other ICPs and external projects/organizations:
LTER-Europe, ALTER-Net, LifeWatch, Expeer Natura 2000, etc.

More meetings could be found on;
https://www.unece.org/environmental-policy/conventions/envlrtapwelcome/meetings-and-events.html#/

LTER Europe
ILTER
ALTER-Net

Other future work priorities

Item 15 Work plan 2017 and 2018-2019

2018

Scientific paper on long-term trends in atmospheric deposition and runoff water chemistry of S and N compounds at ICP IM catchments in relation to changes in emissions and hydrometeorological conditions

Scientific paper on dynamic modelling on the impacts of future deposition scenarios on soil and water conditions in ICP IM catchments

Reporting of ICP IM activities to WGE

LRTAP
Long-range Transboundary Air Pollution

Item 15 Work plan 2017 and 2018-2019

2019

Report on dynamic modelling on the impacts of deposition and climate change scenarios on ground vegetation (ICP IM)

Scientific paper on the relationship between critical load exceedances and empirical ecosystem impact indicators (ICP IM).

Reporting of ICP IM activities to WGE

Item 16

Financing/external applications

- Trust fund – small amendments, slight decrease
- Parties support most important
- EU Horizon 2020
- *FTP and SRA*

Item 17

Next Task Force meeting

ICP Integrated Monitoring of Air Pollution Effects on Ecosystems -

ICP IM

Next Task Force

2018

Swedish University of Agricultural Sciences

ICP IM TF 2018

in May in Poland










LRTAP
Long-range Transboundary Air Pollution

Item 18

Other business

LRTAP
Long-range Transboundary Air Pollution

Item 18

Other business

Sensitive issue

Lars Lundin will retire mainly due to Swedish Regulations
and have a suggestion

Ass. Professor Ulf Grandin will take over

This is recognised by SE EPA and SLU

Item 19

Conclusion and end

Thank You

The End

Swedish University of Agricultural Sciences

DATA AND INFORMATION CENTRE

IM data submission and database status

Sirpa Kleemola, SYKE
ICP IM Task Force meeting,
Uppsala, Sweden
May 9-11, 2017

SYKE

ICP IM network

- data submission for at least part of the 'data period' 2011–2015: Austria, Belarus, the Czech Republic, Estonia, Finland, Germany, Ireland, Italy, Lithuania, Norway, the Russian Federation, Spain, Sweden, Switzerland and site on Crimean peninsula.
- Poland is re-joining and will include one or more sites to the network.
- Total 43 sites from 15 countries.
  - Canada, Latvia and United Kingdom have not reported data for recent years

DATA AND INFORMATION CENTRE

SYKE

DATA AND INFORMATION CENTRE

Data reported in 2016/2017

For data year 2015

- 13 countries have reported 2015 data so far
  - Austria, Belarus, the Czech Republic, Estonia, Finland, Germany, Italy, Lithuania, Norway, the Russian Federation, Spain, Sweden, Switzerland.
  - Some sites/subprogrammes missing from above mentioned countries
- For details please see Draft Annual Report 2017

SYKE

DATA AND INFORMATION CENTRE

Data reporting in 2017

- Deadline 1st of Dec 2017 for 2016 values
- No changes in reporting formats
- Some changes to biological data reporting done in 2010, raw data, not averages, examples and reporting guidelines available
- For new Input programme data per area+subprogramme, e.g. FI01_RW_2016.txt or FI01_RW_2016.xls

SYKE

DATA AND INFORMATION CENTRE

Thank you for your attention!

SYKE