Joint Task Force of ICP Waters and ICP IM 2018
presentations Monday 7 May 2018 - Wednesday 9 May 2018

Content thematic sessions Climate (and land use), Biodiversity, Nitrogen, The NEC directive, Status and progress, Common sessions of ICP Waters and ICP Integrated Monitoring Chemical and biological inter-calibration (ICP Waters)

Climate (and land use)
Predicting DOC response to reductions in acid deposition
Don Monteith

Are boreal lakes pipes or chimneys in the global carbon cycle - Long-term monitoring of DOC and process-based modelling in a lake catchment
Heleen de Wit

Biodiversity
Observed and modelled trends in forest vegetation in ICP Integrated Monitoring, Forests, and LTER sites in Europé — Not available
Gisela Pröll

Nitrogen
Nitrogen and phosphorus at Lysina CZ02
Pavel Krám

Long-term changes in the inorganic nitrogen output fluxes in European ICP Integrated Monitoring catchments - an assessment of the role of internal nitrogen parameters
Jussi Vuorenmaa

Reactive nitrogen in freshwaters - the 2019 ICP Waters report
Heleen de Wit

Nitrogen budget at the IM station Puszcza Borecka
Rafal Ulanczyk

The NEC directive. Status and progress
Introduction/background NEC Directive
Salar Valinia

Spanish aquatic ecosystem monitoring programs: possibilities to comply with requirements of NEC Directive and ICP Waters and ICP IM
Manuel Toro Velasco

Common sessions of ICP Waters and ICP Integrated Monitoring
Chemical and biological inter-calibration (ICP Waters)
Biological intercalibration 2017
Anker Halvorsen

Chemical intercalibration
Øyvind Garmo

Thematic reports of common interest
Status and future plans ICP Waters — Not available
Heleen de Wit

Future plans ICP IM
Martin Forsius

Separate Task Force meetings
ICP IM 26th Task Force
Ulf Grandin, Salar Valinia

ICP IM data base status
Sirpa Kleemola

Predicting DOC response to reductions in acid deposition

Don Monteith –
Centre for Ecology & Hydrology
Lancaster Environment Centre, UK

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With particular thanks to:

Peter Henrys, Jakub Hruška,

Heleen De Wit, Pavel Krám,

Iain Malcolm, Filip Moldan,

Gloria Pereira, Antii Räike,

John Stoddard & Chris Evans

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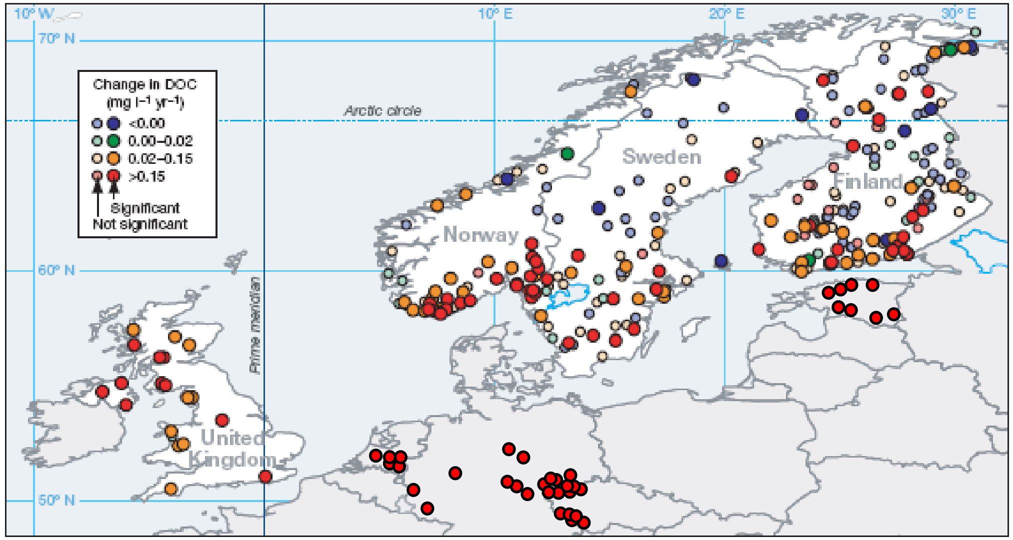
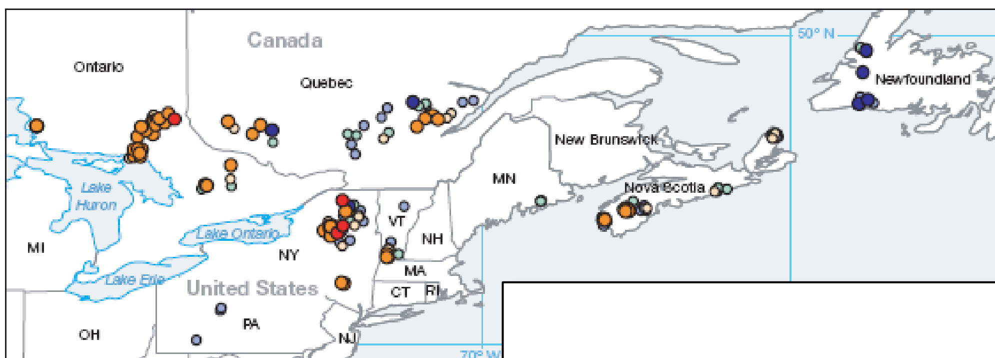
Hemispheric scale increase in Dissolved Organic Carbon (DOC) over recent decades





LETTERS

Dissolved organic carbon trends resulting from changes in atmospheric deposition chemistry

Donald T. Monteith[1]*, John L. Stoddard[2]*, Christopher D. Evans[3], Heleen A. de Wit[4], Martin Forsius[5], Tore Høgåsen[4], Anders Wilander[6], Brit Lisa Skjelkvåle[4], Dean S. Jeffries[7], Jussi Vuorenmaa[5], Bill Keller[8], Jiri Kopácek[9] & Josef Vesely[10]‡

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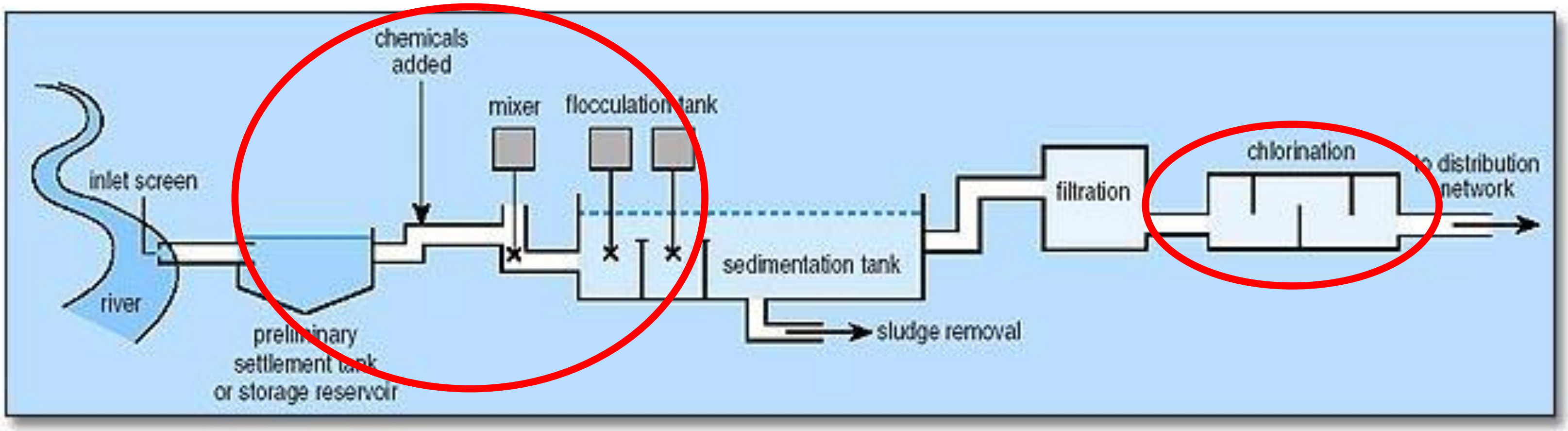
Economics of Dissolved Organic Matter (DOM)

- Upland catchments with organic-rich soils provide 70% of UK drinking water (Defra, 2011)
- DOM + chlorination = Trihalomethanes (THMs)



- DOM removal for typical plant (processing 60 ML/day)

  = £480K per year. (NEA, 2010)
- Scaled up for 70% UK population (150 litres/person)

  £50 million per year

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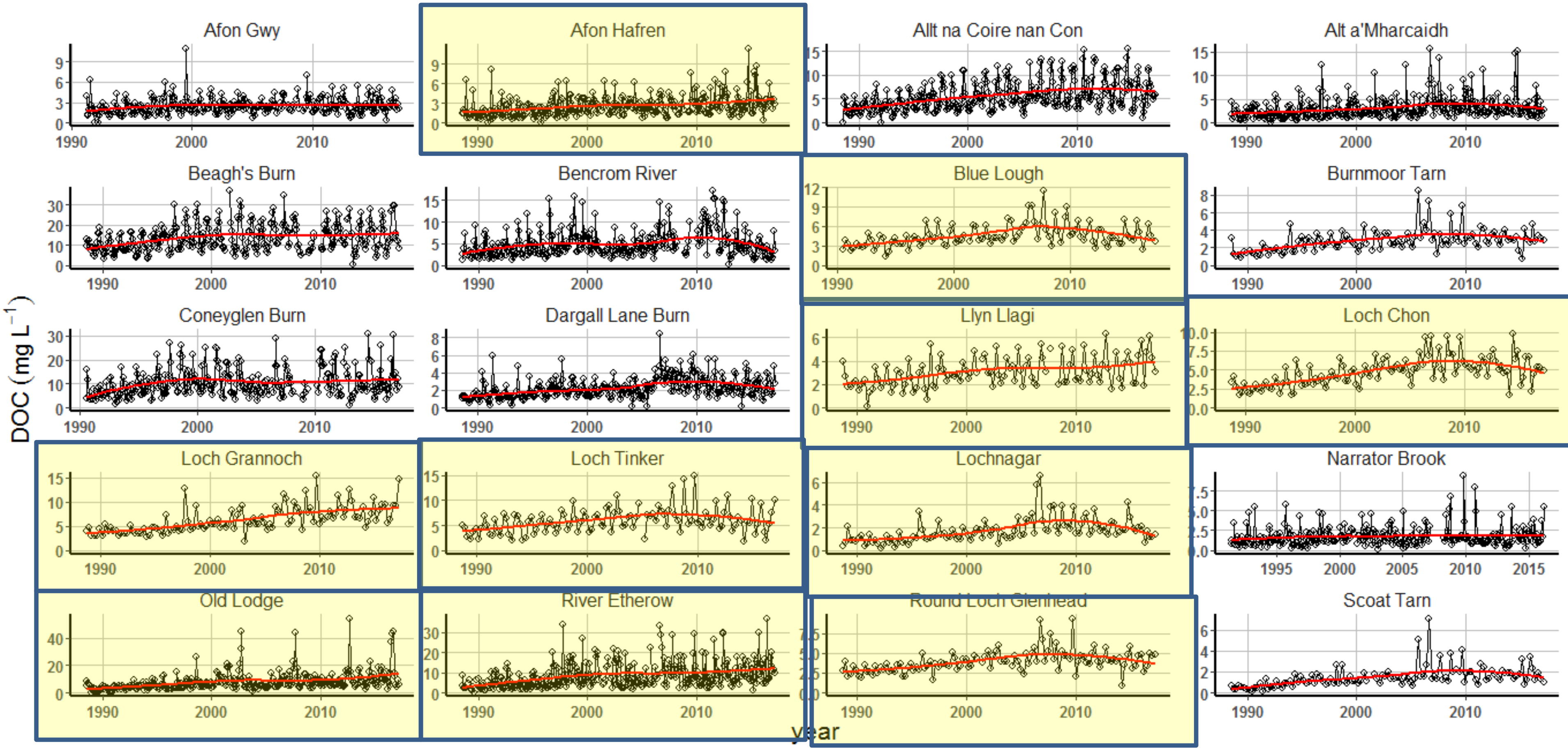
Continuing or flattening out in the UK?



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Industry needs to know what will happen next

in order to:

- Identify water treatment plants most at risk of exceeding threshold concentrations
- Plan for future coagulant use
- Determine potential to intervene at catchment level

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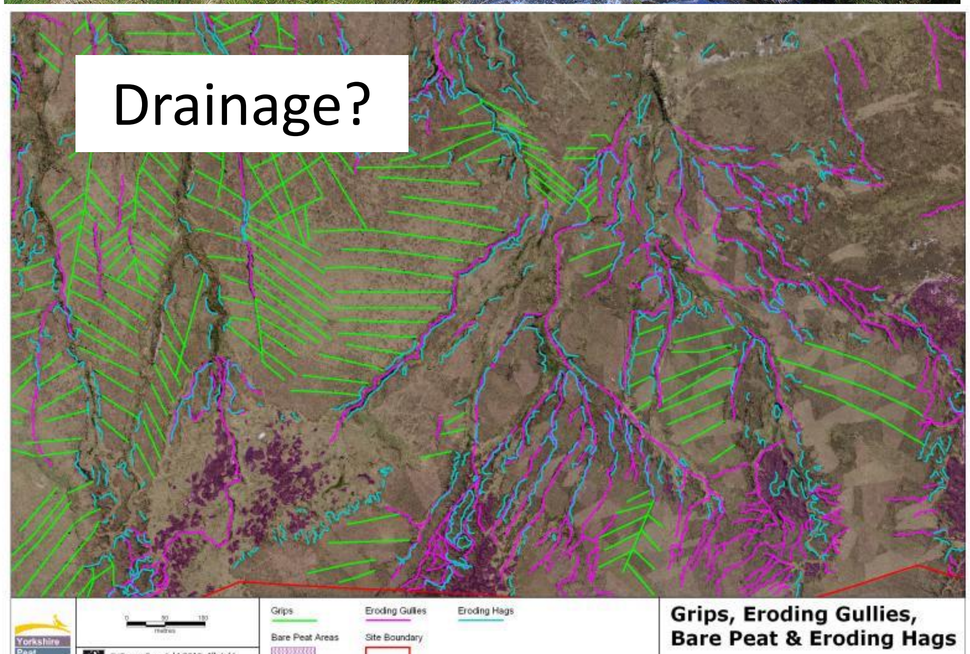
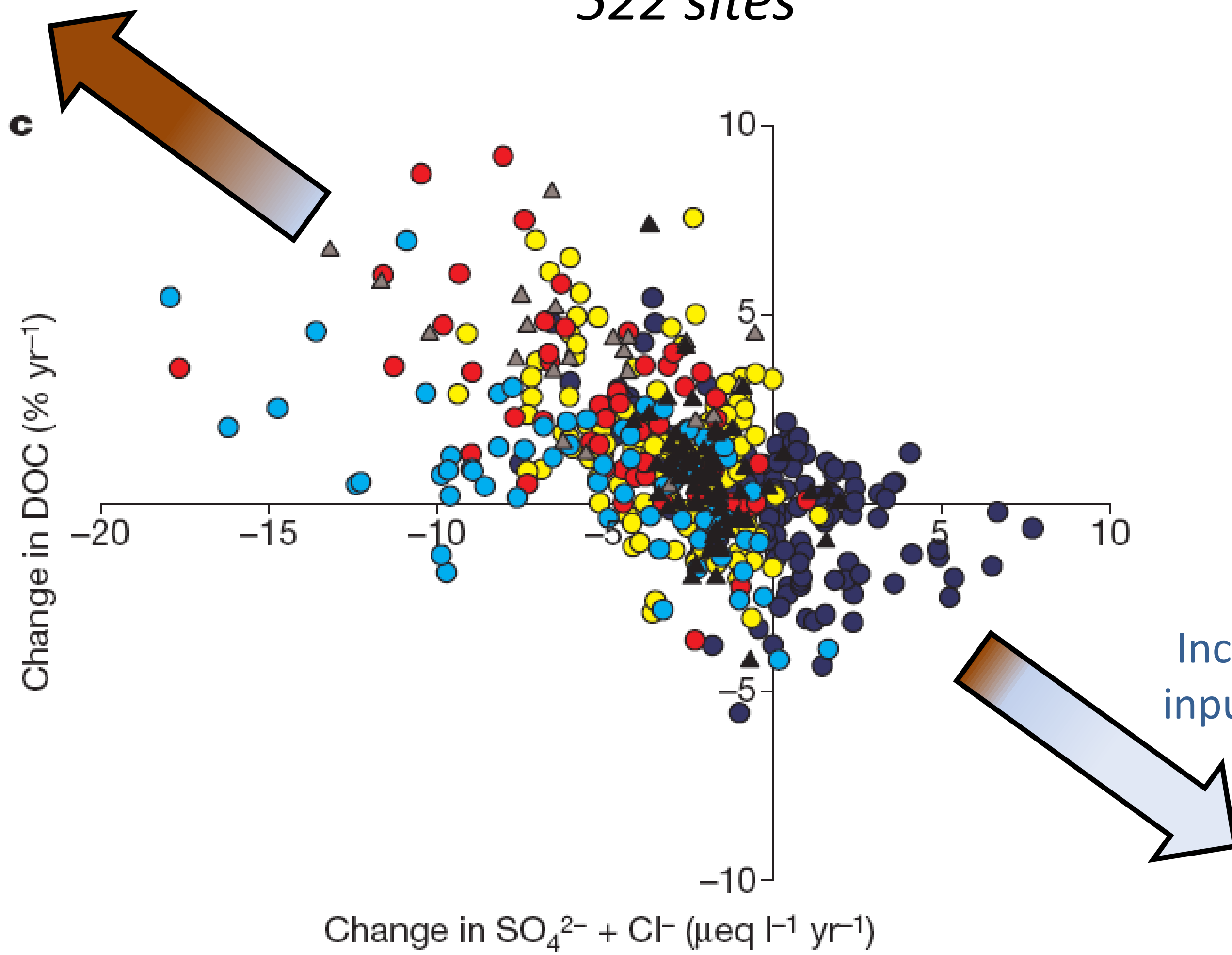
Would it help to control………………..?



DOC trends linked to trends in acid anions

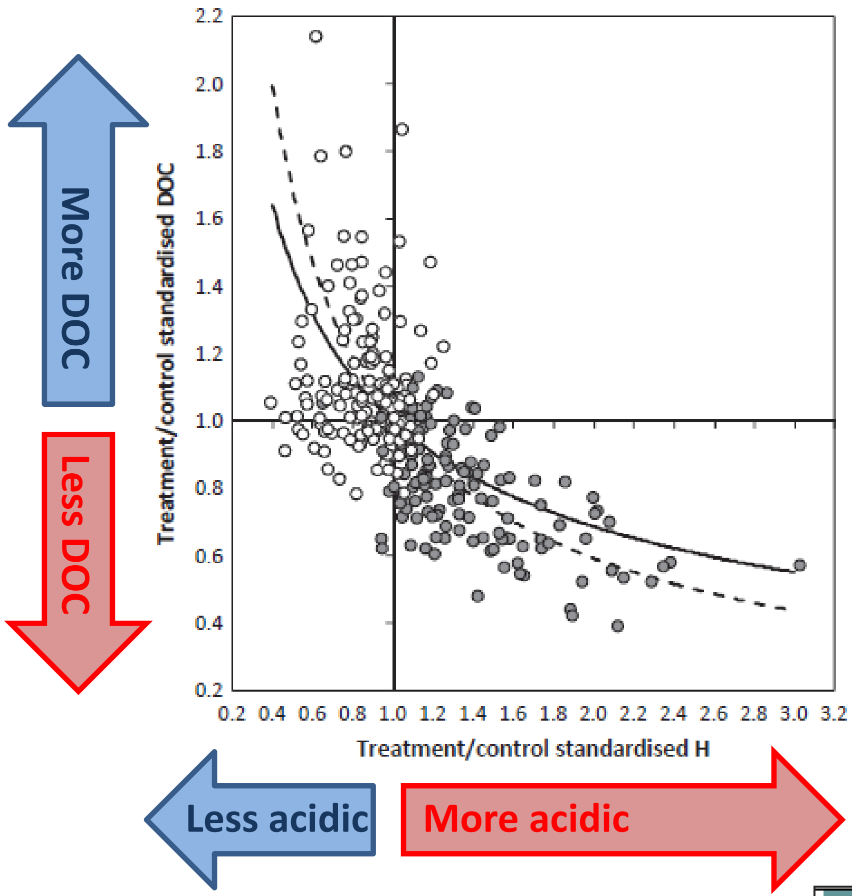
DOC change versus acid anion change:
522 sites



Increasing acid inputs = clearer water

Monteith et al., Nature 2007

and soil acidity



Global Change Biology

Global Change Biology (2012) 18, 3317–3331, doi: 10.1111/j.1365-2486.2012.02794.x

Acidity controls on dissolved organic carbon mobility in organic soils

CHRIS D. EVANS*, TIM G. JONES†, ANNETTE BURDEN*, NICK OSTLE‡, PIOTR ZIELIŃSKI†,§, MARK D. A. COOPER*†, MIKE PEACOCK†, JOANNA M. CLARK¶, FILIP OULEHLE*‖, DAVID COOPER* and CHRIS FREEMAN†

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……….and ionic strength of runoff

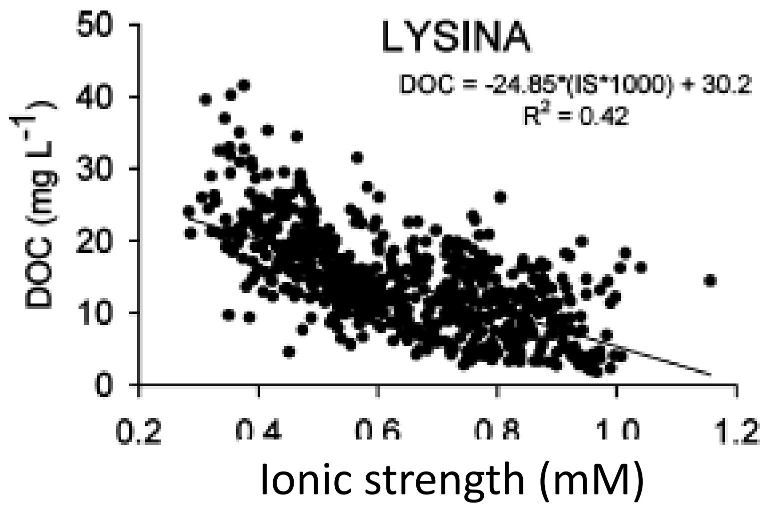
$$IS = 0.5 \times \Sigma_i c_i Z_i^2$$

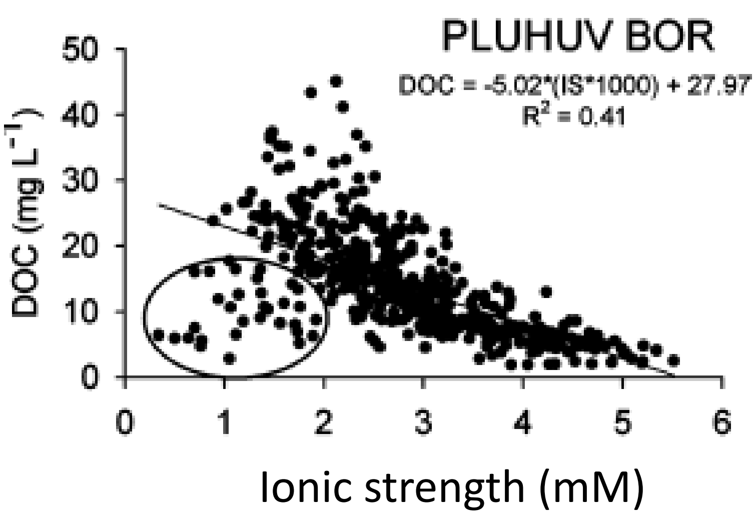
Environmental Science & Technology

Increased Dissolved Organic Carbon (DOC) in Central European Streams is Driven by Reductions in Ionic Strength Rather than Climate Change or Decreasing Acidity

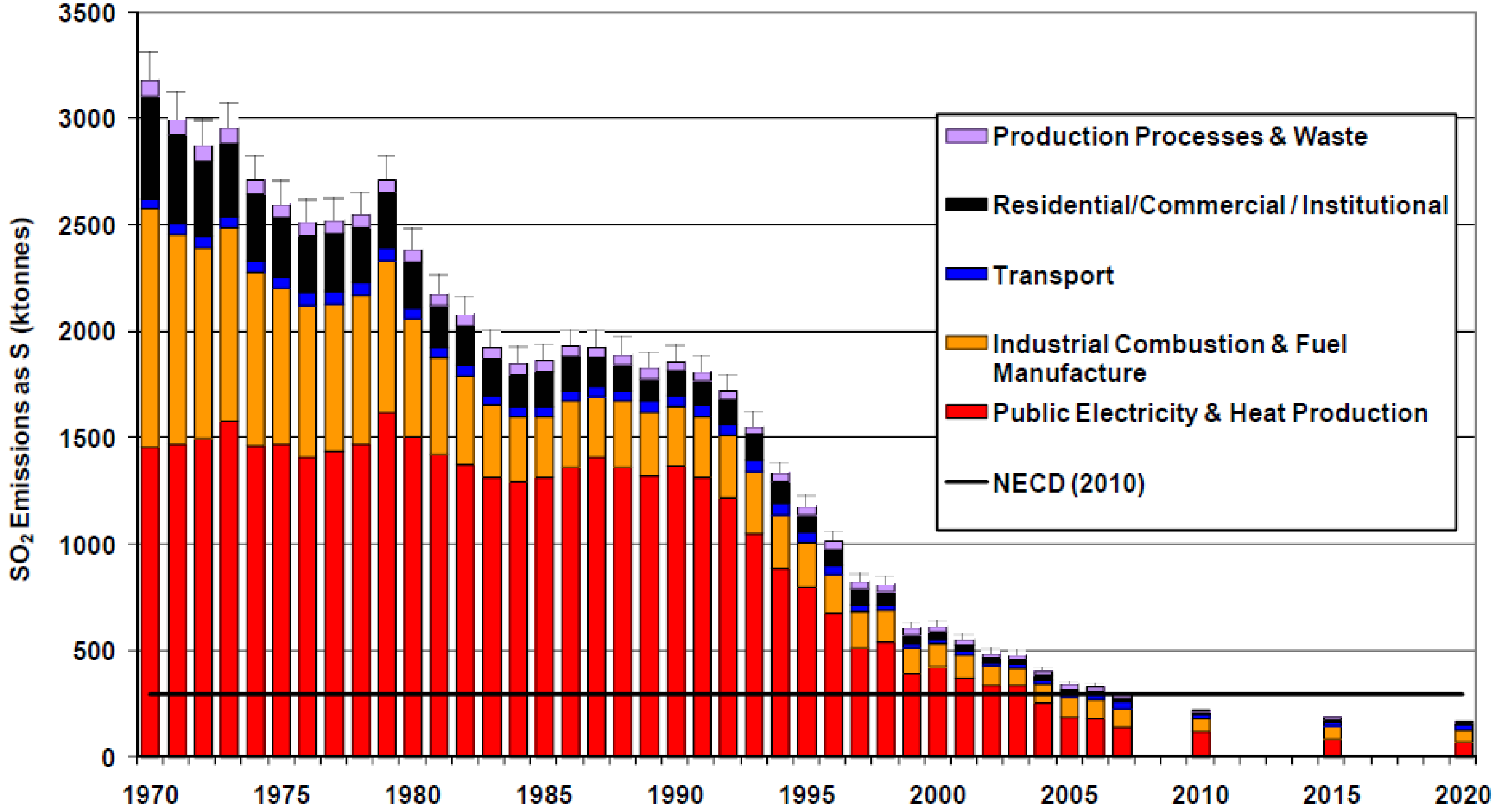
JAKUB HRUŠKA,*,† PAVEL KRÁM,† WILLIAM H. MCDOWELL,‡ AND FILIP OULEHLE†

Czech Geological Survey, Klárov 3, 118 21, Prague 1, Czech Republic, and Department of Natural Resources and the Environment, University of New Hampshire, Durham, New Hampshire 03824





Last few decades - huge reduction in UK sulphur emissions and sulphur deposition



UK Monitoring Starts

NEGTAP: 2010

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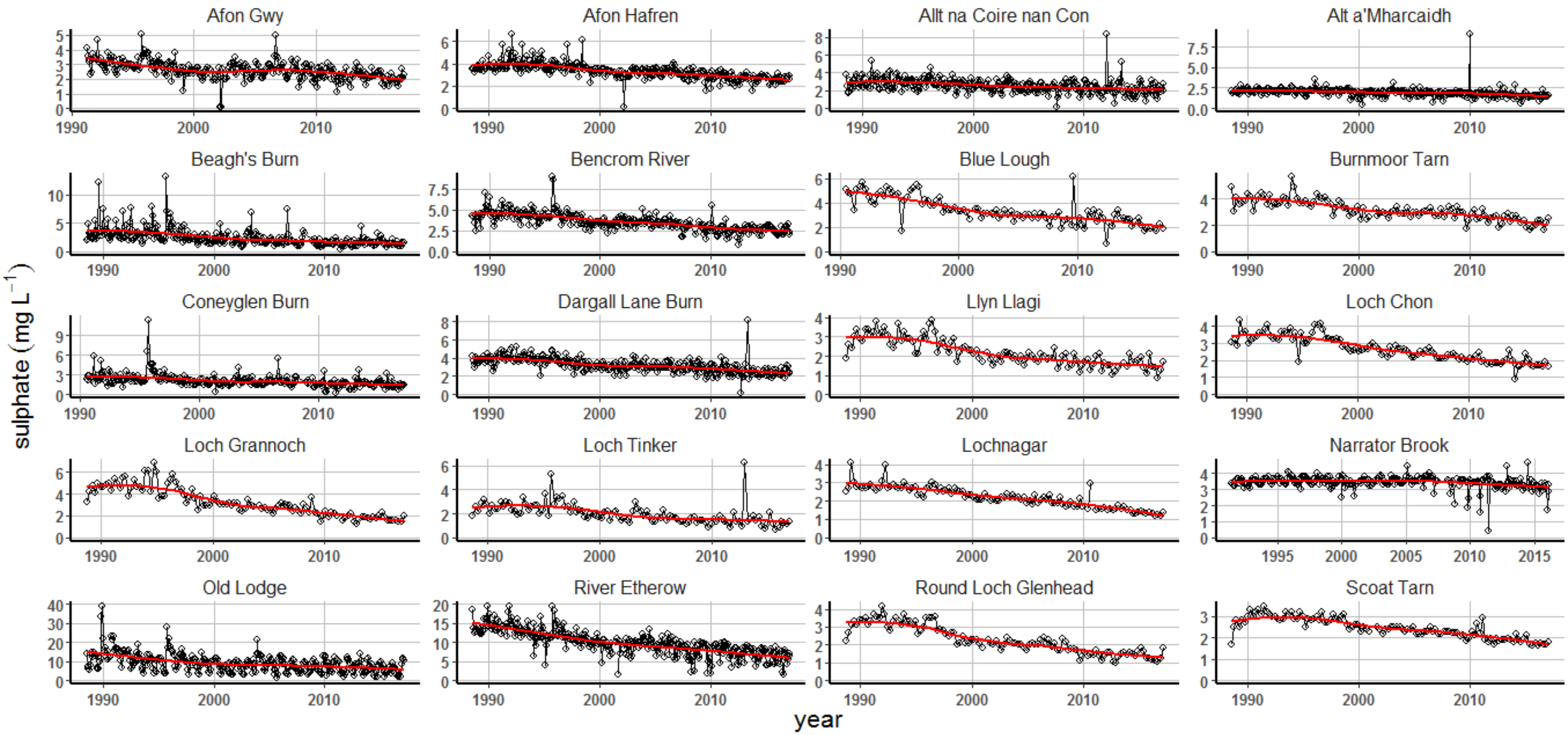
Lagged response in surface water sulphate.
Concentrations continue to trend downwards at several sites



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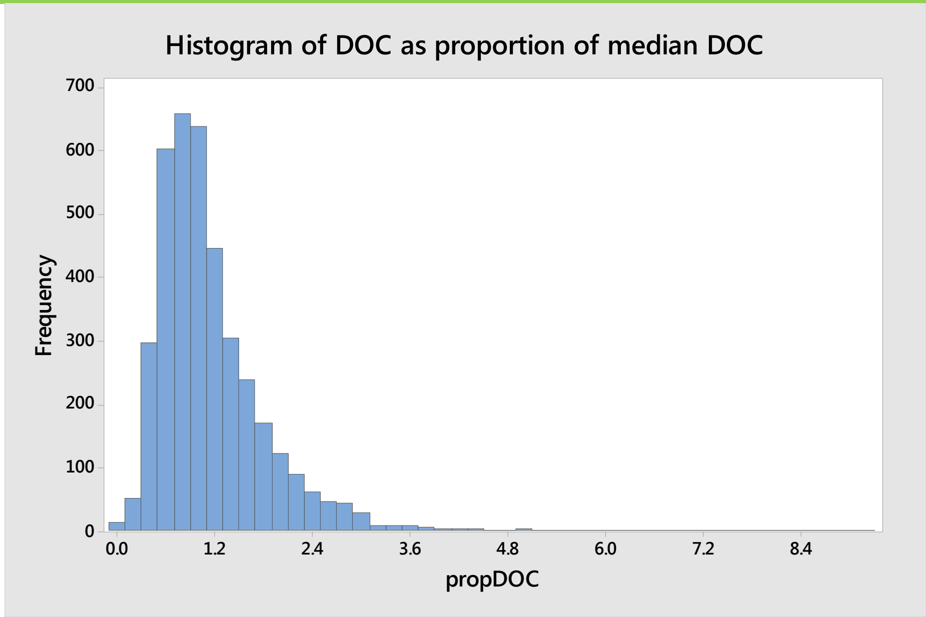
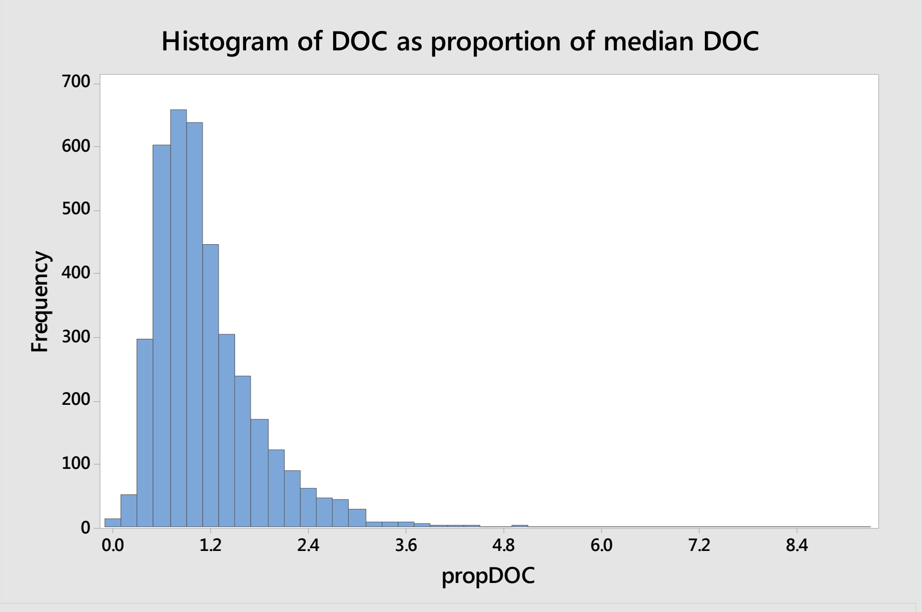
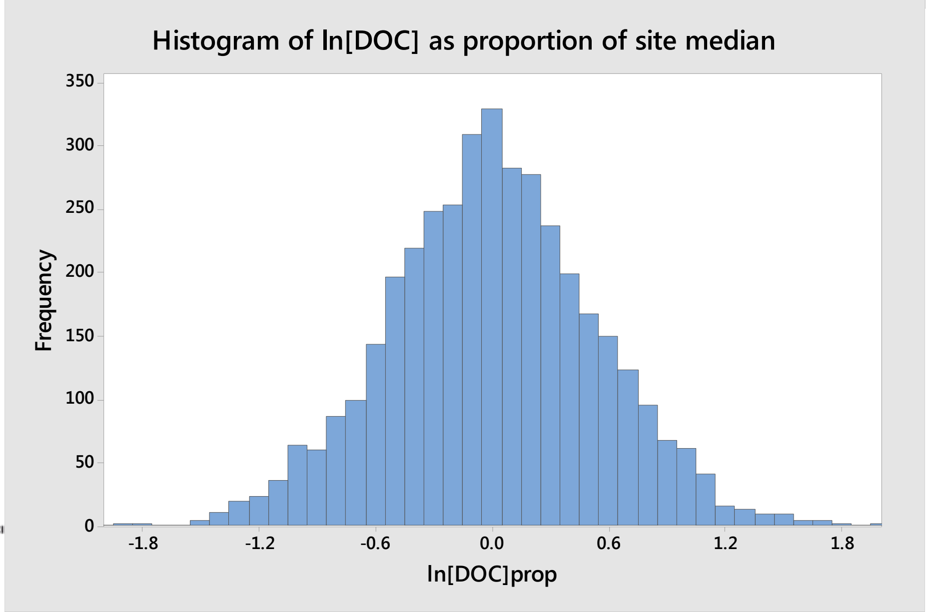
UK DOC data (20 sites, 3700 data points) transformed to: proportion of site median DOC



UK DOC data transformed to: proportion of site median…………..and then logged (ln DOC_{prop})





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What hydrochemical variables best explain variation in ln DOC_{prop}?

Candidates

- SO_4^{2-} concentration
- Cl^- concentration
- Sum Acid Anions (SAA) ($SO_4^{2-} + Cl^- + NO_3^-$)
- ANC (Sum Base Cations – Sum Acid Anions)
- Ionic strength (IS)

$$IS = 0.5 \times \Sigma_i c_i Z_i^2$$

Expressed as:

- Absolute concentrations
- Difference from site mean concentration
- Proportion of site mean concentration

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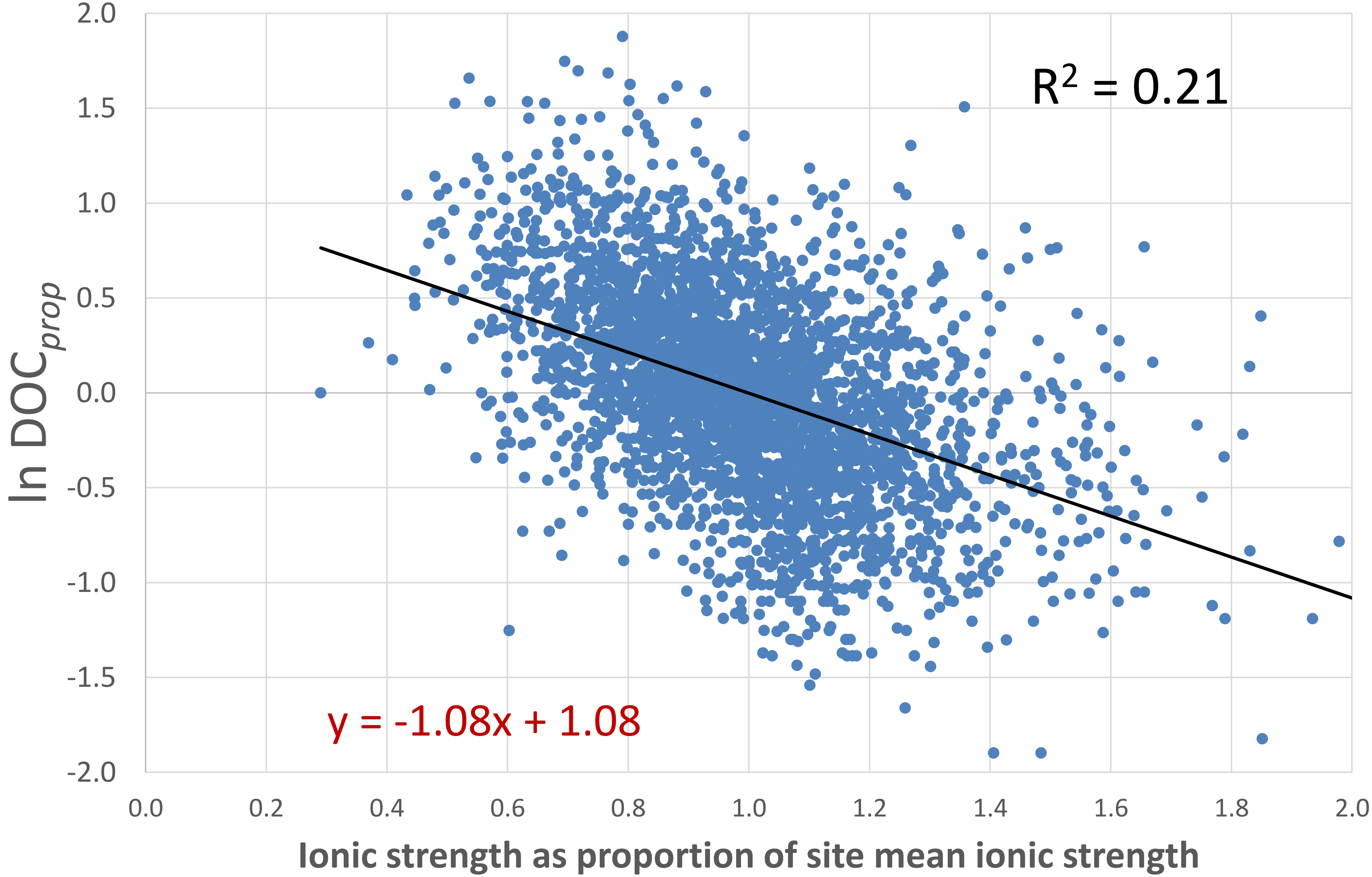
ln DOC_{prop} = 1 - Ionic $strength_{prop}$



Model refined by site-specific calibration

site *i*
time *t*

$$\ln \mathrm{DOC}_{prop(i,t)} = \mathrm{f} - \mathrm{f}^{*}\mathrm{IS}_{\mathrm{prop}\,(i,t)}$$

$$\mathrm{DOC}_{(i,t)} = \mathrm{DOC}\bar{x}_{(i)}.e^{\left(\mathrm{f} - \mathrm{f}*\mathrm{ISprop(i,t)}\right)}$$

Where f = site-specific IS – DOC calibrated constant
Ranging from 1 - 3 depending on base-flow index

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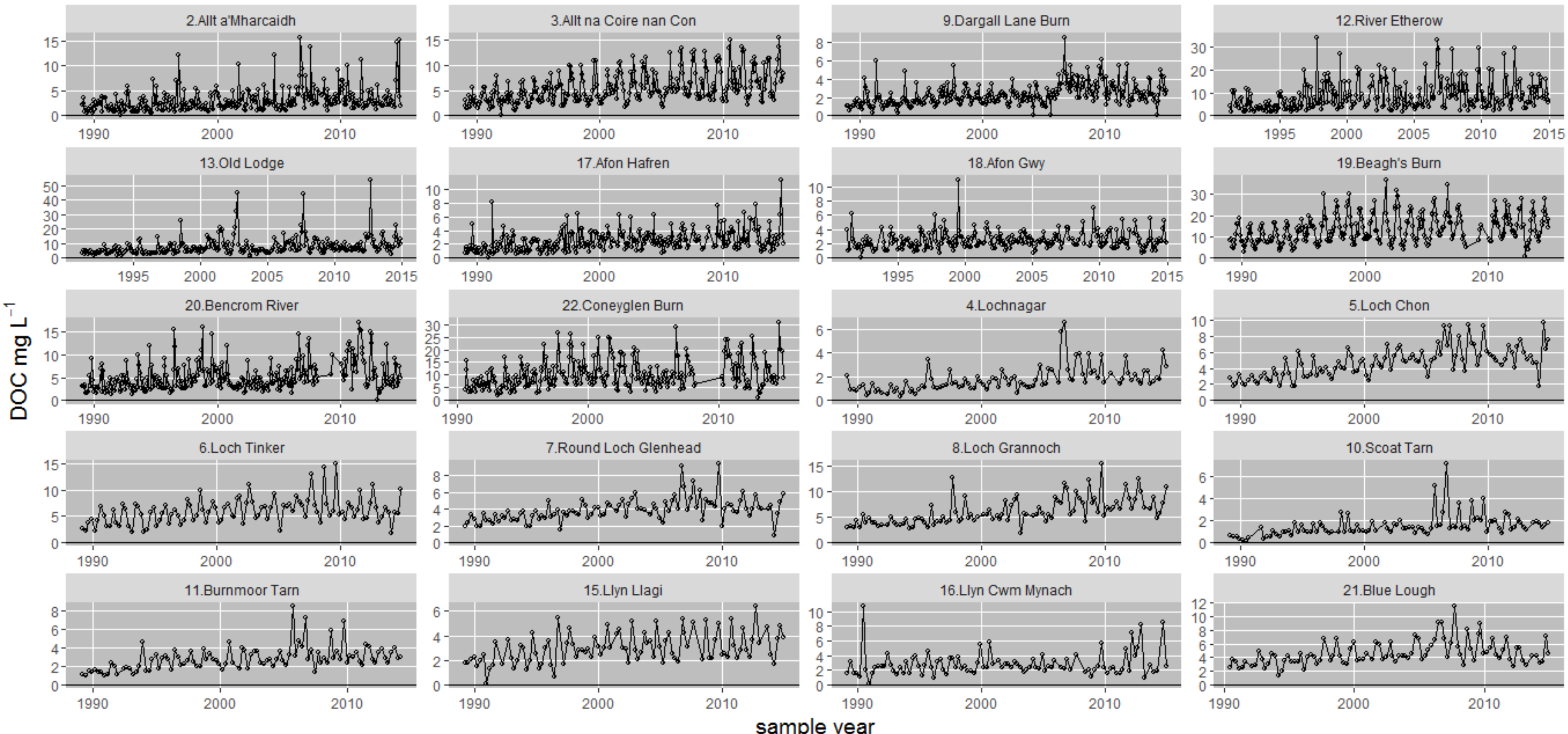
Baseline DOC trend predictable from trend in ionic strength



Black trace = Measured DOC

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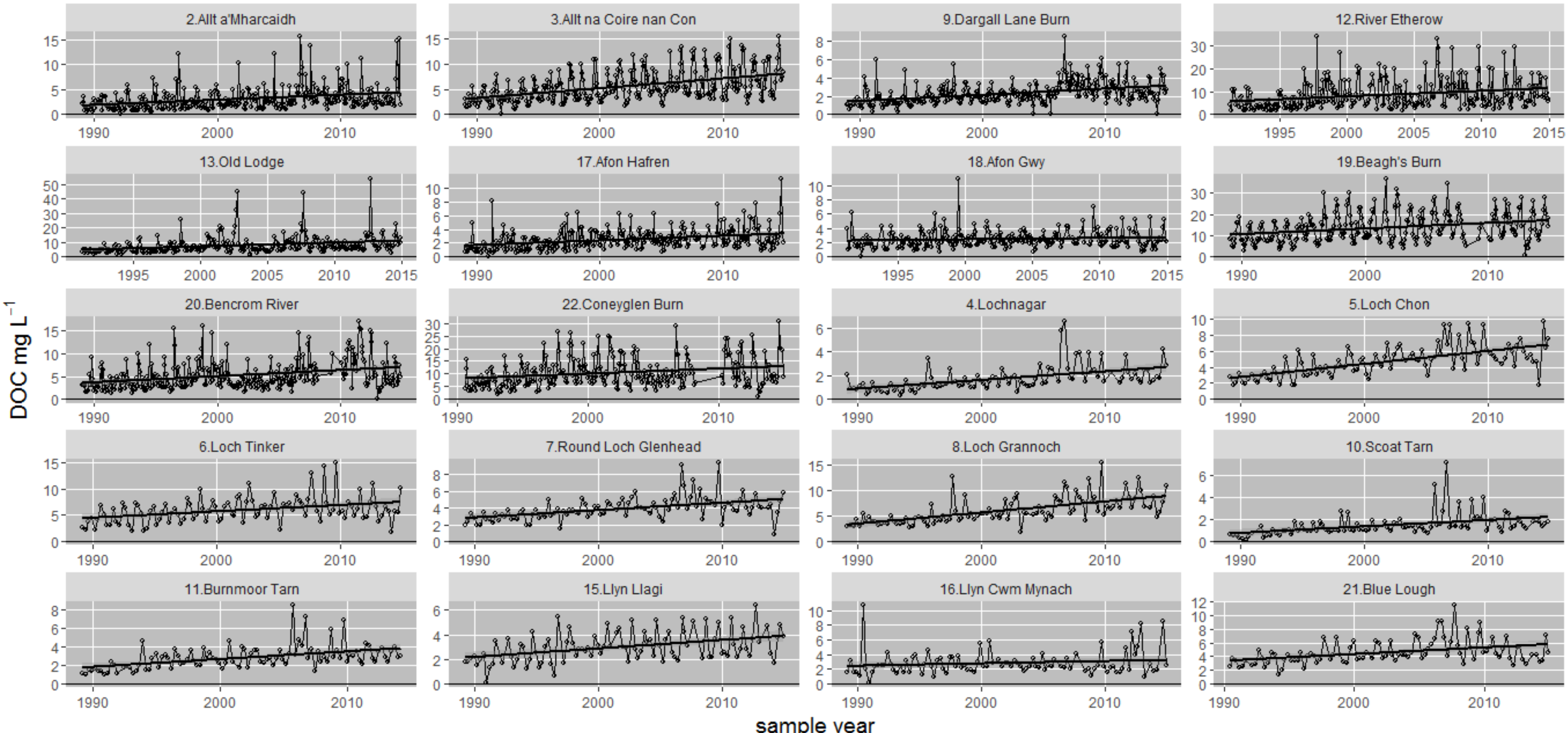
Baseline DOC trend predictable from trend in ionic strength



Black trace = Measured DOC

Black line = linear DOC trend

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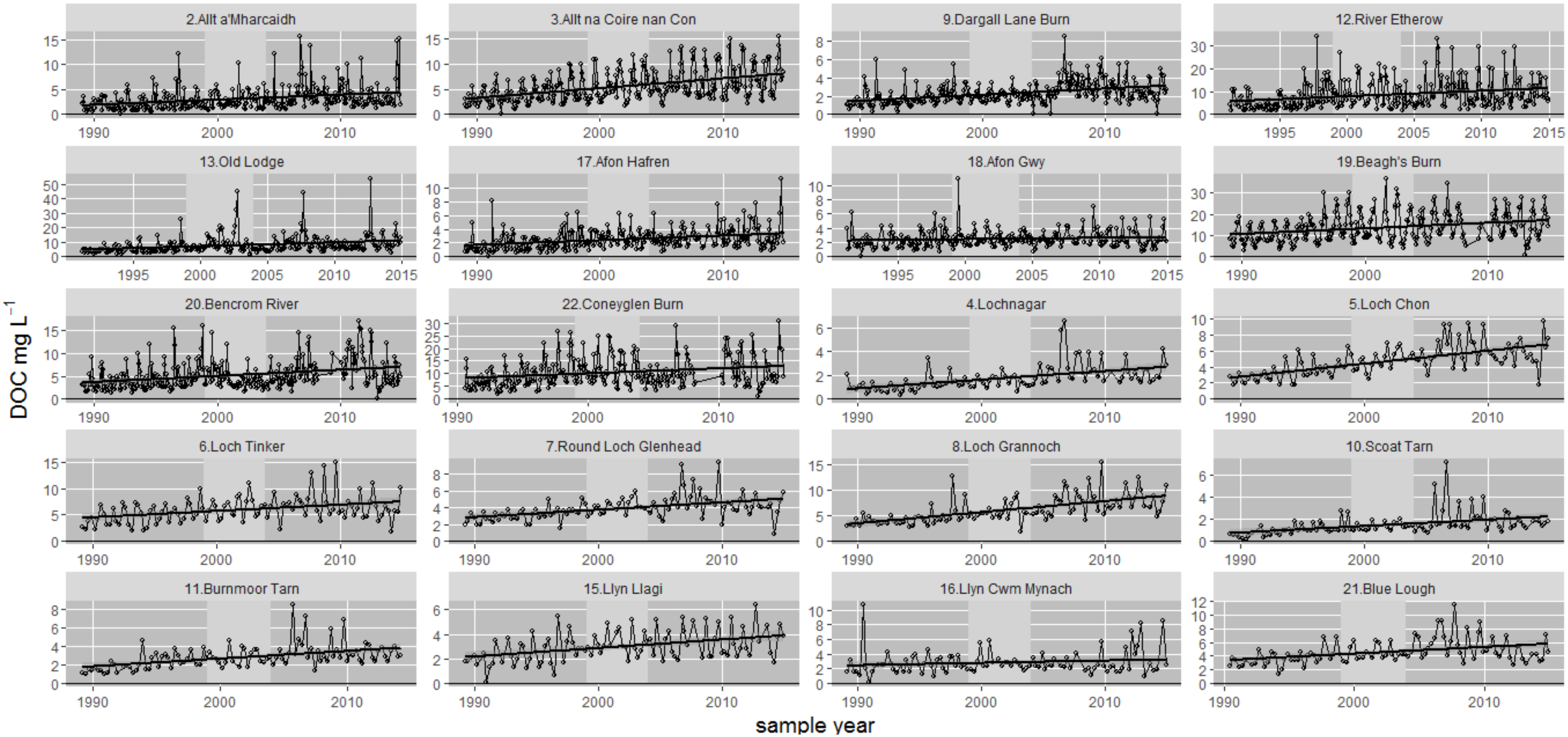
Baseline DOC trend predictable from trend in ionic strength



Black trace = Measured DOC

Black line = linear DOC trend

Light grey hatching = DOC vs IS calibration period

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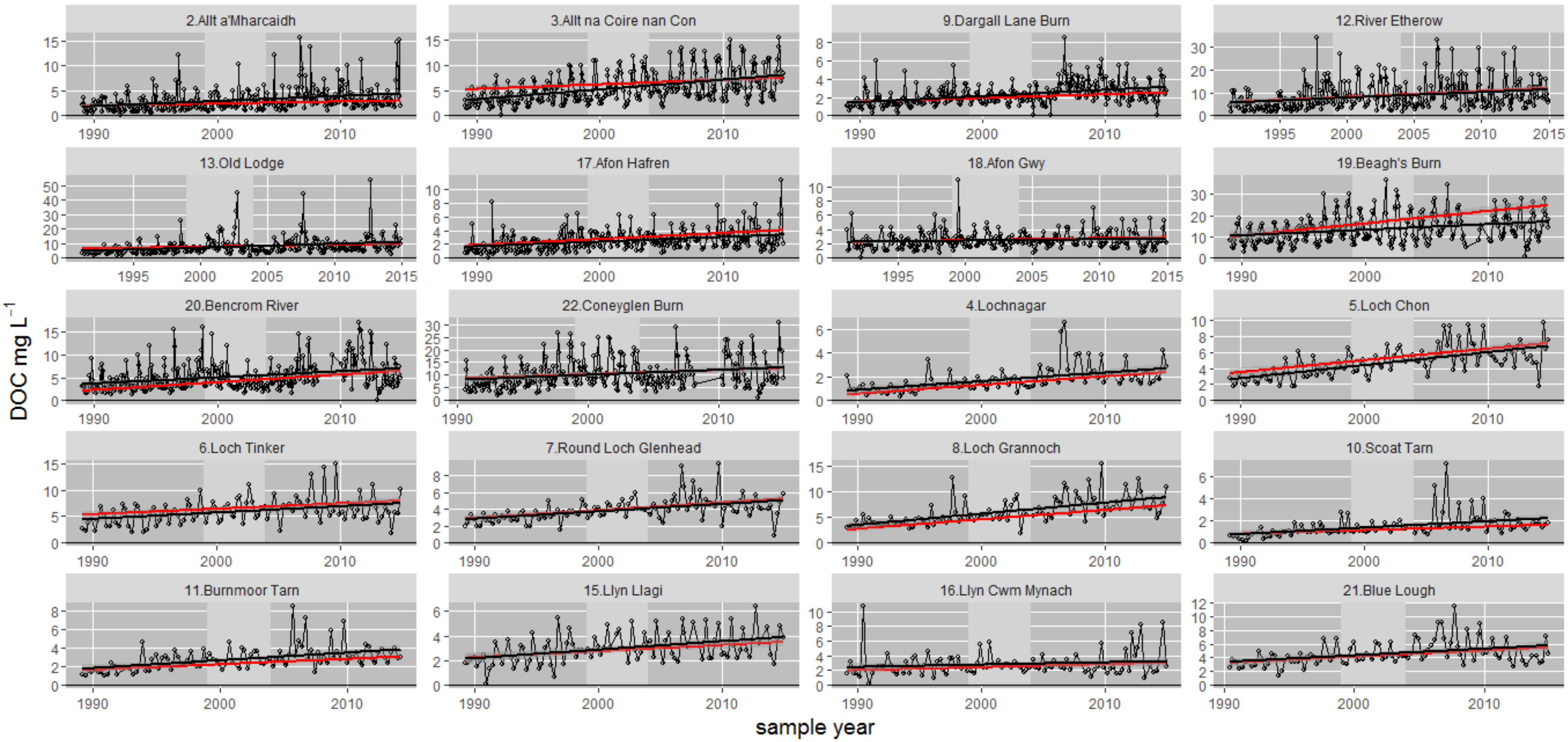
Baseline DOC trend predictable from trend in ionic strength



Black trace = Measured DOC

Black line = linear DOC trend

Red line = linear modelled DOC trend

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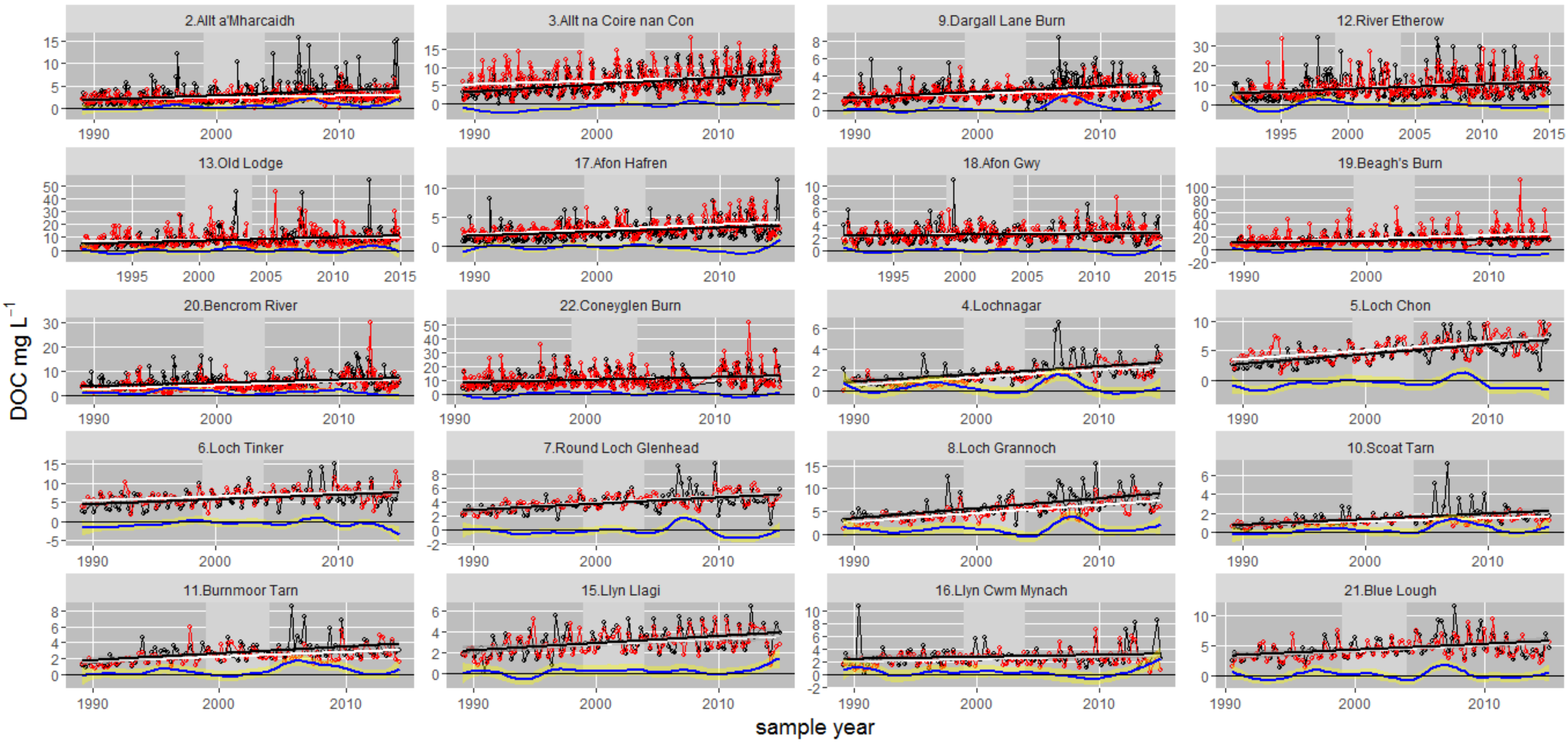
Model including fixed seasonal component



Black trace = Measured DOC

Black line = linear DOC trend

white line = linear modelled DOC trend

Predicting the moving DOC baseline

- If we have access to:
  1. short-term runs of DOC and IS or conductivity data to calibrate f
  2. current non-marine sulphate concentration
  3. knowledge of regional non-marine sulphate trend

- We can then:
  - Predict how IS will respond to further declines in non-marine sulphate
  - And hence the DOC response

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summary

- For a wide range of surface waters logged DOC concentrations vary in inverse proportion to change in ionic strength
- Relationships are similar across sites but vary depending on base flow contribution
- Relationships likely reflect effects of variation in soil acidity on soil organic matter solubility
- Potential to apply relationship to predict likely future behaviour of the DOC baseline in response to expected further reductions in IS
- This provides a framework against which we can then attempt to superimpose catchment-specific effects (e.g. land use manipulations).

Climate-driven changes in removal of DOC in a small boreal lake: a 30-year time series.

Heleen A. de Wit[1*], Raoul-Marie Couture[1,2], Leah Jackson-Blake[1], Martyn N. Futter[3], Salar Valinia[1], Kari Austnes[1], Jose-Luis Guerrero[1] and Yan Lin[1]

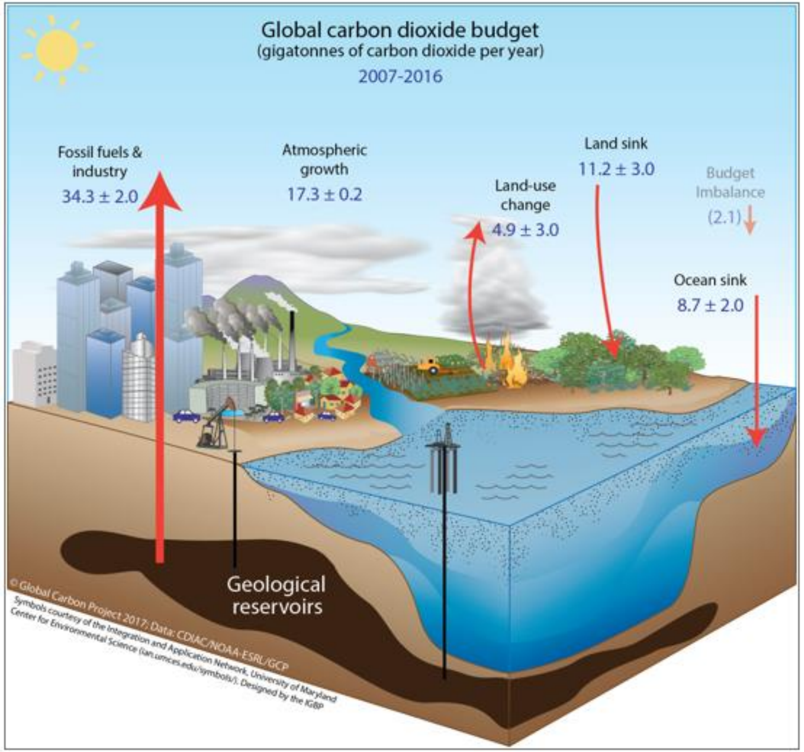
1 NIVA, Oslo, Norway

2 Lavalle University, Quebec, Canada

3 SLU, Uppsala, Sweden

Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2007–2016 ($GtCO_2$/yr)



The budget imbalance is the difference between the estimated emissions and sinks.

Source: CDIAC; NOAA-ESRL; Le Quéré et al 2017; Global Carbon Budget 2017

Global carbon project
www.globalcarbonproject.org

Fate of anthropogenic CO_2 emissions (2007–2016)

Sources = Sinks

34.4 $GtCO_2$/yr

88%

12%

4.8 $GtCO_2$/yr

17.2 $GtCO_2$/yr

46%

30%

11.0 $GtCO_2$/yr

24%

8.8 $GtCO_2$/yr

Budget Imbalance:
(the difference between estimated sources & sinks)

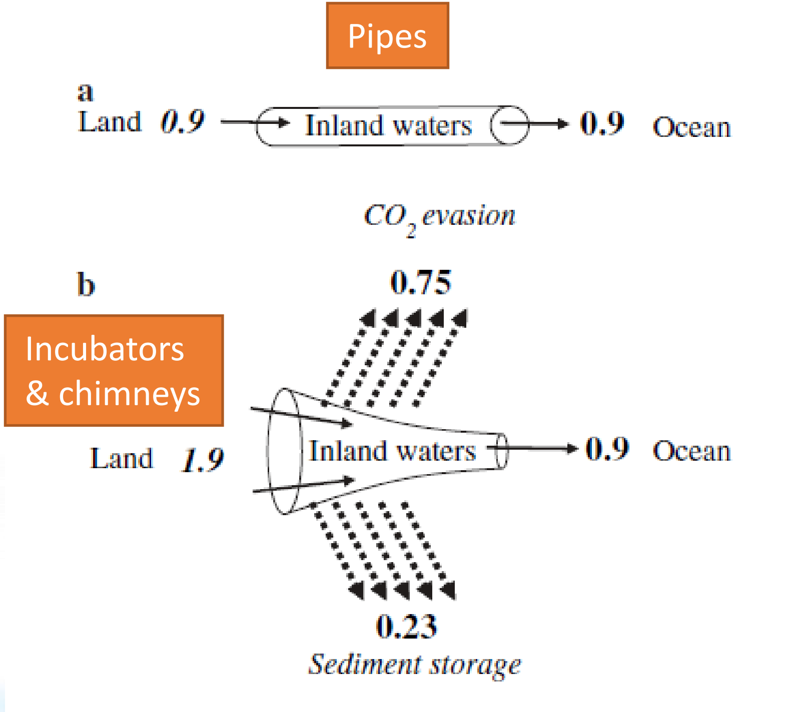
6%
2.2 $GtCO_2$/yr

Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Le Quéré et al 2017; Global Carbon Budget 2017

Global carbon project
www.globalcarbonproject.org

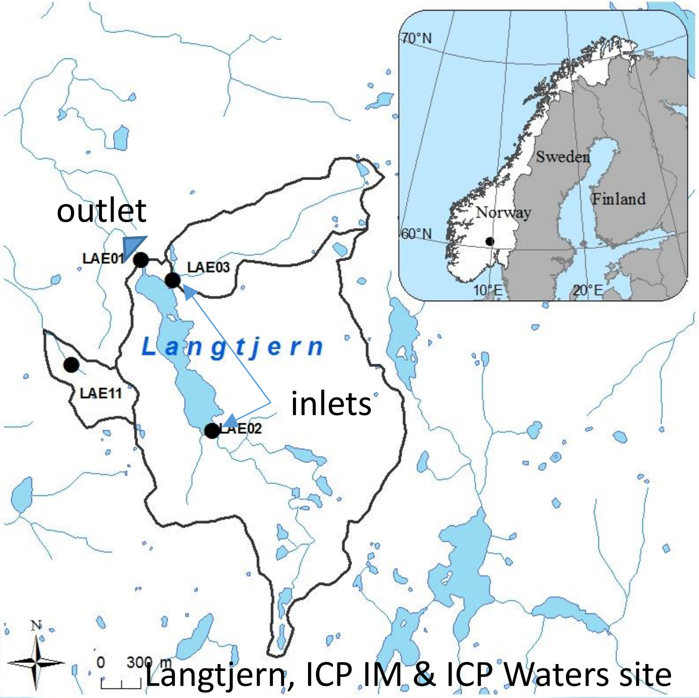
Are boreal lakes pipes or chimneys?

- Are boreal lakes passive pipes for terrestrial OC (DOM), or do they contribute significantly to conversion of DOM to atmospheric CO2?
- Impact of climate change?



Cole et al. 2007 Ecosystems

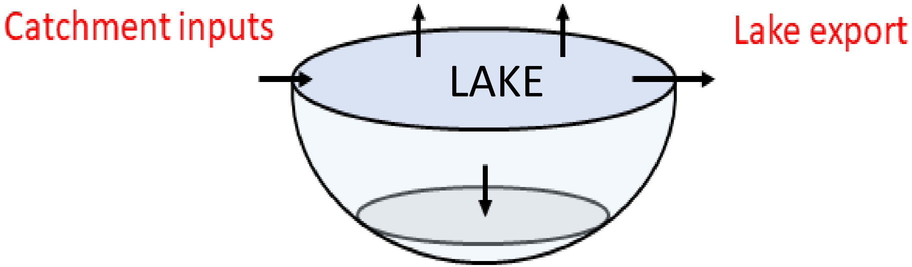
30 year timeseries of catchment inputs and lake export of DOC in forested, boreal catchment



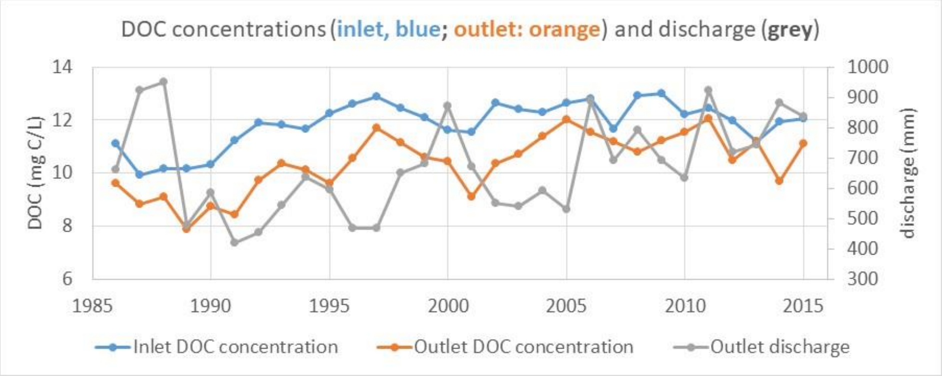
- 4.8 km^2 catchment, 0.23 km^2 lake
- Water residence time lake 2 months
- Acidified, humic, oligotrophic
- Ca 6 months of ice cover

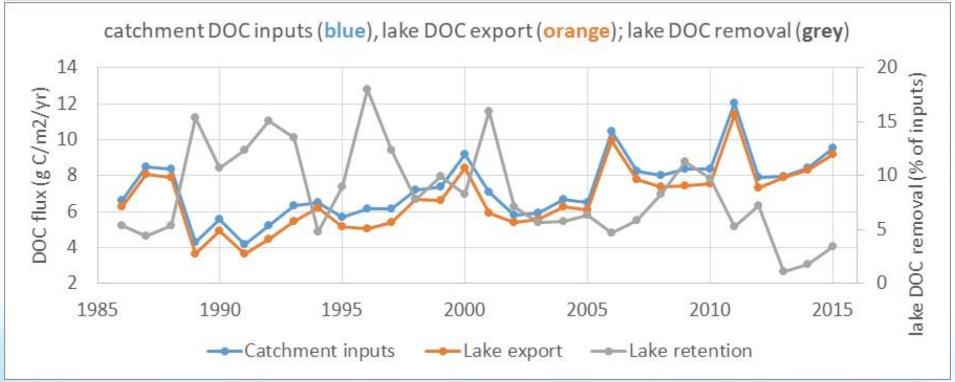
Methods: calculations of lateral fluxes

- Monitoring programme (1986-2015):
  - Two inlet streams: weekly to monthly DOC (TOC = 95% DOC)
  - Outlet stream: weekly DOC
  - Daily discharge
- Catchment DOC inputs to lake calculated by:
  - interpolation to daily DOC concentration, multiplied with discharge;
  - area-scaled (inlet sub-catchments cover ca 70% of catchment)
- Lake DOC export calculated by:
  - interpolation to daily DOC concentration, multiplied with discharge
- Annual lake DOC removal: difference between annual catchments inputs to lake and lake export



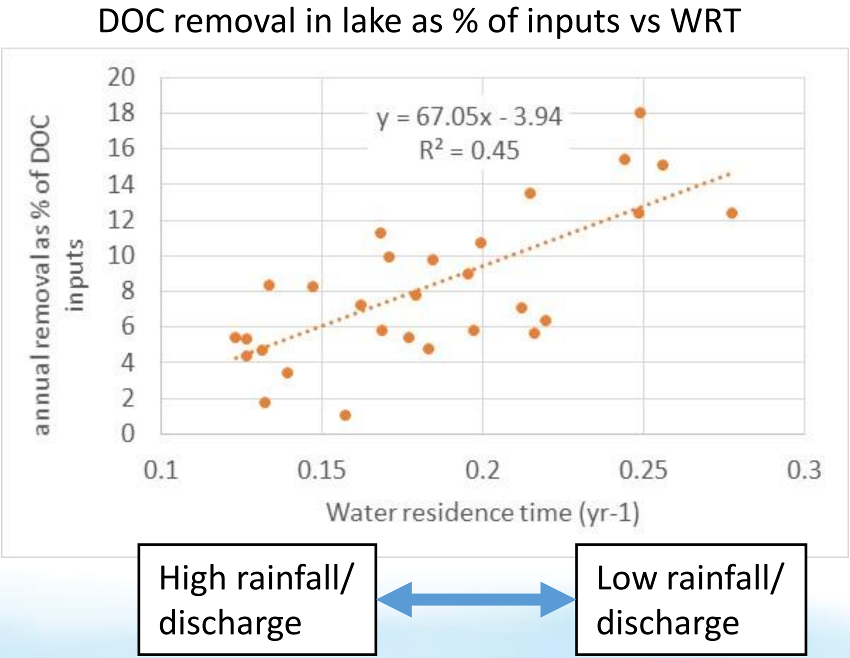
Results – concentrations and fluxes





- The lake is browning ($p<0.01$)
  - Related to reduced SO4 deposition (increased OM solubility)
- Increases in lateral DOC fluxes ($p<0.001$)
  - Related to 1) increased discharge (thus, rainfall); 2) browning (thus, SO4 deposition)
- Removal of DOC (% of inputs) is declining ($p<0.01$)

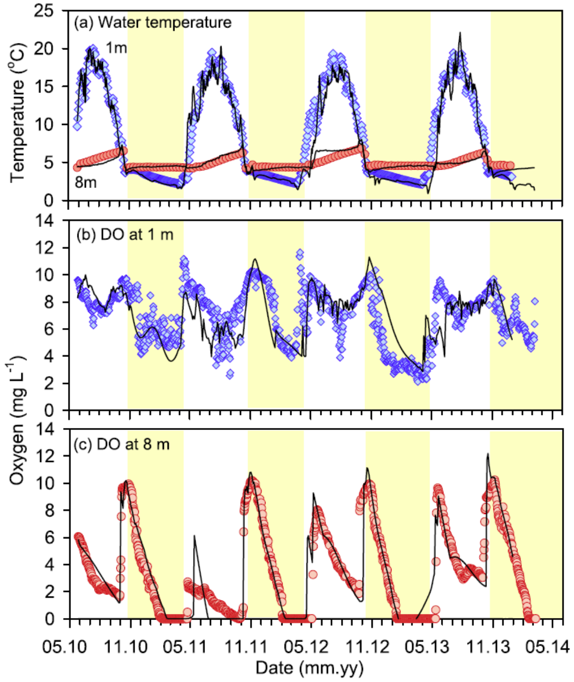
%DOC removal in lake related to WRT (water residence time)



- A higher % of annual DOC inputs to lake (upto ca 18%) is removed by in-lake processing at high water residence time
- Relatively more lake DOC processing in dry years
- Mean removal: 8% of inputs

Methods: attributing in-lake DOC removal to processes, using process-based model

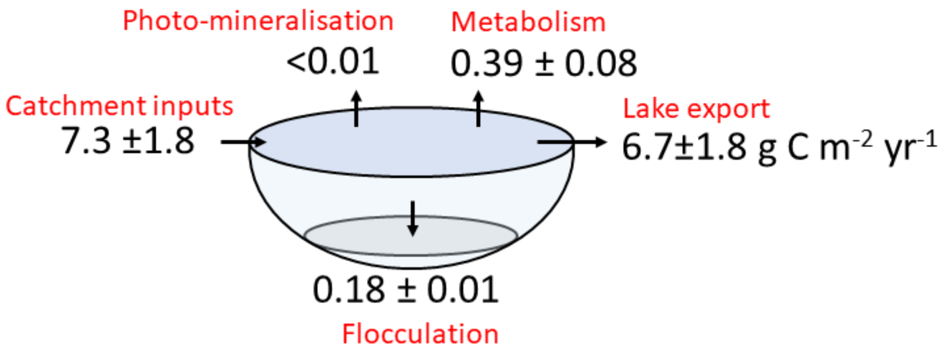
- MyLake model
  - Heat balance of lake (ice cover, thermal stratification)
  - Microbial metabolism (3 pools of DOM (labile, semi-labile, recalcitrant); processing rates dependent on T and O_2), flocculation, photo-degradation of DOM
- Calibrated using high-frequency monitoring of T and O_2 with lake buoy, and dated sediment core
  - Sedimentation at deepest point 'anchored' with dated sediment core



Couture et al. 2015
J of Geophys Res

Which processes remove DOC in the lake?

- Best model fit indicates that on average
  - 67% of DOC is removed by microbial activity
  - 33% is removed by sedimentation
  - Photo-oxidation negligible
    - Humic lake, 6 months ice cover, little UV penetration, 2 months residence time



All fluxes expressed in g C / m² catchment /yr
Standard deviation shows interannual variation

Role of residence time for aquatic DOC processing

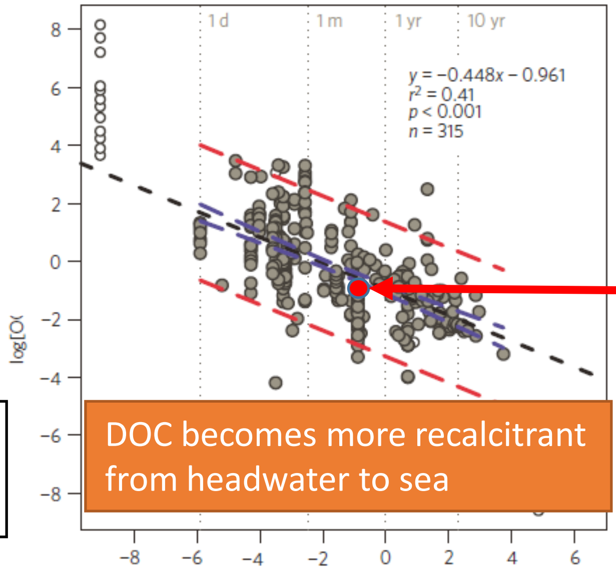
Log OC decay rate ≈ lake DOC removal rate

$$k = -\frac{\ln\left(\frac{DOCout}{DOCin}\right)}{WRT}.$$

Unit: yr^{-1}

Spatial (headwater to ocean) gradient

Log (DOC decay rate) (yr^{-1})



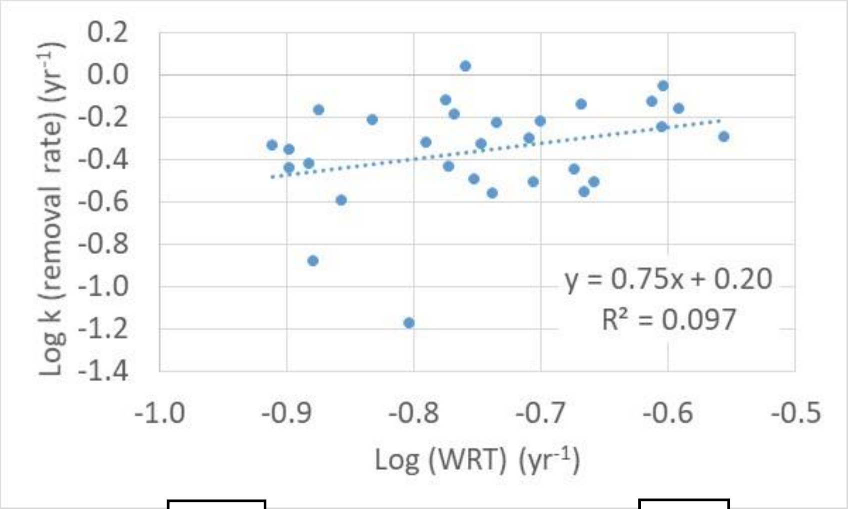
DOC becomes more recalcitrant from headwater to sea

Log (water residence time((yr^{-1})

Catalan et al. 2016 NatGeoSci

Headwaters ↔ Oceans

Time series of 30 years in headwater



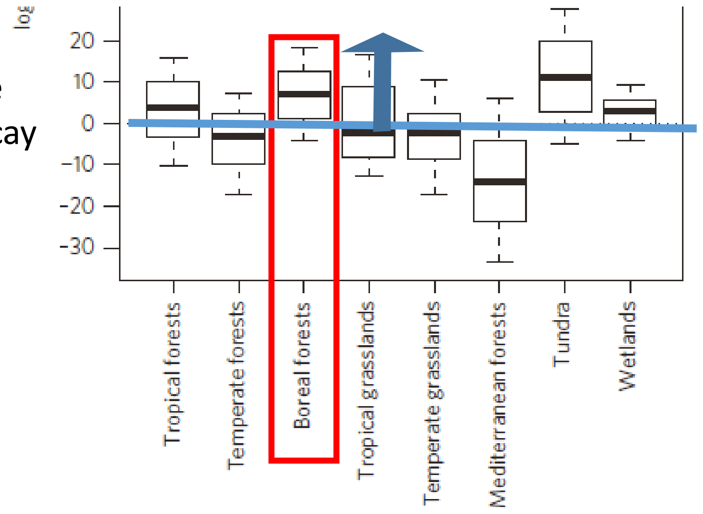
wet ↔ dry

Climate wetting impact on DOC decay: space-for-time substitution ≠ time series

<u>Projection for lakes in boreal forests:</u>

Climate warming -> wetting -> shorter WRT ->increase in decay rate

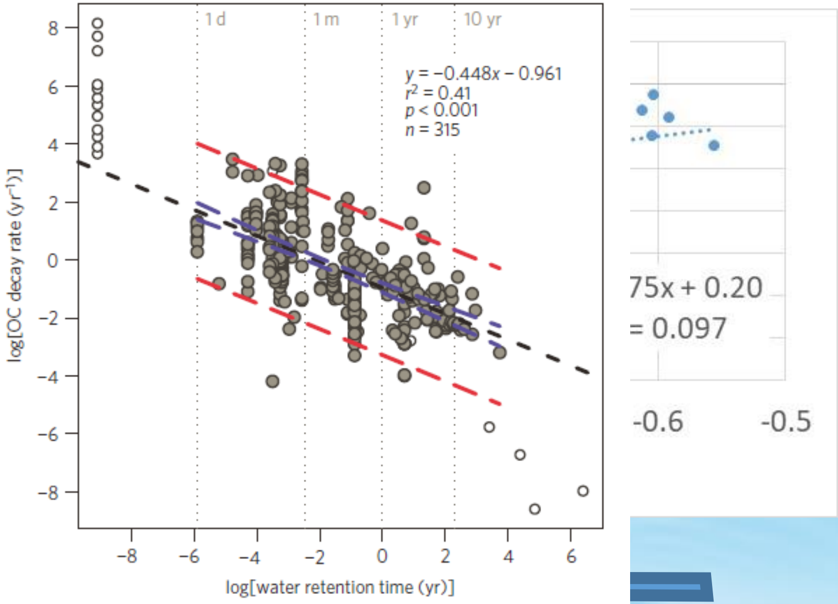
% change in OC decay



Catalan et al. 2016 NatGeoSci

<u>Empirical evidence of climate impact in lakes in boreal forest:</u>

Climate warming -> wetting -> shorter WRT



Conclusions

Time series

- In small boreal lakes (and large catchment to lake ratio), %DOC removal is low.
- A wetter climate results in large increase in lateral DOC fluxes, and in lower % lake removal of DOC
  - Most DOC is removed by microbes
- Lakes act more like pipes than chimneys/incubators under a wetter climate

Space-for-time substitution

- Wetter climate results in faster DOC removal because of a change in DOM character (less time to process, less recalcitrant)
  - Support for 'lakes as incubators'
- Space for time substitutions assume that spatial variation is equivalent to temporal change (Pickett 1989).

Reference & acknowledgements

De Wit H.A., R.M. Couture, L.A. Jackson-Blake L.A., M.N. Futter, S. Valinia, K. Austnes, J.L. Guerrero and Y. Lin. **2018**. Limnology and Oceanography Letters. *Pipes or chimneys? For carbon cycling in small boreal lakes, precipitation matters most.*

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Nordforsk - Nordic Centre of Excellence Biowater

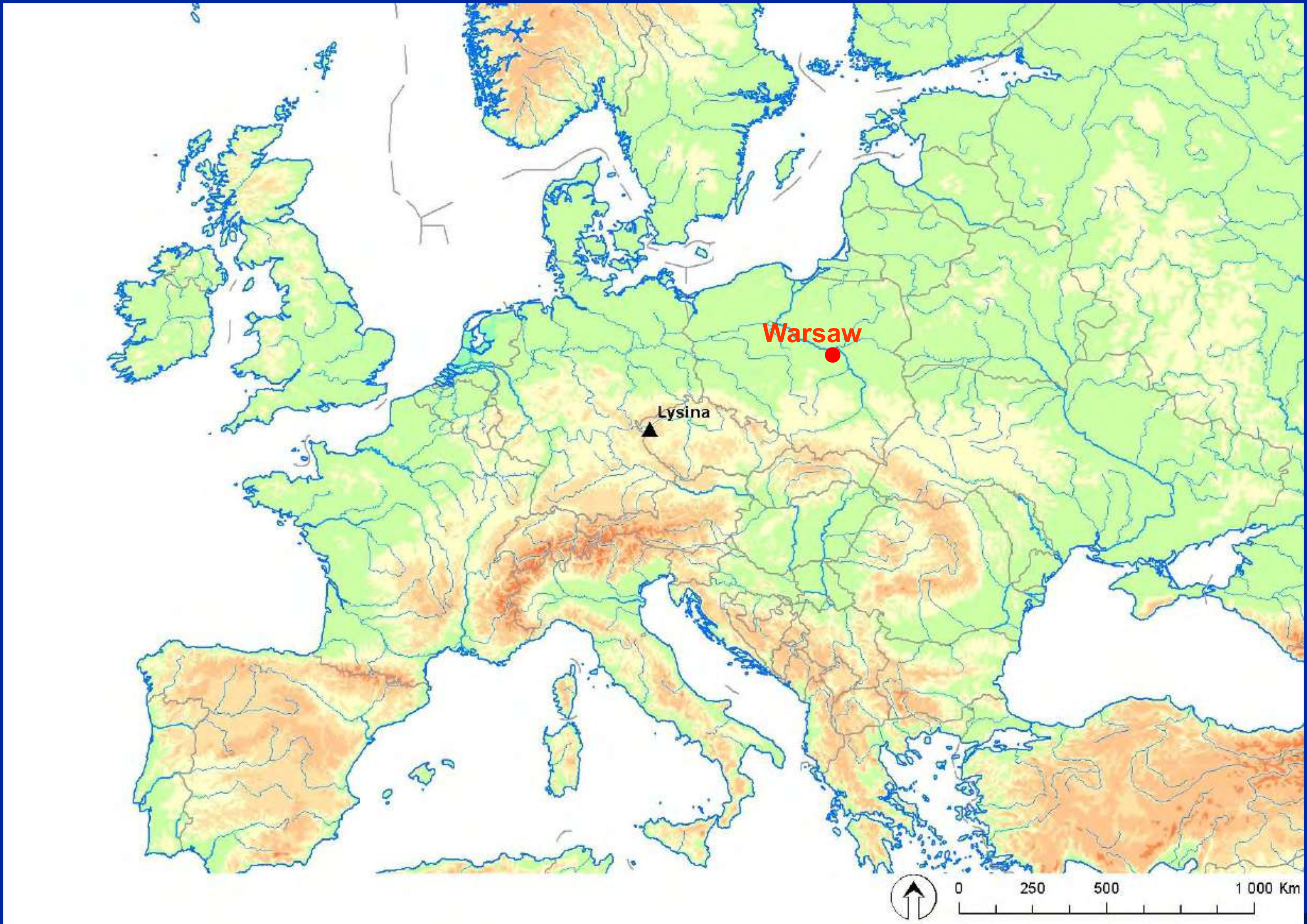
NIVA, EPA Norway

Nitrogen and Phosphorus at Lysina CZ02

Pavel Krám, Oldřich Myška,
Jan Čuřík, František Veselovský
and Jakub Hruška

Czech Geological Survey, Prague, Czech Republic

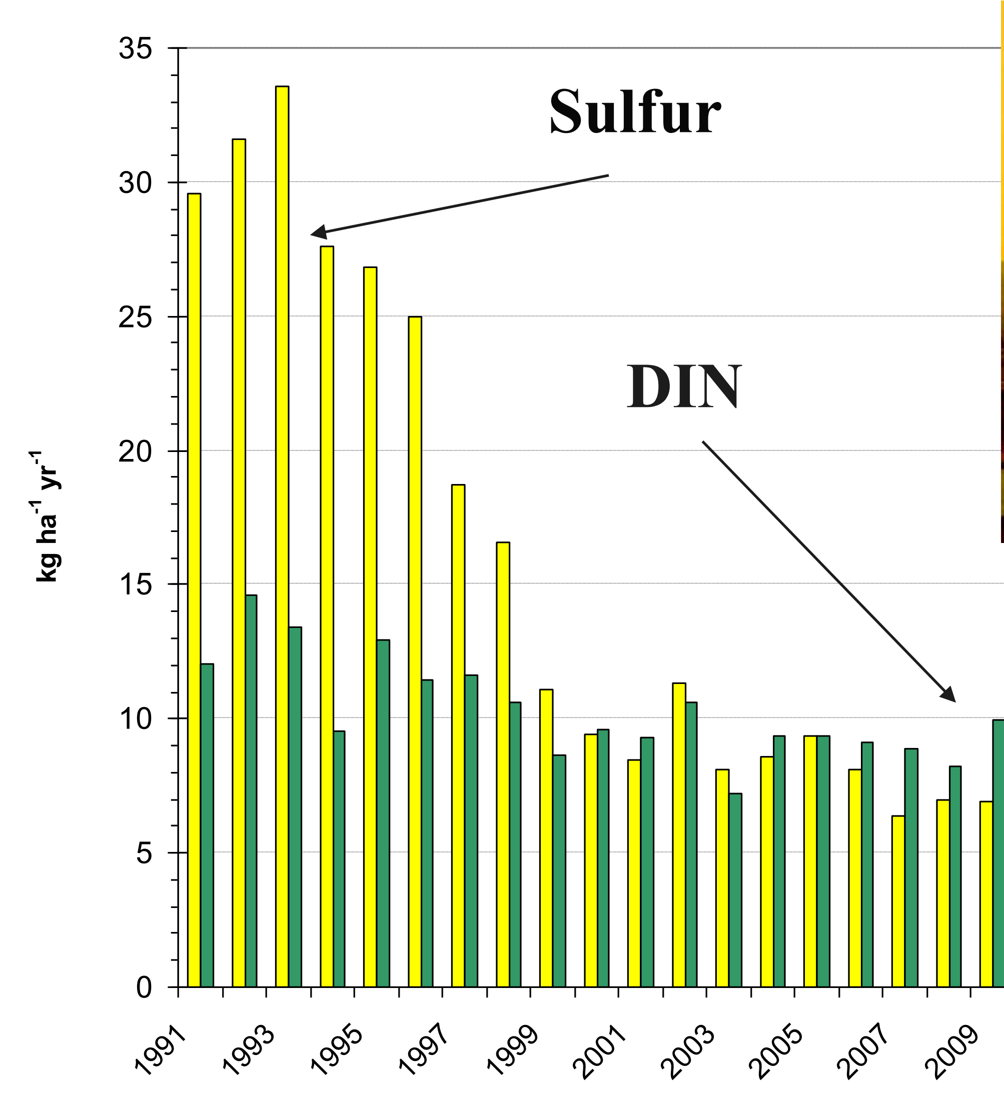
Location of the Lysina catchment (CZ02 in the ICP IM network)



Lysina catchment, 0.27 km^2, 829-949 m a.s.l., (leuco)granite, Podzol, spruce research 1988-2018, regular input-output monitoring since 1991

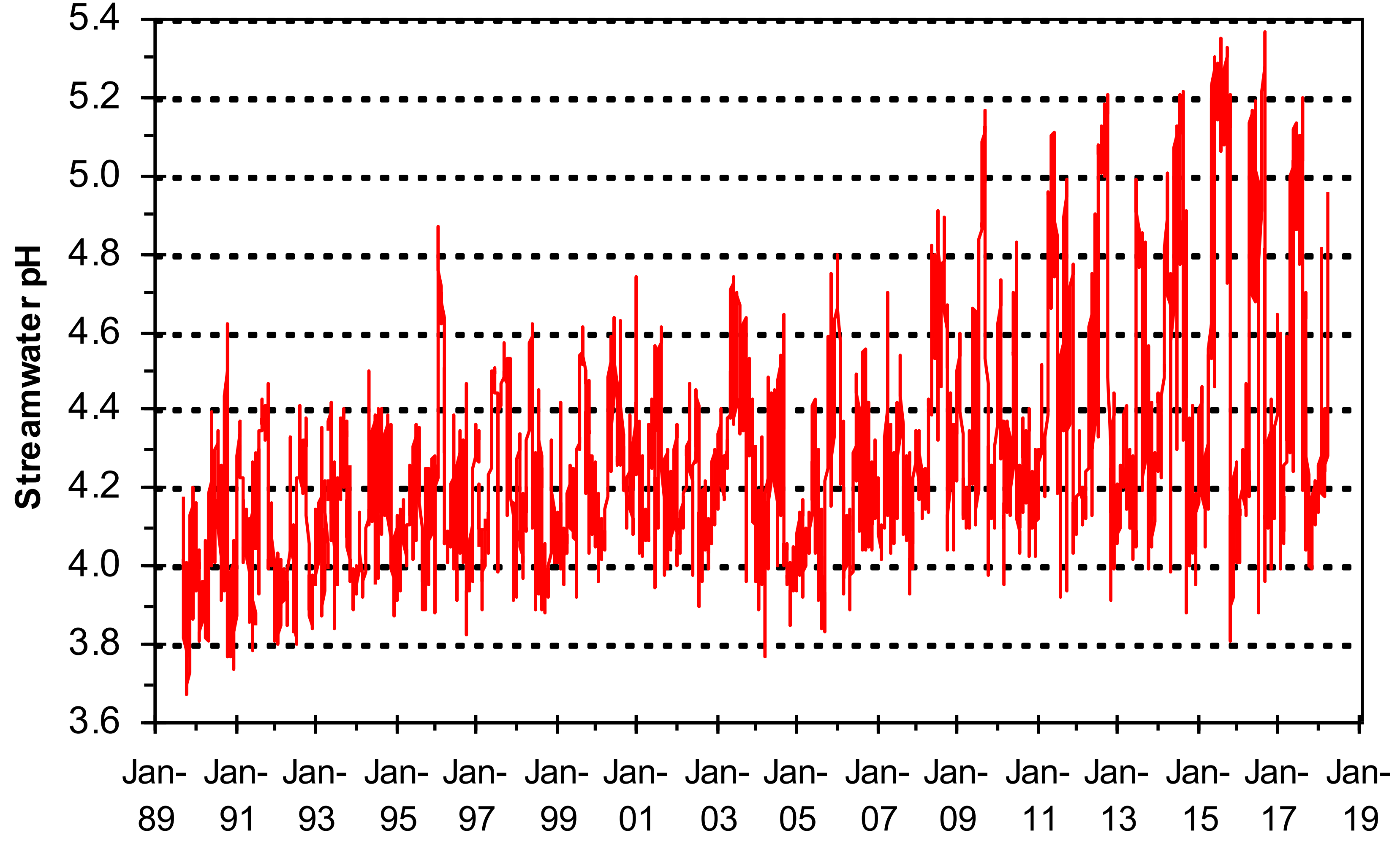
V-notch weir at Lysina during a high flow episode, characterized by brown color due to high concentration of dissolved organic carbon (DOC) generated in shallow water flow paths of forest soils.

Annual Fluxes of Atmospheric Deposition of Sulfur and Inorganic Nitrogen at Lysina in 1991-2017



Tisová, lignite power plant, 12 km NE

Weekly Streamwater pH at Lysina (Sep 1989 – May 2018)

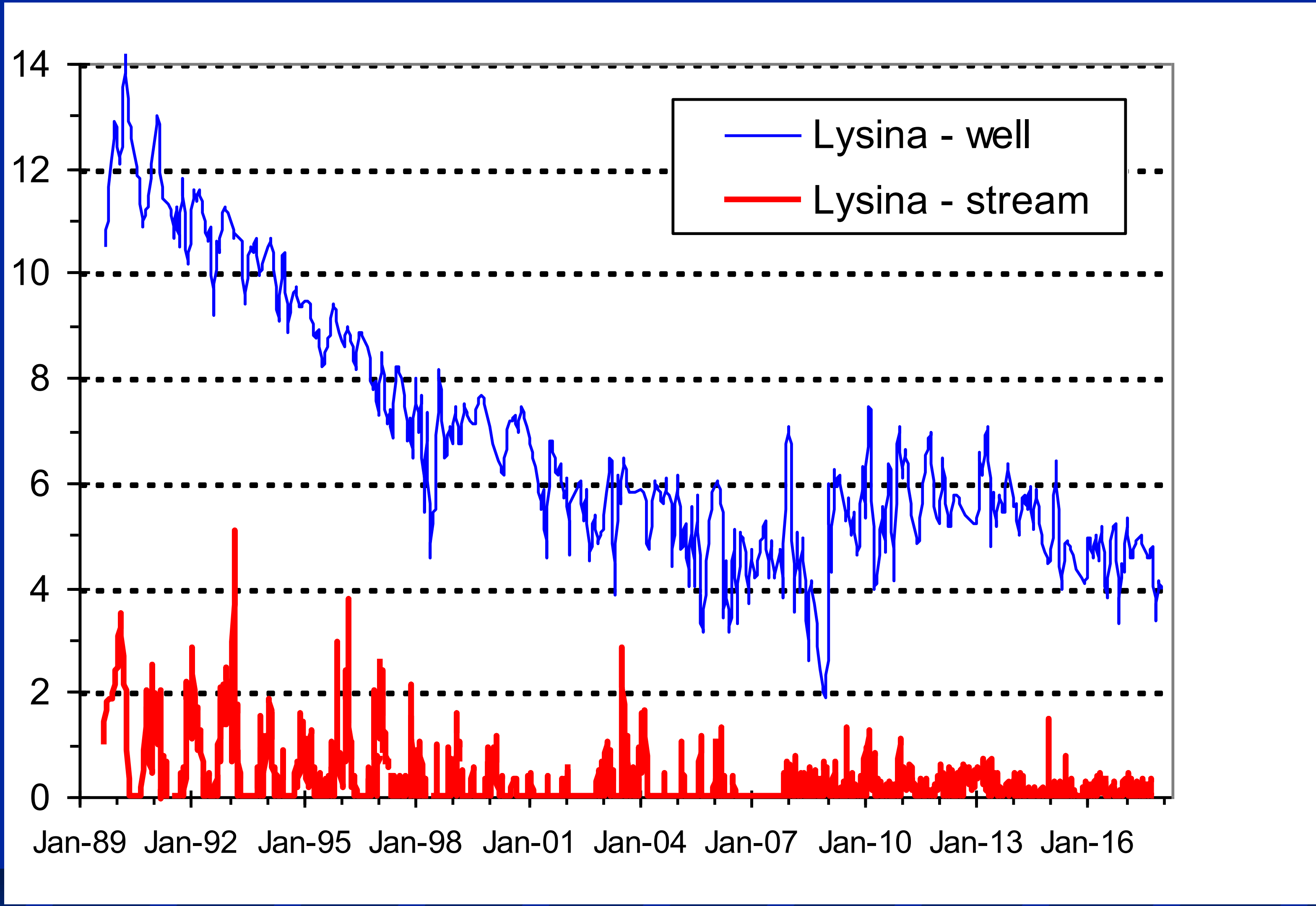


Note 1: Low pH values at Lysina are generally detected during high flow periods, high pH values during low flow periods.

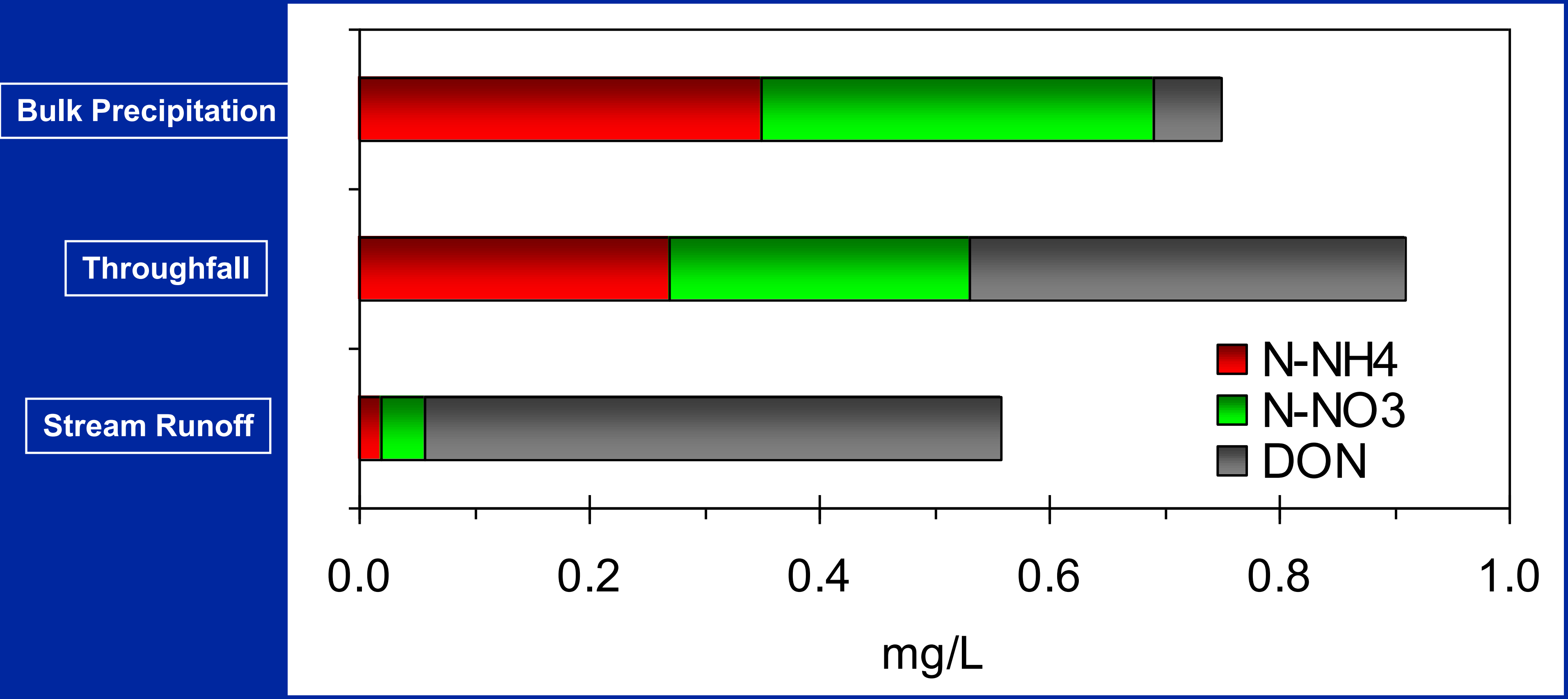
Note 2: The size matters! Streamwater pH values are usually higher downstream (with sampling of higher catchment area). As a consequence also pH values downstream from the Lysina point (area 0.27 km^2) to the catchment size recommended e.g. by the Water Framework Directive (>10 km^2) will be higher due to longer water residence time in the catchment and longer time for chemical weathering processes!

Nitrate in Groundwater and Streamwater at Lysina (Sep 1989 – Dec 2017)

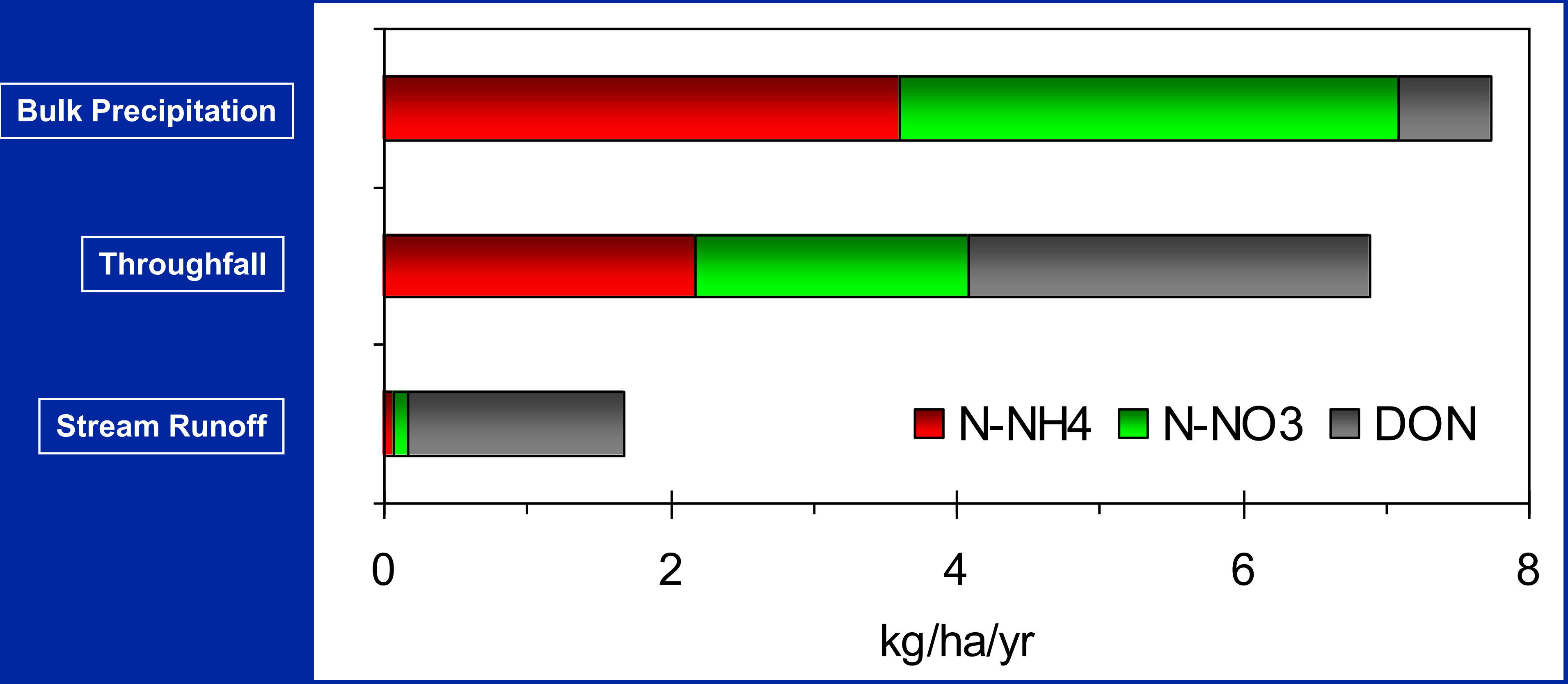
NO_3 (mg/L)



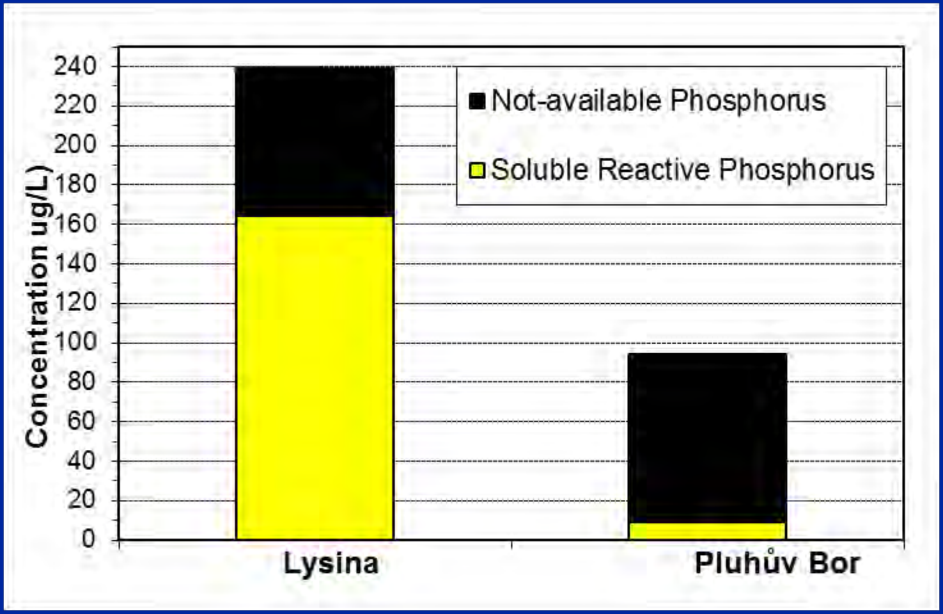
Nitrogen Concentrations at Lysina in 2017 Water Year



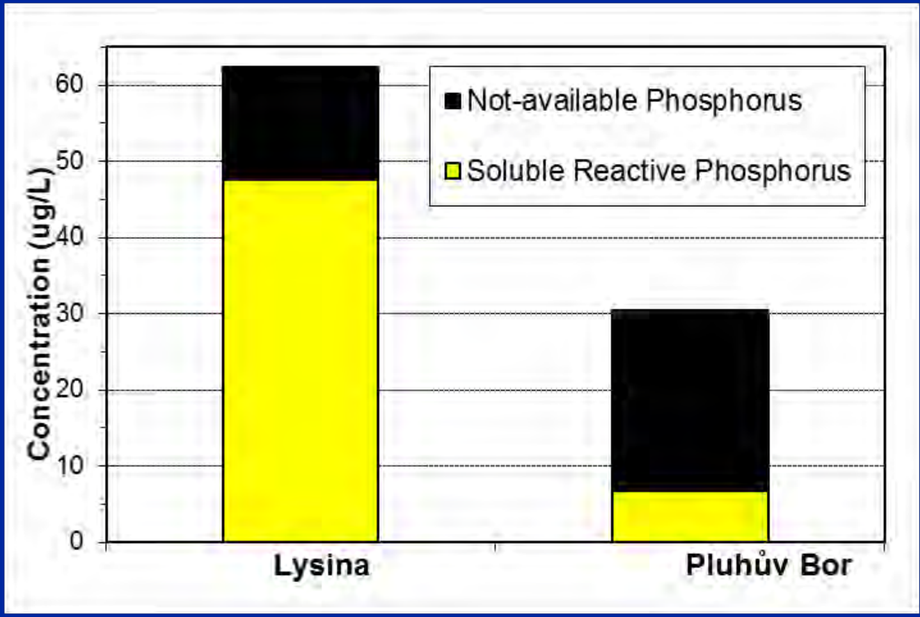
Nitrogen Fluxes at Lysina in 2017 Water Year



Medians of Phosphorus Concentrations in Drainage Waters at Two Geochemically Contrasting Catchments in 2017 Water Year

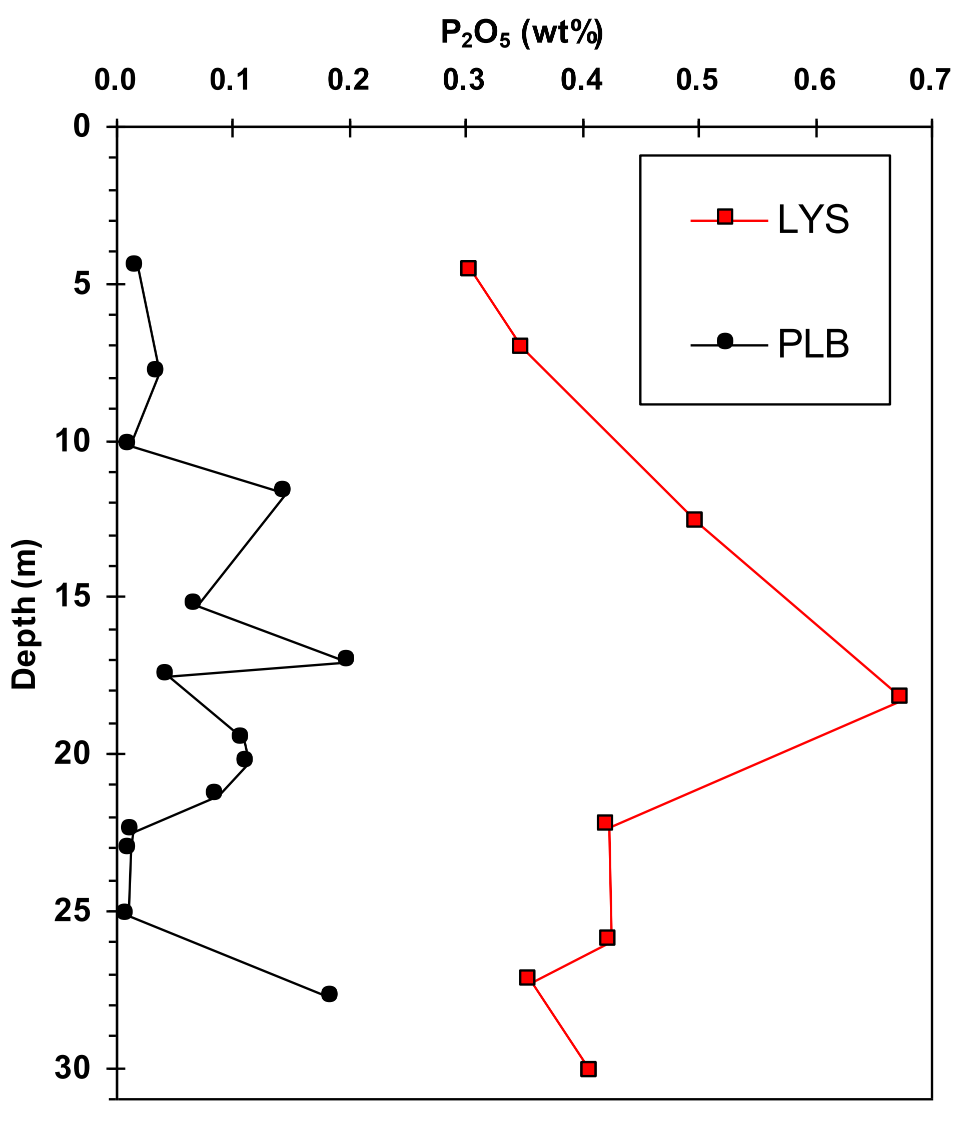


Soil Water

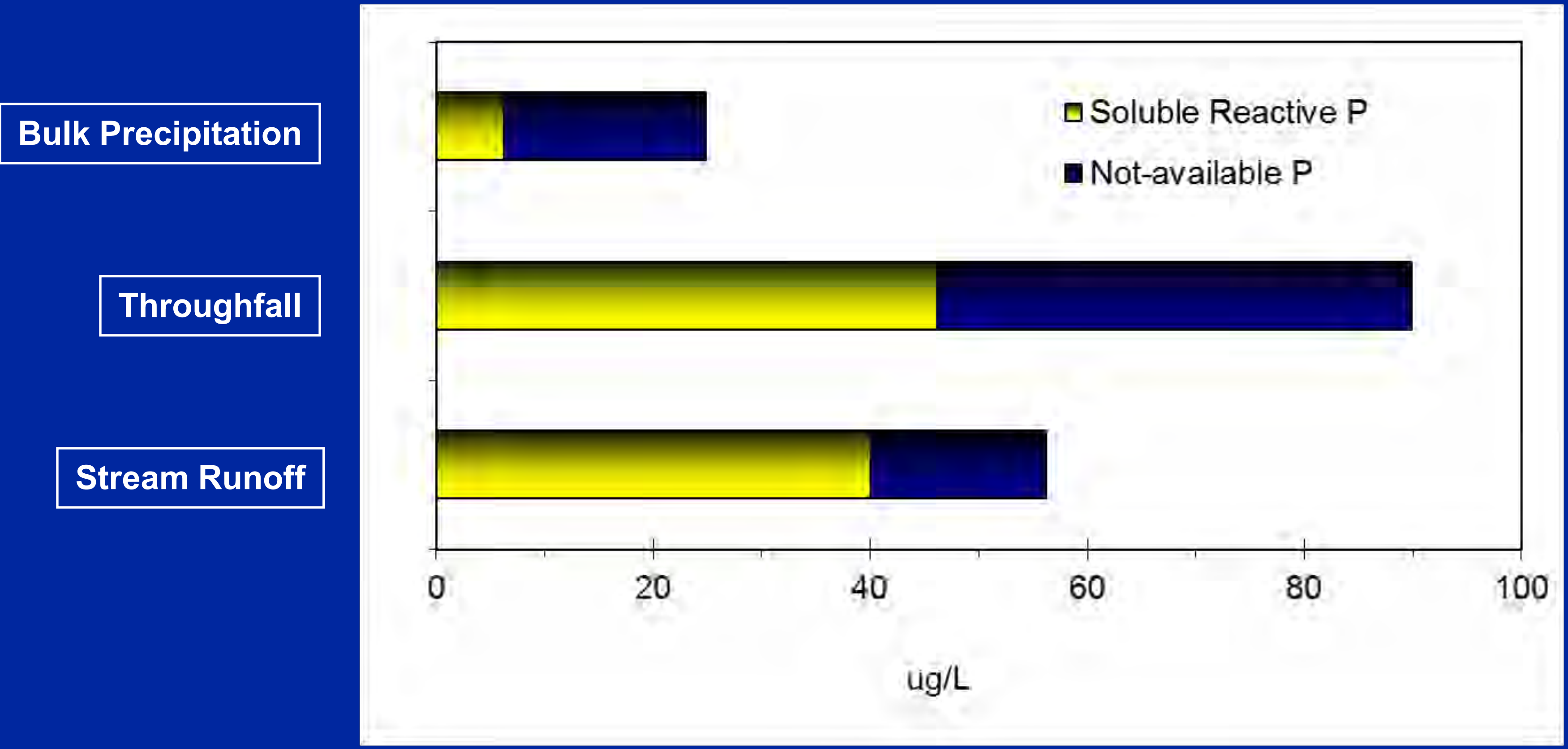


Stream Water

Rock Concentrations of Phosphorus in Borehole Cores at Granitic Lysina and Ultrabasic Pluhův Bor

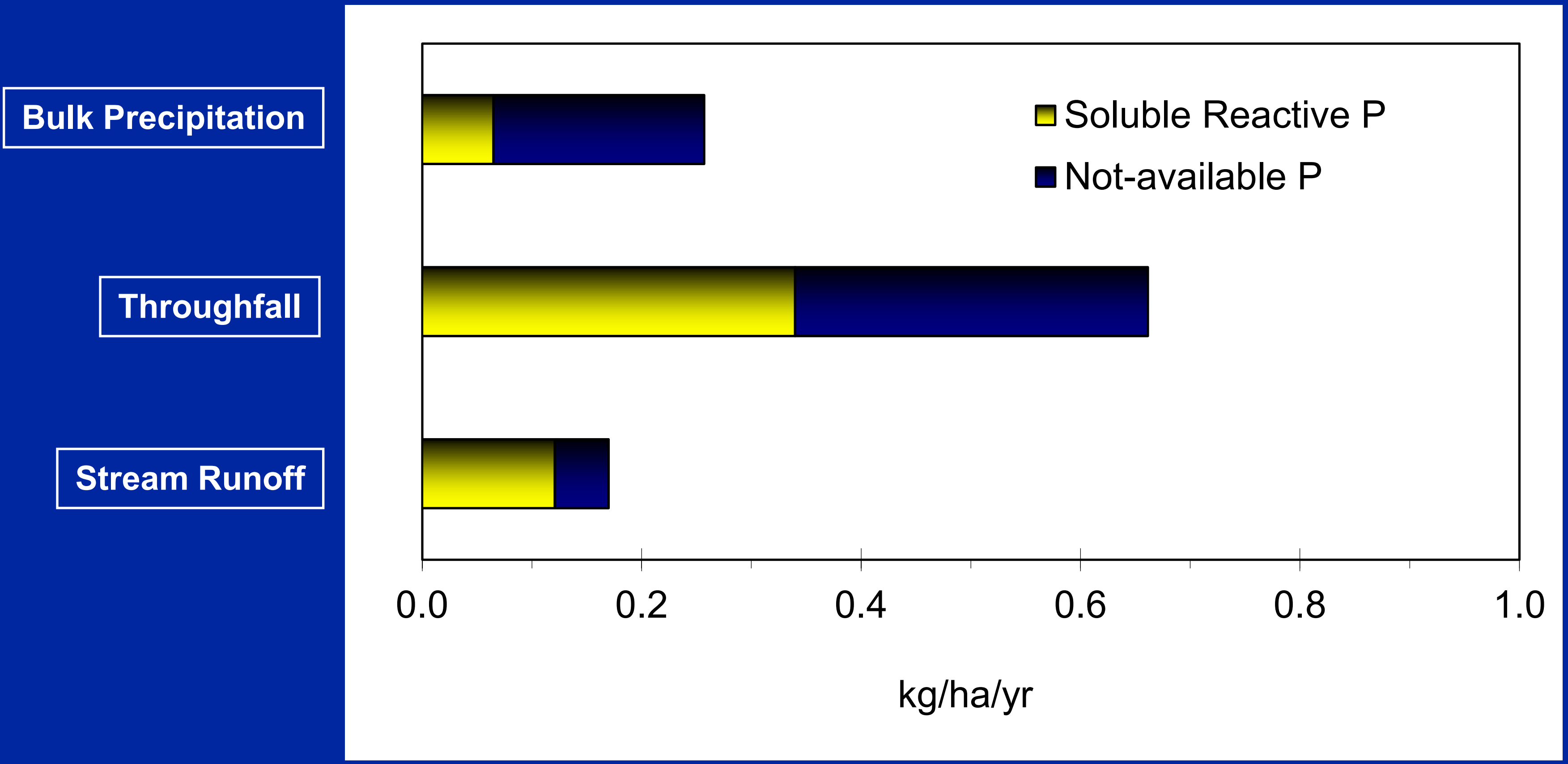


Phosphorus concentrations at Lysina in 2017 Water Year



Info about competition of acidification and phosphorus eutrofization and its influence on benthic algae: Schneider S.C., Oulehle F., Krám P., Hruška J. 2018. Hydrobiologia 805: 33-47.

Phosphorus fluxes at Lysina in 2017 Water Year



Monitoring subprograms of the ICP-IM network in 2017

Meteorology	Groundwater chemistry	Vegetation (plot scale)
Air chemistry *(incl. CO_2)*	Runoff water chemistry	Bioelements
Precipitation chemistry	Lake water chemistry	Vegetation structure
Moss chemistry	Foliage chemistry	Trunk epiphytes
Throughfall chemistry	Litterfall chemistry	Aerial green algae
Stemflow chemistry	Hydrobiology of streams	Microbial decomposition *(incl. CO_2)*
Soil chemistry	Hydrobiology of lakes	Bird inventory
Soil water chemistry	Forest damage	Vegetation inventory

Data-rich catchments (amount of reported subprograms):

21: LV02 (Zoseni); **20:** EE02 (Saarejärve); **19:** DE01 (Forellenbach) and FI01 (Valkea-Kotinen); **18:** SE04, FI03, LT01, LT03 and LV01; **17:** FI04, SE14, SE15 and CZ02 (Lysina)

Note 1: No Rock chemistry subprogram in the ICP IM !

Note 2: Data-rich Latvian catchments (LV) were unfortunately removed from the IM because the data submission lasted only until 2009!

Conclusions

- Total dissolved nitrogen budget at Lysina is incomplete without considering the Dissolved Organic Nitrogen (DON), especially for the runoff
- Relatively high concentrations and fluxes of phosphorus in drainage waters at Lysina were generated by elevated content of phosphorus in granitic bedrock. Soluble Reactive Phosphorus (SRP) fraction available for biota prevailed at Lysina.

Long-term changes in the inorganic nitrogen output fluxes in European ICP Integrated Monitoring catchments – an assessment of the role of internal N-related parameters

Data mapping

Jussi Vuorenmaa, Sirpa Kleemola, Martin Forsius + representatives of focal points…

Joint ICP Waters & ICP IM Task Force meeting,

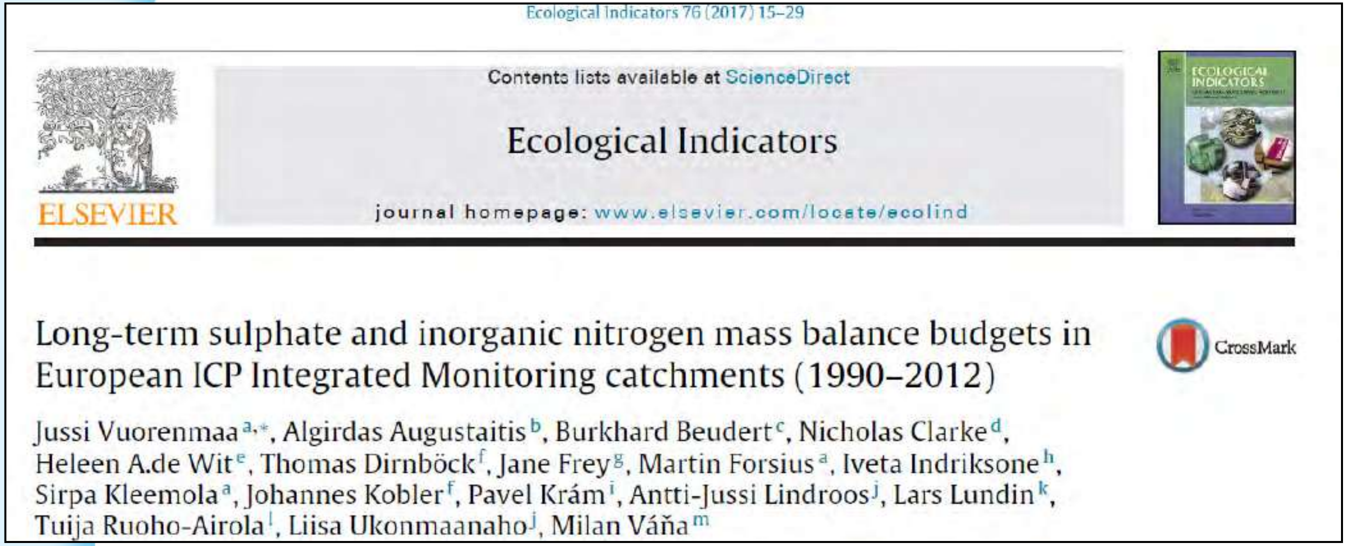
8.5.2018

SYKE

LRTAP

Long-range Transboundary Air Pollution

The latest trend assessements at IM sites


Ecological Indicators 76 (2017) 15–29

Contents lists available at ScienceDirect

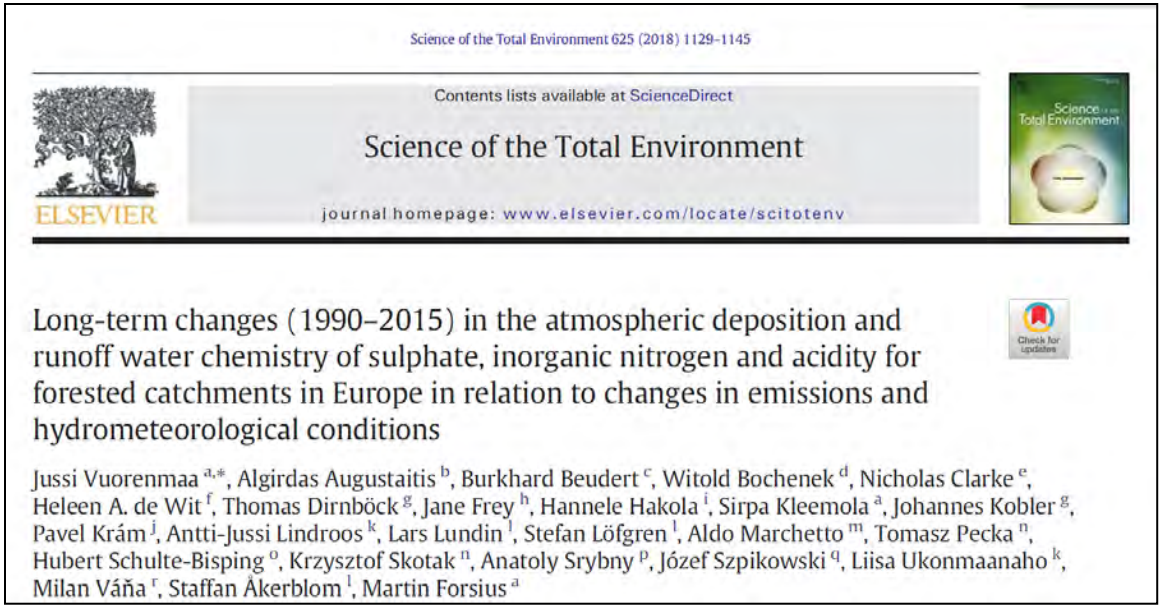
Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

ELSEVIER

Long-term sulphate and inorganic nitrogen mass balance budgets in European ICP Integrated Monitoring catchments (1990–2012)

Jussi Vuorenmaa[a,*], Algirdas Augustaitis[b], Burkhard Beudert[c], Nicholas Clarke[d], Heleen A.de Wit[e], Thomas Dirnböck[f], Jane Frey[g], Martin Forsius[a], Iveta Indriksone[h], Sirpa Kleemola[a], Johannes Kobler[f], Pavel Krám[i], Antti-Jussi Lindroos[j], Lars Lundin[k], Tuija Ruoho-Airola[l], Liisa Ukonmaanaho[j], Milan Váňa[m]


Science of the Total Environment 625 (2018) 1129–1145

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

ELSEVIER

Long-term changes (1990–2015) in the atmospheric deposition and runoff water chemistry of sulphate, inorganic nitrogen and acidity for forested catchments in Europe in relation to changes in emissions and hydrometeorological conditions

Jussi Vuorenmaa[a,*], Algirdas Augustaitis[b], Burkhard Beudert[c], Witold Bochenek[d], Nicholas Clarke[e], Heleen A. de Wit[f], Thomas Dirnböck[g], Jane Frey[h], Hannele Hakola[i], Sirpa Kleemola[a], Johannes Kobler[g], Pavel Krám[j], Antti-Jussi Lindroos[k], Lars Lundin[l], Stefan Löfgren[l], Aldo Marchetto[m], Tomasz Pecka[n], Hubert Schulte-Bisping[o], Krzysztof Skotak[n], Anatoly Srybny[p], Józef Szpikowski[q], Liisa Ukonmaanaho[k], Milan Váňa[r], Staffan Åkerblom[l], Martin Forsius[a]

S Y K

The results from the ICP IM network show the positive effects of the S emission reduction measures in Europe

- Concentrations and deposition fluxes of xSO_4 (wet + dry) have decreased significantly almost at all (> 95%) studied IM sites

- xSO_4 concentrations and fluxes in runoff have consequently decreased (significant at 90% and 60% of the sites, respectively), and the IM catchments have increasingly responded to the decreases in deposition of xSO_4 during the last 25 years

- The most acid-sensitive IM catchments are experiencing a recovery from SO_4-driven acidification, although net release of SO_4 from soil may delay the recovery

SYKE

The results from the ICP IM network document the positive effects also for the N emission reduction measures in Europe

- Bulk deposition of NO_3 and NH_4 decreased significantly at 60–80% (concentrations) and 40–60% (fluxes) of the sites
- Concentrations and fluxes of NO_3 in runoff decreased at 73% and 63% of the sites, respectively, and NO_3 concentrations decreased significantly at 50% of the sites
- In general, TIN (NO_3 + NH_4) was strongly retained (> 90%) in the catchments not affected by natural disturbances.
- As yet there are no widespread signs of a consistent increase in NO_3 concentrations or exports in sensitive undisturbed freshwater

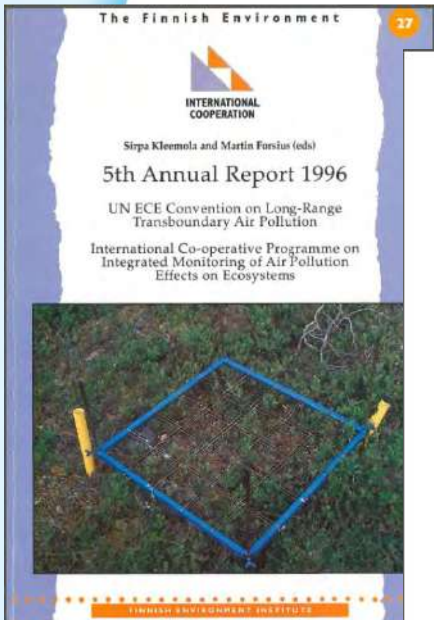
SYKE

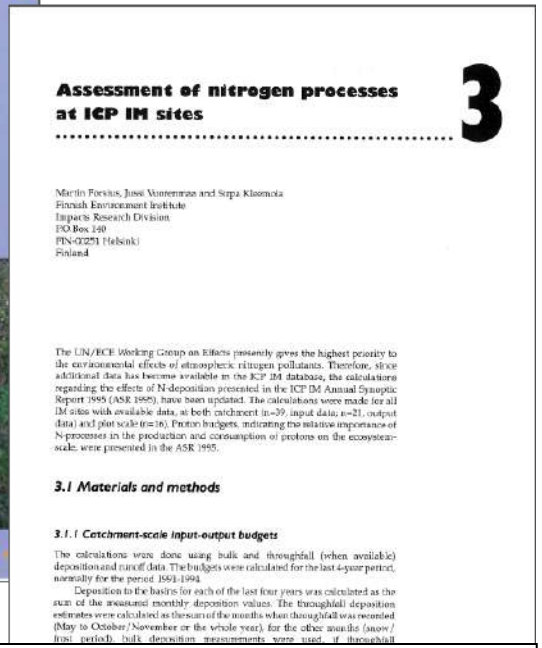
The N cycling is complex

- The present decreasing trend of TIN deposition at IM sites should generally lead to decreased NO_3 concentrations in runoff !?
- Routine monitoring variables do not explain variation/change in TIN output satisfactorily, because obviously not all potential drivers were included in the empirical models

  ➡ Further analysis with specific catchment and soil data is needed: **Data mapping on internal catchment N-related parameters at IM sites**
- No detailed research plan yet, but main questions will be: What is the present status of these N-related parameters? How these parameters explain the variation/trends of TIN at IM sites?

Previous N-assessment





Assessment of nitrogen processes at ICP IM sites 3

Martin Forsius, Jussi Vuorenmaa and Sirpa Kleemola
Finnish Environment Institute
Impacts Research Division
P.O.Box 140
FIN-00251 Helsinki
Finland

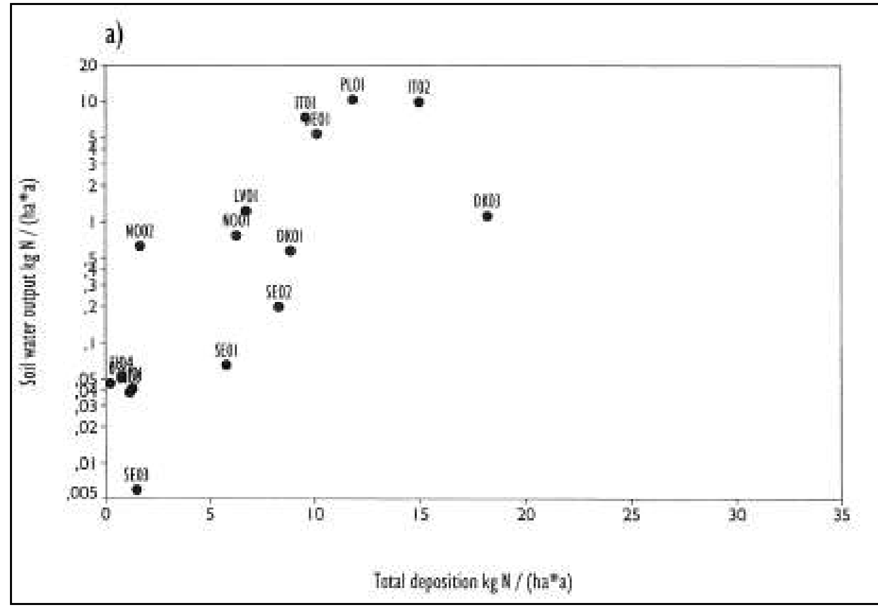
The UN/ECE Working Group on Effects presently gives the highest priority to the environmental effects of atmospheric nitrogen pollutants. Therefore, since additional data has become available in the ICP IM database, the calculations regarding the effects of N-deposition presented in the ICP IM Annual Synoptic Report 1995 (ASR 1995), have been updated. The calculations were made for all IM sites with available data, at both catchment (n=39, input data; n=21, output data) and plot scale (n=16). Proton budgets, indicating the relative importance of N-processes in the production and consumption of protons on the ecosystem-scale, were presented in the ASR 1995.

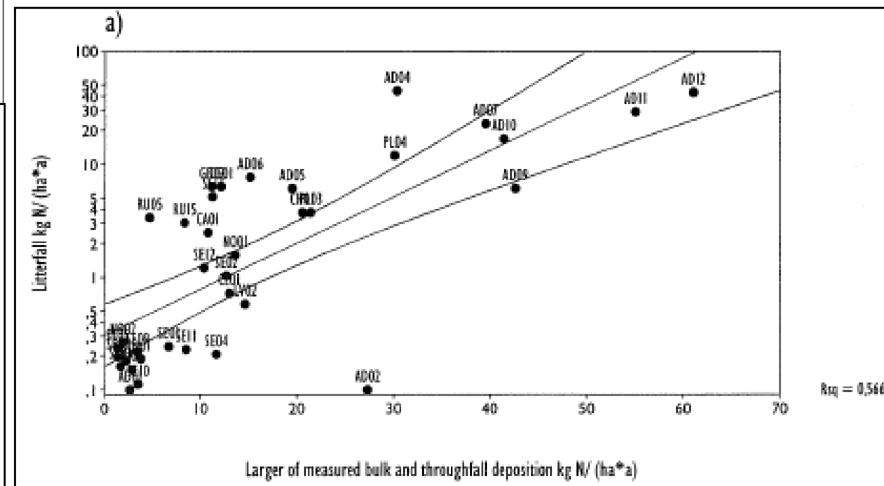
3.1 Materials and methods

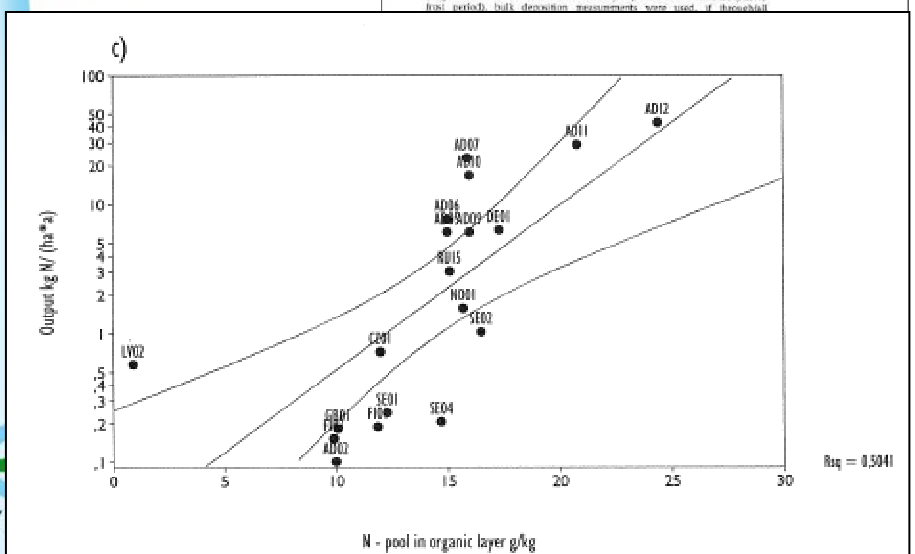
3.1.1 Catchment-scale input-output budgets

The calculations were done using bulk and throughfall (when available) deposition and runoff data. The budgets were calculated for the last 4-year period, normally for the period 1991-1994.

Deposition to the basins for each of the last four years was calculated as the sum of the measured monthly deposition values. The throughfall deposition estimates were calculated as the sum of the months when throughfall was recorded (May to October/November or the whole year), for the other months (snow/frost period), bulk deposition measurements were used, if throughfall







Submitted/existing data 2000-2016

Site	Country	Hydrometeorology			Deposition		Runoff	Litterfall	Foliage	Soil		Soil water
		Prec.	Runoff	Air temp.	Bulk	Throughfall	Conc./flux			(chemistry)	(physics)	
		PC	RW	AM	BD	TF	RW	LF	FC	SC	SC	SW
AT01	Austria	x	x	x	x	x	x	x	x	x	x	x
BY02	Belarus	x	x	x	x	n.d.	x				x	
CH02	Switzerland	x	x		x	n.d.	x					
CZ01	Czech R.	x	x	x	x	x	x				x	x
CZ02	"	x	x	x	x	x	x	x				x
DE01	Germany	x	x	x	x	x	x	x	x	x	x	x
DE02	"	x	n.d.	x	x	x	n.d.	x	x	x	x	x
EE01	Estonia	x	n.d.	x	x	x	n.d.	x	x	x	x	x
EE02	"	x	x	x	x	x	x	x	x	x	x	x
ES02	Spain	x	x	x	x	x	x	x	x	x	x	x
FI01	Finland	x	x	x	x	x	x			x	x	x
FI03	"	x	x	x	x	x	x			x	x	x
FI06	"	x	x	x	x	x	x					x
IE01	Ireland	x			x	x						x
IT01	Italy	x	x	x	x	x	x	x	x	x	x	x
IT03	"	x	n.d.		x	x	x		x			x
IT07	"	x	n.d.		x	x	n.d.		x	x	x	
IT09	"	x	n.d.		x	x	x		x	x	x	x
LT01	Lithuania	x	x	x	x	x	x	x	x	x		x
LT03	"	x	x	x	x	x	x	x	x	x		x
LV01	Latvia	x	x		x	x	x	x	x			x
LV02	"	x	x		x	x	x	x	x			x
NO01	Norway	x	x	x	x	x	x				x	x
NO02	"	x	x		x	x	x					x
NO03	"	x	x		x	n.d.	x					x
PL01	Poland	x		x	x	x				x	x	x
PL06	"	x	x		x	x	x	x	x			x
PL10	"	x	x		x	x	x	x	x			x
SE04	Sweden	x	x	x	x	x	x	x	x		x	x
SE14	"	x	x	x	x	x	x	x	x		x	x
SE15	"	x	x	x	x	x	x	x	x		x	x
SE16	"	x	x	x	x	x	x	x	x		x	x
										N tot	Soil temp.	NO3, NH4, N tot
N=32	**N=15**									pH	Bulk density	pH
										TOC		DOC
										C:N		Flow

SYKE

Empirical data needed

- If TF agrees & willingness to share national data
  - Soil chemistry (SC): N tot, TOC, C/N, pH
  - Soil water chemistry (SW): NO_3, NH_4, N tot, TOC/DOC, pH, flow
  - Litterfall chemistry (LF): N tot, TOC, litterfall amount (d.w.)
  - Foliage chemistry (FC): N tot, TOC, sample weight (d.w.)
  - Other parameters? Soil moisture and temperature, stand age…

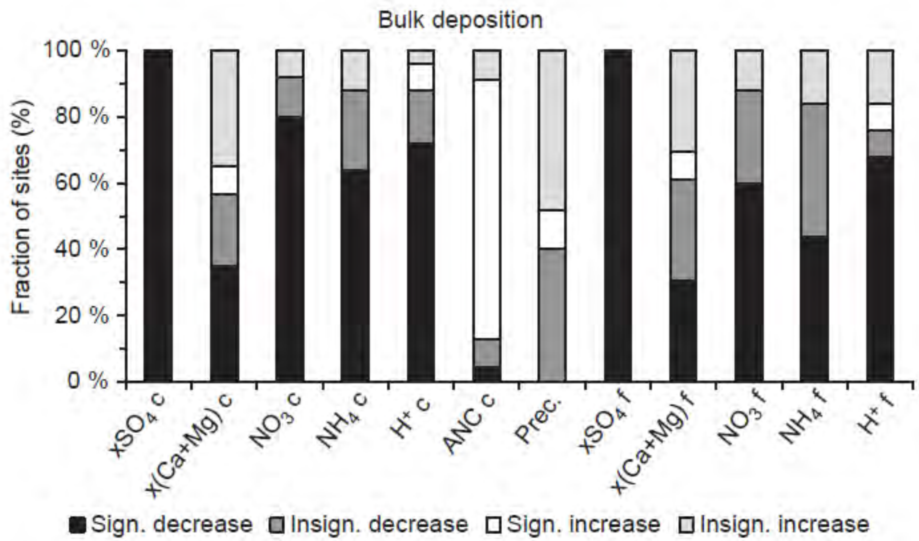
- Time schedule and work plan
  - Data submitted by 30.9.2018
  - Draft Material and Methods by 31.10.2018
  - Manuscript submission by 31.12.2019

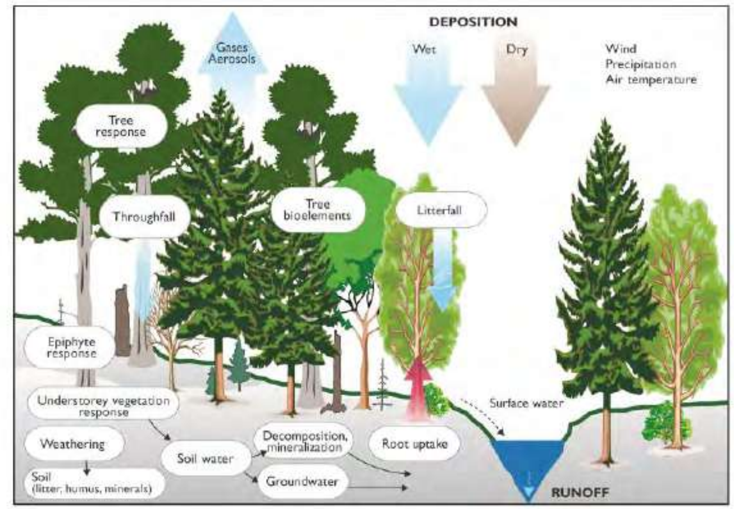
SYKE

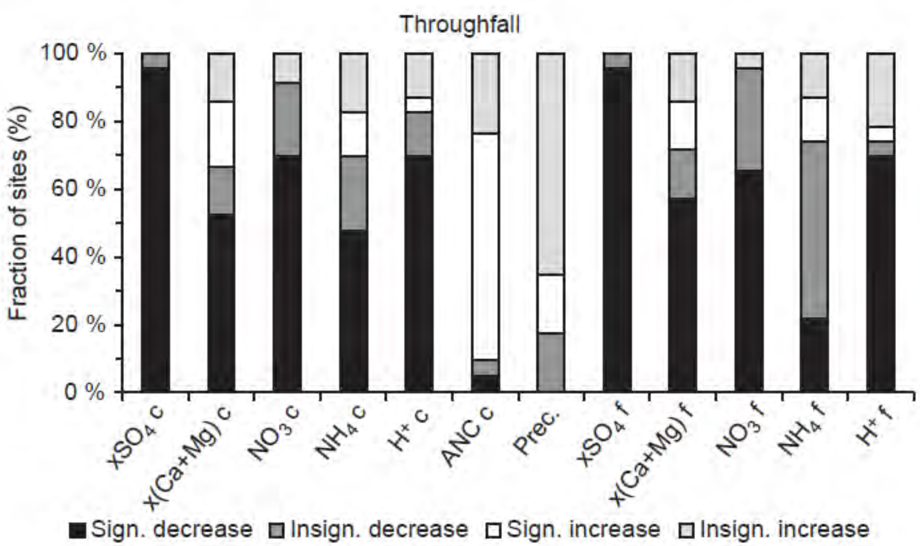
Thank you

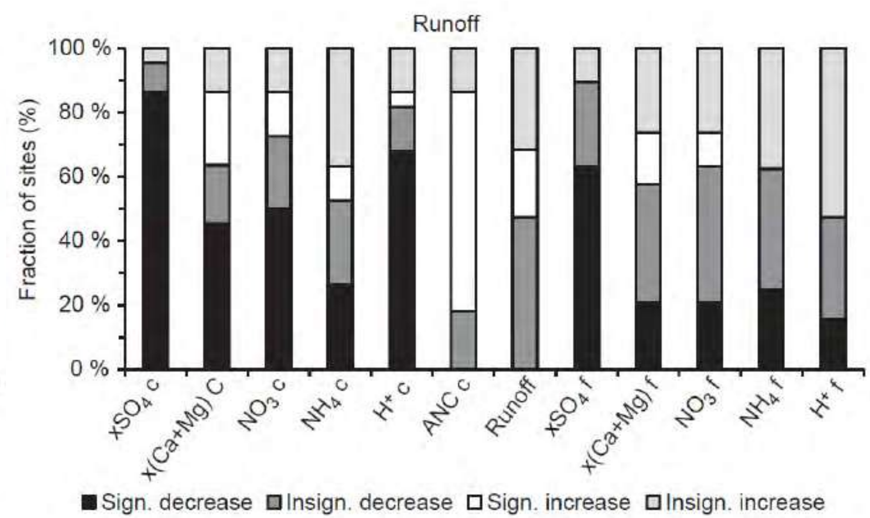
SYKE

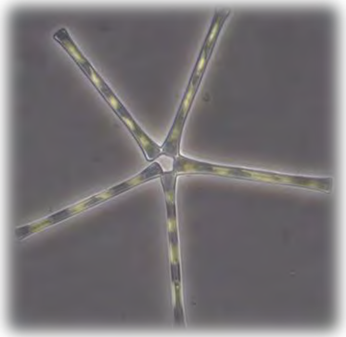
Percentage of IM sites with a significant decreasing (black), insignificant decreasing (dark grey), significant increasing (white) and insignificant increasing (light grey) trend in concentrations and fluxes in 1990–2015







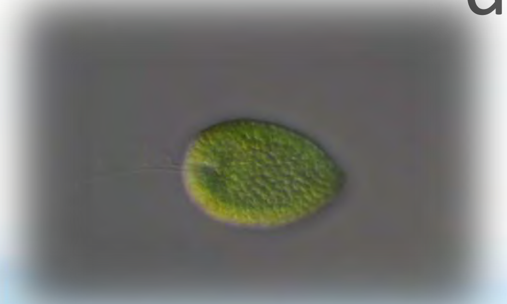


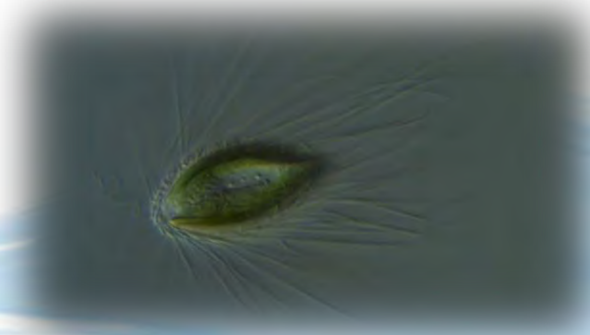


Reactive Nitrogen – impacts on freshwaters

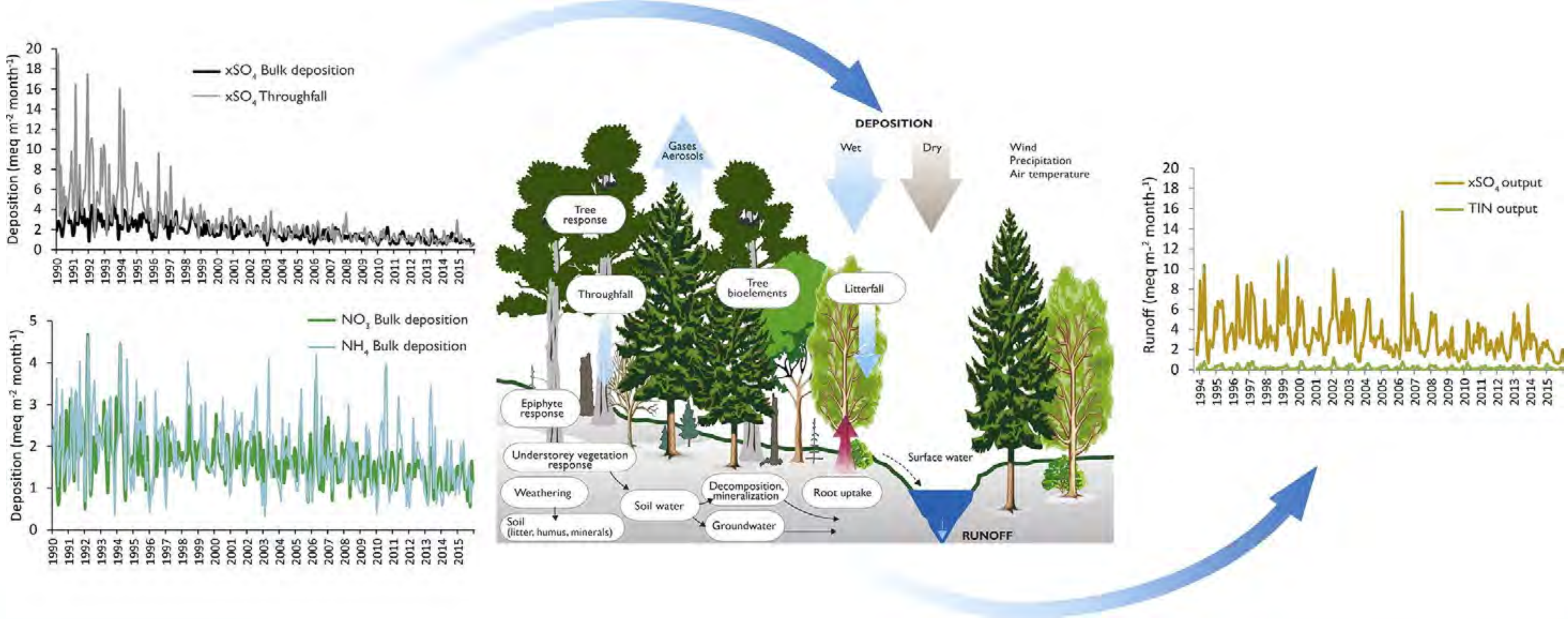
Topic for the 2019 thematic report

Jan Erik Thrane, Benoit Demars and Heleen de Wit



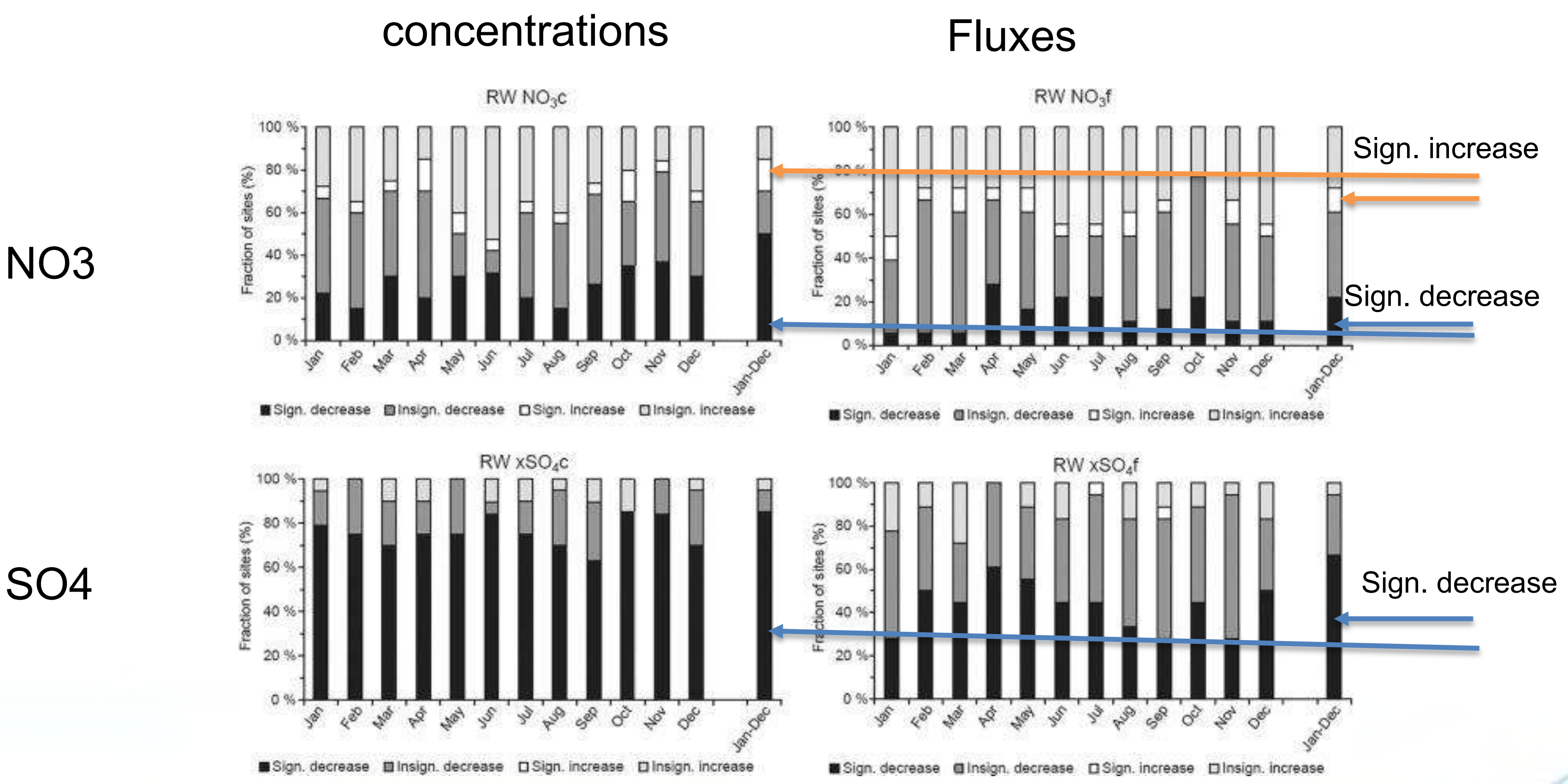


Nitrogen deposition accumulates in catchments and leads to leaching of DIN to surface waters



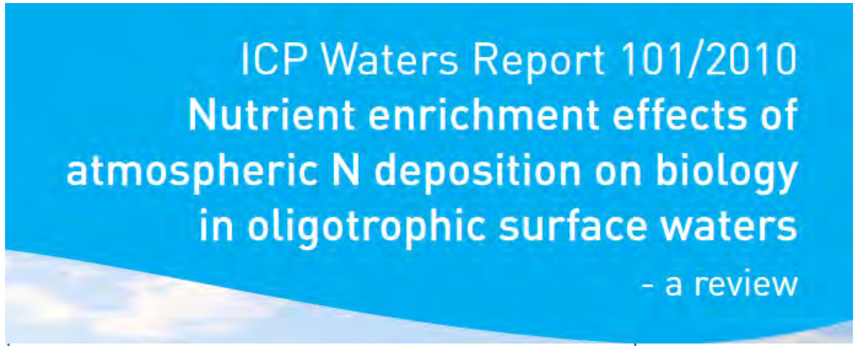
Vuorenmaa et al. 2018 Stoten

Trends in NO3 concentrations and fluxes



Vuorenmaa et al. 2018 Stoten

Aren’t freshwaters just P-limited?



Schindler 1977:
– whole-lake manipulations
show that lakes are P-limited

P-limitation paradigm has been
Challenged by Sterner and Elser,
and others

All three papers that critically review the P limitation paradigm (Elser et al., 2007; Lewis and Wurtsbaugh, 2008; Sterner, 2008) agree that there is compelling evidence that phytoplankton productivity can be limited both by N and P. They also agree that the mechanism proposed by

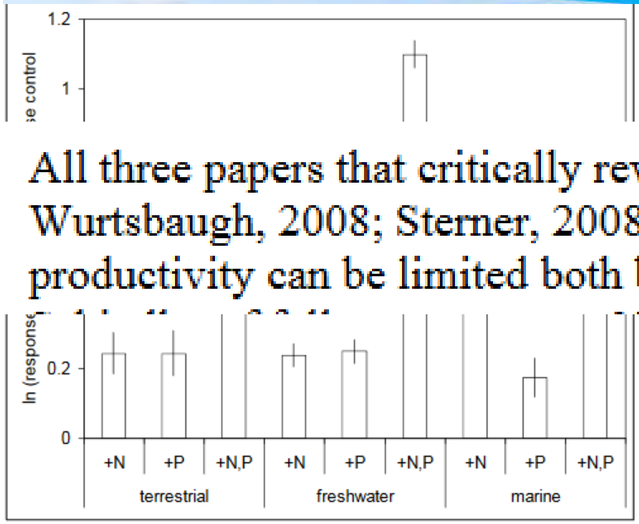
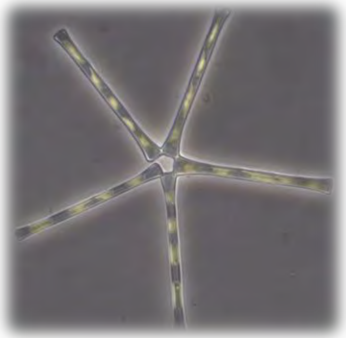


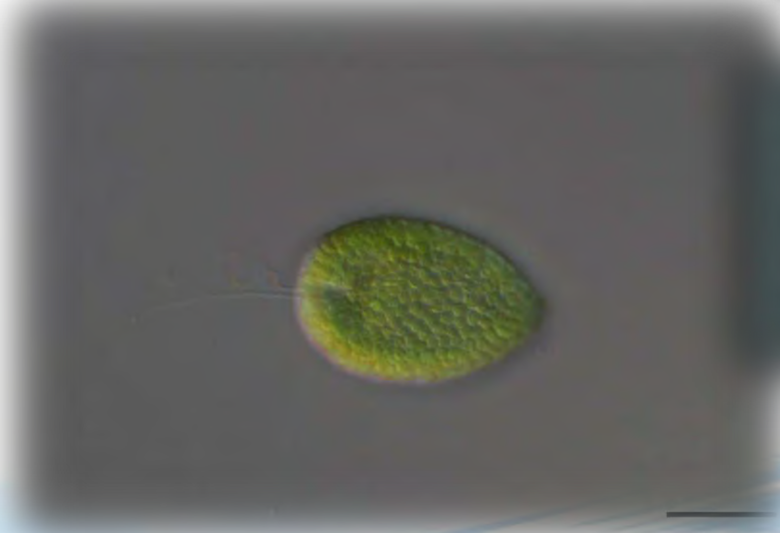
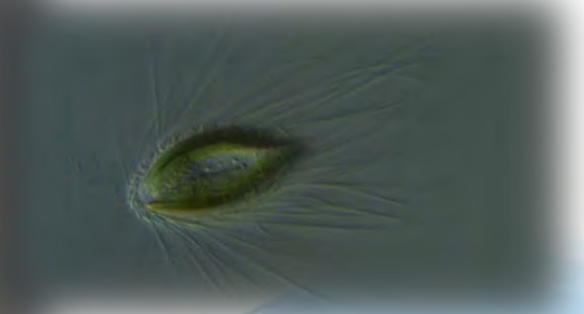
Figure 1 Responses of autotrophs to single enrichment of N or P or to combined N + P enrichment in terrestrial, freshwater and marine ecosystems. Data are given as natural-log transformed response ratios (RRx) in which autotroph biomass or production in the enriched treatment is divided by its value in the control treatment and then ln-transformed. Error bars indicate + or – one standard error. Redrawn from Elser et al. (2007) (Figure 1)

De Wit and Lindholm 2010
ICP Waters report 101/2010

Phytoplankton in oligotrophic lakes

- Microscopic, unicellular organisms that do photosynthetis
- The basis for pelagic food chains in lakes
- Needs light, CO_2, and macro- and micro nutrients to grow
- Most important macronutrients are **nitrogen** and **phosphorus**
  - These may limit growth rate and biomass



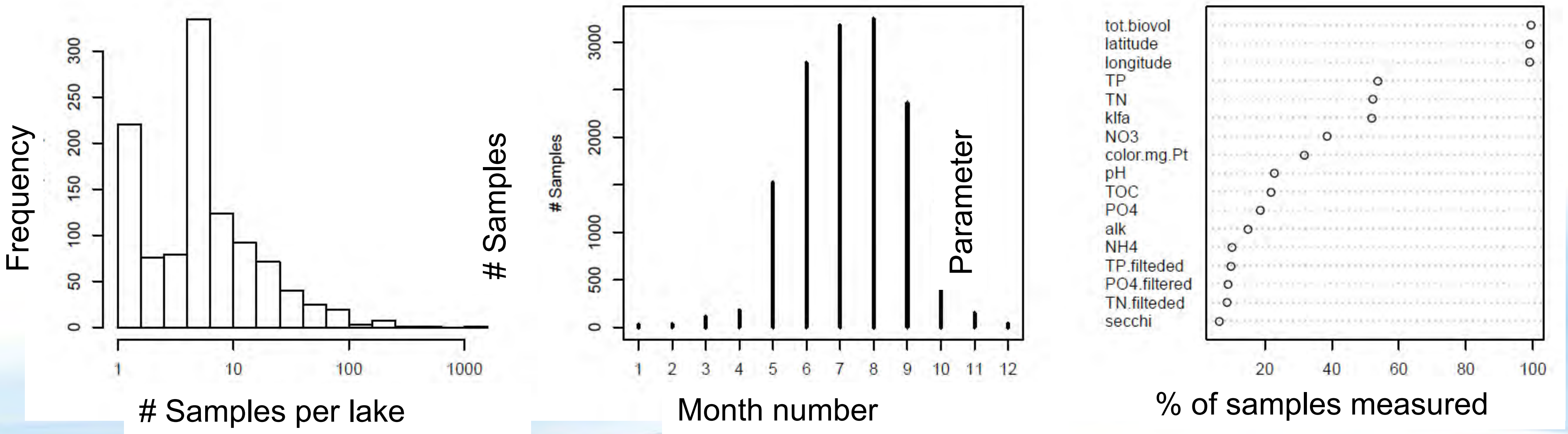



Reactive nitrogen – preliminary data exploration

- Based on existing Norwegian database where water chemistry has been linked to data on phytoplankton, in 1100 lakes
- Contains many data from eutrophic, agriculturally impacted lakes
- So far:
  - Separate lakes with <TP 15 µg/L from the rest.
  - Test relationships between ‘algal biovolume’ (a proxy for algal biomass) and water chemical parameters
  - Test relationships between community (nr of taxa) and water chemistry.
  - Key question – is reactive nitrogen limiting freshwater productivity?

Water chemistry

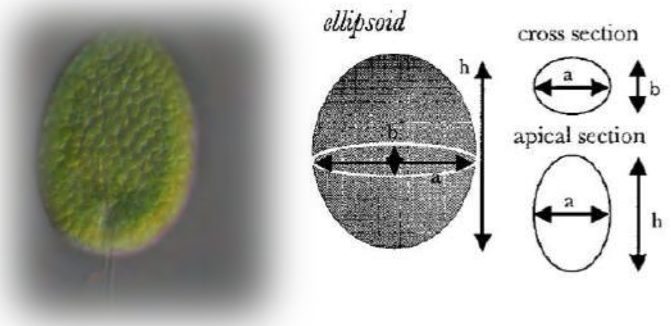
- TN and TP measured in 53 % of the samples (~7500 observations)
- NO3 in ca. 40 %
- NH4 in < 20%
- Several observations per lake (some > 100) and year



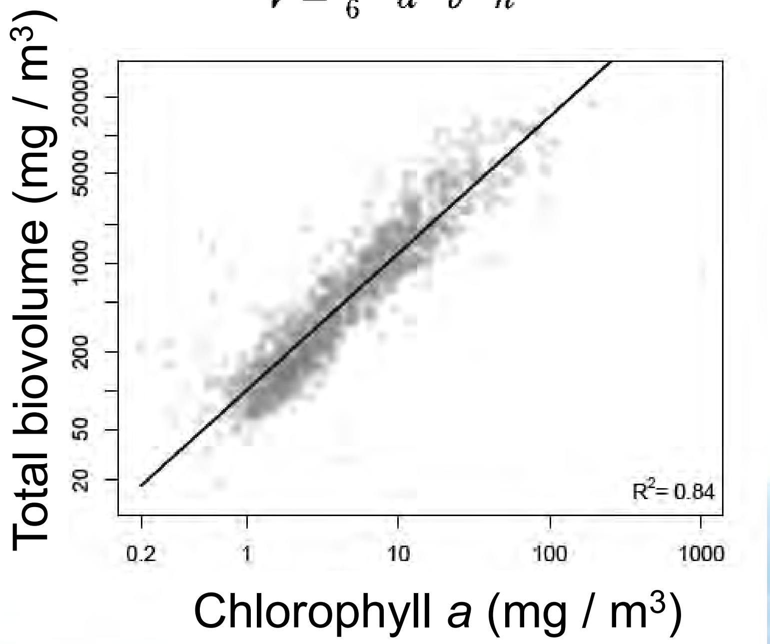
Algal biomass

- 15 000 observations of phytoplankton total biovolume
  - **Biovolume** = the volume of an algal cell
  - Calculated based on the shape of the cell, e.g an ellipspoid
  - **Total biovolume** = the sum of the volumes for all cells of all taxa present in the sample

  - Well correlated with **chl *a*** concentration



$$V = \frac{\pi}{6} \cdot a \cdot b \cdot h$$

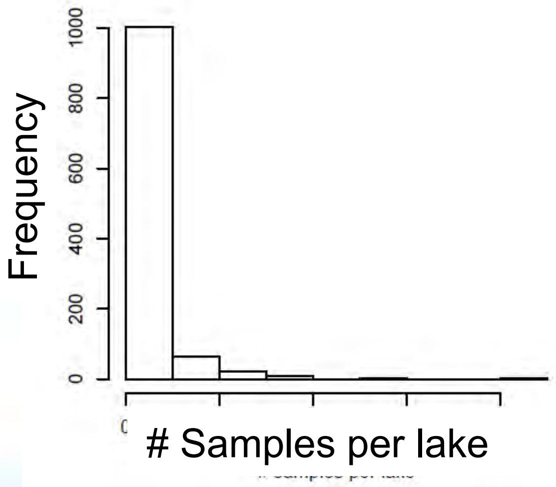


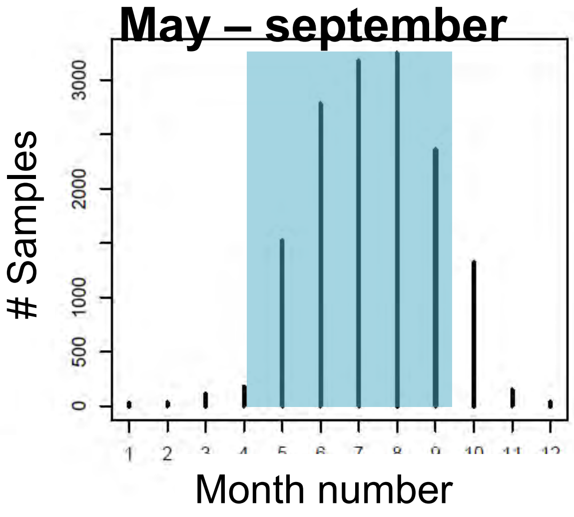
TP, TN and algal biomass

- TN and TP is measured on unfiltered water samples
- Contains both dissolved and particulate N and P.
  - A large fraction of the total P pool is bound in phytoplankton.
  - Almost always > 40%, often > 90 %
    - In oligotrophic water, humus-rich water possibly lower
- There will necessarily be an autocorrelation when relating TP to algal biovolume or chl *a*.
- The same is true for TN, but a smaller fraction of TN is bound in algal biomass
  - Median fraction of 15 % based on data from 75 Norwegian and Swedish lakes

Aggregated dataset

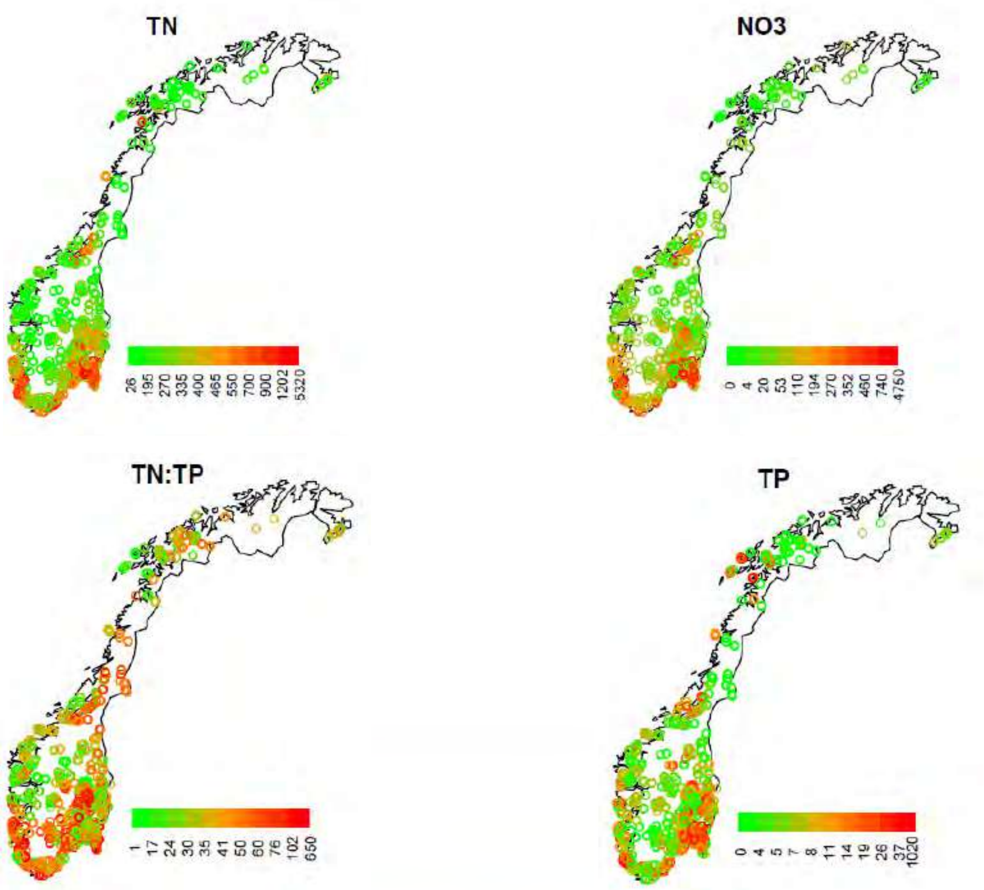
- Subset to the algal growth season (May-Sept)
- Aggregated by taking the mean for each lake within each year
  - Reduced the dataset from 15 000 to about 2500 datapoints for biovolume
  - From ca. 7500 til 1250 obs for TN and TP
  - Most lakes now with < 10 samples per lake

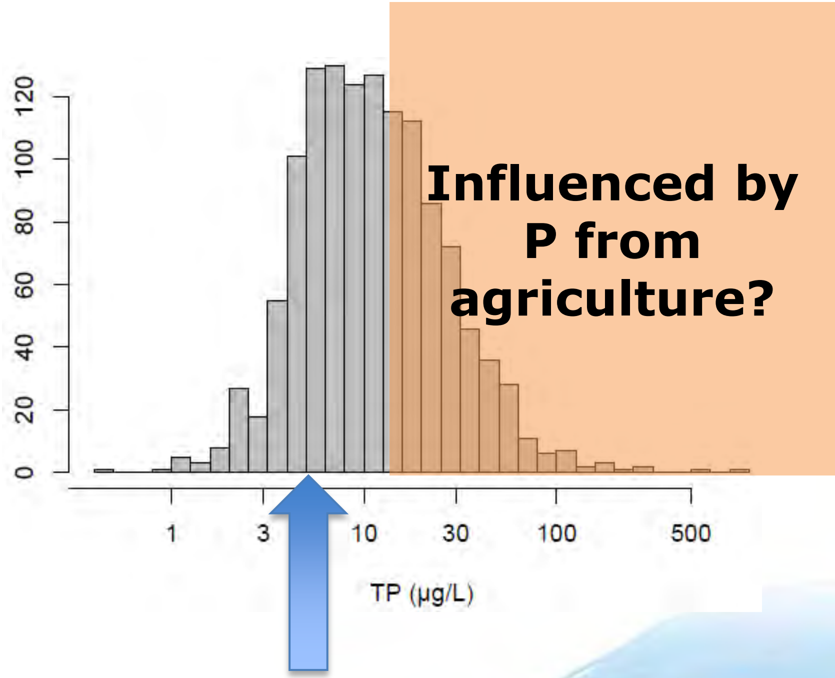




NB! Preliminary analyses are done on this dataset, but the datapoints are not independent (later: e.g. use of mixed effect models to account for dependeny within lakes)

Distributions of N, P, NO_3 and N:P in the database

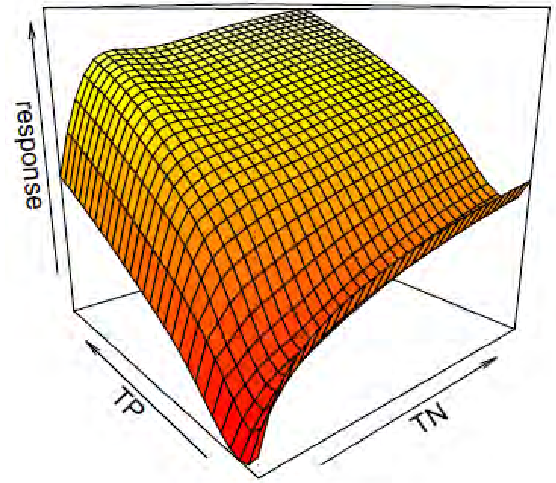


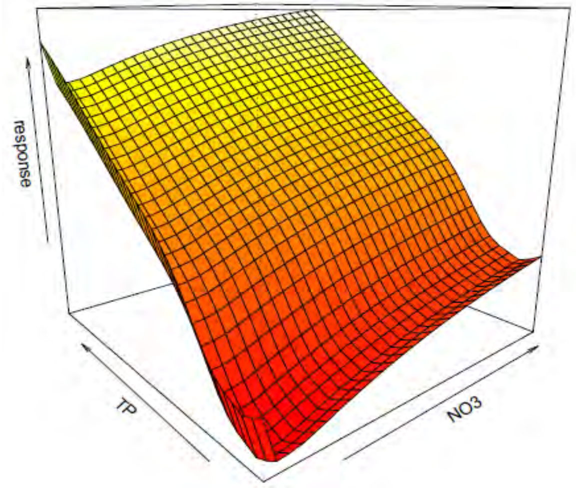


Ca 800 data points

Co-limitation? Responses of phytoplankton biomass to N and P

- Strong relationship between total biovolume and TP alone (whole dataset: $R^2 = 0.61$; oligotrophic lakes: $R^2 = 0.3$)
- Moderate relationship with TN alone (whole dataset: $R^2 = 0.41$; oligotrophic lakes: $R^2 = 0.2$)
- Including both variables increased the explained variation slightly (whole dataset: $R^2 = 0.64$; oligotrophic lakes: $R^2 = 0.37$)
- Plots show response of biomass to TN and TP (upper), and NO3 and TP (lower) for oligotrophic lakes (TP < 15 µg/L)
  - Strong TP-effect for all N-concentrations
  - A postive effect of N, but generally only in the lower end of the N-gradient





Effects of atmospheric nitrogen deposition on nutrient limitation and phytoplankton biomass in unproductive Swedish lakes

2005

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Peter Blomqvist[2]
Department of Limnology, Evolutionary Biology Centre, Uppsala University, Norbyvägen 20, SE-752 36 Uppsala, Sweden

Mats Jansson
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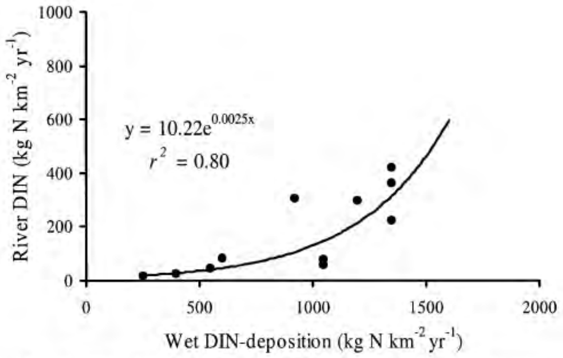
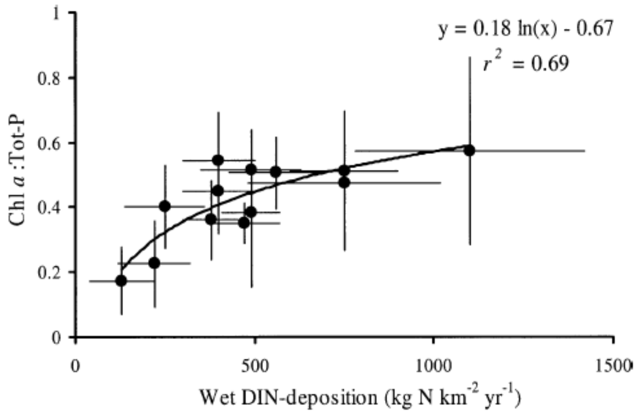


Fig. 3. The relationship between mean river transport of inorganic nitrogen (river DIN) and mean wet inorganic nitrogen deposition (wet DIN deposition) for different river catchments in Sweden (mean values from 1995–2001).



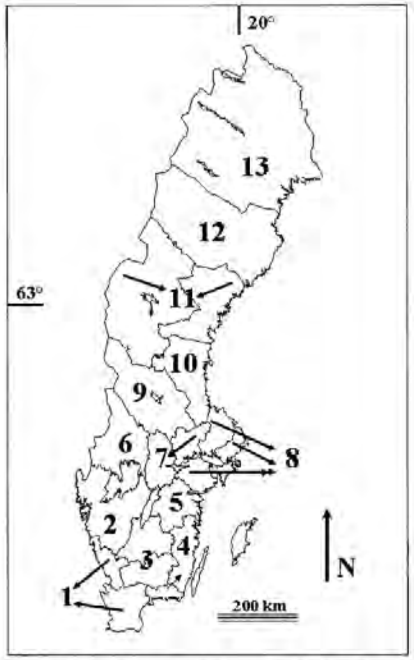
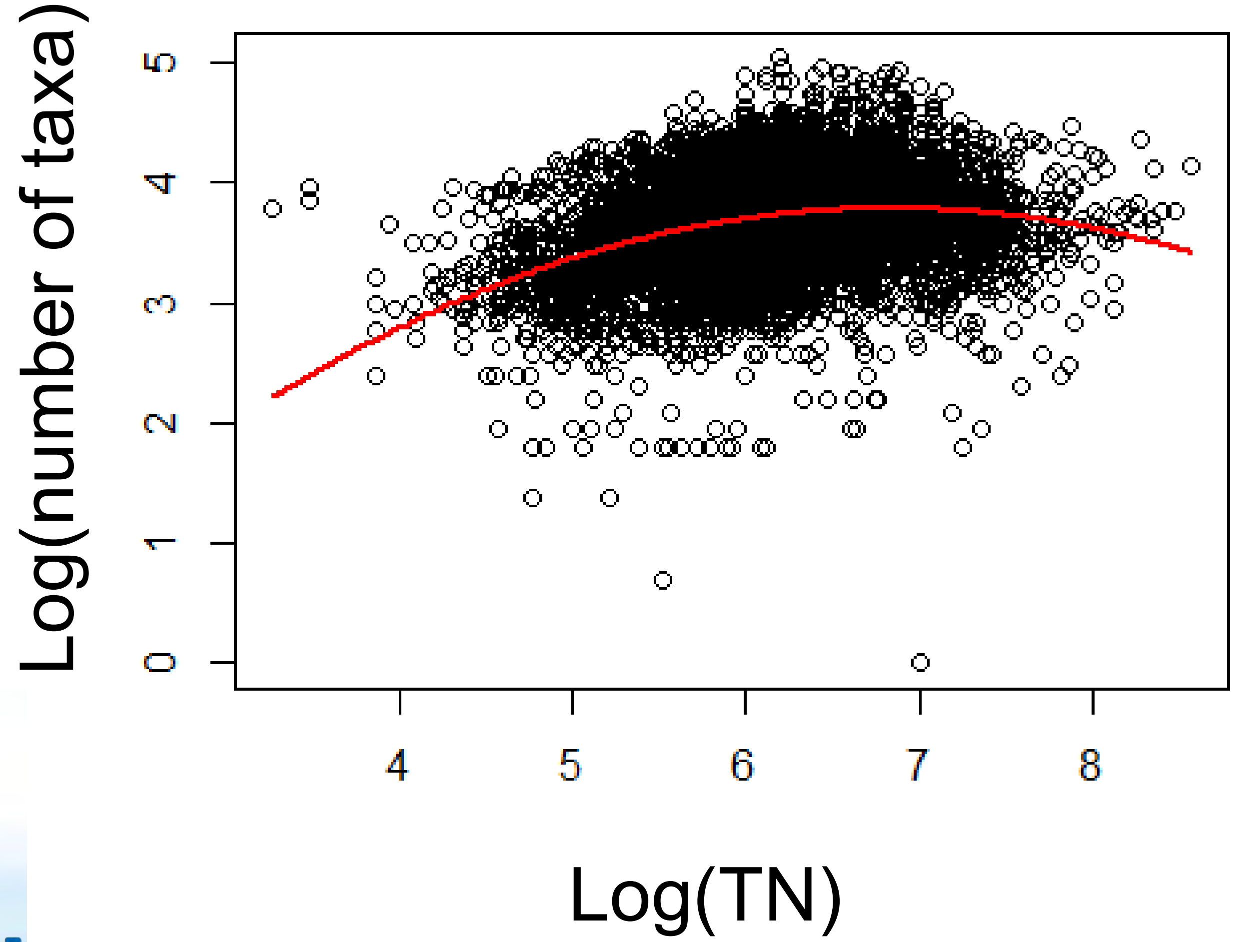


Fig. 1. The different Swedish regions used in this study.

Effect of total nitrogen on species diversity

Gaussian curve: looking for optimum TN for maximum number of taxa (richness)



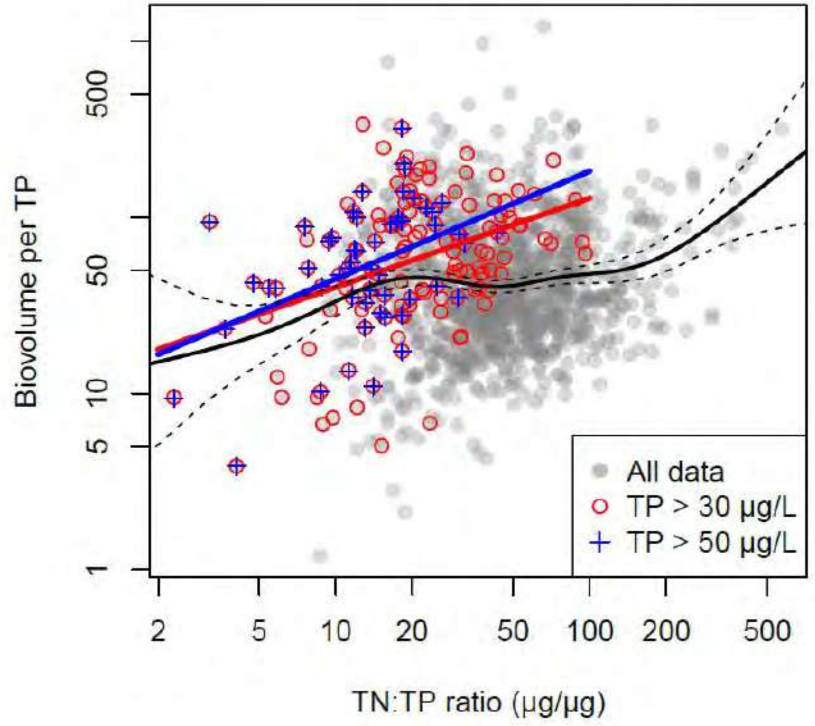
Optimum
915 µg N L^{-1}
Tolerance
121-6904 µg N L^{-1}
Maximum
41 taxa

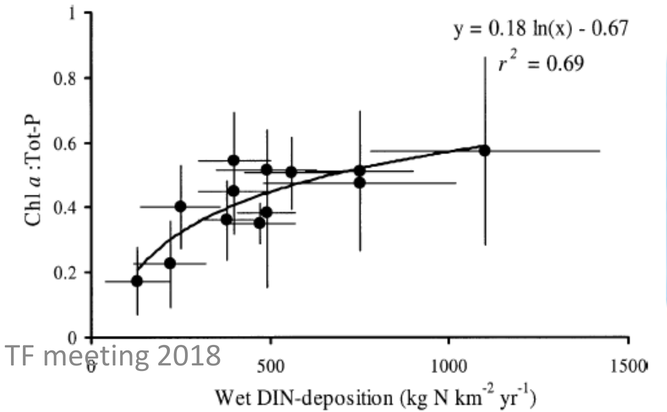
Conclusions

- Preliminary analysis supports that P-limitation of algal productivity is most common, but suggests co-limitation of P and N at low concentrations of N
- However…
  - The dataset contains (too) few data from oligotrophic lakes
  - Not clear which lakes are impacted only by deposition
- To be discussed
  - Availability of other data
  - Approach – key questions – methods
  - Interest of NFCs to participate in the analysis.

Responses of phytoplankton biomass to N and P

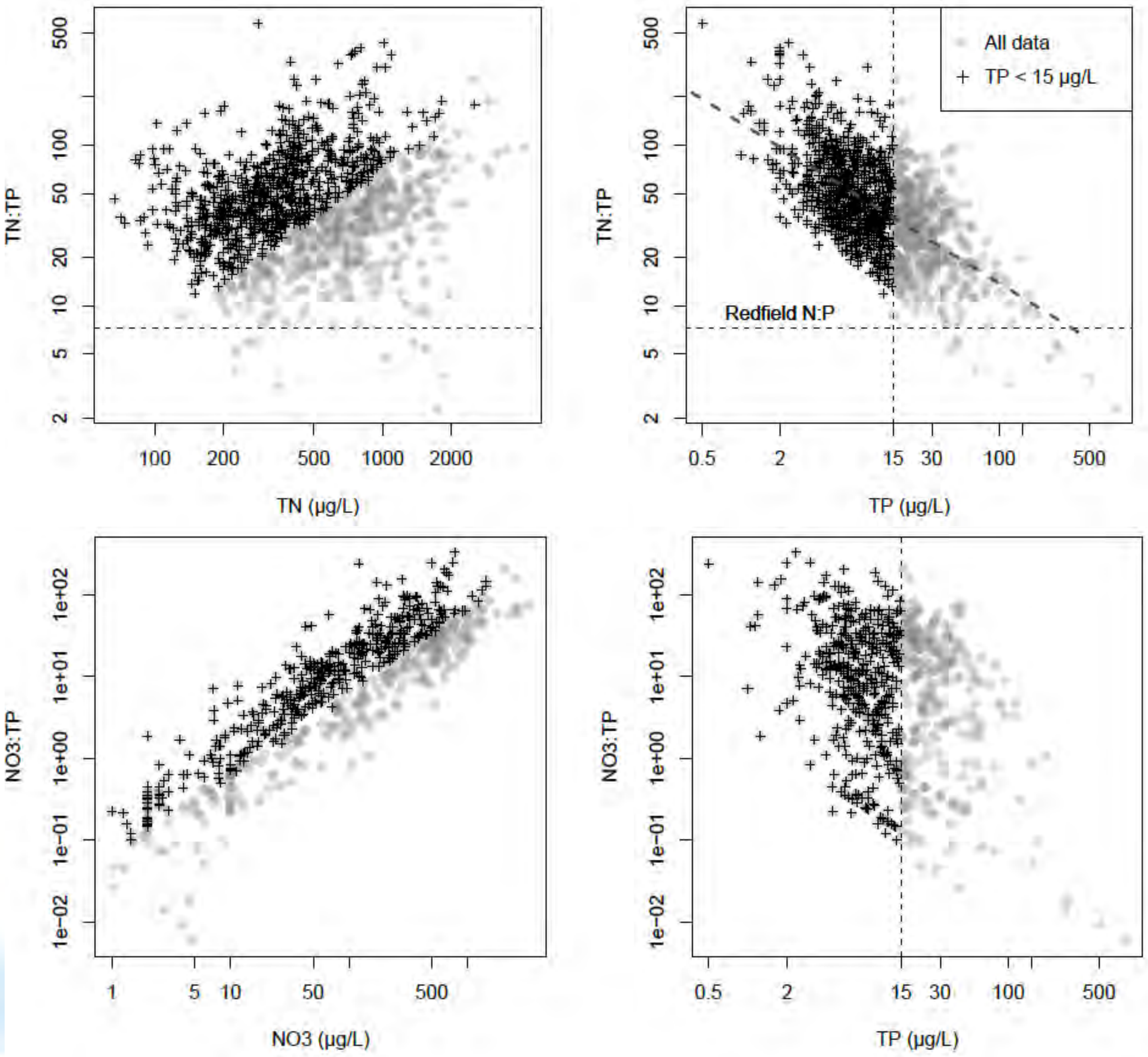
- When lakes are P-limited, we expect the ratio of biovolume to TP to be fairly constant
- If we have N-limitation, this is expected at low TN:TP ratios
- If N-limitation, we expect a decrease in biovolume per TP towards low TN:TP ratios
- There is some indication of that trend in the dataset (right)
- Mostly driven by high P (eutrophic) lakes (red dots: data with TP > 30 µg/L, blue crosses; data with TP > 50 µg/L; grey dots all data)



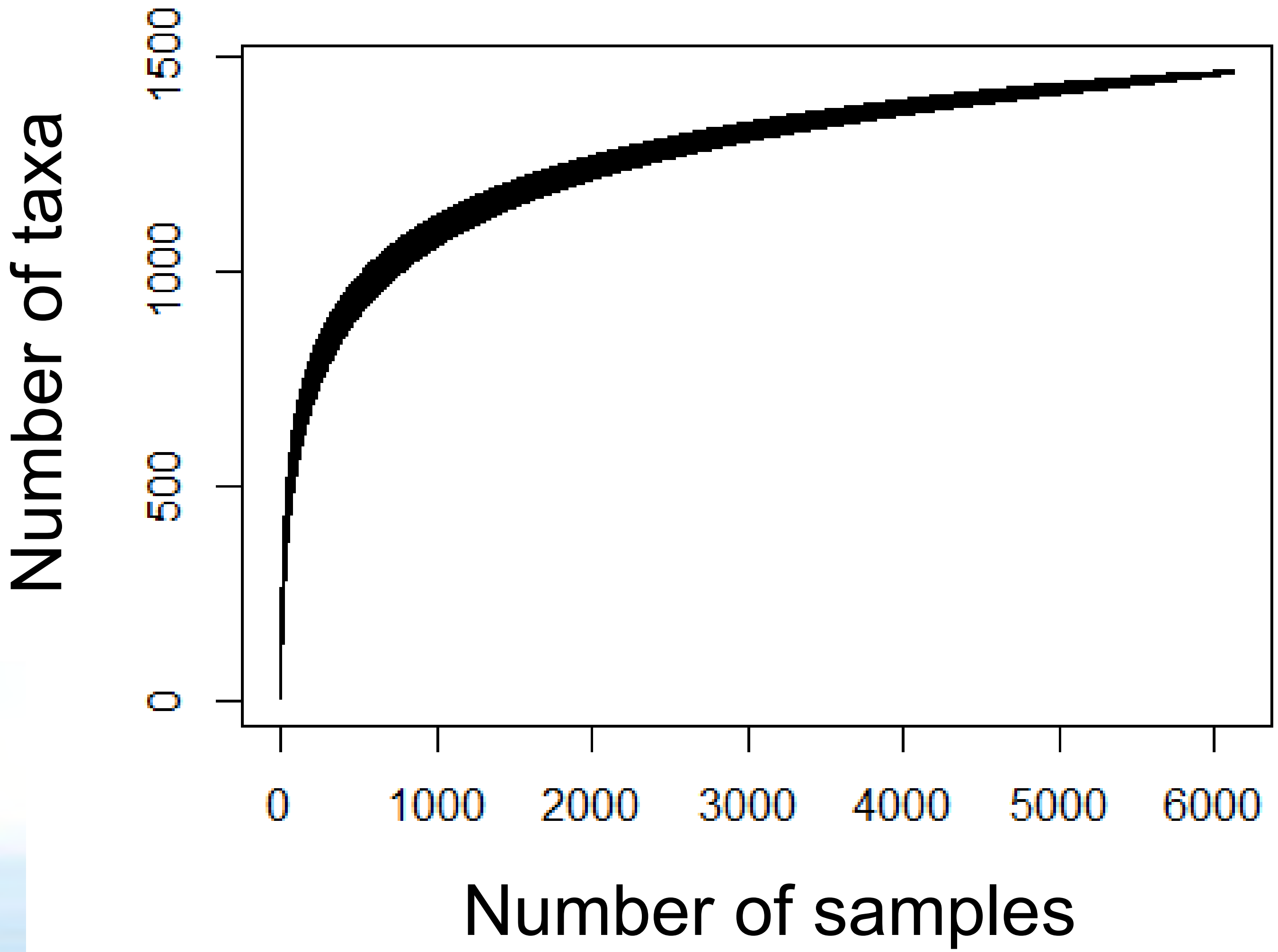


N:P ratios indicative of N or P limitation

- Majority of TN:TP ratios above Redfield N:P ratio, especially in oligotrophic lakes
  - Indicates P-limitation, rather than N-limitation
- NO3:TP is driven mainly by changes in NO3
  - Possible relationship between N-deposition and NO3



Species accumulation curve (sampling effort)



Joint 34th ICP Waters and 26th ICP IM Task Force Meeting, Warsaw, Poland, 7-9 May 2018

Nitrogen budget at the IM station "Puszcza Borecka“

Rafał Ulańczyk
Krzysztof Skotak
Tomasz Pecka
Anna Degórska
Agnieszka Pasztaleniec
Agnieszka Kolada

Institute of Environmental Protection
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LRTAP
Long-range Transboundary Air Pollution

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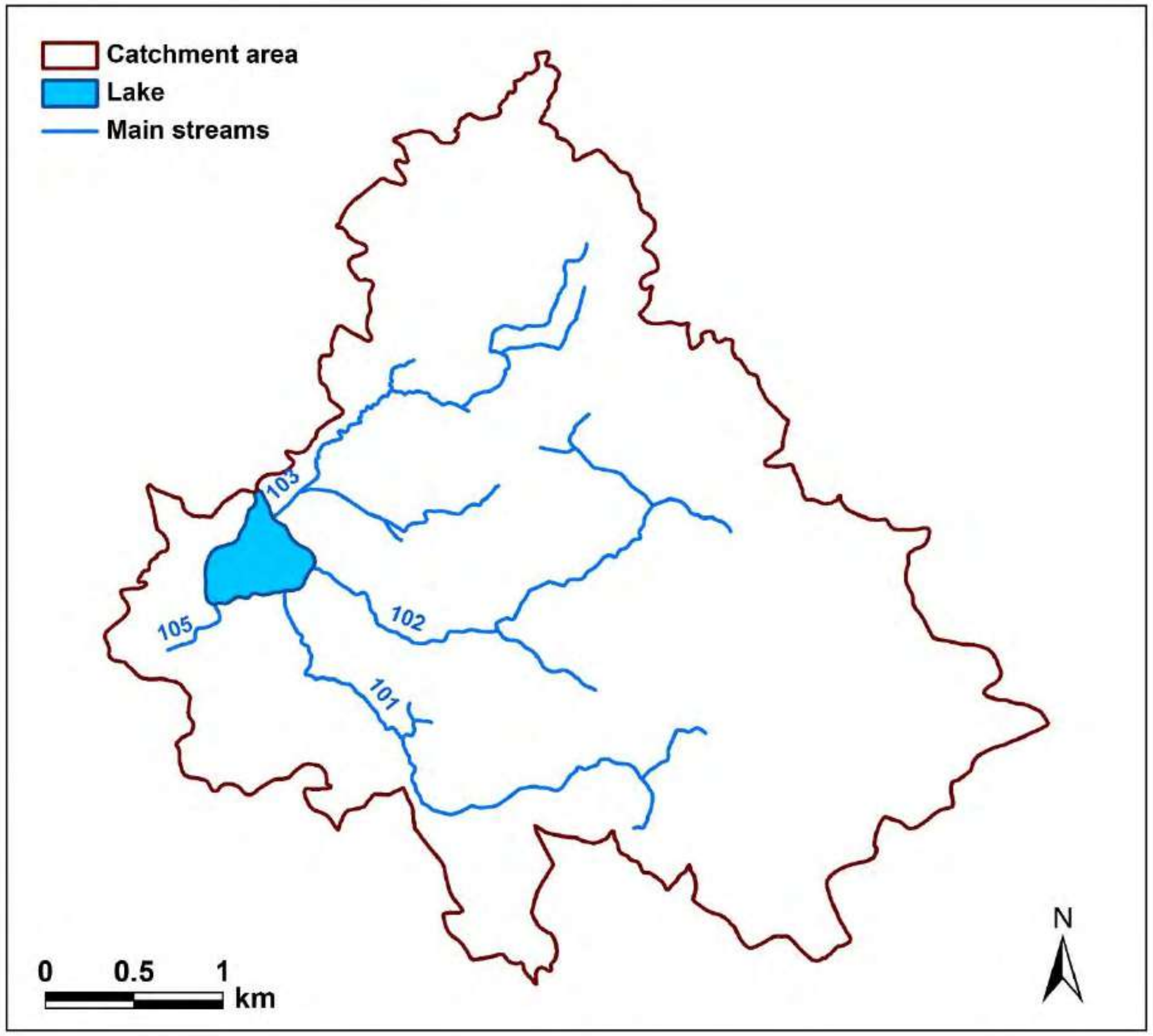
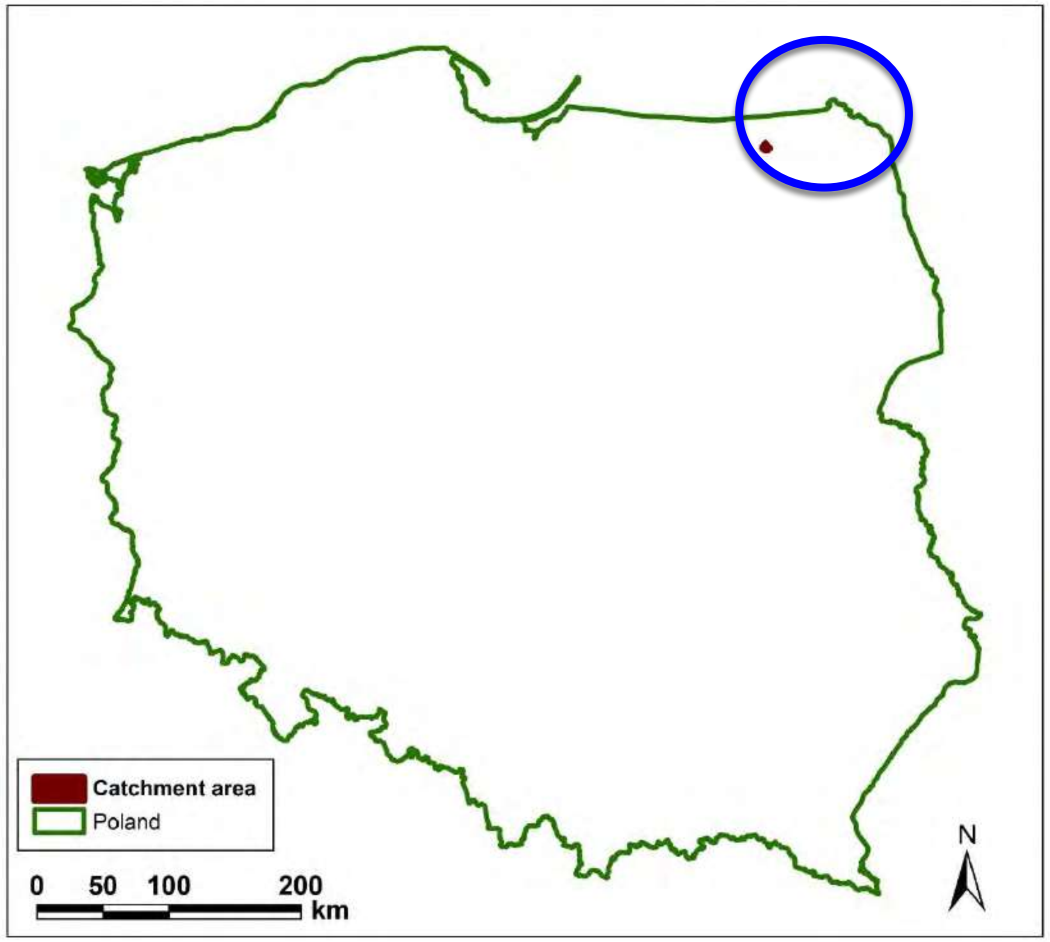
IM „Puszcza Borecka”

- **Area** of the monitored catchment: 13.268 km^2
- **86%** of catchment belongs to the **protected** area Puszcza Borecka
- **100% Natura 2000**
- **EMEP station** (PL05 „Diabla Góra”)



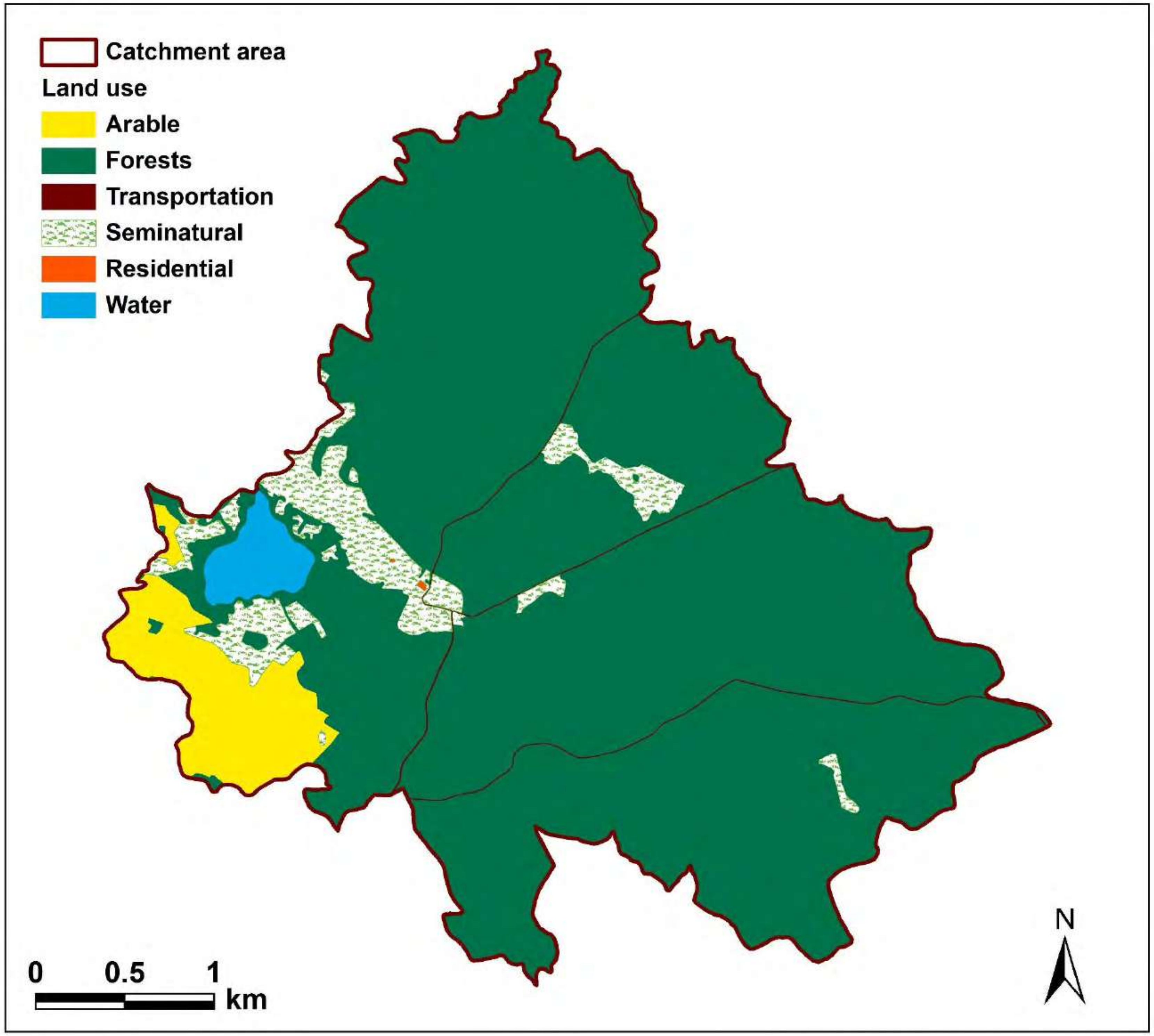
- **Lake (Łękuk Wielki)** located at the outflow
- Area of lake: 21.297 ha
- **4 main streams** flowing into the lake (partially of seasonal character)
- **Elevation:** 127.3 – 198.8 m a.s.l. (station at 157.5)



IM „Puszcza Borecka”

Land use:

- Forests: 78%
- Agriculture: 5.6%
- Seminatural: 14.3%
- Water: 1.6%
- Residential: 0.2% (low density)



Monitoring of nitrogen

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Scope:

- Concentration of $N\text{-}NO_{2,3}$ and $N\text{-}NH_4$ in **air and precipitation** and wet deposition (daily since 1994)
- Concentration of $N\text{-}NO_3$ and $N\text{-}NH_4$ in:
  - **troughfall** (monthly since 2005)
  - **stemflow** (monthly since 2004)
  - **litterfall** (monthly sampling, yearly analyses since 2004)
  - **Soil water** at 3 depths: 20, 50 and 80 cm (2-9 samples/year since 2010)
  - **groundwater** (1-8 samples/year since 1995)
  - **lake** + outflow (1-8 samples/year since 1991, outflow since 1995)
  - **streams** (1-10 samples/year since 1995, discontinued)

Monitoring of nitrogen – basic results, trends

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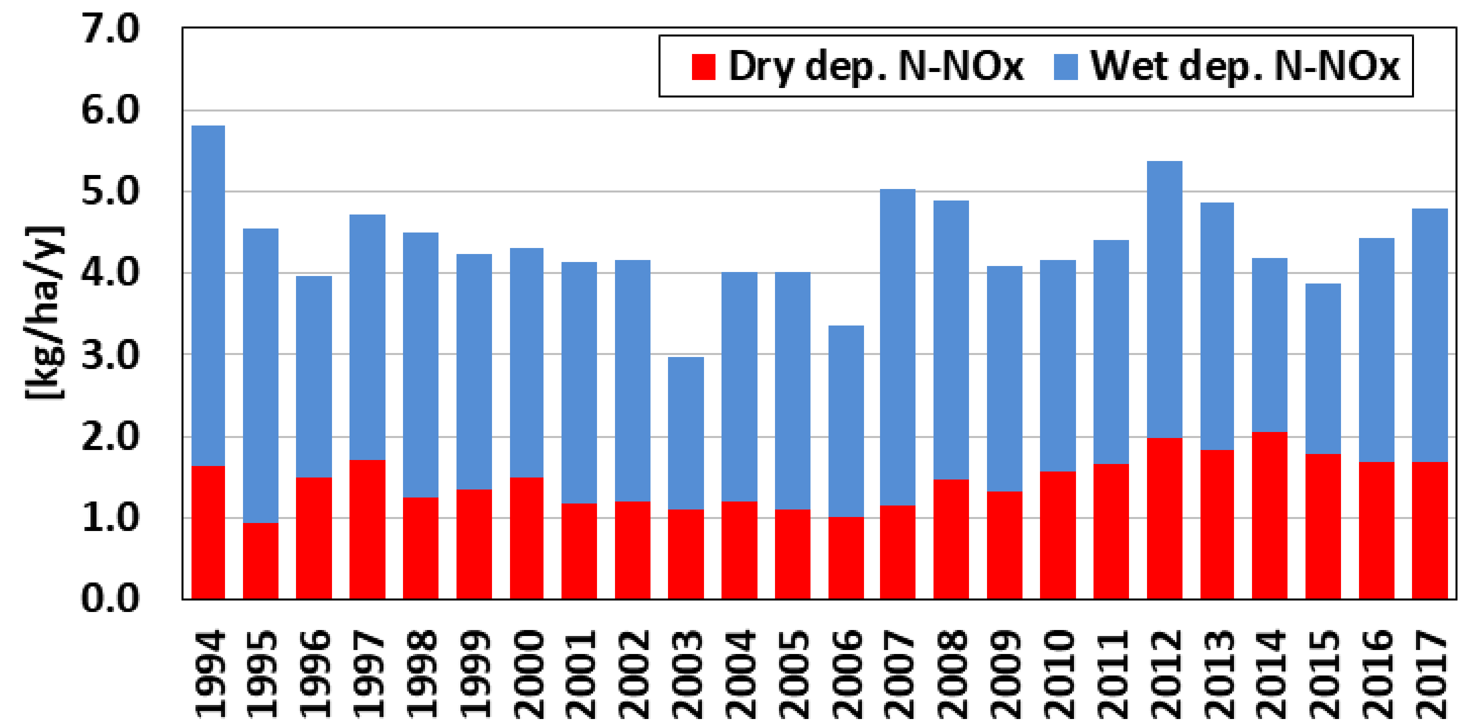
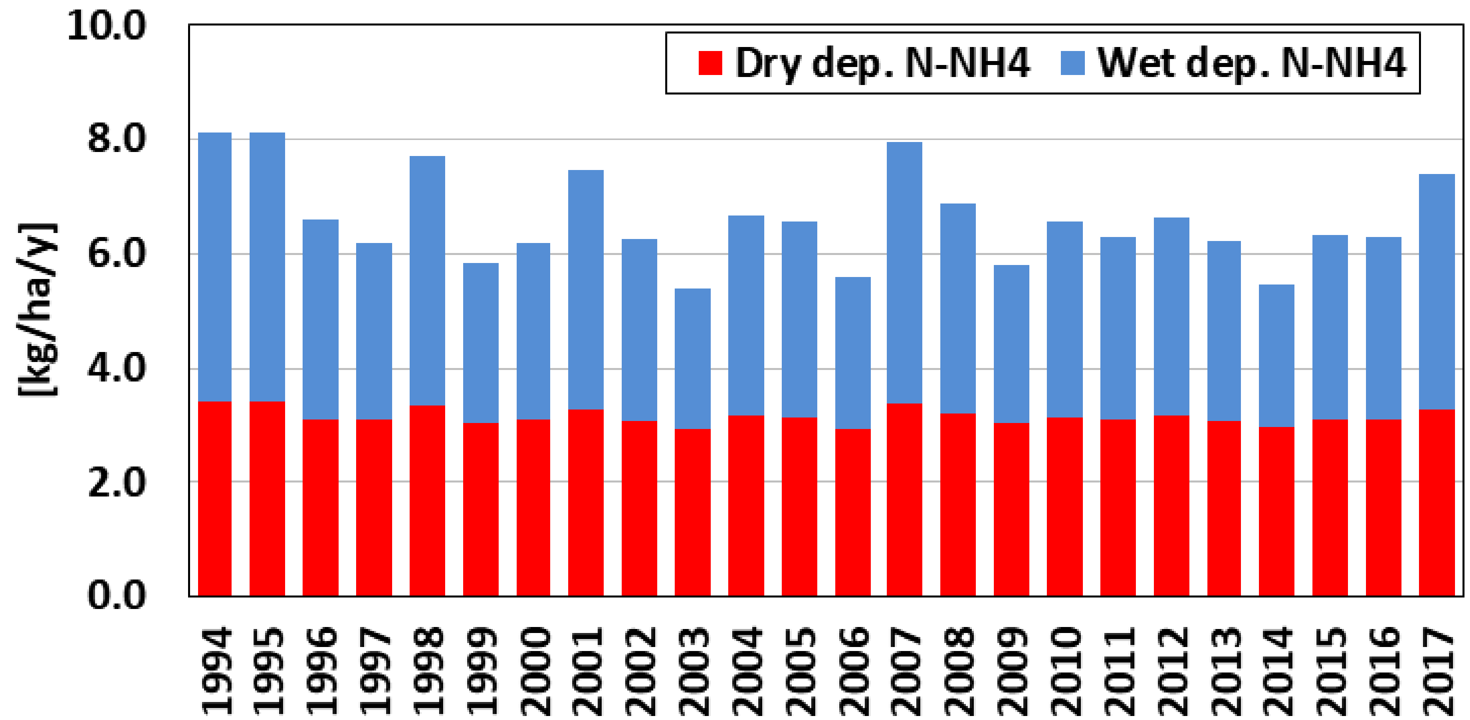
Deposition of N

- no statistically significant trends in the total deposition of nitrogen
- for NO_x decrease in wet deposition and increase in dry ($p<0.05$ and $p<0.1$)
- no decrease because of the atmospheric precipitation (see concentrations)





Monitoring of nitrogen – basic results, trends

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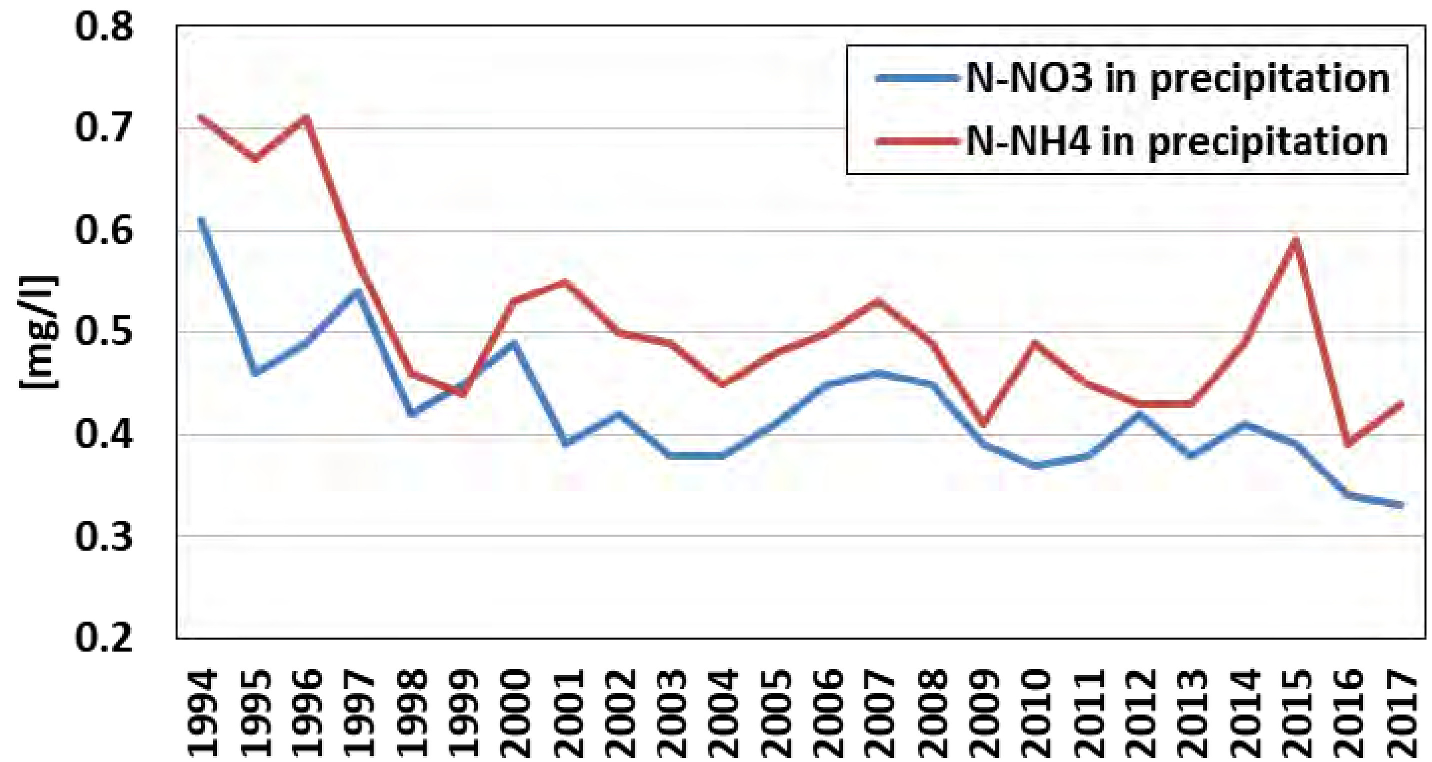
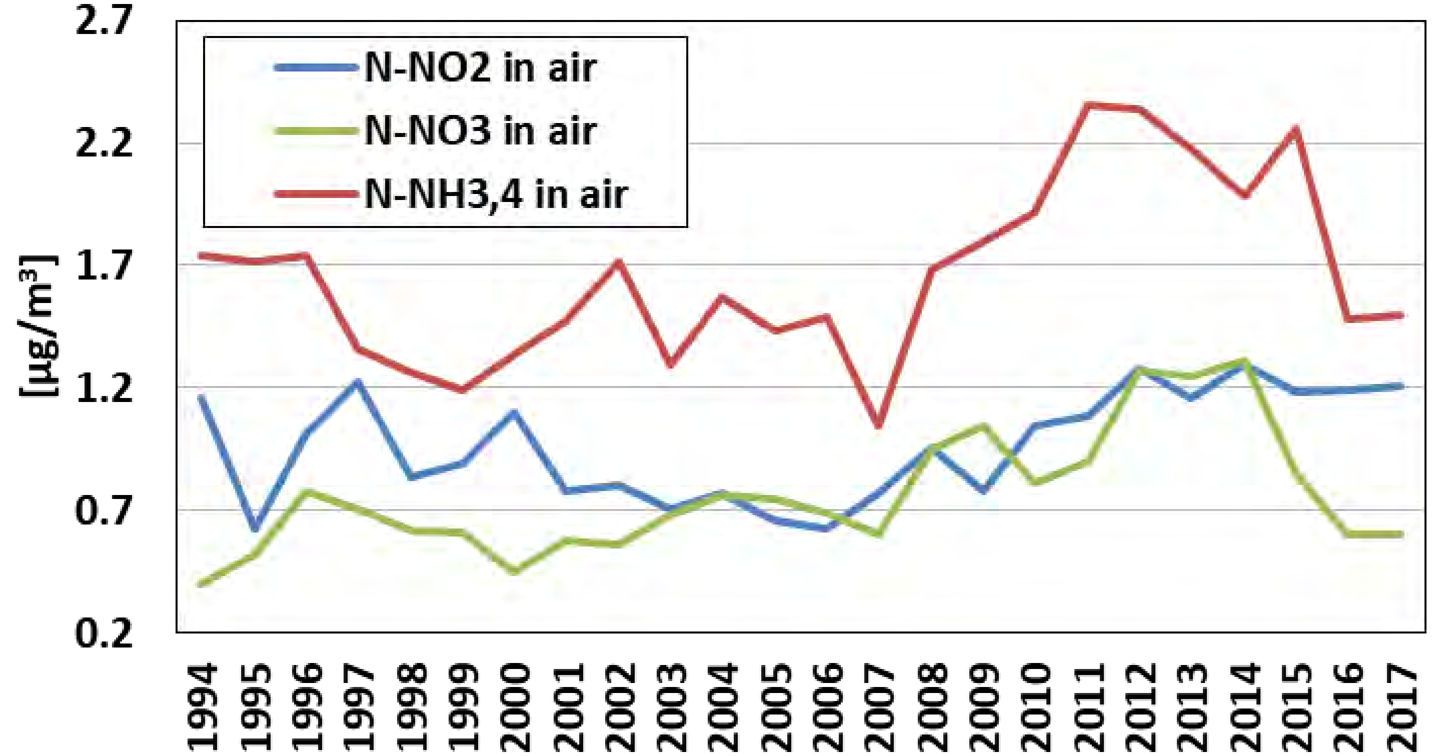
Concentration of N in precipitation

- Significant **decrease** in the N concentrations ($p<0.001$, decrease nearly 1.5 % per year)

Concentration of N in air

- Significant **increase** in the N concentrations ($p<0.01$ for NO_3, $p<0.025$ for NO_2 and $NH_{3,4}$, increase approx. 2 % per year)





Monitoring of nitrogen – N inputs

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		Yearly average	Unit	Trend	n	Significance*
$N\text{-}NO_3$	Dry deposition	1.46	kg/ha/y	▲ 1.63% / year	24	p=0.015
	Wet deposition	2.91		▼ 0.75% / year	24	p=0.059
	Troughfall	4.28		▼	13	N. s.
	Stemflow	0.49 Hornbeam 0.92 Oak 2.73 Spruce	mg/l	▼ ▲ ▲ 7.54% / year	14	N. s. N. s. p=0.018
$N\text{-}NH_4$	Dry deposition	3.15	kg/ha/y	▼	24	N. s.
	Wet deposition	3.45		▼	24	N. s.
	Troughfall	4.72		▲	13	N. s.
	Stemflow	0.75 Hornbeam 1.21 Oak 2.71 Spruce	mg/l	▲ ▲ ▲ 4.80% / year	14	N. s. N. s. p=0.063
N tot.	Litterfall	53.53	kg/ha/y	▼	5	N. s.

* "N. s." (not significant) means $p<0.1$ in the Mann-Kendall test

Monitoring of nitrogen – N outputs (sinks)

			Yearly average	Unit	Trend	n	Significance *
$N\text{-}NO_3$	Soil water at:	20 cm	0.546	mg/l	▼ 24.19% / year	7	p=0.064
		50 cm	0.203		▼	7	N. s.
		80 cm	0.141		▼	7	N. s.
	Groundwater		0.060		▲	20	N. s.
	Surface water outflow		0.334		-	17	N. s.
	Surface water outflow		**0.523**	kg/ha/y	Not analysed**		
	Lake at:	-1 m	0.356	mg/l	▲ 6.66% / year	13	p=0.071
		-5 m	0.665		▲	7	N. s.
		-11 m	0.628		▲	13	N. s.
$N\text{-}NH_4$	Soil water at:	20 cm	0.141	mg/l	▲ 23.28% / year	7	p=0.008
		50 cm	0.055		▲ 21.28% / year	7	p=0.017
		80 cm	0.086		▲ 26.70% / year	7	p=0.017
	Groundwater		0.090		▲ 3.91% / year	21	p=0.054
	Surface water outflow		0.174		▲ 14.26% / year	13	p=0.004
	Surface water outflow		**0.070**	kg/ha/y	Not analysed**		
	Lake at:	-1 m	0.165	mg/l	▲ 12.24% / year	13	p=0.016
		-5 m	0.301		▲	7	N. s.
		-11 m	0.861		▲ 10.51% / year	13	p=0.001

* "N. s." (not significant) means $p<0.1$ in the Mann-Kendall test

** reliable flow rate data available to 2008.

Monitoring of nitrogen
– correlations between sources and sinks of N

What	Input	Output	Correlation*
$N\text{-}NO_3$	lake (at 11 m)	dry deposition	moderate
		concentration in air	moderate
		concentration in troughfall	moderate
$N\text{-}NH_4$	soil water at all depths	dry / wet / total deposition	moderate
		load in troughfall	moderate
	lake (at 1 m)	concentration in air	high
	lake (at 5 m)	concentration in troughfall	moderate
	lake (at 11 m)	concentration in air	moderate
	Surface water (outflow)	concentration in air	high

* Pearson coefficient:
Moderate: $0.5 \leq R < 0.75$
High: $0.75 \leq R$

Monitoring of nitrogen – limitations of the data interpretation

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- Usually **not all desired forms of N are measured** or measurable (e.g. nitrogen uptake)
- Usually **not all processes affecting the N** transport are **measured** (e.g. percolation) or measurable (e.g. lateral flow)
- **Monitoring periods** are can be different for different parameters
- **Gaps** in data
- **Frequency** of monitoring may not be enough to analyse dynamic processes
- **Assessment** of interdependences between variables is usually **limited to statistical analyses and expert judgements**

Modelling of nitrogen dynamics – what for?

- Usually **not all desired forms of N are measured** or measurable (e.g. nitrogen uptake)
- Usually **not all processes affecting the N** transport are **measured** (e.g. percolation) or measurable (e.g. lateral flow)
- **Monitoring periods** can be different for different parameters
- **Gaps** in data
- **Frequency** of monitoring may not be enough to analyse dynamic processes
- **Assessment** of interdependences between variables is usually **limited to statistical analyses and expert judgements**

- **All desired forms of N** can be **included**
- **All desired processes** can be **included** in deterministic models
- **All processes** are simulated for **the same period**
- **No gaps** in outputs
- **Frequency** of outputs can be **adjusted to needs** (usually)
- Statistical analyses and expert judgements can be complemented with **complex physically based calculations**

Integrated assessment of environmental processes – conceptual design of the system in Puszcza Borecka

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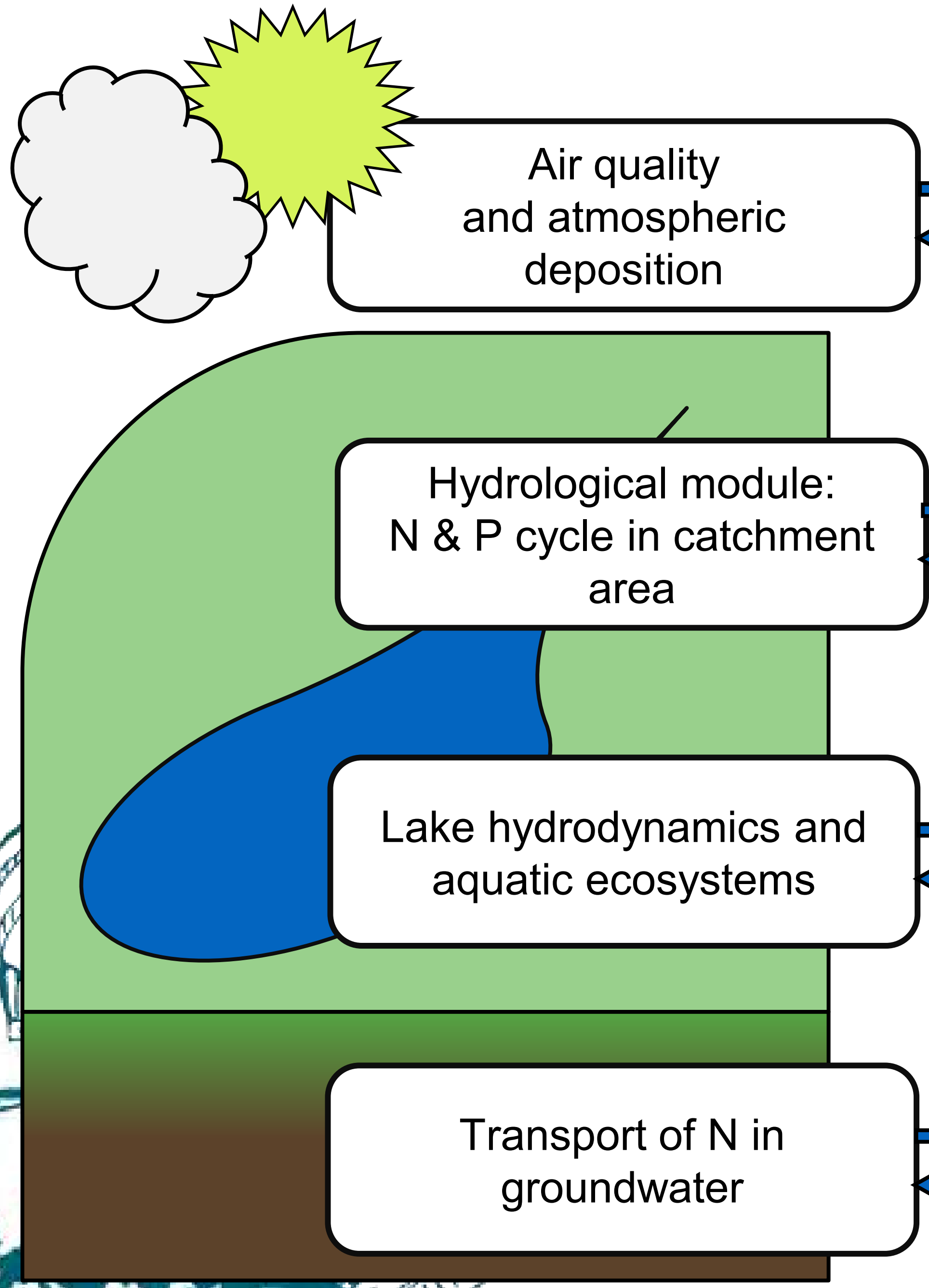
Four main modules (models)



Database

Input data: concentrations, deposition, meteorological parameters, emitters, surface elevation and land use,
Outputs: concentrations, deposition

Input data: meteorological data, land morphology and land use, soils, N and P monitoring data, water balance monitoring data, deposition, management practices
Outputs: water balance (e.g. evaporation, percolation, groundwater recharge, surface runoff), nutrient balance

Input data: surface water inflows and quality (e.g. chlorophyll, N, P, Si, C, O, temperature, pH), meteorological data, bottom sediments, characteristic and initial conditions for plankton, macroalgae, invertebrates and fish
Outputs: 3D concentrations (e.g. chlorophyll, N, P, Si, C, O), temperature, biomass of plankton, macroalgae, invertebrates and fish.

Input data: recharge, loads of N, geological structure, initial water table elevation, wells, intakes.
Outputs: directions and velocity of flow, water table elevation, concentrations

Integrated assessment of environmental processes – conceptual design of the system in Puszcza Borecka

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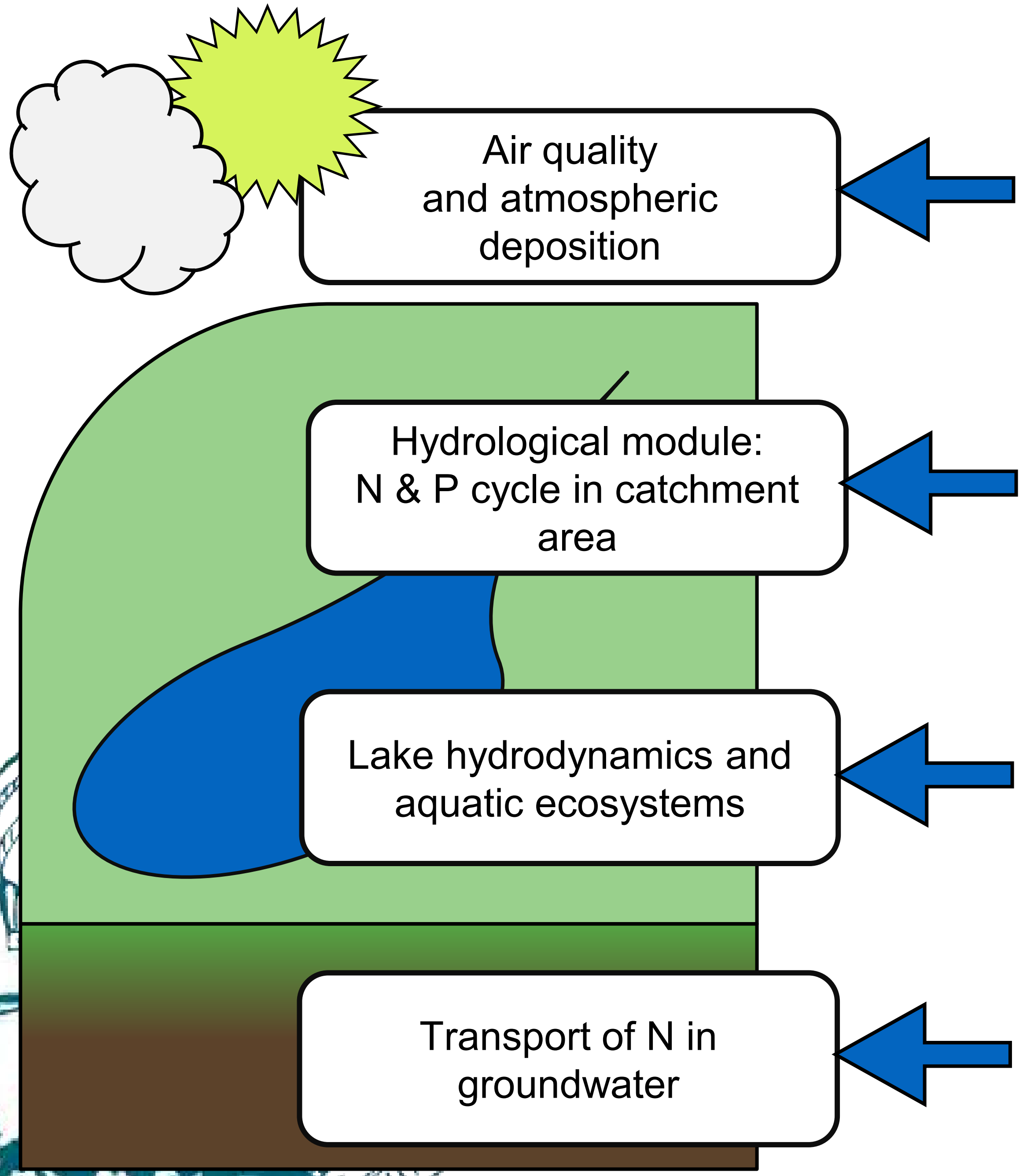
Models (to be) **used**



CALMET-CALPUFF (2019)

SWAT (2017-2018)

AEM3D (2017-2018)

MODFLOW-MT3D (2018-2019)

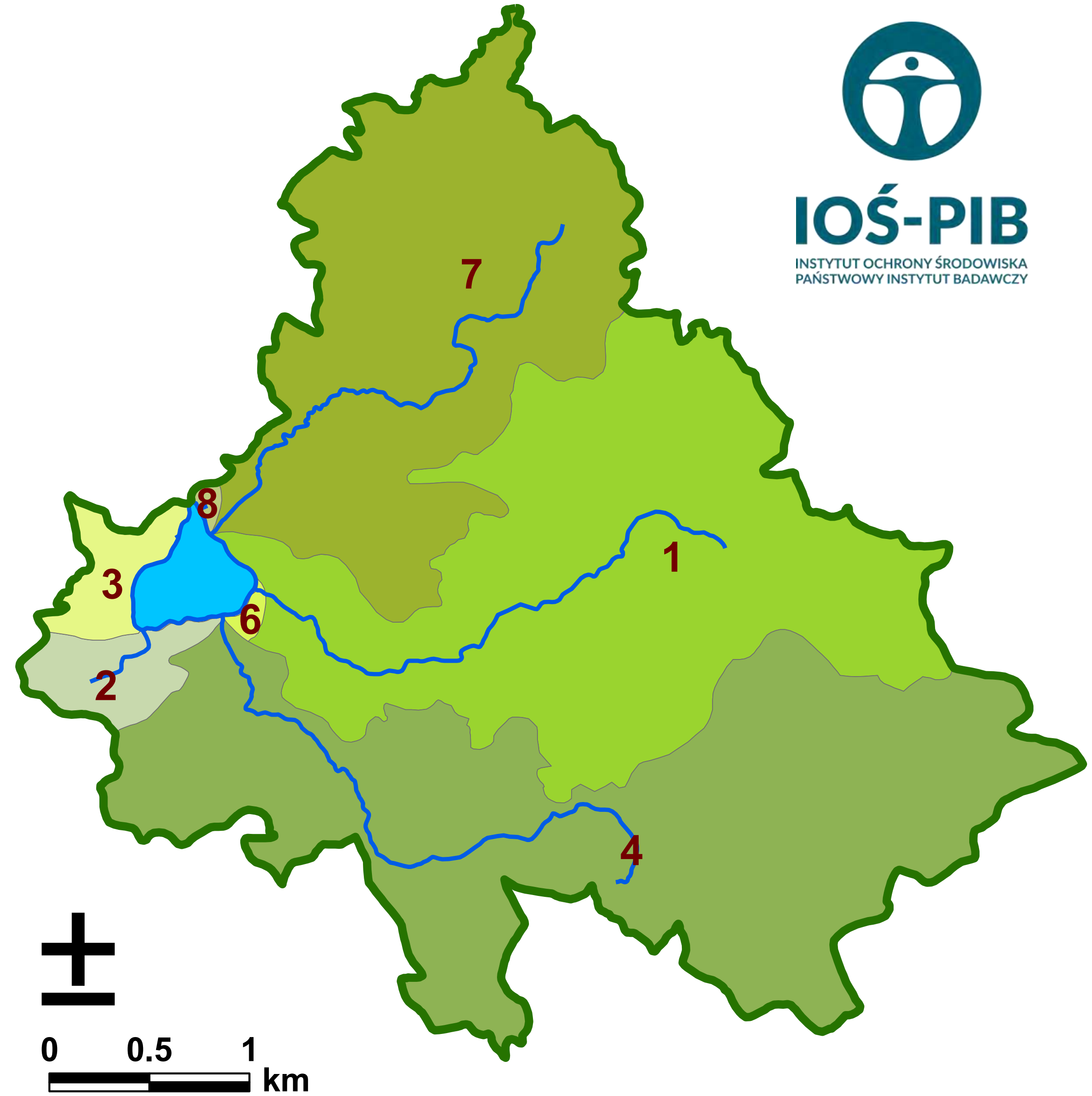
Model of the Łękuk Wielki **catchment area**

Model:

Soil and Water Assessment Tool (SWAT)

Main features:

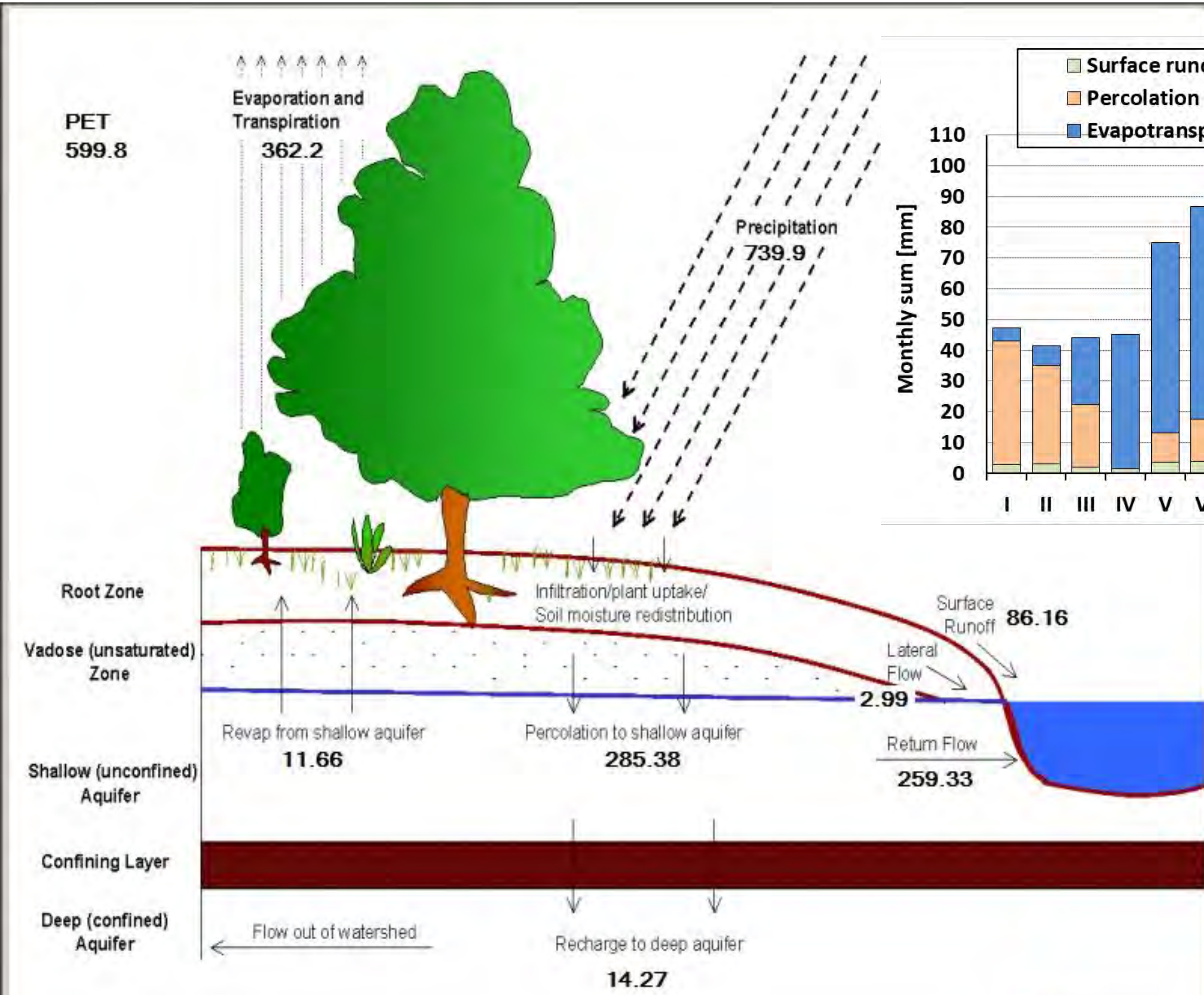
- Subbasins of 4 main inflows
- Direct catchment area of the lake
- 265 hydrological response units (unique combinations of land use
- Soil type and land slope)
- Time step: 1 day – 1 year
- Analysed period: 1995-2014

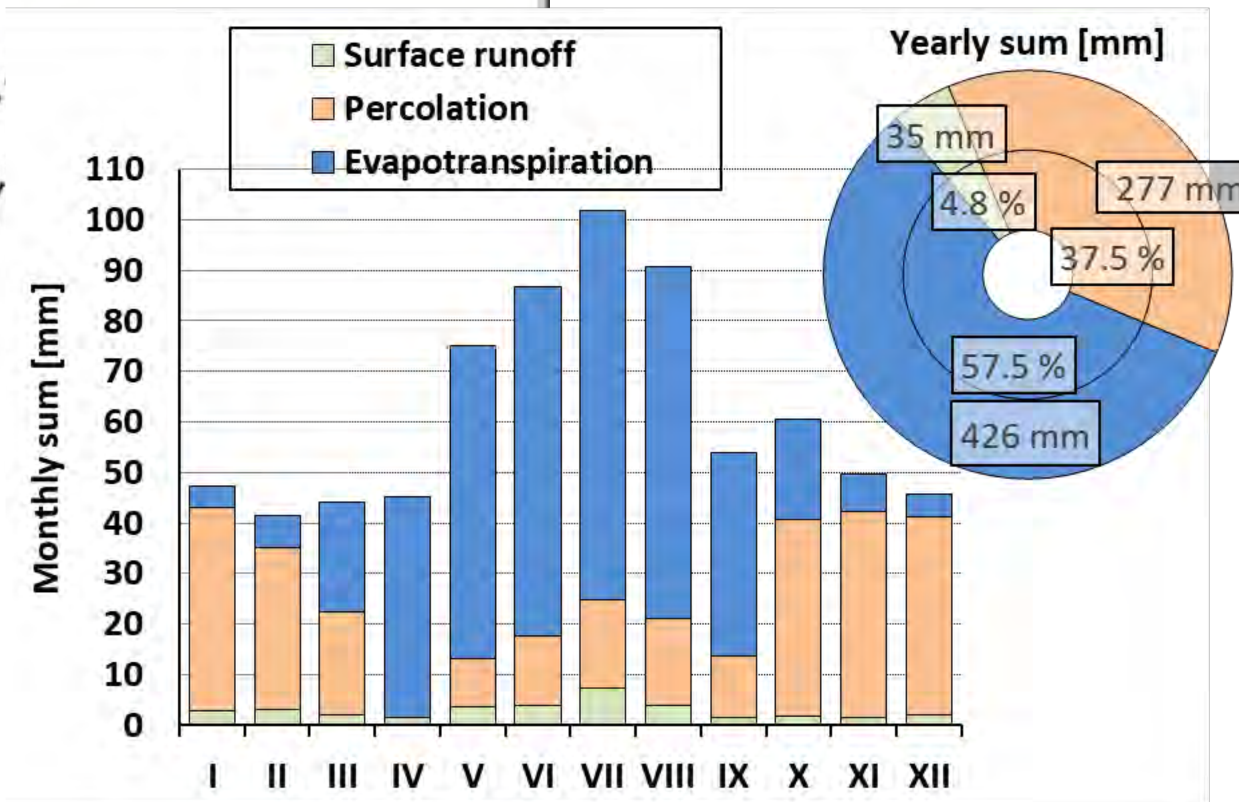


Main inputs:

- Land use
- Digital elevation model
- Hydrographic maps
- Soil parameters
- Fertilisers
- Deposition
- Meteorological data
- Flow rate in streams (for calibration)
- Concentrations of N in streams (for calibration)

Model of the Łękuk Wielki **catchment area** - calculated water balance



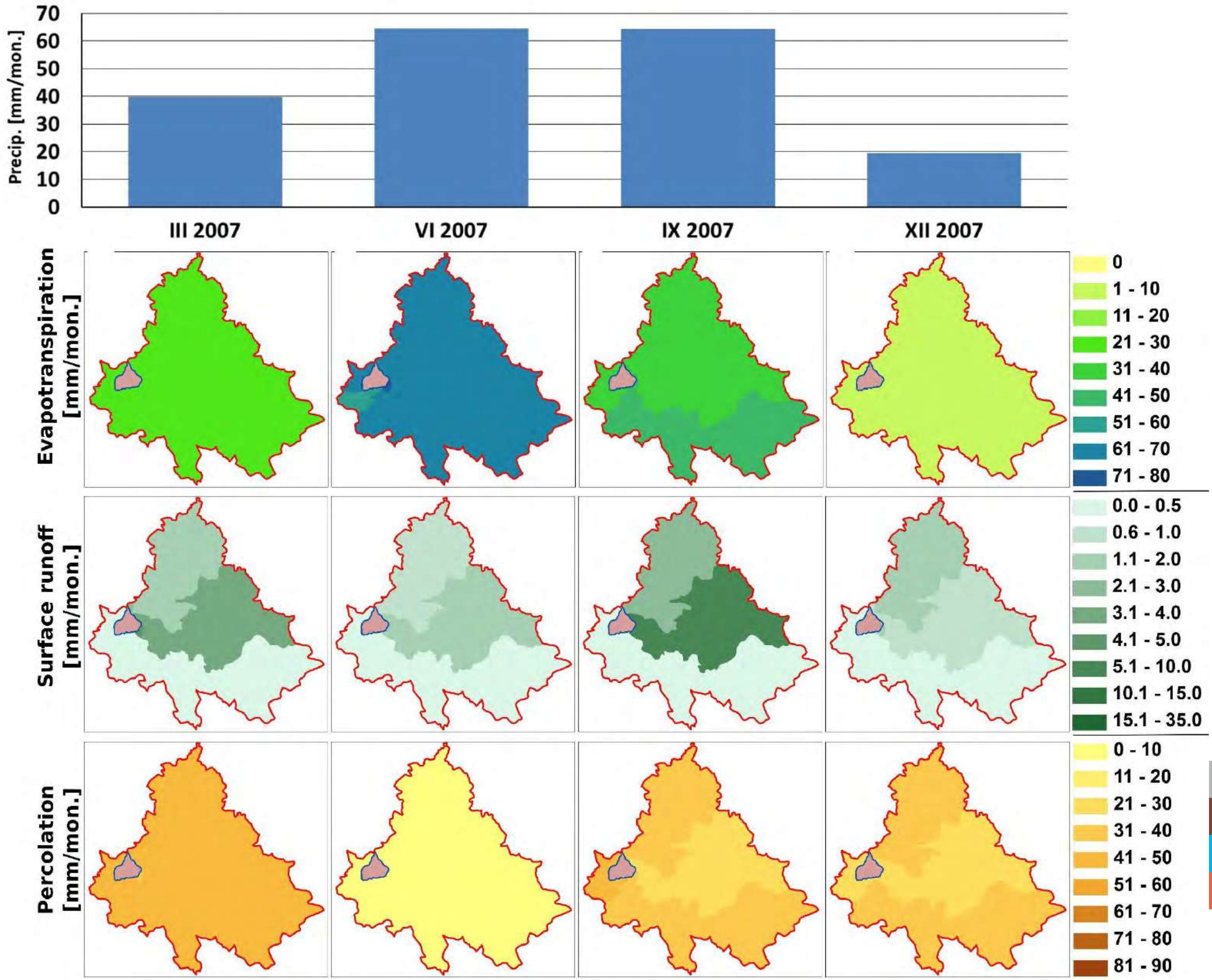


Yearly average

Period:
1995-2014

Unit:
mm/y

Model of the Łękuk Wielki **catchment area** - calculated water balance

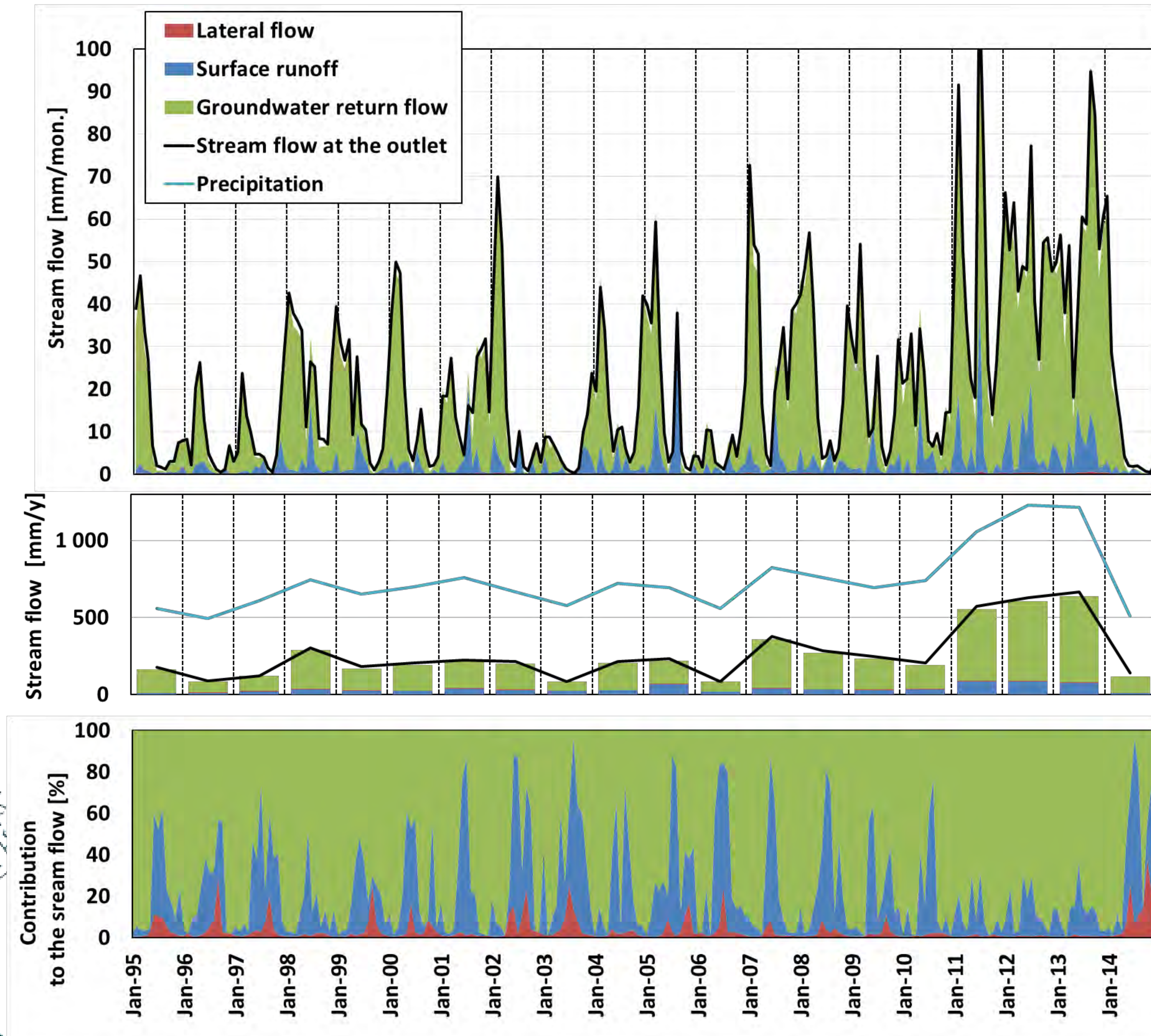


Example of monthly averages in 2007

(year with average precipitation)

Model of the Łękuk Wielki **catchment area** - calculated instream water balance

Contribution of surface runoff, lateral flow and groundwater to streams



Model of the Łękuk Wielki **catchment area**
- calculated nitrogen balance

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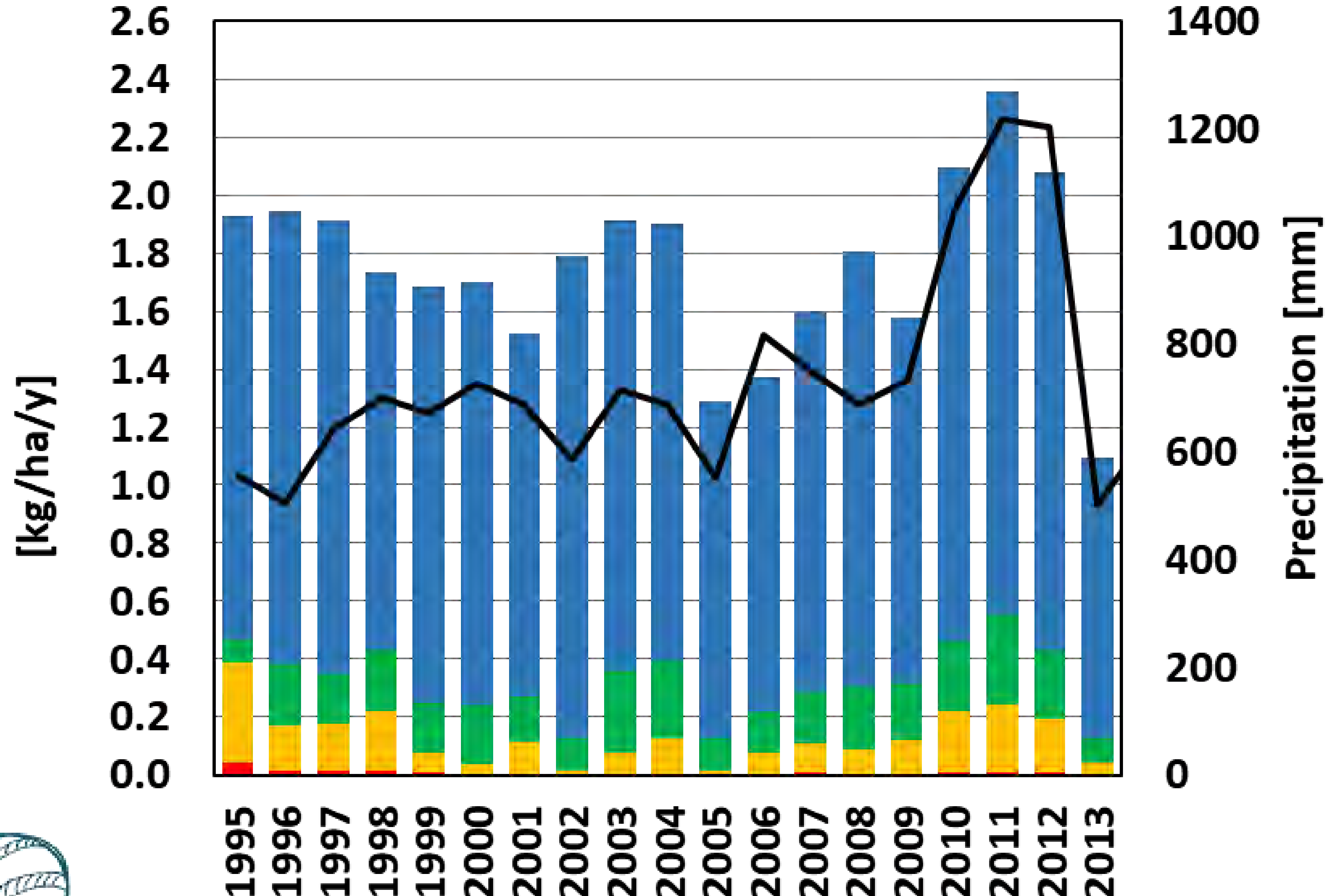

Initial results:

Yearly outflows of the nitrogen

Model of the Łękuk Wielki **catchment area** - calculated nitrogen balance

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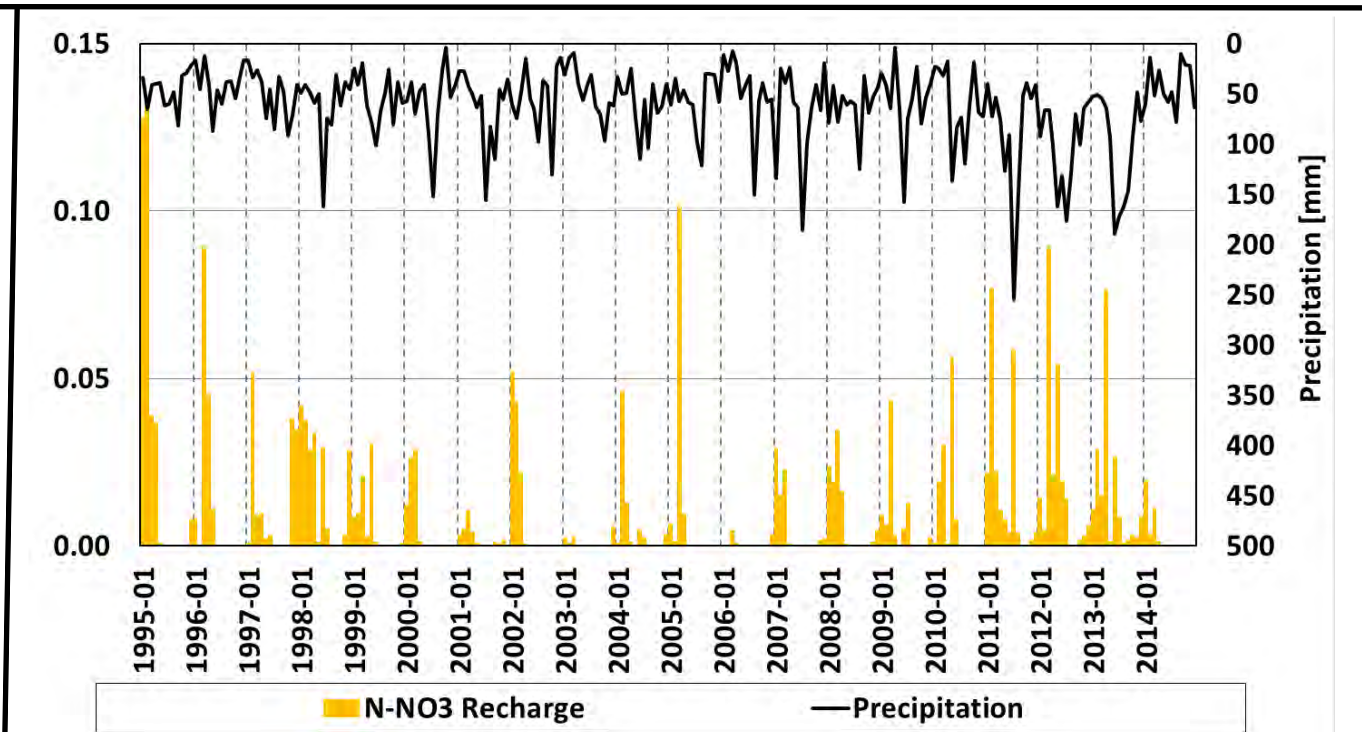
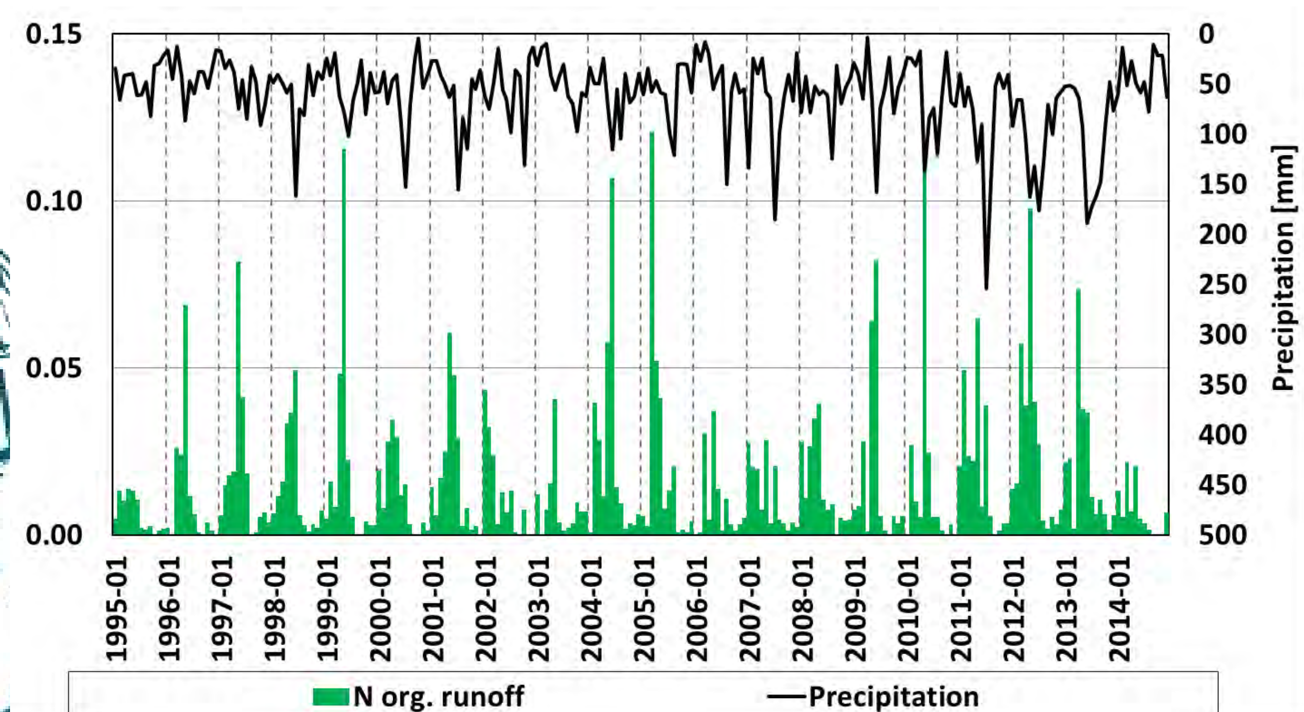
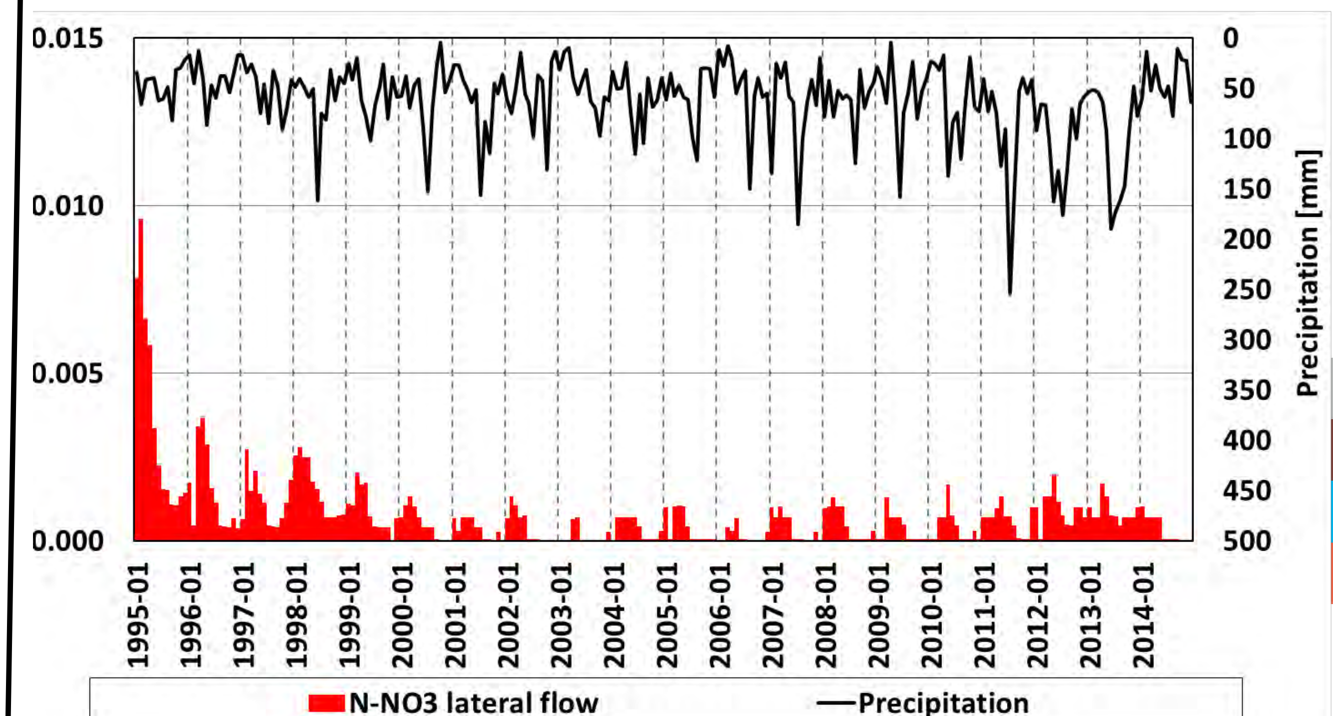
Initial results:
Monthly outflows of the nitrogen kg/ha/mon.







Model of the Łękuk Wielki **catchment area** - calculated nitrogen balance

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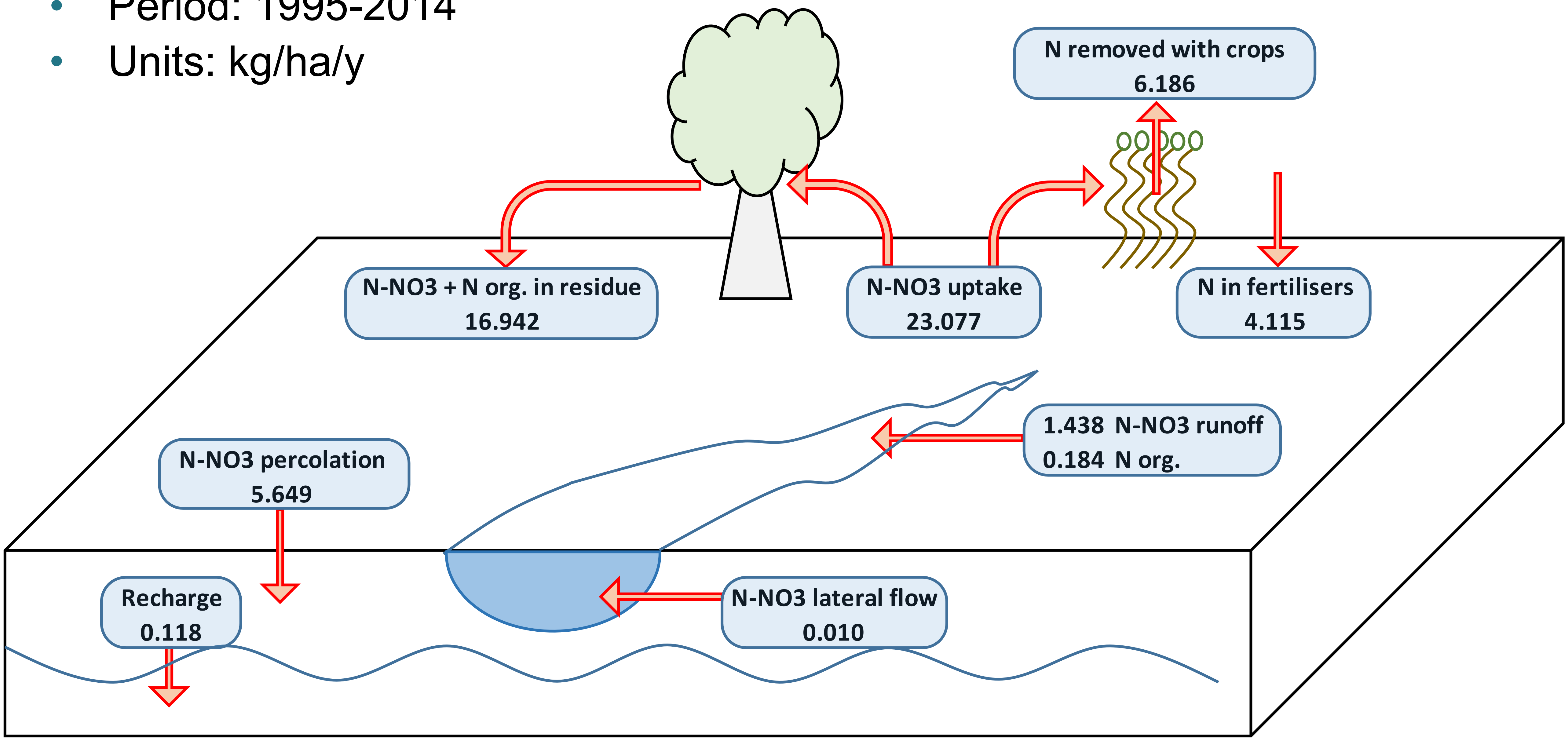
PAŃSTWOWY INSTYTUT BADAWCZY

Initial outputs:

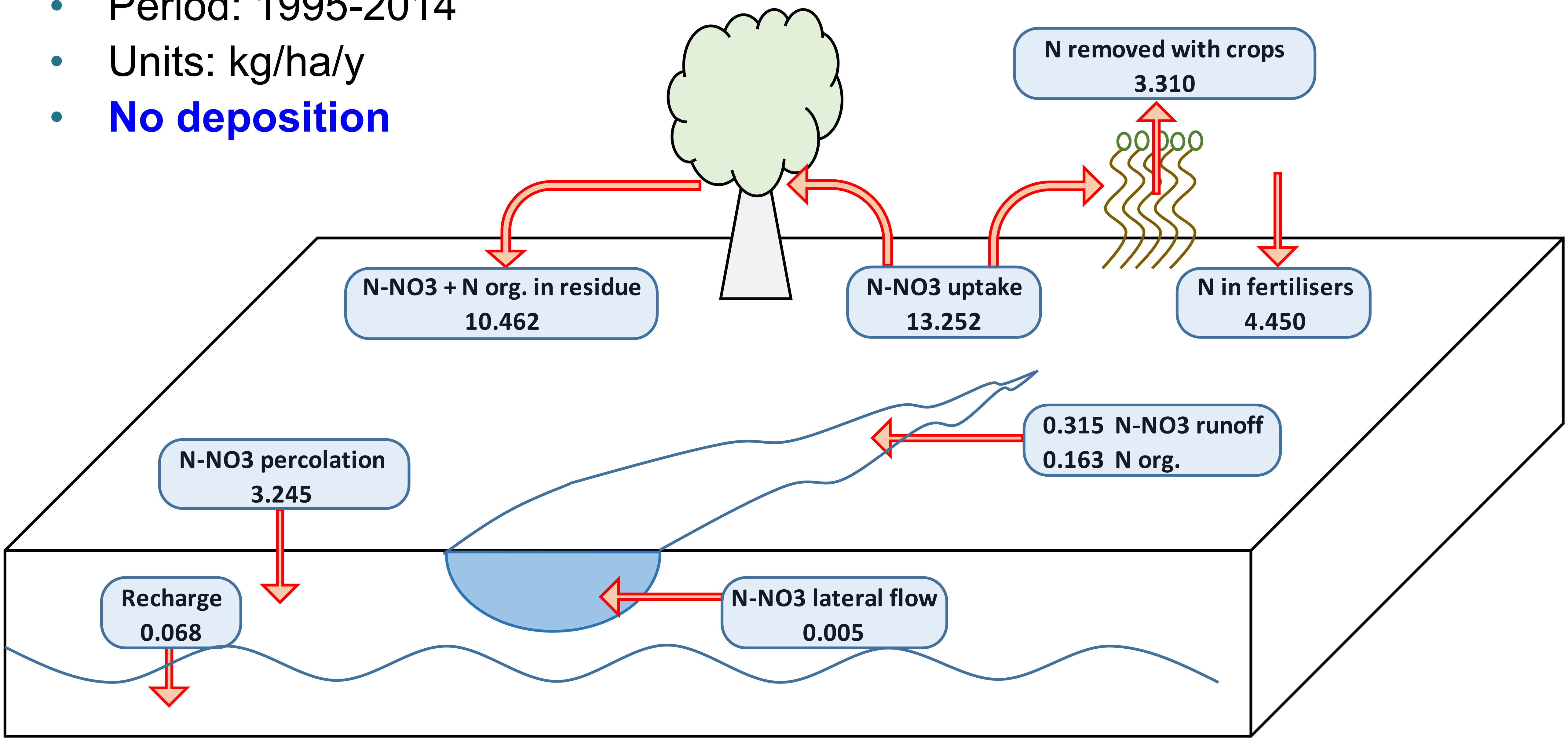
- Yearly average loads of nitrogen
- Period: 1995-2014
- Units: kg/ha/y



Model of the Łękuk Wielki **catchment area** - calculated nitrogen balance

Initial outputs:

- Yearly average loads of nitrogen
- Period: 1995-2014
- Units: kg/ha/y
- **No deposition**



Model of the Łękuk Wielki **catchment area** - calculated nitrogen balance

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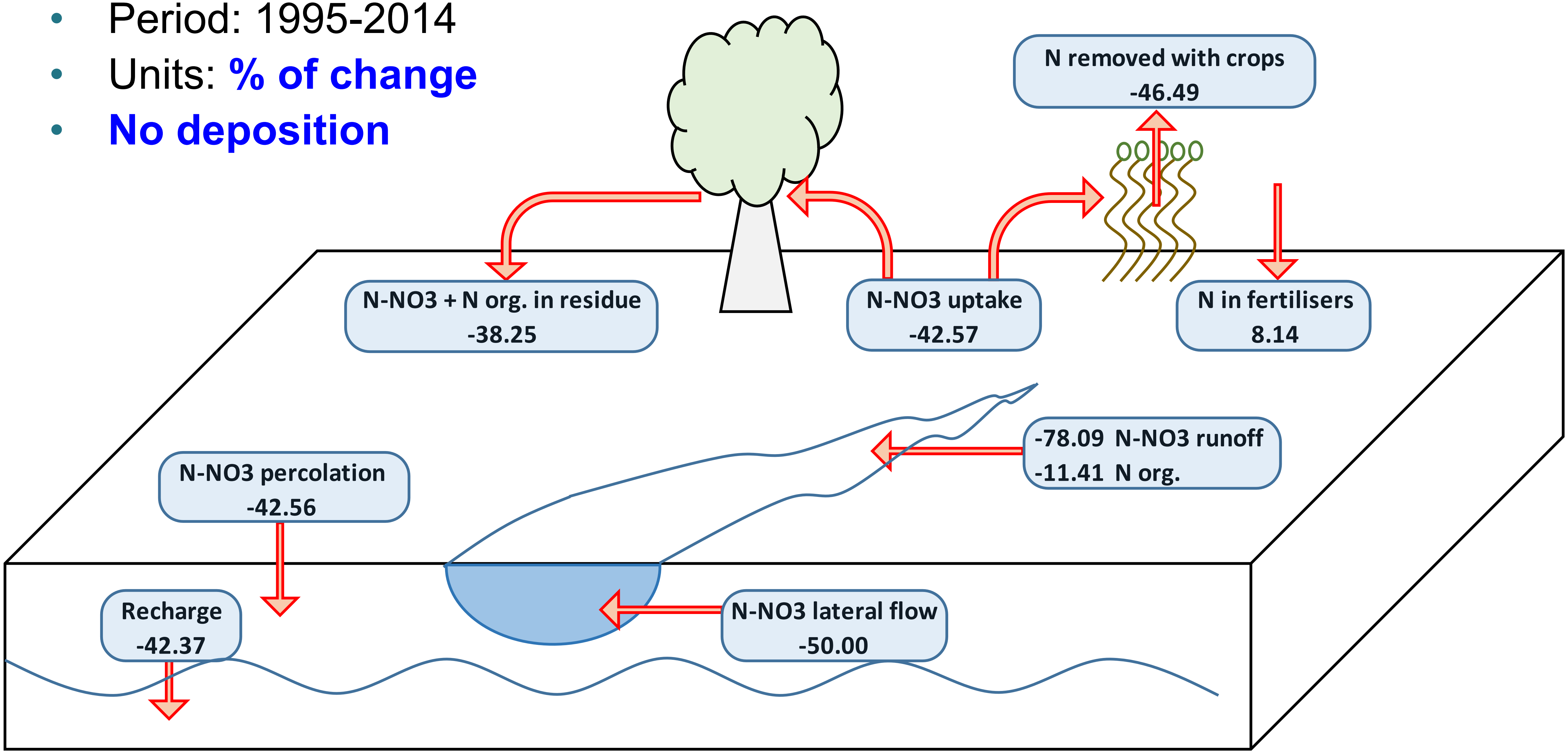
PAŃSTWOWY INSTYTUT BADAWCZY

Initial outputs:

- Yearly average loads of nitrogen
- Period: 1995-2014
- Units: **% of change**
- **No deposition**



Model of the Łękuk Wielki **Lake**

The model is aimed to simulate:

1. **flow** in the lake taking intro account inflows, outflow and meteorological conditions
2. changes in the water **temperature** (and stratification) inflows, outflow and meteorological conditions
3. impact of inflows on the **water quality** (including nutrients)
4. impact of inflows and meteorological conditions on **ecosystems** (mainly phytoplankton and zooplankton)

Model of the Łękuk Wielki **Lake**

IOŚ-PIB
INSTYTUT OCHRONY ŚRODOWISKA
PAŃSTWOWY INSTYTUT BADAWCZY

The model is aimed to simulate:

1. **flow** in the lake taking intro account inflows, outflow and meteorological conditions
2. changes in the water **temperature** (and stratification) inflows, outflow and meteorological conditions

DONE

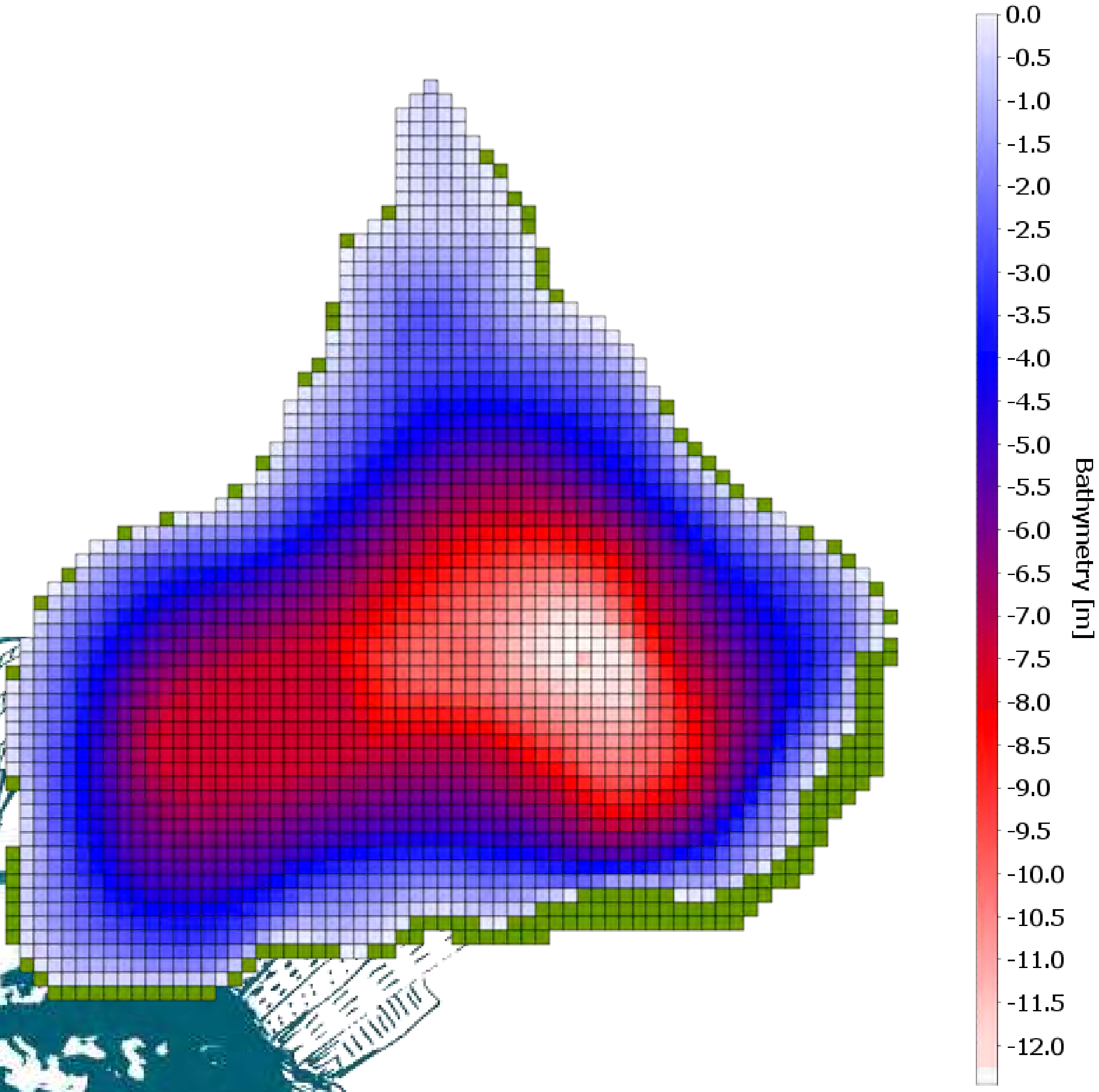
3. impact of inflows on the **water quality** (including nutrients)
4. impact of inflows and meteorological conditions on **ecosystems** (mainly phytoplankton and zooplankton)

ONGOING

Model of the Łękuk Wielki **Lake**

Model:

Aquatic Ecosystem Model (AEM3D)



Main features:

- Horizontal resolution: 10 m
- Number of layers: 21
- Thickness of layers: 0.25 – 1.00 m
- Total calculation cells: 33 622
- Time step: 0.5 min.
- Analysed period:
  April 2004 – March 2006
- Includes:
  - 4 inflows (streams),
  - 2 direct catchments,
  - groundwater inflow/outflow,
  - main outflow

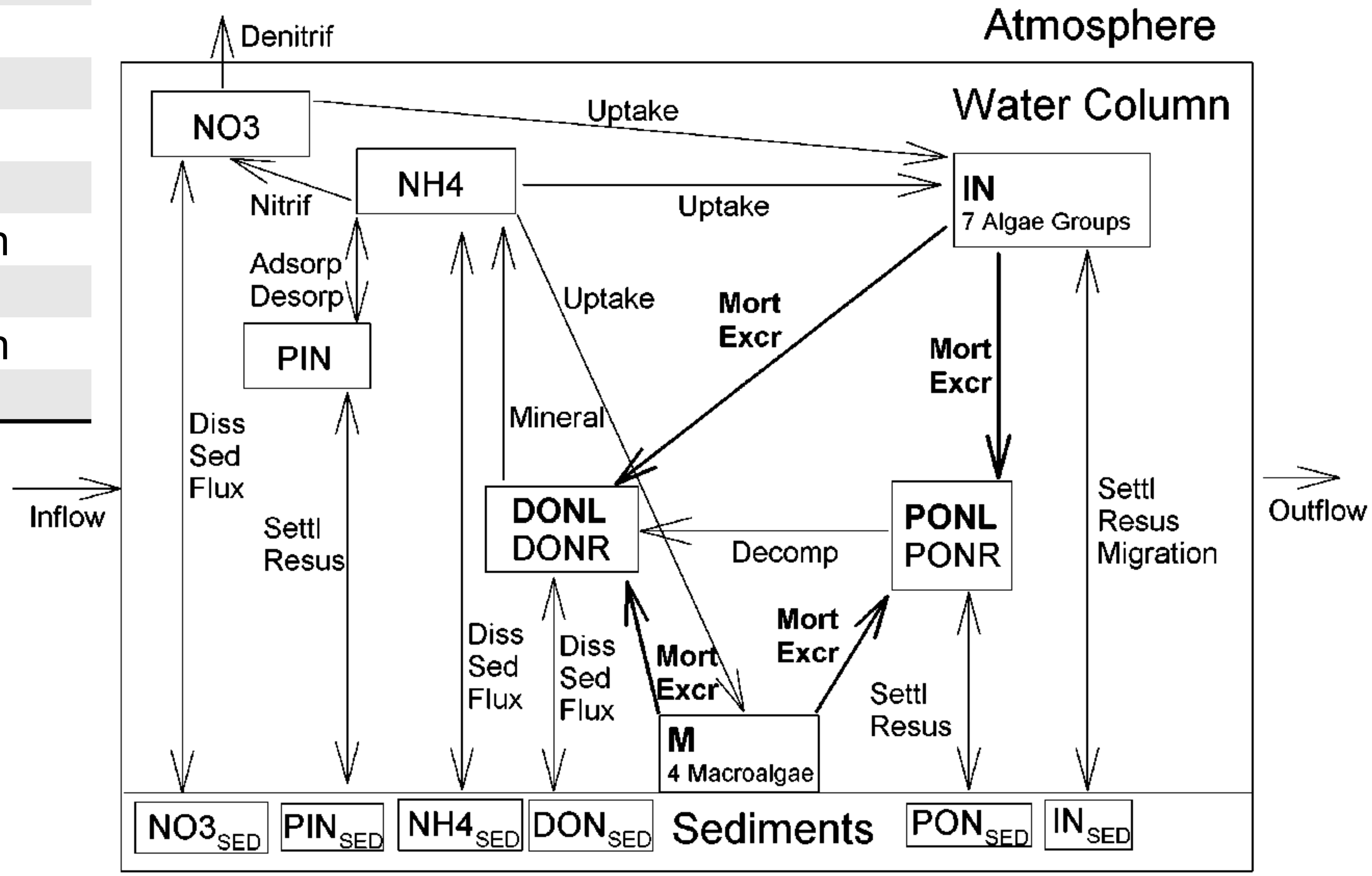
Model of the Łękuk Wielki **Lake**

IOŚ-PIB
INSTYTUT OCHRONY ŚRODOWISKA
PAŃSTWOWY INSTYTUT BADAWCZY

Nitrogen in AEM3D

Variable	Description
NO3	Nitrate + Nitrite
NH4	Ammonium
DON	Dissolved Organic Nitrogen
PON	Particulate Organic Nitrogen
AIN	Algal Internal Nitrogen
PIN	Particulate Inorganic Nitrogen
BIN	Bacterial Internal Nitrogen
ZIN	Zooplankton Internal Nitrogen
FIN	Fish Internal Nitrogen

L	Labile
R	Refractory (optional)



Hipsey, M.R., 2010, Computational Aquatic Ecosystem Dynamics Model: CAEDYM v3, v3.2 Science Manual (DRAFT), Centre for Water Research, University of Western Australia, September 29, 2010

Model of the Łękuk Wielki **Lake**

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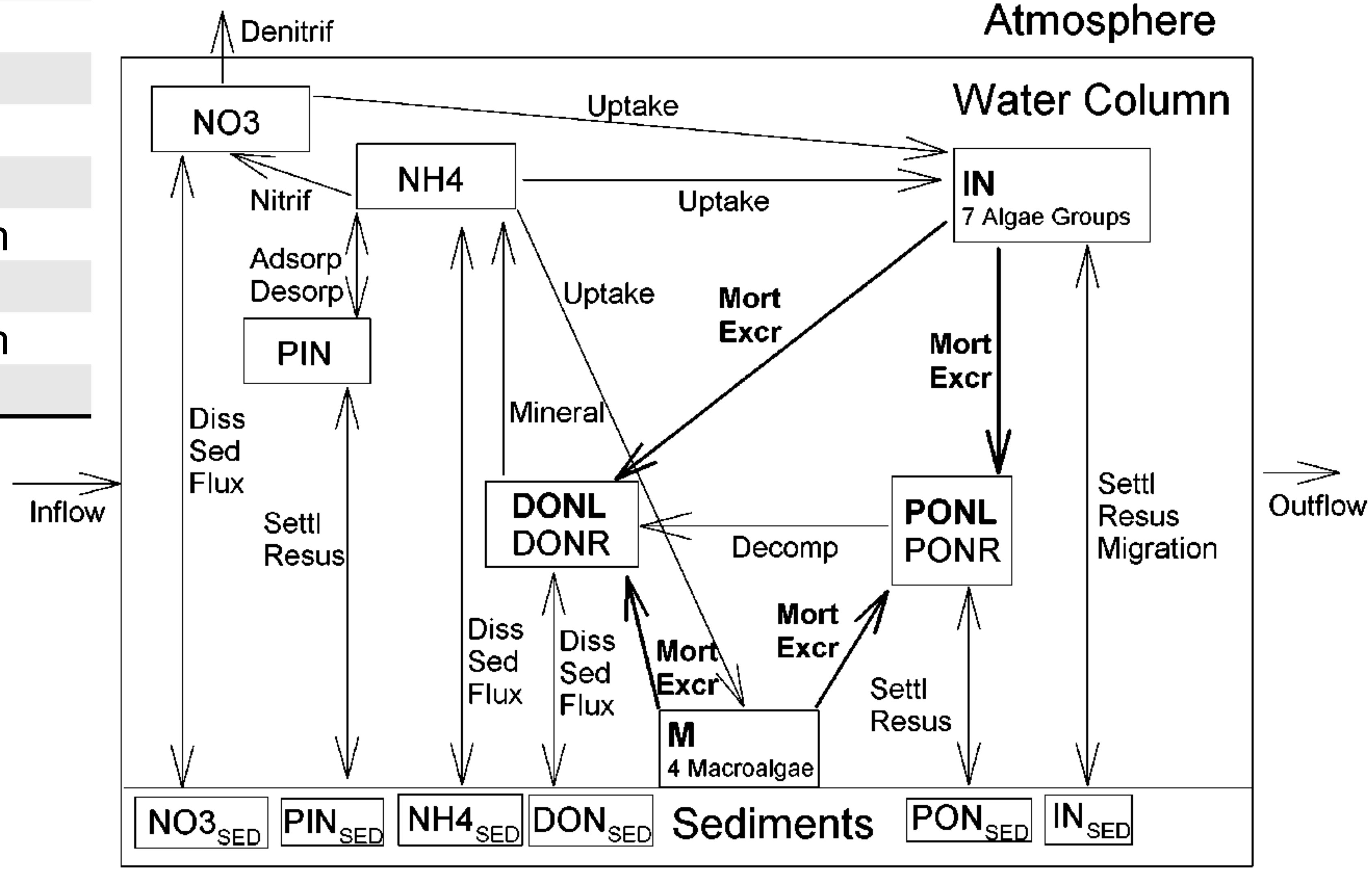
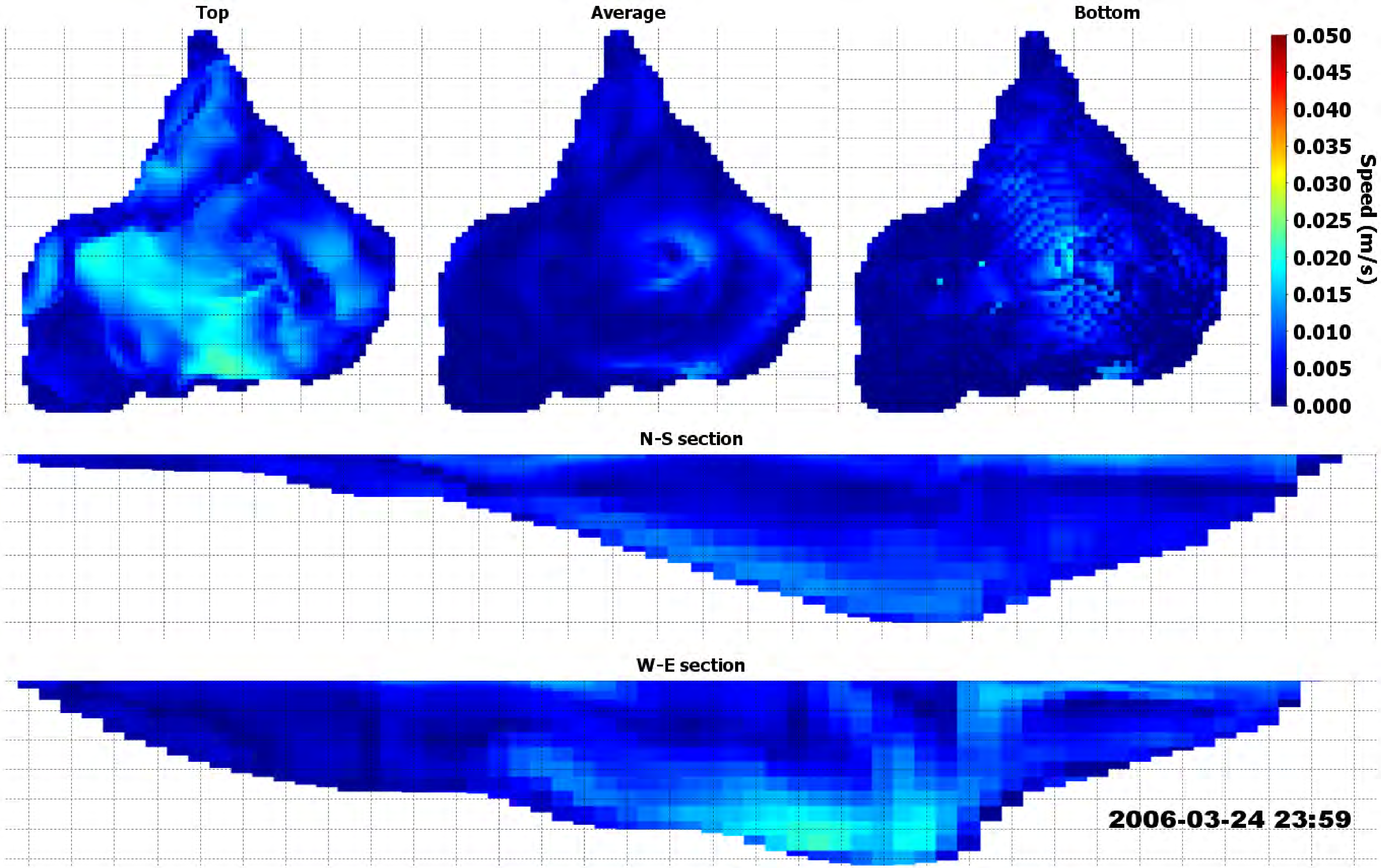


Hipsey, M.R., 2010, Computational Aquatic Ecosystem Dynamics Model: CAEDYM v3, v3.2 Science Manual (DRAFT), Centre for Water Research, University of Western Australia, September 29, 2010

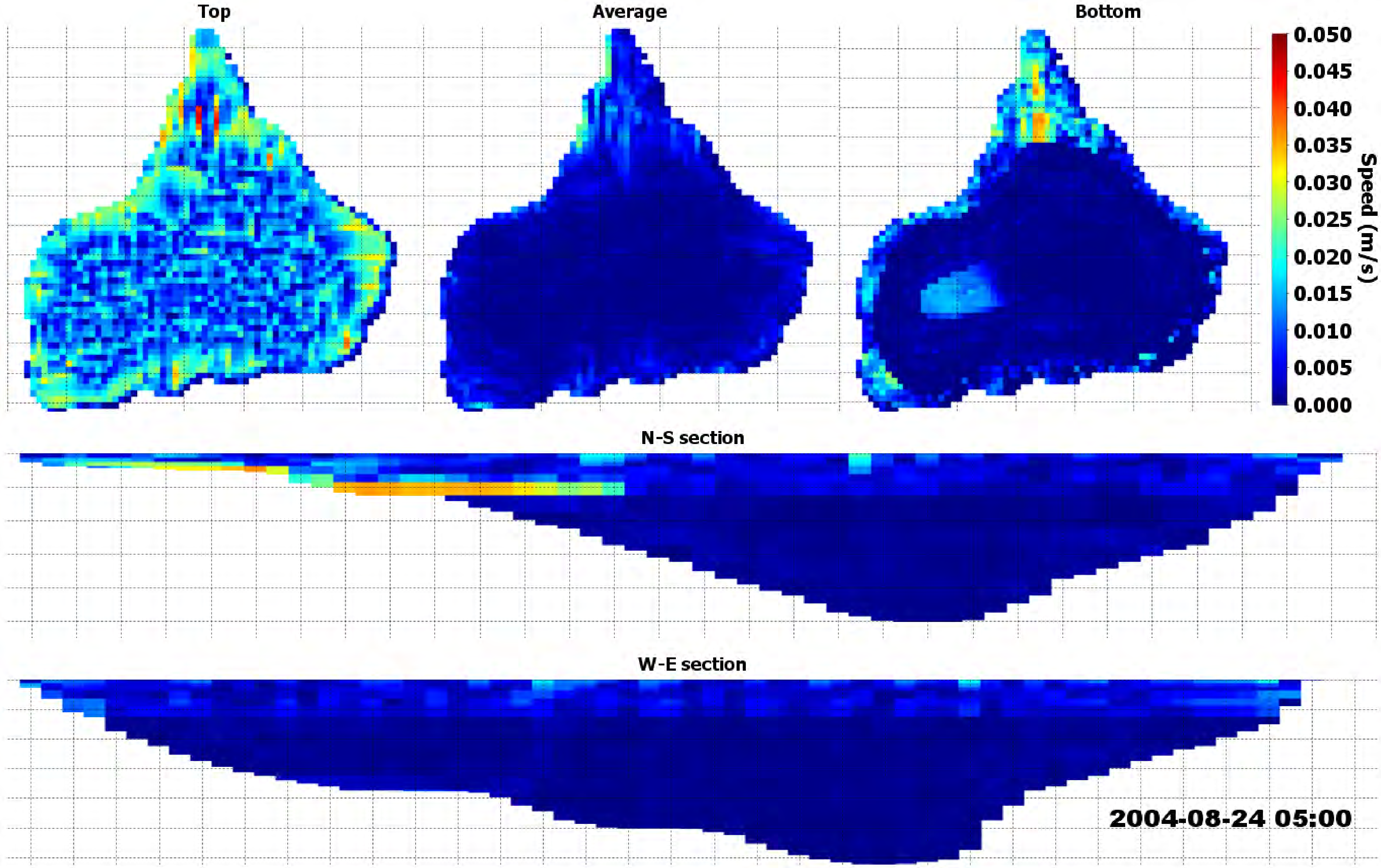
Model of the Łękuk Wielki **Lake**
- Examples of outputs

Flow velocity in the cold season (Similar velocity at different depths)



Model of the Łękuk Wielki **Lake**
- Examples of outputs

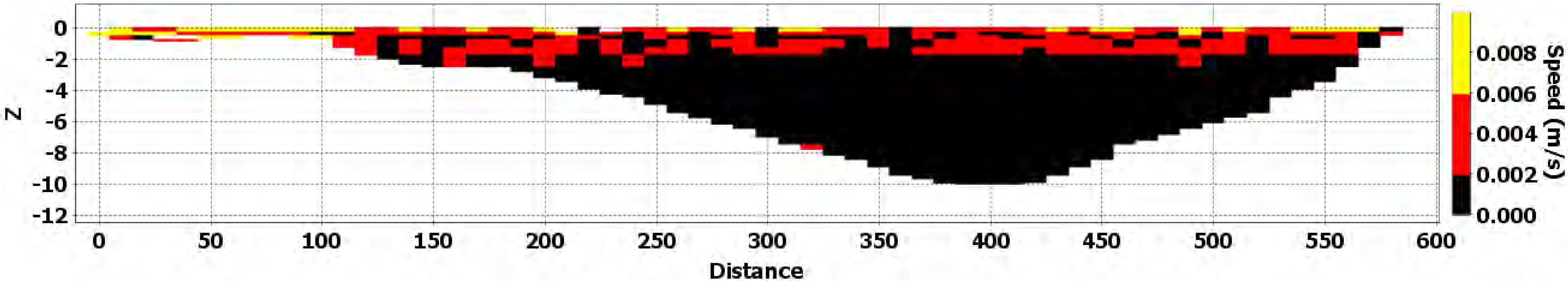
Flow velocity in the warm season (Increased velocity near the surface)

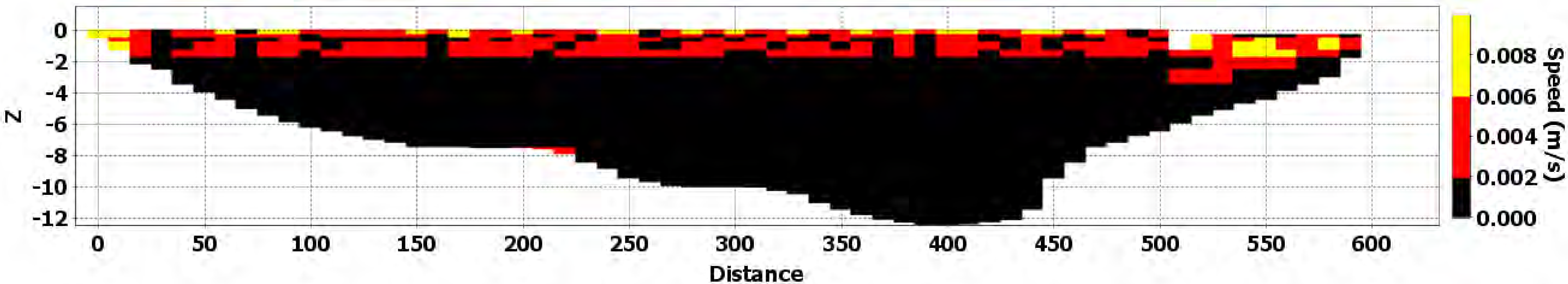


Model of the Łękuk Wielki **Lake**
- Examples of outputs

IOŚ-PIB
INSTYTUT OCHRONY ŚRODOWISKA
PAŃSTWOWY INSTYTUT BADAWCZY

Flow velocity in N-S and W-E cross-sections (average for 2 years)

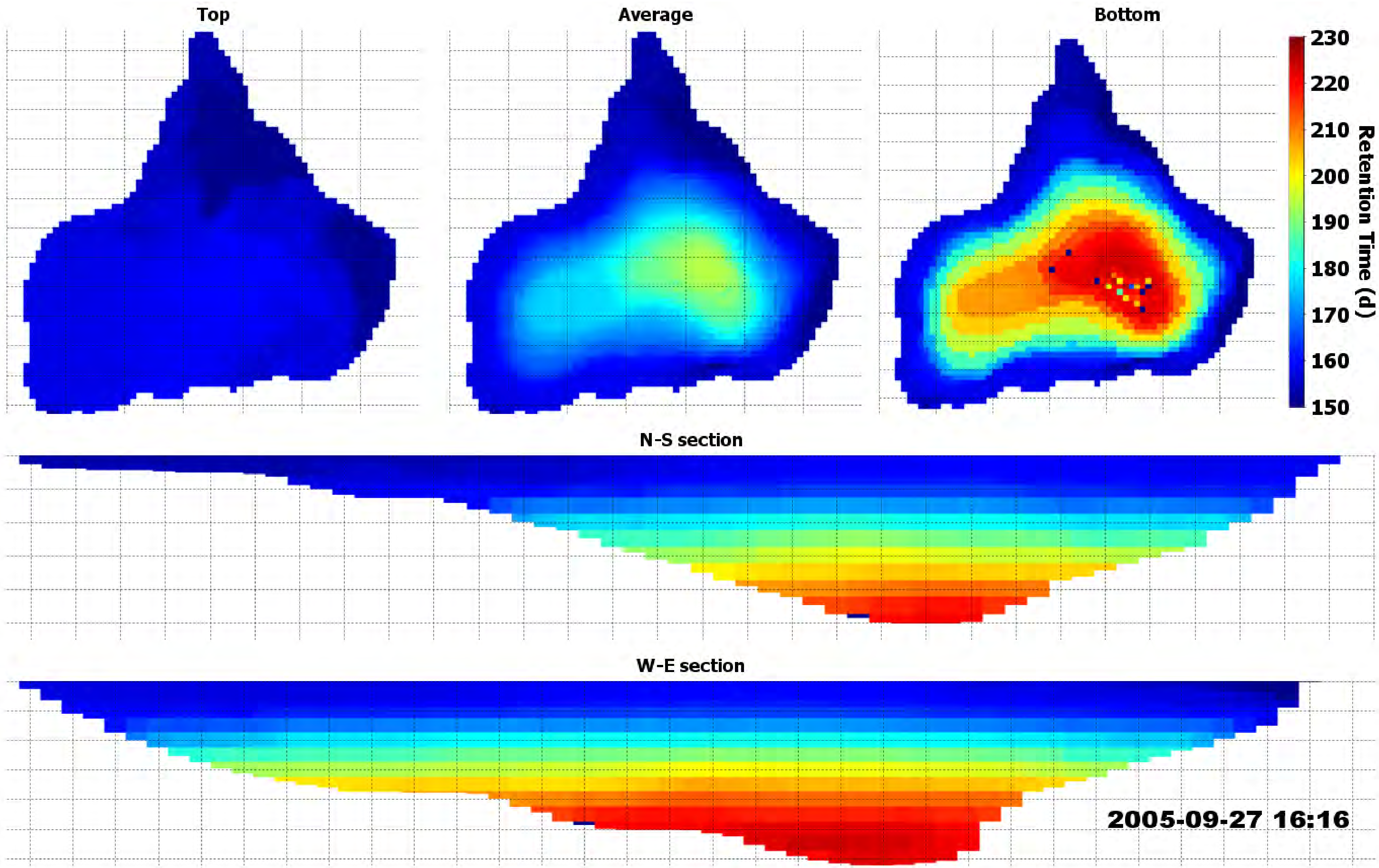




Model of the Łękuk Wielki **Lake**
- Examples of outputs

IOŚ-PIB
INSTYTUT OCHRONY ŚRODOWISKA
PAŃSTWOWY INSTYTUT BADAWCZY

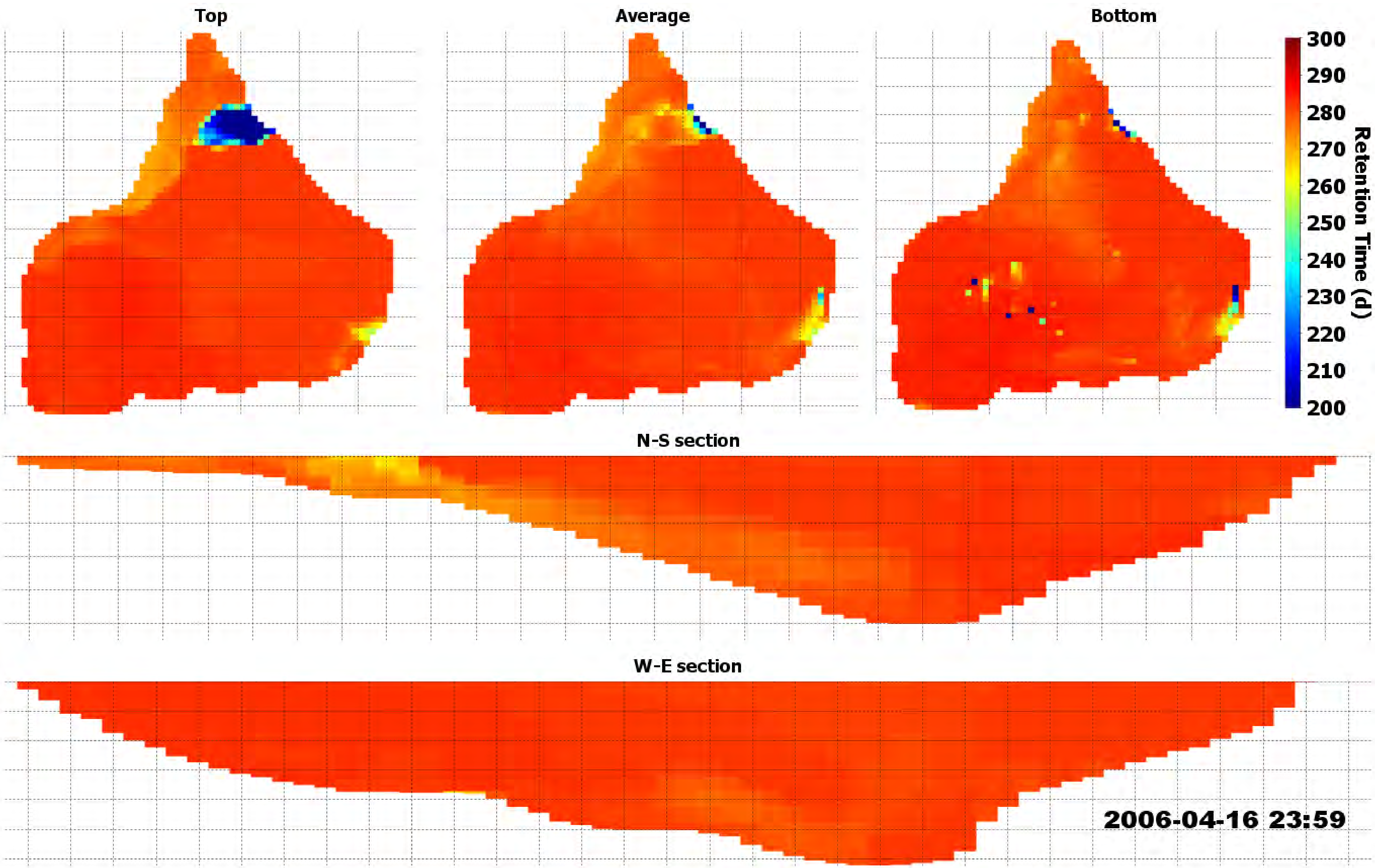
Water retention time in warm season after 1.5 year simulation (approx. 150 days near the surface, and 220 days in the deepest part)



Model of the Łękuk Wielki **Lake**
- Examples of outputs

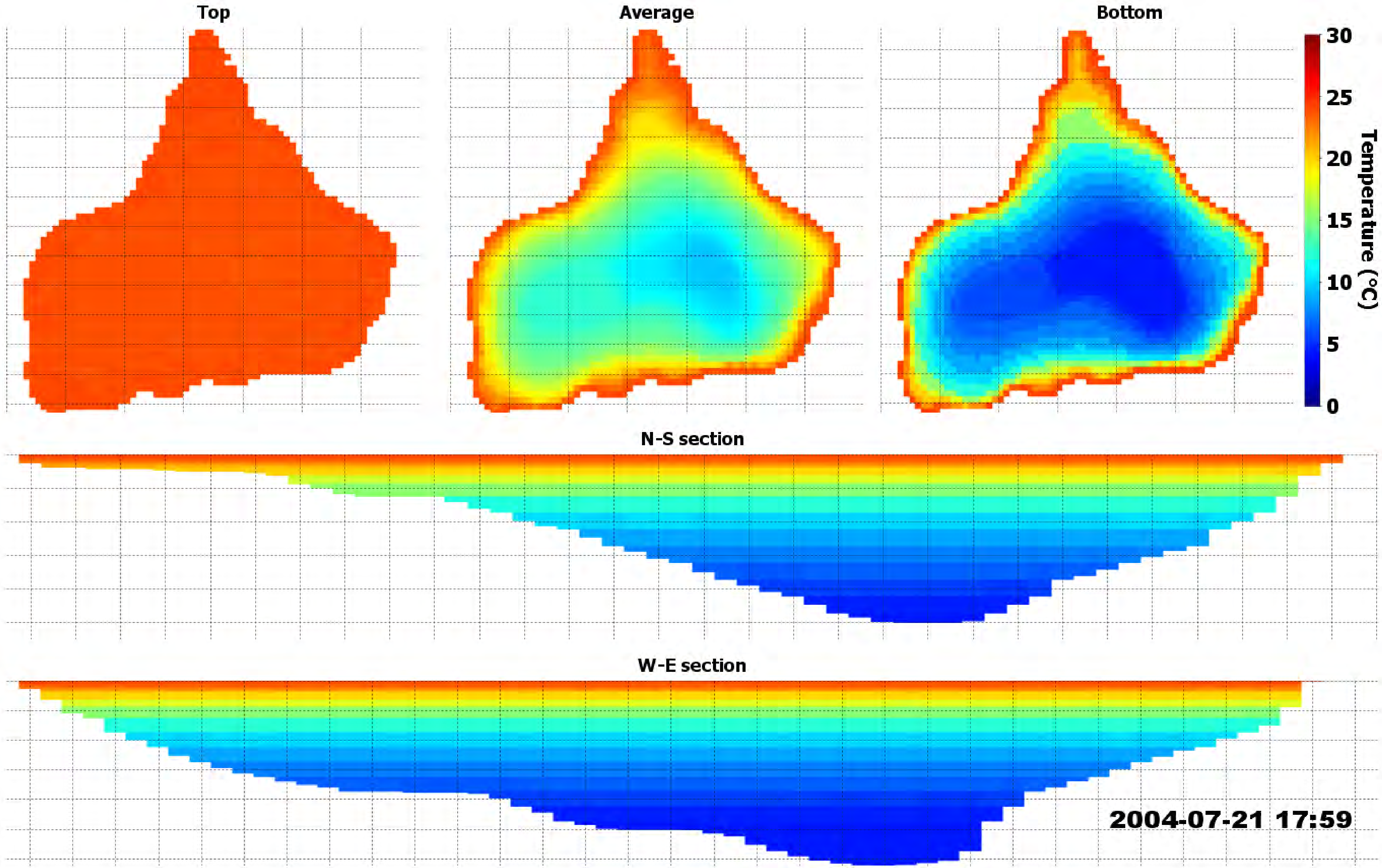
IOŚ-PIB
INSTYTUT OCHRONY ŚRODOWISKA
PAŃSTWOWY INSTYTUT BADAWCZY

Water retention time after 2 years
(approx. 280 days in the entire lake except areas near main inflows)



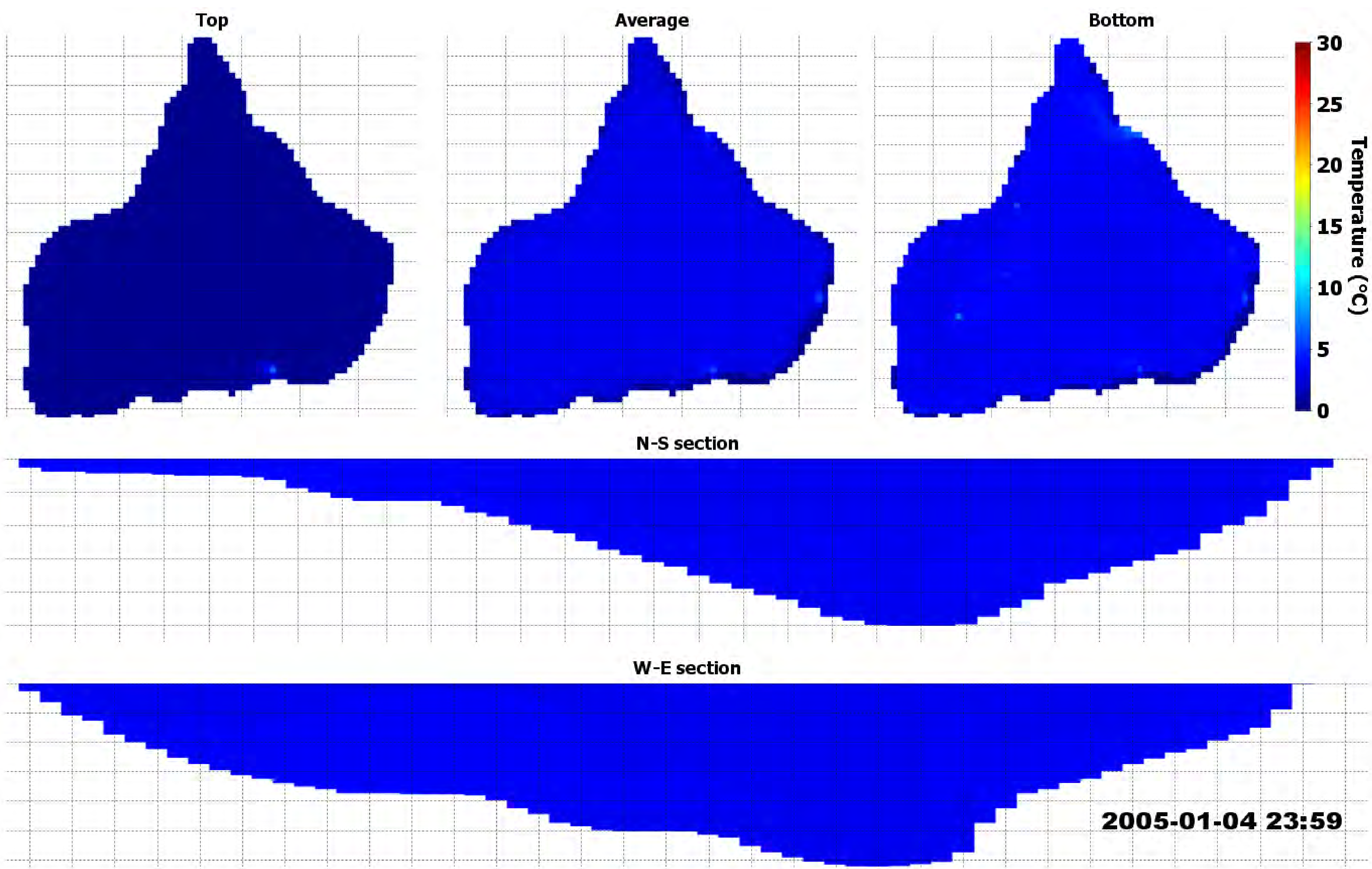
Model of the Łękuk Wielki **Lake**
- Examples of outputs

Water temperature - warm season



Model of the Łękuk Wielki **Lake**
- Examples of outputs

Water temperature - cold season



Conclusions:

- Wide range of monitoring data available for the “Puszcza Borecka” station (since early 1990’s)
- It is difficult to assess the impact of atmospheric deposition of nitrogen on ecosystems and water quality based on the monitoring data only
- SWAT model was used to simulate the nitrogen cycle in analysed area (first step to assess the impact of deposition has been taken)
- AEM3D model was used to simulate the lake’s hydrodynamics and thermodynamics and to give a basis for the assessment of impact od the deposition on water quality and aquatic ecosystems.

Thank You

Rafal.Ulanczyk@ios.edu.pl

LRTAP
Long-range Transboundary Air Pollution

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

National emission ceiling – a opportunity for WGE?

Salar Valinia

Co-chair ICP IM & Swedish EPA

NATUR VÅRDS VERKET
SWEDISH ENVIRONMENTAL PROTECTION AGENCY

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SWEDISH ENVIRONMENTAL PROTECTION AGENCY

DIRECTIVES

DIRECTIVE (EU) 2016/2284 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 14 December 2016

on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC

(Text with EEA relevance)

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

NATUR VÅRDS VERKET
SWEDISH ENVIRONMENTAL PROTECTION AGENCY

The aim of the directive

In order to move towards achieving levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment, this Directive establishes the emission reduction commitments for the Member States' anthropogenic atmospheric emissions of sulphur dioxide (SO2), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC), ammonia (NH3) and fine particulate matter (PM2,5)

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

NATUR VÅRDS VERKET

SWEDISH ENVIRONMENTAL PROTECTION AGENCY

SWEDEN

	2005	2012	2020 NEC	2030 CLE	2030 NEC	2030 MTFR
SO_2	36	-23%	-22%	-14%	-22%	-18%
NO_x	175	-25%	-36%	-66%	-66%	-70%
$PM_{2.5}$	30	-10%	-19%	-16%	-19%	-48%
NH_3	56	-8%	-15%	-10%	-17%	-33%
VOC	198	-6%	-25%	-39%	-36%	-54%

POLAND

	2005	2012	2020 NEC	2030 CLE	2030 NEC	2030 MTFR
SO_2	1217	-30%	-59%	-66%	-70%	-79%
NO_x	851	-4%	-35%	-49%	-39%	-63%
$PM_{2.5}$	141	-2%	-16%	-11%	-58%	-53%
NH_3	272	-3%	-1%	1%	-17%	-37%
VOC	575	10%	-25%	-34%	-26%	-67%

UK

	2005	2012	2020 NEC	2030 CLE	2030 NEC	2030 MTFR
SO_2	709	-40%	-59%	-80%	-88%	-91%
NO_x	1592	-33%	-55%	-72%	-73%	-80%
$PM_{2.5}$	93	-17%	-30%	-28%	-46%	-57%
NH_3	302	-8%	-5%	-8%	-16%	-27%
VOC	1160	-28%	-37%	-37%	-39%	-52%

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SWEDISH ENVIRONMENTAL PROTECTION AGENCY

Brief description of the ecosystem monitoring NECD

To ensure the **monitoring of negative impacts of air pollution upon ecosystems** based on a network of monitoring sites that is representative of their **freshwater, non-forest natural and semi-natural habitats, and forest ecosystem types**, taking a cost-effective and risk-based approach (article 9 paragraph 1 first subparagraph)

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

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SWEDISH ENVIRONMENTAL PROTECTION AGENCY

What has to be done?

- To report by 1 July 2018 and every four years thereafter, to the Commission and the European Environment Agency, the location of the monitoring sites and the associated indicators used for monitoring air pollution impacts (article 10 paragraph 4(a))

- To report by 1 July 2019 and every four years thereafter, to the Commission and the European Environment Agency, the monitoring data referred to in Article 9 (Article 10 paragraph 4(b)).

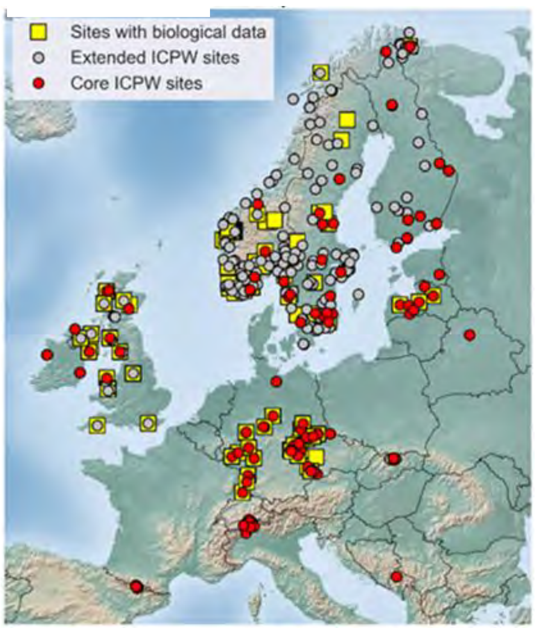
wge Working Group on Effects of the Convention on Long-range Transboundary Air Pollution

WGE Ecosystems Monitoring Network

3 ICPs: specific and complementary ecosystem monitoring covering from aquatic to terrestrial ecosystems

- Harmonized methodologies
- Manuals available
- Historical data sets
- Monitoring & Reporting routines
- Chemical and biological data
- Data: Collection, processing, analysis, reporting and communication
- Linked to atmospheric deposition data (sites/EMEP)

ICP- Waters



ICP-Integrated Monitoring

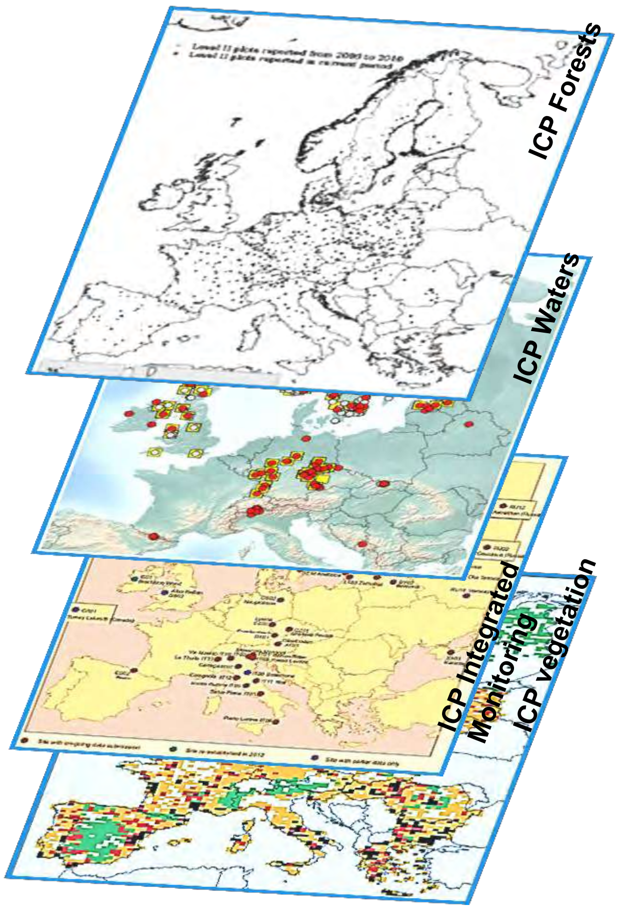
ICP- Forests

Plots of the Level II monitoring in 2009.

Courtesy of Isaura Rabajo (chair WGE)

WGE Ecosystems Monitoring Network

The existing WGE monitoring networks under the LRTAP Convention fits to the NEC Directive objectives as:



- ✓ Is an operational network
- ✓ Monitors key indicators of air pollution
- ✓ In sites that are representative of European ecosystem types

WGE provides a suitable platform for ecosystem monitoring as it has:

Tools (Methodologies & Manuals)

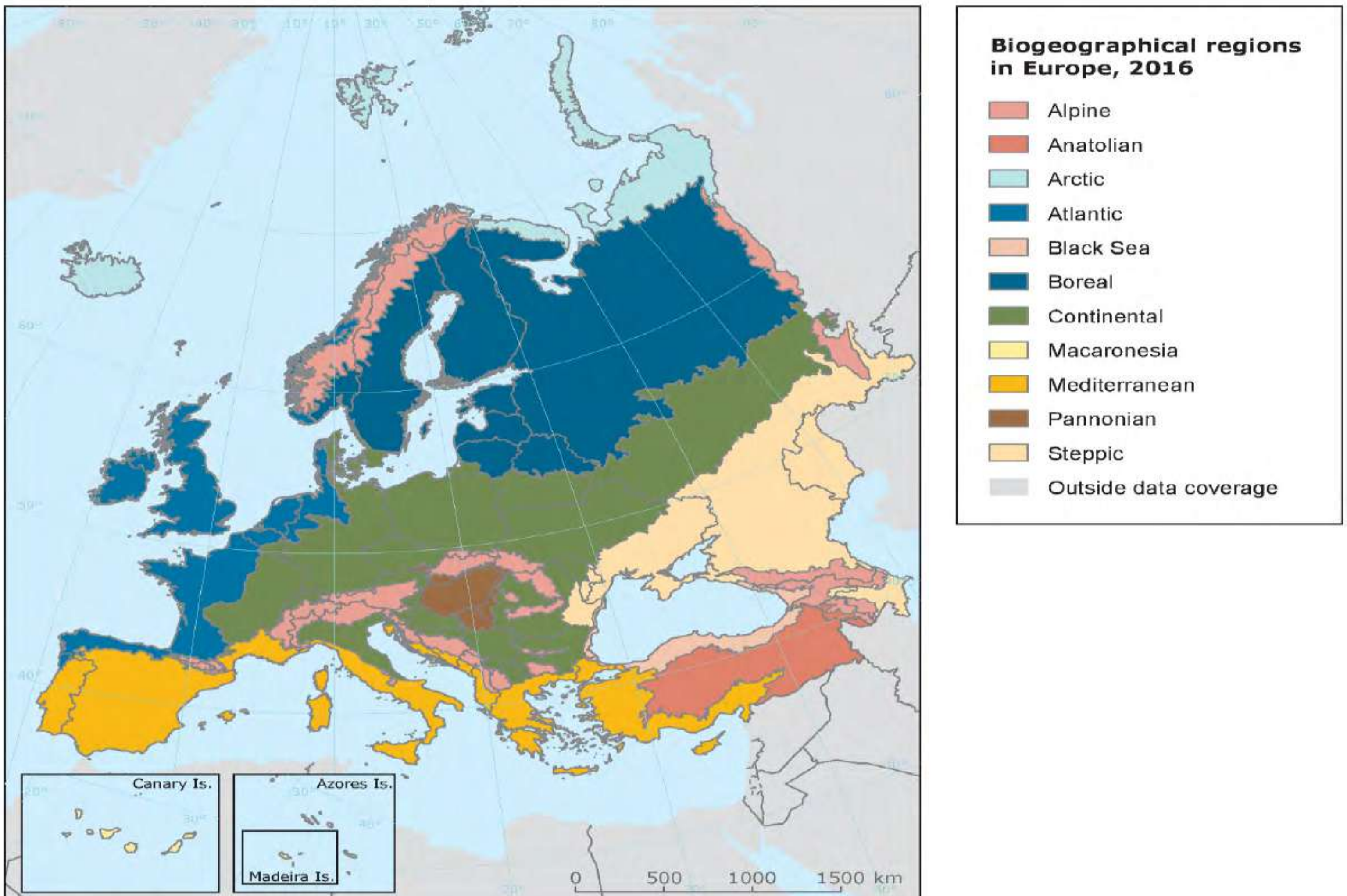
A broad panel of experts (international& multidisciplinary)

More than 20 years of experience

- Almost all MS participate in any of the ICPs related with monitoring
- Easy incorporation into the network
- Scientific and technical support

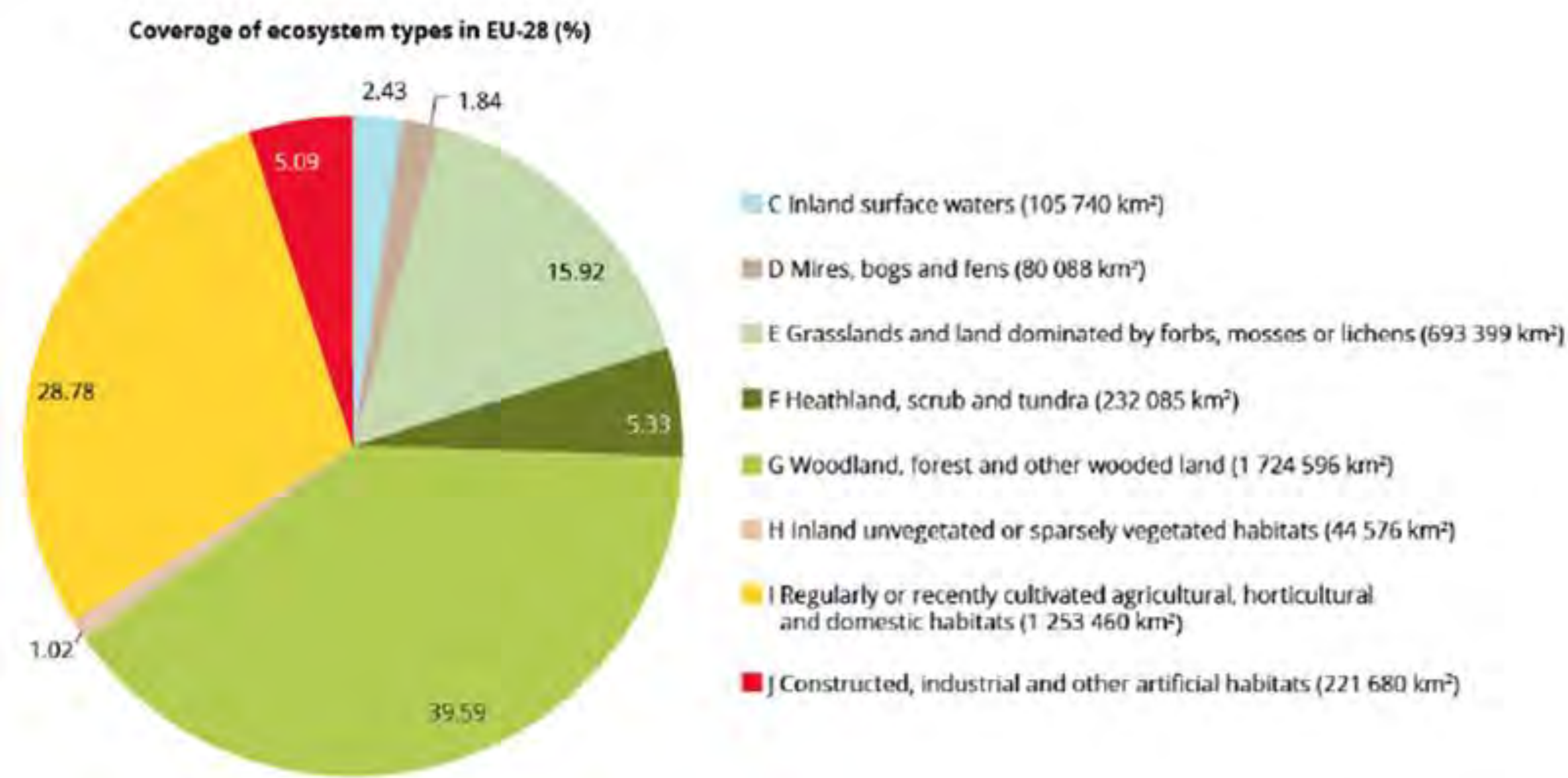
LRTAP Courtesy of Isaura Rabajo (chair WGE)

Biogeographical regions of Europe



https://www.eea.europa.eu/data-and-maps/data/biogeographical-regions-europe-3

MAES terrestrial and freshwaters ecosystem types EU-28



MAES Technical Report 2016-095 " Mapping and assessing the condition of Europe's ecosystems: Progress and challenges. 3rd Report – Final, March 2016)

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SWEDISH ENVIRONMENTAL PROTECTION AGENCY

Ecosystem monitoring under Article 9 and Annex V of Directive 2016/2284 (NECD)

Draft Guidance – Version 2

How and what to monitor?

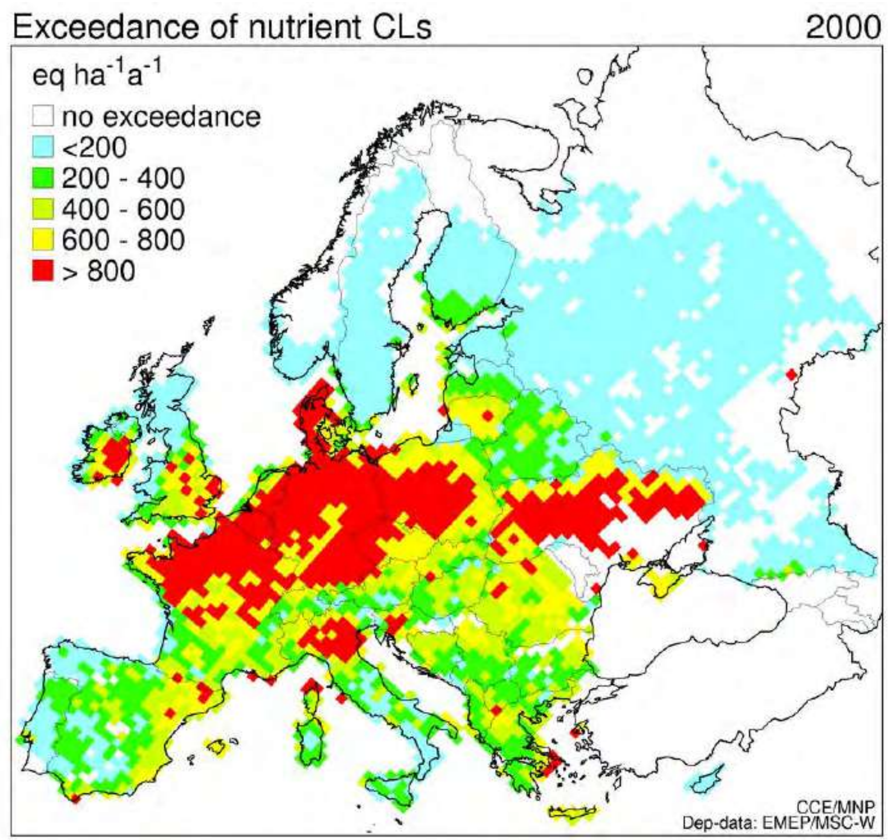


Table 2: Selected indicator complexes, parameters, and sources for methods from the ICP Forests Programme to cope with the NECD, Annex V; []: concentrations.

Measurement (Indicator complex)	Parameters	Frequency	Methods
Soil acidity in the soil solid phase	Element concentrations (base cations etc.) Ca, Mg, K, Na, Alex, Ntot and ratios C/N	Every 10-15 years at Level I and LevelII plots	Part X
Soil acidity in the soil solution	pH, [SOx], [NO3], [base cations (Ca, Mg, K, Na)], [Alex].	Every 4 weeks at Level II plots	Part XI
Soil nitrate leaching, in soil solution	[NO3+] at deepest soil layer (40-80 cm); to calculate fluxes a soil water flux model (water balance model) has to be applied.	Every 4 weeks at Level II plots	Part X, water balance model cf. Part IX
C/N ratio + total soil N, in soil solid phase	Cstock, Nstock, C/N ratio.	Every 10-15 years at Level I and Level II plots	Part X
Nutrient balance in foliage	[N], [P], [K], [Mg], and ratios with [N].	Every 2 yrs. at Level II, every 10-15 yrs. at Level I plots	Part XII

Measurement	Parameters	Frequency	Method	Data to be reported
Lake catchment sensitivity and hydrochemical effects of air pollution (acidification)	Alkalinity, sulphate, nitrate, chloride, pH, calcium, magnesium, sodium, potassium, dissolved organic carbon, and specific conductivity	Seasonal/quarterly to annual, depending on flush rate	Grab sampling of the upper layer (0,1-1 m) or lake outlet. Described in chapter 3.	Major ions (mg/l), nitrate (µg N/L), pH, DOC (mg C/l), alkalinity (µeq/L), conductivity at 25 °C (µS/cm)
River/stream catchment sensitivity and hydrochemical effects of air pollution (acidification)	Alkalinity, sulphate, nitrate, chloride, pH, calcium, magnesium, sodium, potassium, dissolved organic carbon, and specific conductivity	Monthly	Grab sampling. Described in chapter 3.	Major ions (mg/l), nitrate (µg N/L), pH, DOC (mg C/l), alkalinity (µeq/L), conductivity at 25 °C (µS/cm)

Table 5: Key indicators for assessing ozone damage to vegetation according to Annex 5 of the NECD.

Indicator	Measurement	Frequency	Reference for methodology and data reporting
Ozone foliar damage to trees	Visible ozone symptoms in leaves of tree species and on trees and wood plants at 'light exposed sampling sites' (LESS); Tree diameter growth.	Visible ozone symptoms: annually at Level II plots; Diameter growth: every 5 yrs.	Part VIII (visible ozone symptoms) and Part V (diameter growth) of ICP Forests Manual
Ozone foliar damage to crops and non-tree species	Visible ozone symptoms in leaves; Crops: harvested yield	Visible ozone symptoms: at least annually during growing season, preferably just after (3-7 days) an ozone episode[i]; Crop yield: annually	http://icpvegetation.ceh.ac.uk. To be revised from past manuals to suit NECD (including lists of ozone-sensitive species)
Exceedance of flux-based critical levels of ozone	Ozone concentration[ii], meteorology[iii] (temperature, relative humidity, light intensity, rainfall, wind speed, atmospheric pressure) and soil type (sandy, clay or loam) at or near site[iv]. Flux-based model DO_3SE can be used to calculate ozone flux and exceedance of critical levels	Every year: Hourly data during growing season[v]	Method in Modelling and Mapping Manual LRTAP Convention, Chapter 3 – 'Mapping critical levels for vegetation' (http://icpvegetation.ceh.ac.uk, including link to online version of the DO3SE model[vi]).

Measurement (Indicator complex)	Parameter	Frequency	Method
Meteorology	Precipitation, temperature of the air, soil temperature, relative humidity, wind velocity, wind direction, global radiation/net radiation	Monthly	Part 7.1
Air chemistry	sulphur dioxide, nitrogen dioxide, ozone, particulate sulphate, nitrates in aerosols and gaseous, nitric acid, ammonia and ammonium in aerosols	Monthly	Part 7.2
Precipitation chemistry (EMEP manual)	sulphate, nitrate, ammonium, chloride, sodium, potassium, calcium, magnesium and alkalinity	Monthly	Part 7.3
Throughfall	Sulphate, nitrate, ammonium, total N, chloride, sodium, potassium, calcium, magnesium, dissolved organic carbon and strong acid (by pH)	Weekly to monthly	Part 7.5
Soil chemistry	pH (CaCl2), S total, P total N total, Ca exchangeable, Mg exchangeable. K exchangeable, Na exchangeable, Al exchangeable, TOC, exchangeable titrable acidity (H+Al)	Every fifth years	Part 7.7
Soil water chemistry	pH, Electrical conductivity, Alkalinity, Gran plot, N total, ammonium, nitrate, P total, Ca, Mg, K, Na, Aluminium total, Aluminium labile	Four times annually	Part 7.8
Runoff water chemistry	alkalinity, sulphate, nitrate, chloride, dissolved organic carbon, pH, calcium, magnesium, sodium, potassium, inorganic (labile) aluminium, total nitrogen, ammonium, stream water runoff, specific conductivity	Monthly	Part 7.10
Foliage chemistry	Ca, K, Mg, Na, N, P, S, Cu, Fe, Mn, Zn and TOC	Every fifth year	Part 7.12
Litterfall chemistry	Ca, K, Mg, Na, N, P, S, Cu, Fe, Mn, Zn and TOC	Annually	Part 7.13
Vegetation (intensive plot)	Ground, field, shrub and tree layer vegetation, specifically soil-growing vascular plants, bryophytes and lichens. Tree diameter, canopy structure,	Three year	Part 7.17
Trunk epiphytes	Lichen species growing on living tree trunks	Every fifth year	Part 7.20
Aerial green algae	number of branches , youngest shoot with algae thickest coating of algae per tree, number of annual	Annually	Part 7.21

NATUR VÅRDS VERKET

SWEDISH ENVIRONMENTAL PROTECTION AGENCY

What happens now?

- National expert group meeting took place 9th of April were reporting template was presented together with explanatory notes
- Many member states were positive to the ecosystem monitoring (big surprise!!!)
- Draft template has been accepted and reporting has to be done by 1st of july 2018
- Many references to monitoring methods by the ICPs, could fill many gaps!

Cont.

Has your ministry been in contact with you as national focal centers and experts?

NECD ecosystem monitoring

1. Has your ministry been in contact with you as national focal centers and experts?

2. Have you been involved in the national design of the monitoring?

3. How has the country developed its national ecosystem monitoring program?

4. Share your experiences on what has happened and how we can get involved?

Spanish aquatic ecosystem monitoring programs: possibilities to comply with requirements of NEC Directive and ICP Waters / Integrated Monitoring

Manuel Toro
Department of Water Environment
Centre for Hydrographic Studies (CEDEX)
manuel.toro@cedex.es
and in representation of Directorate General for Water

Outline:

1. Introduction to Spanish Institutions involved in this tasks
2. Ecological characterization of Spanish rivers and lakes
3. Spanish Freshwater ecosystems monitoring networks
4. Possibilities to comply with NECD & ICPs requirements

1. Introduction to Spanish Institutions involved in this tasks

GOBIERNO DE ESPAÑA | MINISTERIO DE FOMENTO | MINISTERIO DE AGRICULTURA Y PESCA, ALIMENTACIÓN Y MEDIO AMBIENTE | CEDEX CENTRO DE ESTUDIOS Y EXPERIMENTACIÓN DE OBRAS PÚBLICAS

Ministry of Public Works

Ministry of Agriculture and Fisheries, Food and Environment

Center for Studies and Experimentation of Public Works (CEDEX) (6 Centers)

Directorate General for Water

Center for Hydrographic Studies

national competences in the subject of environment and water resources

research, experimentation and technical assistance related to water resources

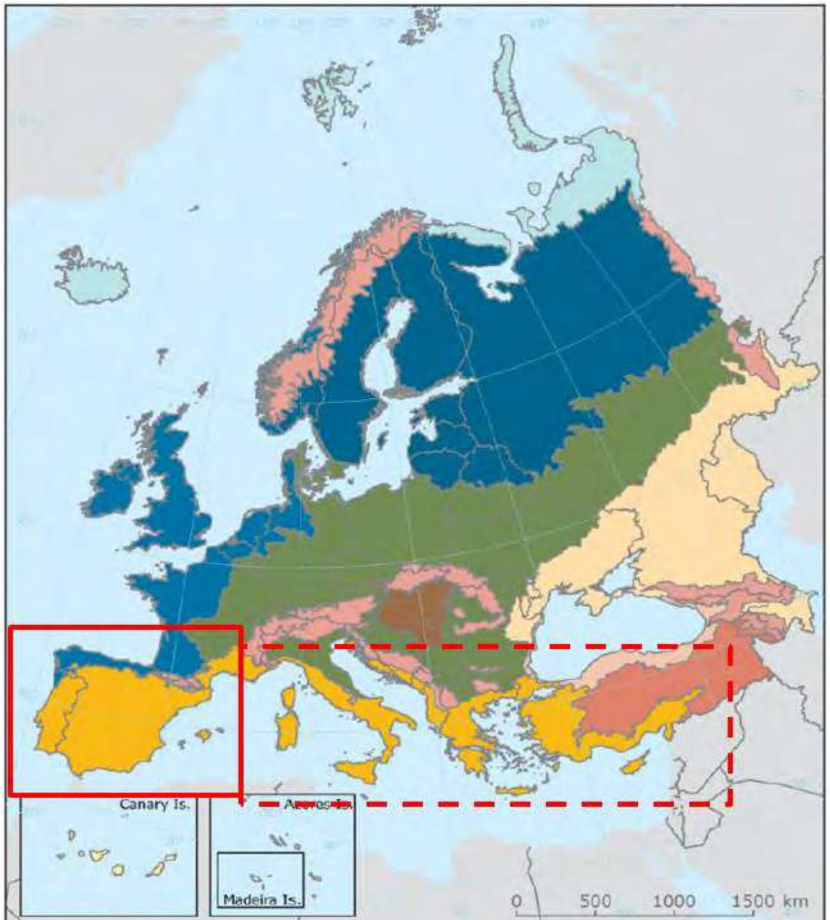
Department of Water Environment (Centre for Hydrographic Studies)

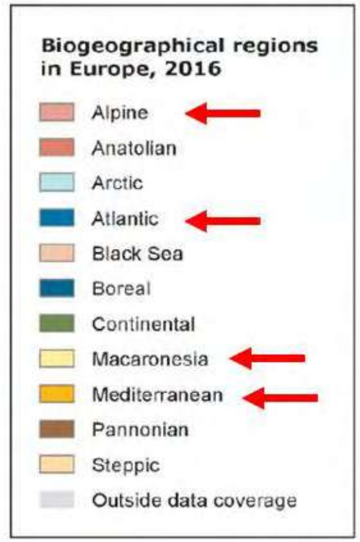
- **National and European regulations**
  - ➢ European Directives: 2000/60/CE, 92/43/CEE
  - ➢ Technical instructions, protocols, assessment of ecological status, ecological indicators,…
- **Limnological studies**
  - ➢ Effects of pressures on aquatic ecosystems: (contaminants, eutrophication, toxicity, regulation,...)
  - ➢ Ecological characterization / biodiversity
  - ➢ Instrumentation and monitoring of water bodies
  - ➢ Exotic aquatic species

- **Climate change effects on aquatic ecosystems**
  - ➢ National Plan of adaptation to climate change
  - ➢ Environmental changes reconstruction / paleolimnology
- **Laboratory for chemical analyses**
  - ➢ Surface and groundwater, sediment analyses
  - ➢ Contaminants and emerging substances
  - ➢ Toxicity - bioassays

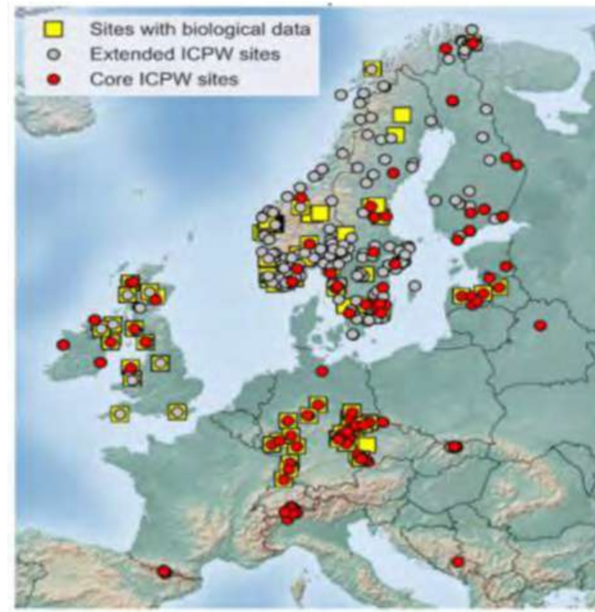
2. *Ecological characterization of Spanish rivers and lakes shows a high environmental diversity*

Aim ICP-W: Assess the degree and geographic extent of the impact of atmospheric pollution on Surface waters





https://www.eea.europa.eu/data-and-maps/data/biogeographical-regions-europe-3



ICP Waters Monitoring Network

ICP Integrated Monitoring Network (primarily forest-based)

"Med-water" is missing

The three large biogeografical regions in Iberian Peninsula include several very different bioclimatic regions…

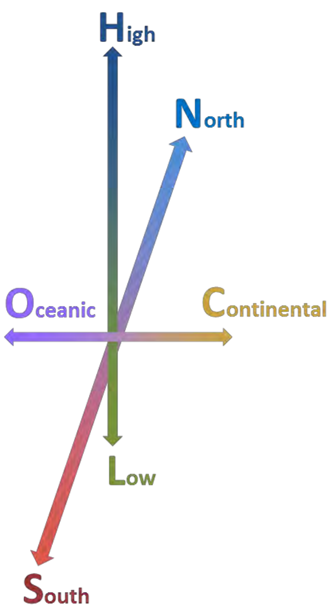
Atlantic

Alpine

Mediterranean

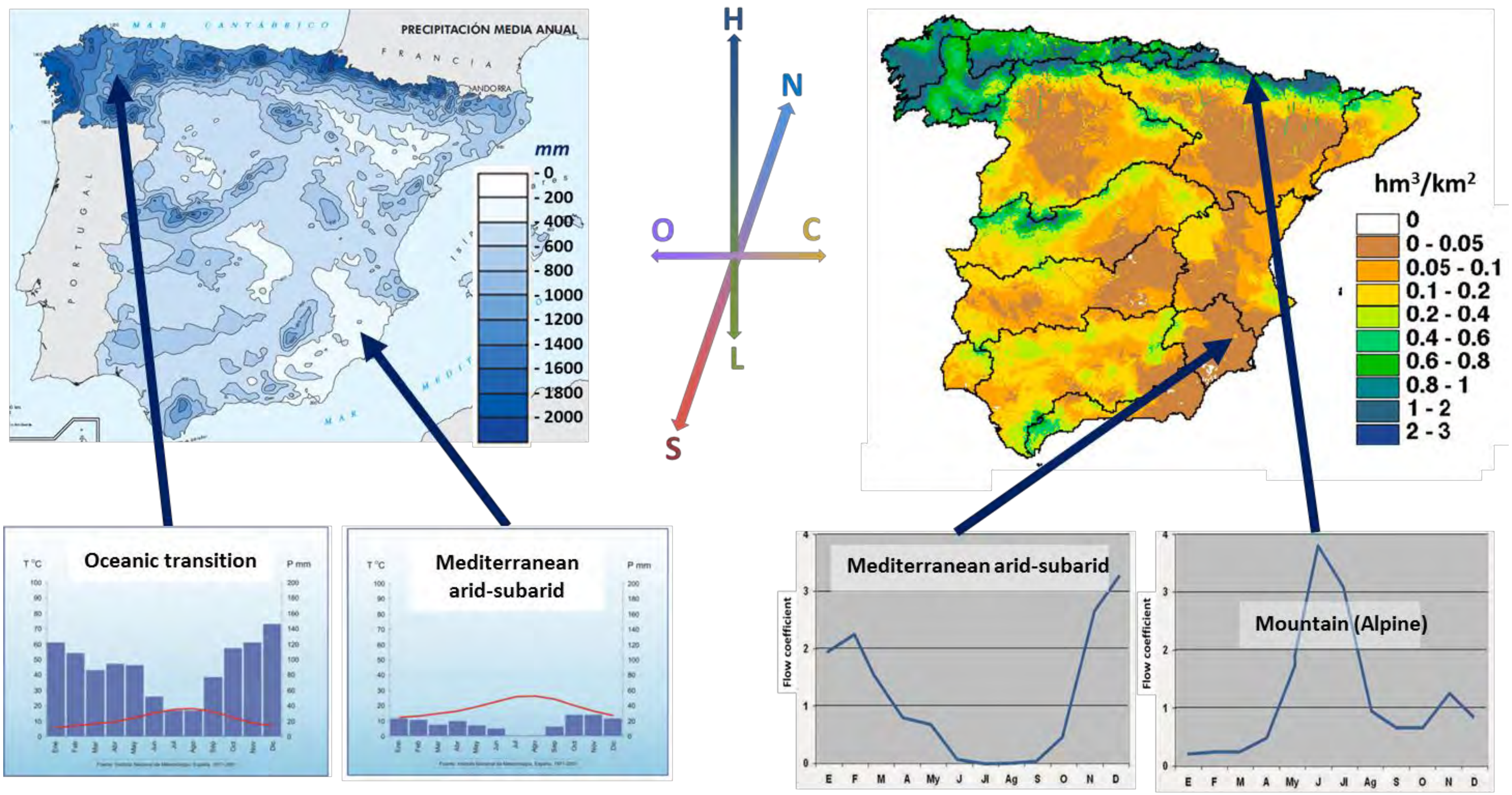
https://www.eea.europa.eu/data-and-maps/data/biogeographical-regions-europe-3

There are 9 bioclimatic regions in Spain (Iberian Peninsula) determined mainly by two factors: Geography + Atmosphere.
They respond to three different gradients:



https://www.ign.es/espmap/clima_bach.htm

Mean annual precipitation in Spain* → Specified annual drainage in Spain**



** https://www.ign.es/espmap/clima_bach.htm*

*** CEDEX. 2005. Characterization of rivers and lakes typologies for Directive 2000/60/CE*

Characterization of rivers and lakes in accordance with WFD (system B) reflect the high environmental diversity

RIVERS

Variables (GIS analyses)

- Altitude (m.a.s.l.)
- Air temperature range (ºC)
- Watershed area (km^2)
- Annual mean flow (m^3/s)
- Specific annual drainage (hm^3/km^2)
- Geology/Estimated conductivity (µS/cm)
- Latitude (UTM 30)
- Longitude (UTM 30)
- River order (Stralher)
- Catchment slope (%)
- Months with river flow = 0 (%)
- Mean air temperature (ºC)

LAKES

Variables (ranges and thresholds)

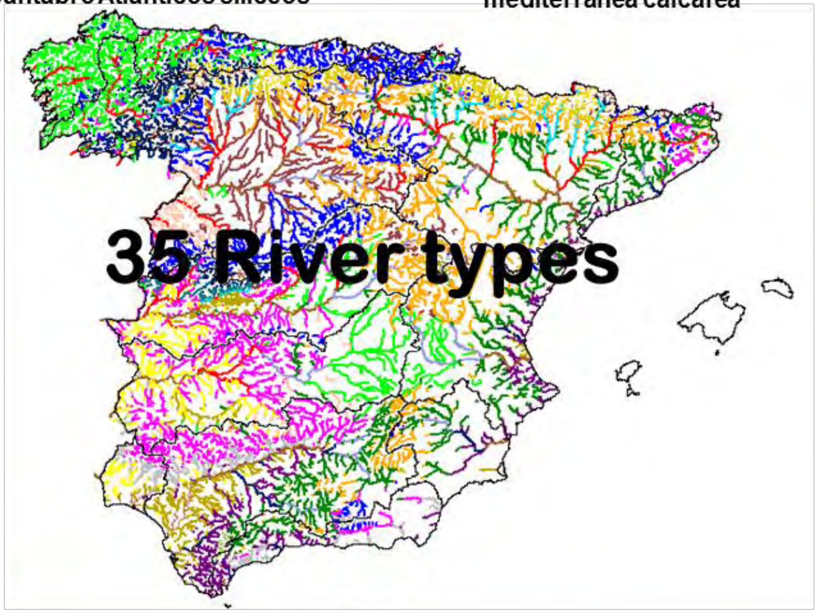
- Humide index (prec./ETP): >2, < 2
- Altitude: 0-15, 15- 1500, > 1500
- Origen: karstic, not karstic
- Thermal regime (hot momomictic, cold monomictic, dimictic, polymictic)
- Drainage inflow regimen
- Hydroperiod: temporal, permanent
- Max depth: < 3 m, 3 – 15 m, > 15 m
- Salinity: Hammer criterium (anual salinity evolution)
- Alkalinity: > 1 meq/l , < 1 meq/l

Tipo 31. Pequeños ejes fluviales Cántabro Atlánticos silíceos

Tipo 12. Ríos de montaña mediterránea calcárea

Tipo 21. Ríos Cántabro Atlánticos silíceos

Tipo 27. Ríos de Alta montaña



Tipo 3. Ríos de las Penillanuras silíceas de la Meseta Norte

Tipo 5. Ríos Manchegos

Tipo 24. Gargantas de Gredos - Béjar

Tipo 9. Ríos mineralizados de Baja montaña mediterránea

Tipo 18. Ríos costeros mediterráneos

Tipo 17. Grandes ejes fluviales en ambiente mediterráneo

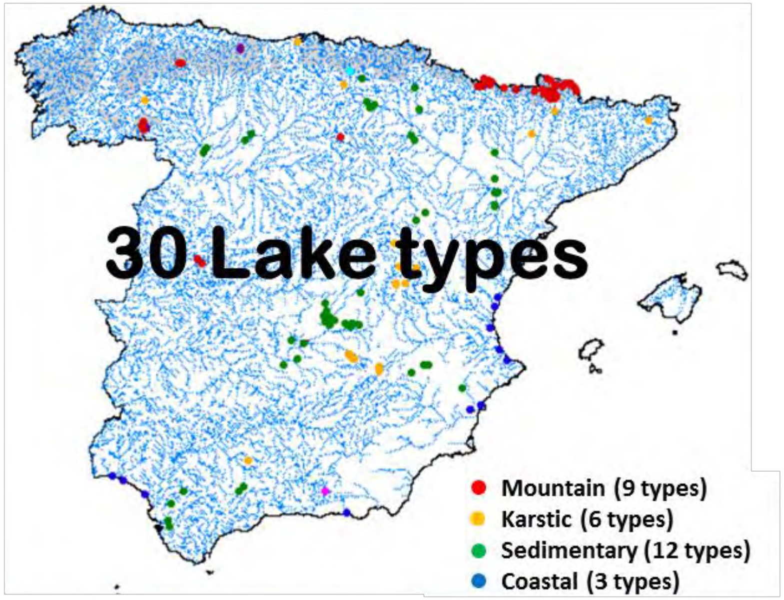
Tipo 10.

Tipo 12.

Tipo 14.

Tipo 6.

Tipo 21.



Tipo 23.

Tipo 1.

Tipo 2.

Tipo 10.

Tipo 23.

3. Current monitoring networks in freshwater ecosystems in Spain

At national-level, there are two main monitoring networks in freshwater ecosystems

2000/60/CE (Water Framework Directive)

Water Bodies types: rivers, lakes, HMWB, artificial, transitional and coastal.

Water bodies: ≈ 3800 rivers + ≈ 320 lakes

92/43/CEE (NATURA 2000)

Habitats (SCI)/Species: Running and standing waters (rivers and lakes/wetlands)

Rivers: 2950 SCIs + Wetlands: 1400 SCIs

Competences

Spanish Government + Regional Governments
(inter-communities) (intra-communities)

Regional Governments

Current monitoring

All river basins ≈ 10 years (some basins > 15-20 y)

Regional differences, and only wetlands

Lack of correspondence between WFD and HD types

Ecological criteria for classification

- **Tipo 8** Ríos de baja montaña mediterránea silícea
- **Tipo 11** Ríos de montaña mediterránea silícea
- **Tipo 12** Ríos de montaña mediterránea calcarea
- **Tipo 25** Ríos de montaña húmeda silícea
- **Tipo 26** Ríos de montaña húmeda calcarea

- **Tipo 3220** Ríos alpinos con vegetación herbácea en sus orillas
- **Tipo 3230** Ríos alpinos con vegetación leñosa en sus orillas de *Myricaria germanica*
- **Tipo 3240** Ríos alpinos con vegetación leñosa en sus orillas de *Salix eleagnos*

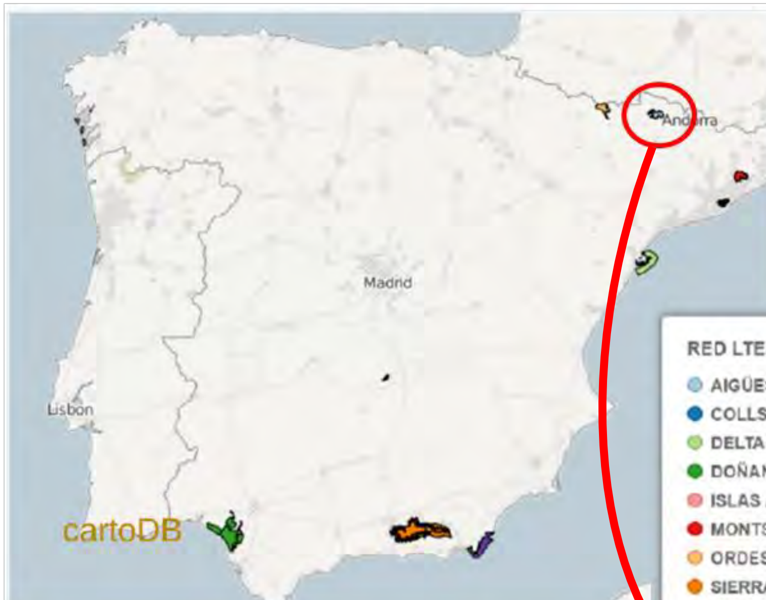
. . . / . . .

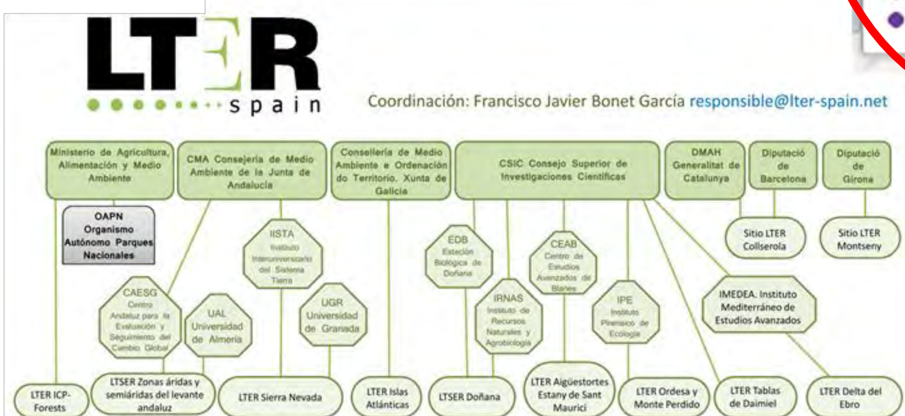
Phytosociological criteria for classification

A national working group is coordinating the optimization of both networks to comply with the requirements of both Directives in coincident sites, based on WFD monitoring network.

Also at national-level, but very limited in number of sites:

- **LTER-Spain / National Parks Network**





LTER AIGÜESTORTES

LTER-Aigüestortes was established in 2008 by 6 institutions, and covers six areas: climatology, CO_2 flows, biogeochemistry of atmospheric precipitation and surface water, reconstruction of past environmental change , populational trends and phenological changes.

http://parcsnaturals.gencat.cat/ca/aiguestortes/coneixeu-nos/ambits_o_linies_de_treball/node_lter/

Source: http://www.lter-spain.net/

4. Which are the possibilities to comply with NECD & ICPs requirements?

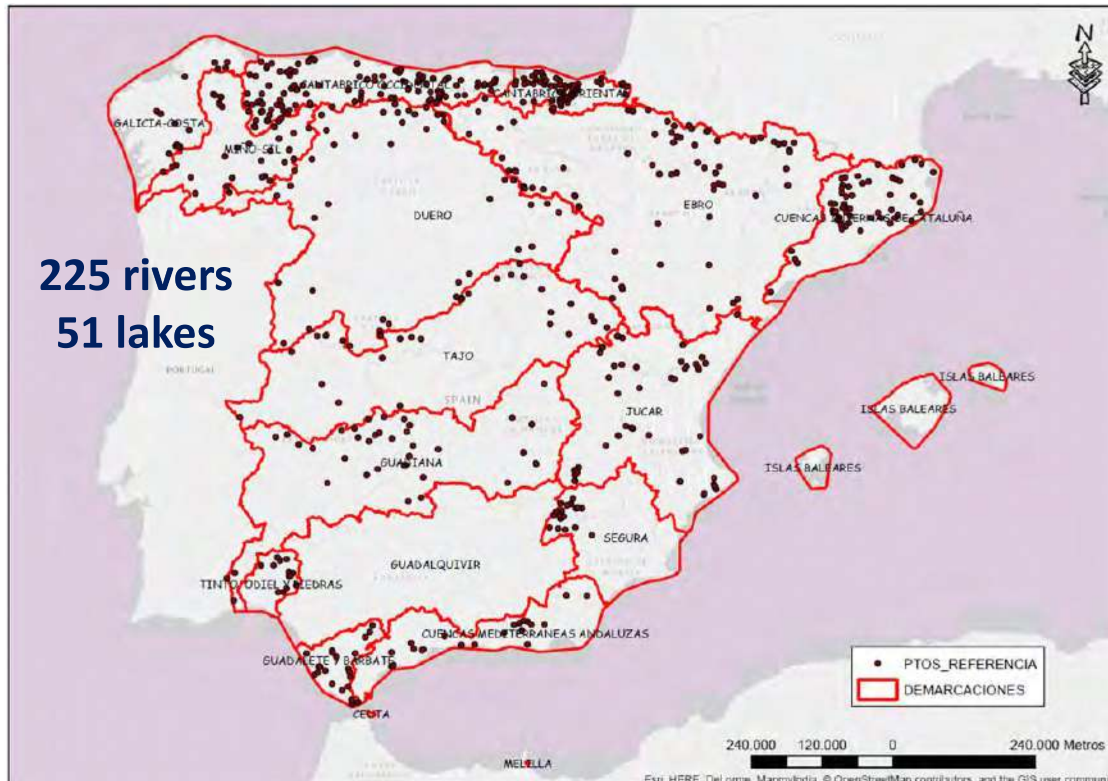
- **Selection of sites for NECD from national-level monitoring networks**
- **Proposals of future sites for ICP-Waters/IM with intensive monitoring programmes**

To comply with NECD requirements is necessary to look for representative sites of different habitats (environmental gradient) and without any pressures:

<u>Starting point</u> is the Subprogramme of selected reference sites in rivers/lakes for WFD.
The criteria used to select reference sites in rivers/lakes for WFD was the existence of:

<u>Minor</u> or no alterations from:

- **Land uses (%)(agric., livest., urban., indust.)**
- **Morphological alterations**
- **Hydrological alterations**
- **Exotic species**
- **Waste waters**
- **Recreational uses**
- **Groundwater connection**
- **Eutrophication**



But a selection of reference sites **<u>without any minor pressure</u>** is needed

Does this programme fit the NECD requirements (Annex V)?

Sub-programme of monitoring for Reference sites : indicators and frequency of sampling

BIOLOGICAL ELEMENTS
PHYTOPLANKTON
BENTHIC DIATOMS
MACROPHYTES
MACROINVERTEBRATES
FISHES

GENERAL CHEMICAL PARAMETERS
TURBIDITY
pH
ALKALINITY = ANC
DISSOLVED OXYGEN (mg/L + %sat)
Total HARDNESS
TEMPERATURE
CONDUCTIVITY
DISSOLVED SOLIDS
SUSPENDED SOLIDS
PHOSPHATE
Total PHOSPHORUS
NITRATE
NH_3
AMONIUM
NITRITE

OTHER CHEMICAL PARAMETERS
MERCURY
SILICA
Total CLORIDE
SH_2
SO_4
CHLOROPHYLL *A*
DQO
PERMANGANATE INDEX
ANIONIC TENSOACTIVES
DBO5
N Kjeldahl
N Total

- It comply NEC Directive
- But DOC is missing

- All protocols and methodologies were adopted according to WFD.
- Because many labs are involved in the different basins, IC is needed.

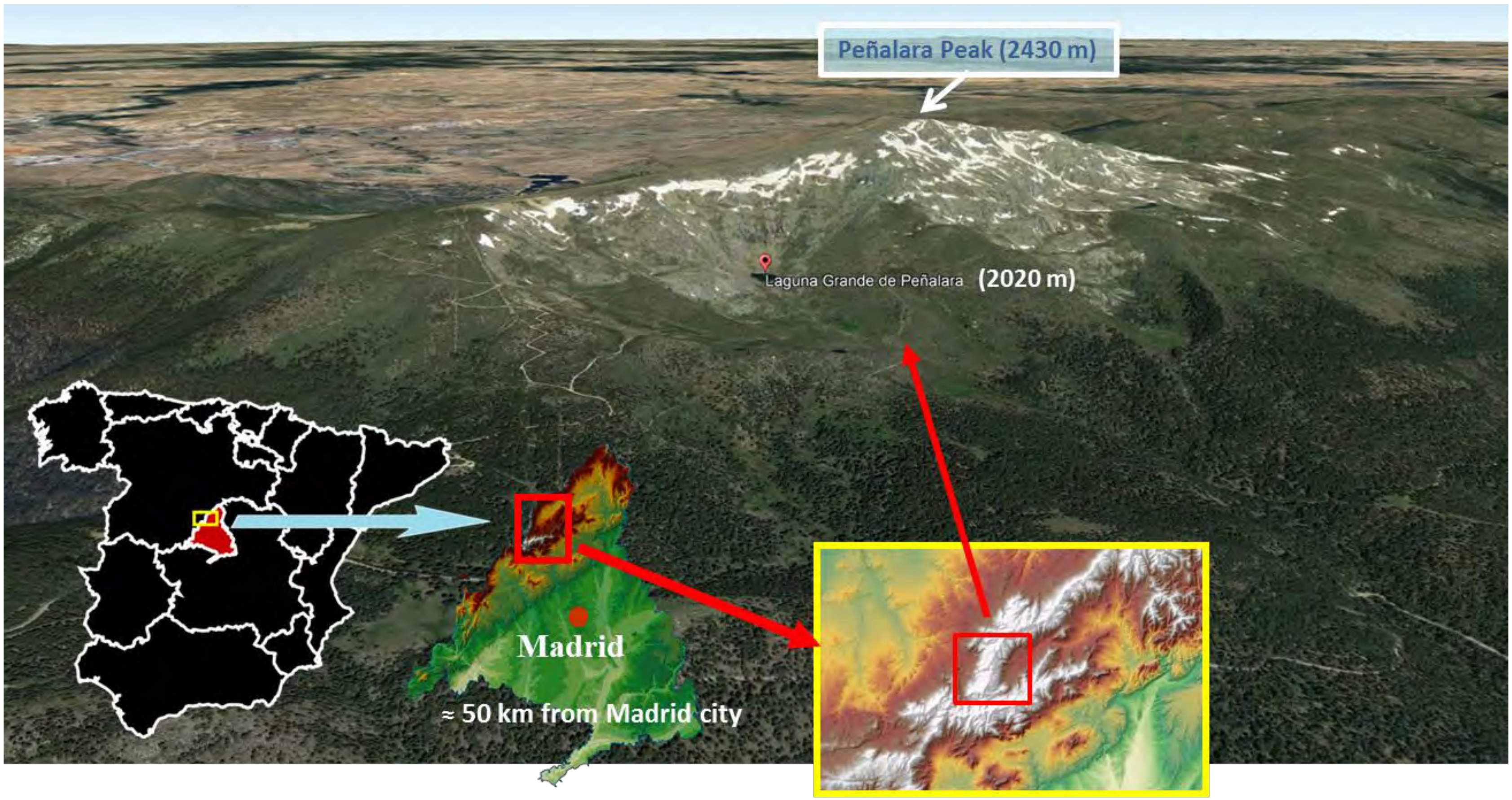
Surveillance Monitoring Frequency is according to WFD: ≥ 1 year/RBM Plan (6 y) (some basins yearly)

	Rivers	Lakes
Phytoplankton	- -	1/6 months
Other flora and fauna	1/3 years	1/3 years
Physico-chemical	1/3 months	1/3 months
Hydromorphology	1/3 years	1/3 years

- Frequency do not comply NEC Directive (Annex V: yearly in lakes/ monthly in rivers) in some basins and need to be increased.

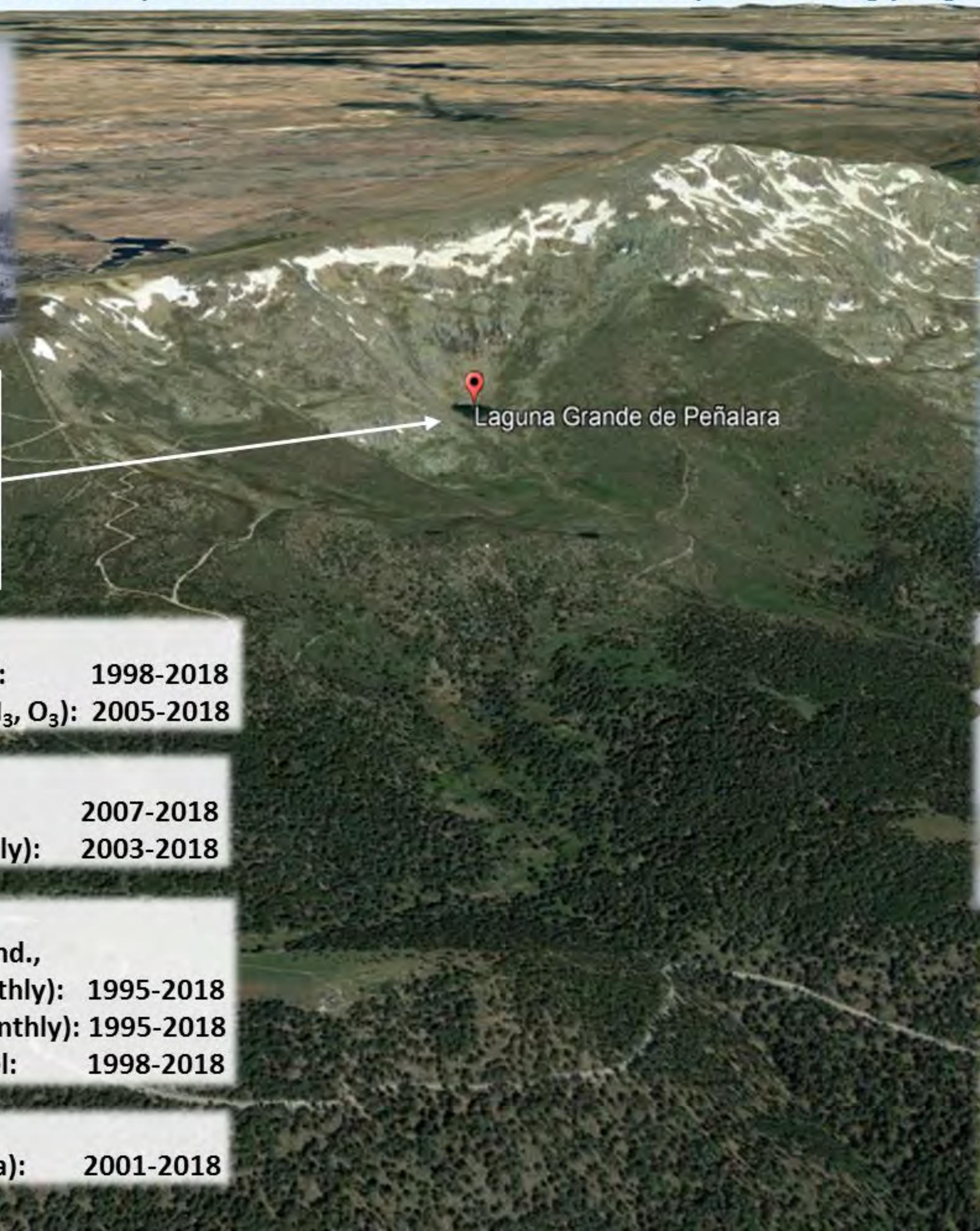
To comply with ICP-Waters/IM requirements is necessary to look for appropriate sites with long-term intensive monitoring (including air-pollution).

1º Proposal: Peñalara Lake – Lozoya River basin (Sierra de Guadarrama National Park)



In April- 2018, the Regional Goverment began talks with several Research Institutions for the establishment of a monitoring programme, including the possibility of the creation of a EMEP site in the National Park, adapting the current programme GuMNet (*An atmospheric and ground observational network in the Guadarrama Mountains*) (https://www.ucm.es/gumnet/noticias/presentation-of-the-project-gumnet)
It would include a current lake-river monitoring programme started in 1995.

Peñalara Lake – Lozoya River basin (Sierra de Guadarrama National Park) monitoring programme includes data from



Alk.: 0,05 meq/l
pH: 5,9-7,2
Conduct.: 7-17 µS/cm
Ca^{++}: < 1 mg/l

Automatic Weather Stations:

- Meteorological parameters: 1998-2018
- Air pollution (NOx, SOx, NH_3, O_3): 2005-2018

River monitoring (7 sites):

- Hydrochemistry (yearlly): 2007-2018
- Biological (Invertebr.) (yearlly): 2003-2018

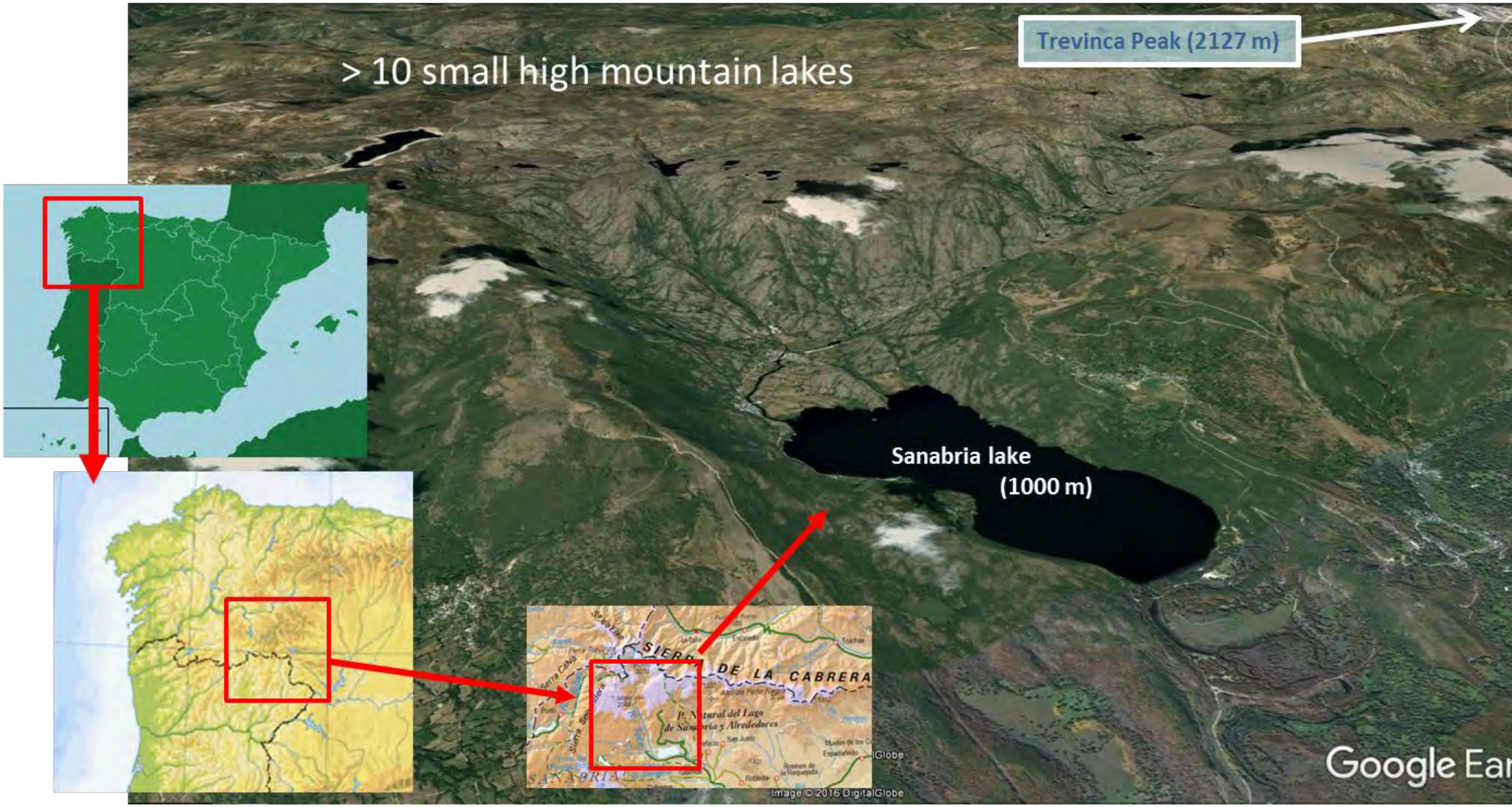
Lake monitoring:

- Hydrochemistry (pH, Tª, Cond., Odis, P, N, Ca, Mg, Alk)(monthly): 1995-2018
- Biological (Plankt+Inv.) (monthly): 1995-2018
- Ice phenology and lake level: 1998-2018

Flow gauging monitoring:

- Continuous flow/Tª (136 ha): 2001-2018

2º Proposal: Sanabria Lake – Tera River basin (Natural Park of Sanabria)



- Since 1987, a basic limnological lake monitoring (hydrochemistry: Tª, pH, cond., Odis, P, N, Si, Chl a, Alk) is running monthly, with several 1-2 years periods of phytoplancton surveys (monthly).
- An intensive monitoring (including atmospheric deposition) of the lake and its catchment carried out from 2015 to 2018 could be a starting point to establish a possible site for ICP-Waters.
- There are more than 10 small high mountain lakes in Sanabria Lake basin.

Sanabria lake – Tera River monitoring programme includes data from:

Automatic Weather Stations:
- Meteorological parameters: 1983-2018
- Air pollution (NOx, SOx, NH_3, O_3): 2016-2018

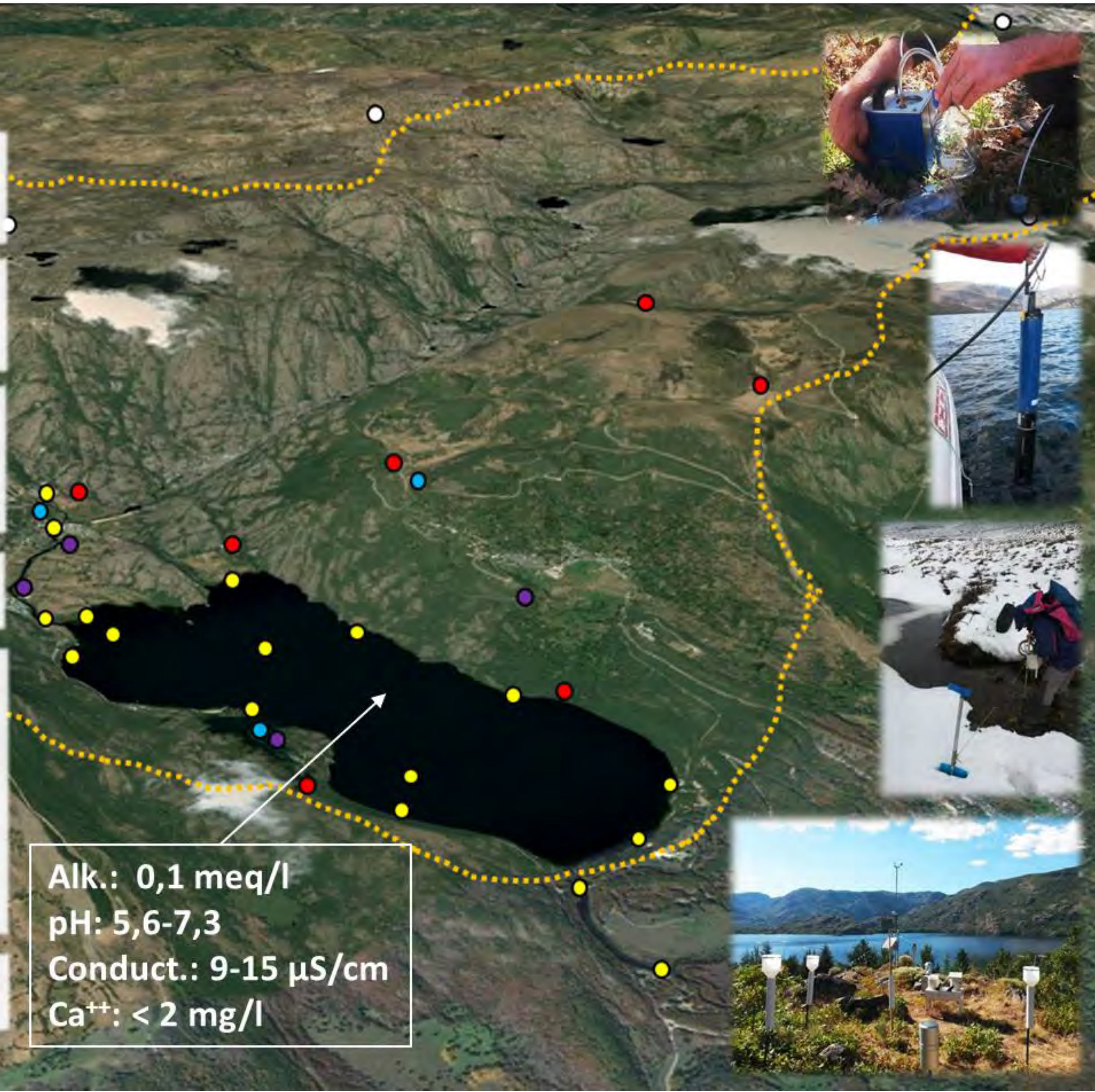
Snow depth monitoring (5 sites):
- Telenivometer/poles: snow gauge + SWE sensing 2008-2018

Stream monitoring (11 sites):
- Hydrochemistry (P, N, SOx, Ca, Mg, Na, K, Alk, DOC) + Flow (continuous/monthly): 2015-2018

Soil water (5 sites):
- Eventually (rainfalls) (P, N): 2016-2018

Lake monitoring:
- Hydrochemistry (Tª, pH, cond, O_{dis}, P, N, Si, Chl a, Alk) (monthly): 1987-2018
- Hydrochemistry (complete) (monthly): 2015-2017
- Biological (Plankt+Invert.) (1-4 months): 2015-2017
- Lake level: 2016-2018

Flow gauging monitoring (3 sites):
- Continuous flow/Tª (11 km^2): 2015-2018



Main Needs for the selection of sites to comply with NECD and ICP-W/ICP-IM

*About sites from national running monitoring networks (**for NECD**)*:

- **Subprogramme of Reference sites (WFD):**
  - Selection of representative sites for NECD following established criteria (**July-18**)
  - Required sampling frequency in some basins and indicators
  - Include additional parameter for water chemistry (DOC)

- **LTER-Spain sites :**
  - Selection of sites that comply with requirements for NECD **(July-18)**
  - To establish agreements with each site responsible funding/research institution.

*About proposed frequent-monitoring "pilot sites" (**for ICP-Waters/ICP-IM**)*:

- **Peñalara Lake – Lozoya River: *(in process)***
  - Monthly frequency for sampling in rivers is needed
  - Some additional parameters for waters, air-precipitation, and soil/water chemistry
  - Some additional parameters for vegetation/soil (if considered for IC-IM)
  - Comply with methodologies of ICP and participate in IC exercises.
- **Sanabria Lake – Tera River: *(in project)***
  - Institutional agreement for funding continuous monitoring is needed
  - Some additional parameters for waters, air-precipitation, and soil/water chemistry
  - All parameters for vegetation (for ICP-IM)
- **Other possible sites from LTER (eg. Aigüestortes NP)** (it needs an agreement)

Some additional ideas to be considered…

Relevance of atmospheric input of phosphorus as eutrophying substance in Iberian Peninsula (SW Europe)

African dust can be a significant source for alkalinity, base cations, nitrogen… and phosphorus:

- Avila & Alarcon_2003_Precipitation chemistry at a rural Mediterranean site. J.Geophys.Res.
- Camarero & Catalan_2012_Atmospheric phosphorus deposition may cause lakes to revert from P limitation back to N limitation. Nature Comm.
- Izquierdo_etal_2012_Atmospheric P deposition in a near-coastal rural site in NE Iberian Peninsula. Atm.Env.
- Morales-Baquero_etal_2013_Chemical signature of Saharan dust on dry-wet atmospheric deposition in the south-western Mediterranean region.TellusB
- Yu etal_2015_The fertilizing role of African dust in the Amazon rainforest_Geoph.Res.Lett.
- Jiménez etal_2018_Climate change and Saharan dust drive recent cladoceran and primary production changes in remote alpine lakes of Sierra Nevada, Spain. Glob.Chang.Biol.


Thank you!
Questions?
Lake Sanabria

Biological intercalibration: Invertebrates 2017

uni Research

Objectives

- The biological intercalibration should promote international harmonisation of monitoring practices
- An important tool in this work is an inter-laboratory quality assurance test
- The bias between analyses carried out by the individual participants of the ICP Waters Programme should be identified and controlled

uni Research

Objectives

- Evaluate the quality of the taxonomic work on the biological material delivered to the Programme centre
- Harmonise the biological database
- Maintain and improve the taxonomic skill of the participating laboratories

uni Research

Methods

- Two test samples of invertebrates is composed by the programme subcentre and sent to participating laboratories

- The results are controlled and evaluated by the Programme subcentre

- Feedback is given directly to the individual laboratory and in reports

uni Research

The test samples

- Made of material sent from each participating laboratory
- Material added by the subcentre

It is important to use animals from the home region of each laboratory

uni Research

The test samples

An example:

The test samples to Switzerland 2015 was composed of material from: Switzerland, Norway and Sweden

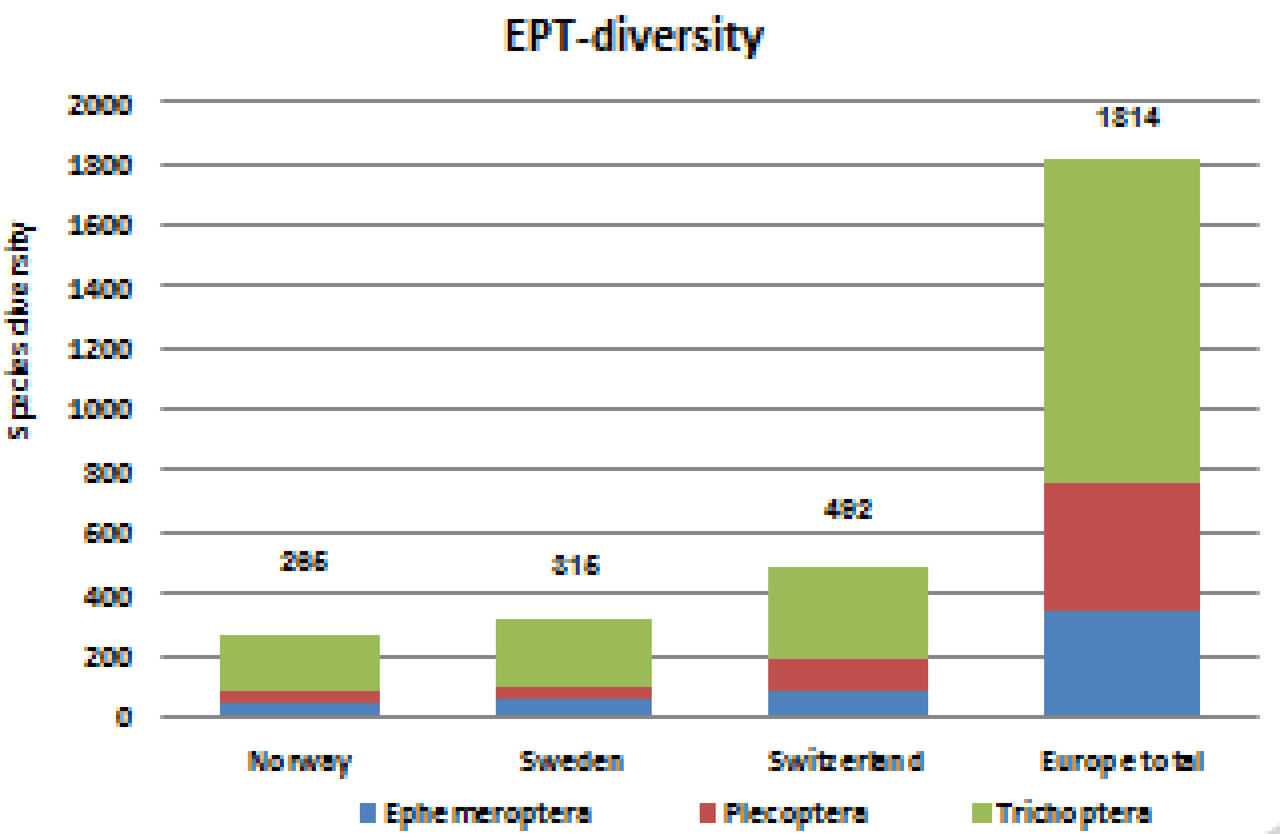
Fauna Europea is used to control the geographical relevance of the test material

FAUNA EUROPAEA

http://www.faunaeur.org/

uni Research

Total number of species within the insect orders Ephemeroptera, Plecoptera and Trichoptera in Norway, Sweden and Switzerland



Source: Fauna Europaea

uni Research

The Quality index (Qi)

The index is based on the identification of individuals to correct species, genus and the % identified:

Qi = % correct species/10 * % correct genus/10 * % identified individuals/100

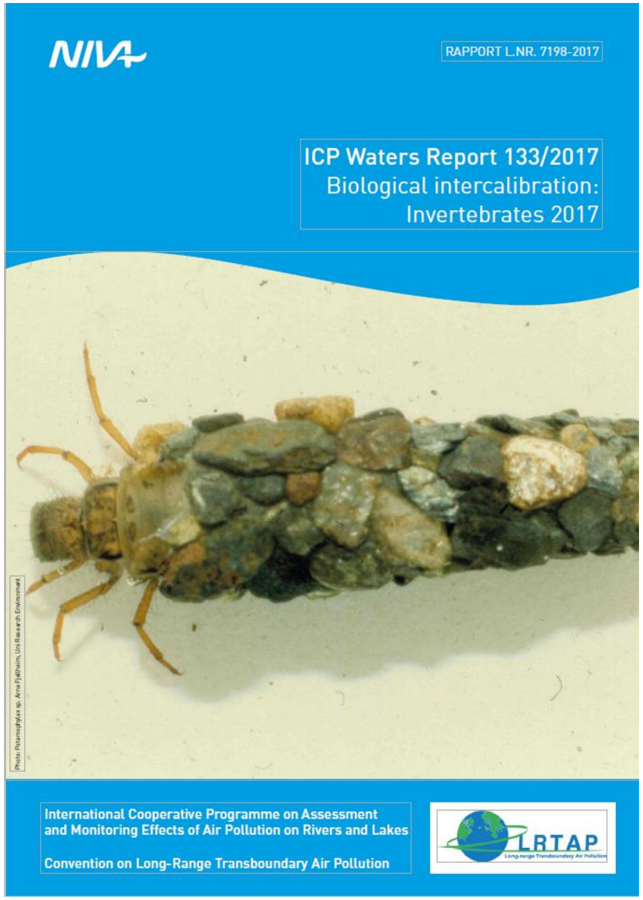
Qi will be a number between 0 and 100. It will decrease exponentially by faults made on genus level and by low % identified

A Qi above 80 is regarded as good taxonomic work

uni Research

Biological intercalibration 2017

- The report was published in the autumn



uni Research

Results

The results will be presented separately for:

- **Mayflies (Ephemeroptera)**

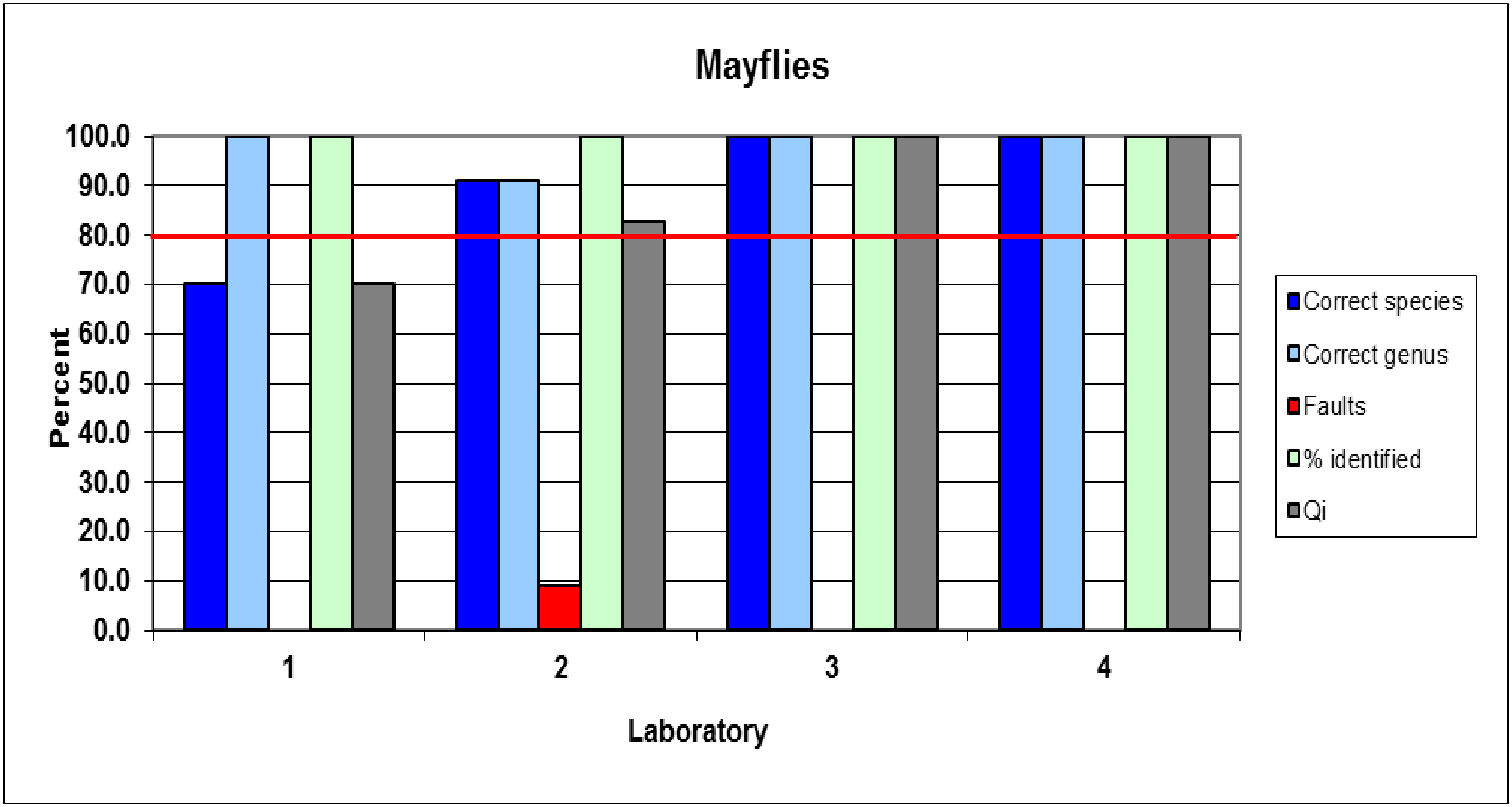
- **Stoneflies (Plecoptera)**

- **Caddisflies (Trichoptera)**

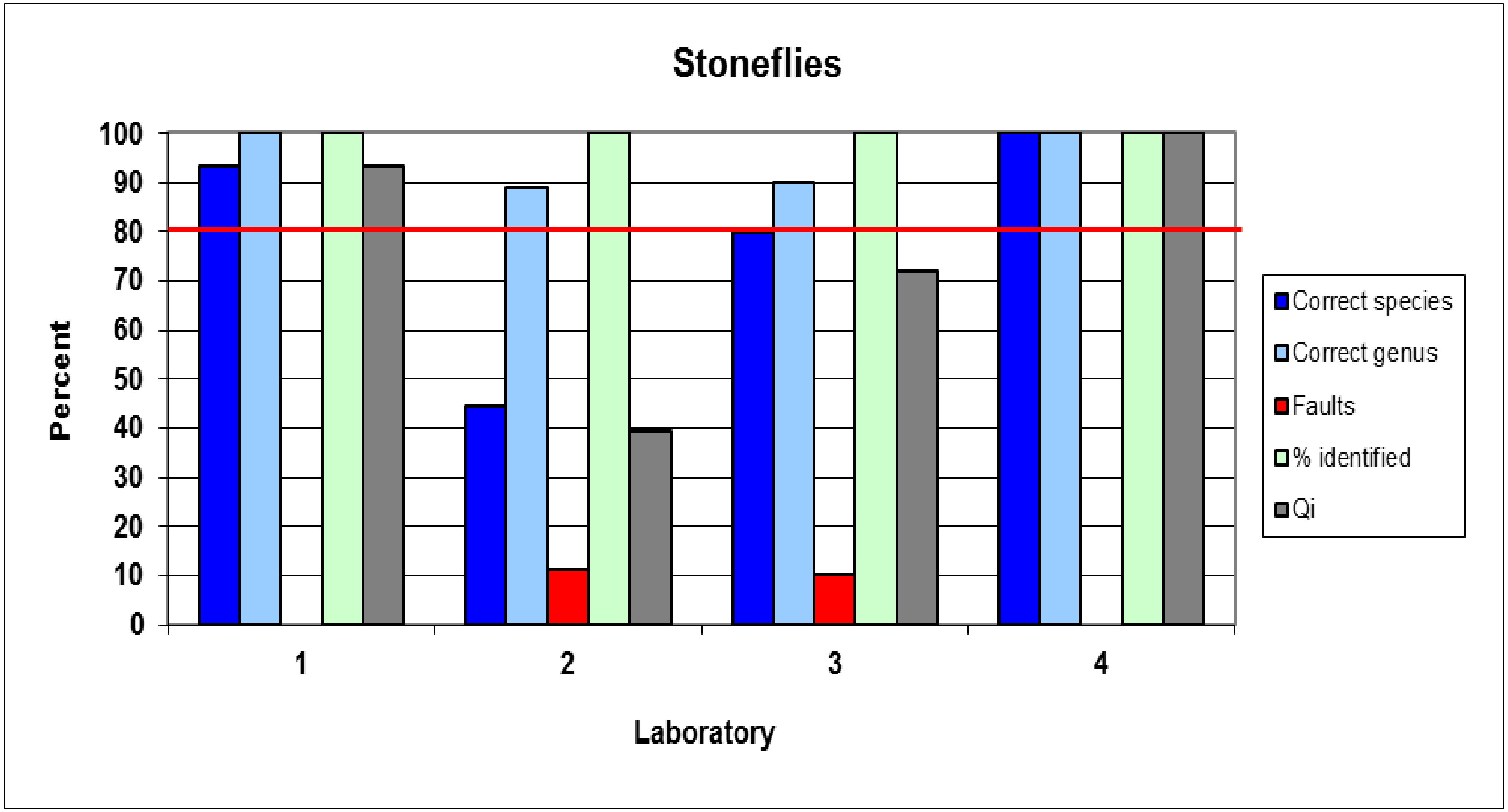
- **Other groups**

uni Research

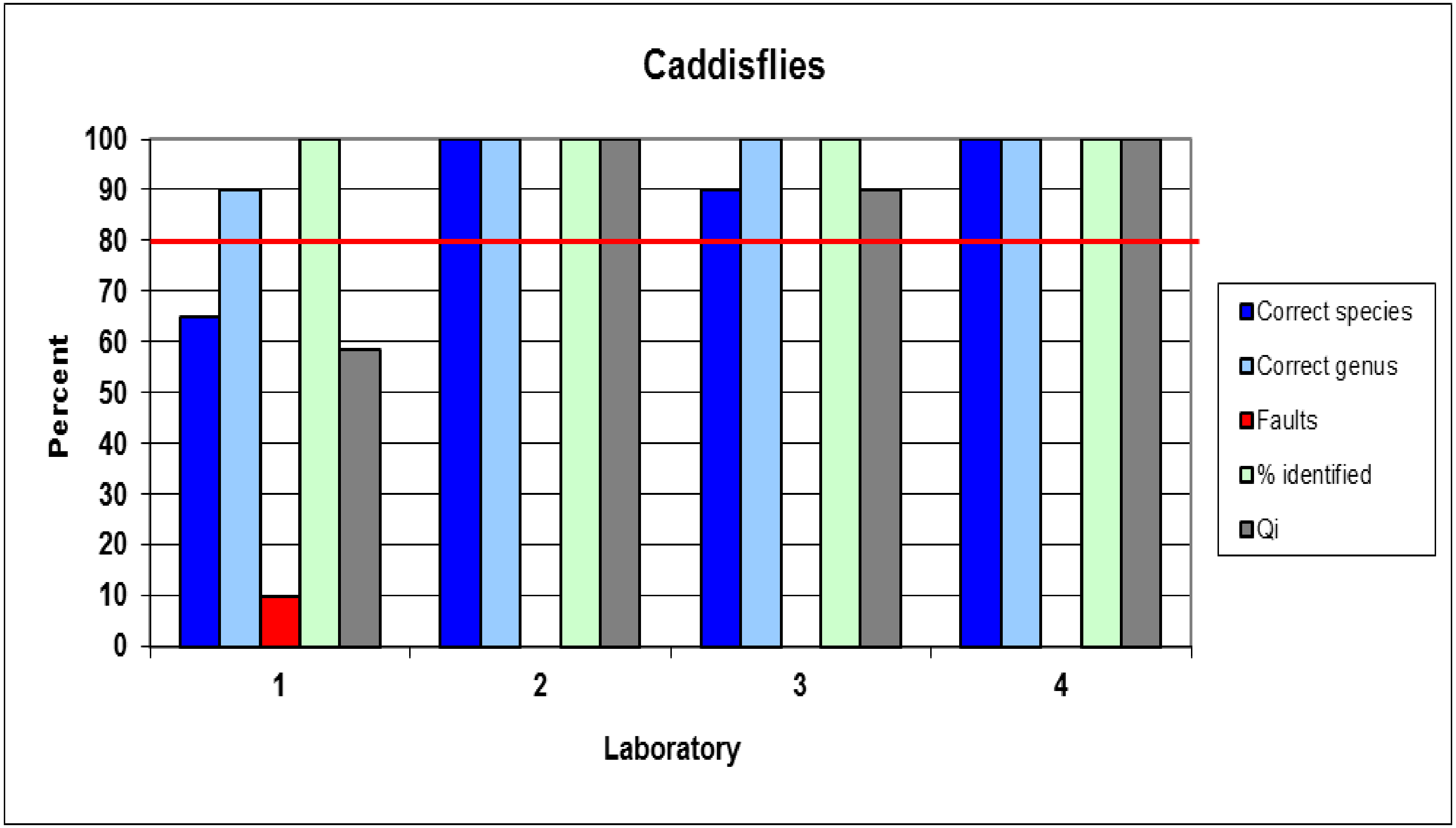
Mayflies


Mayflies
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Percent
1
2
3
4
Laboratory
Correct species
Correct genus
Faults
% identified
Qi

Stoneflies

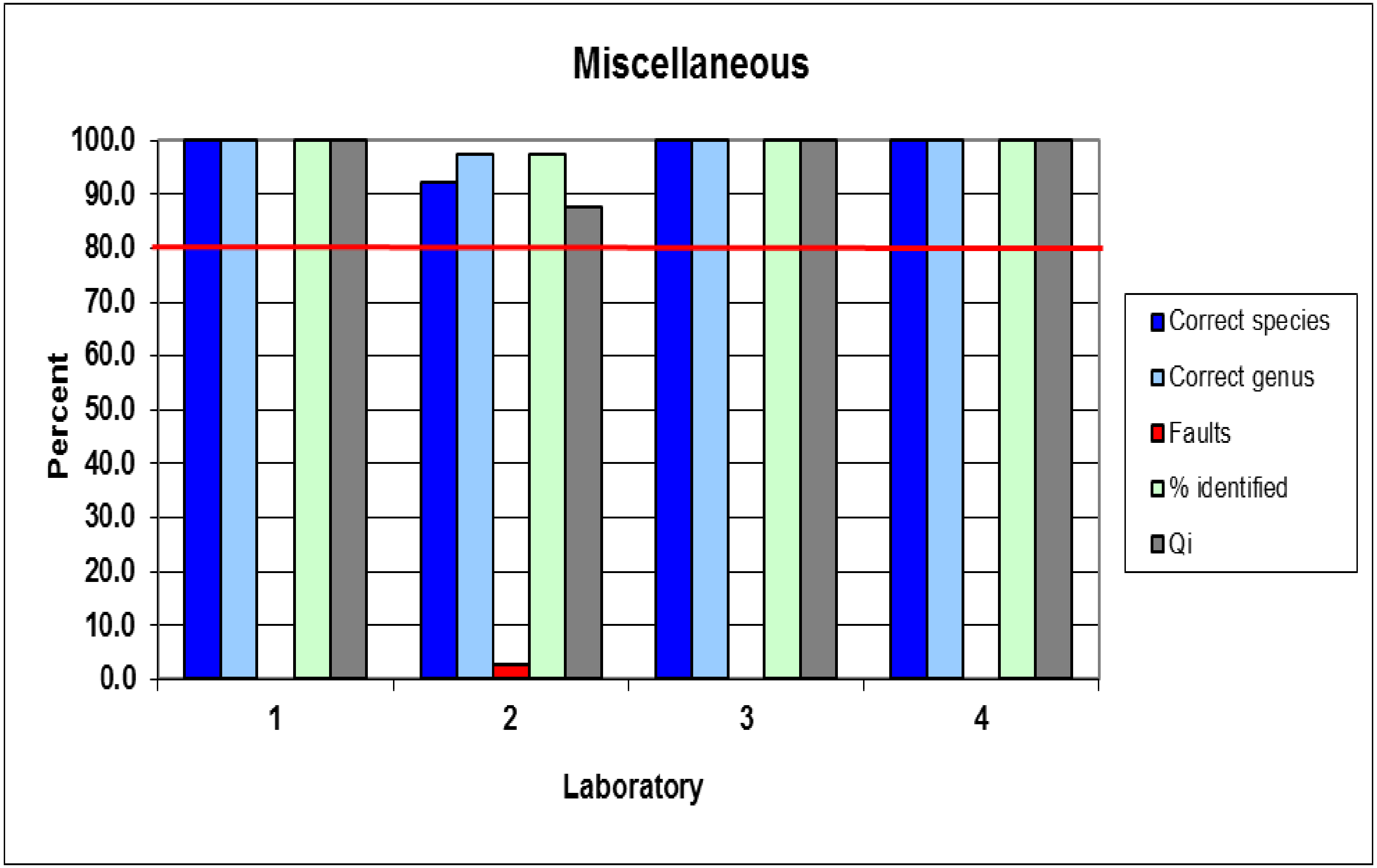

Stoneflies
Percent
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
Laboratory
Correct species
Correct genus
Faults
% identified
Qi

Caddisflies

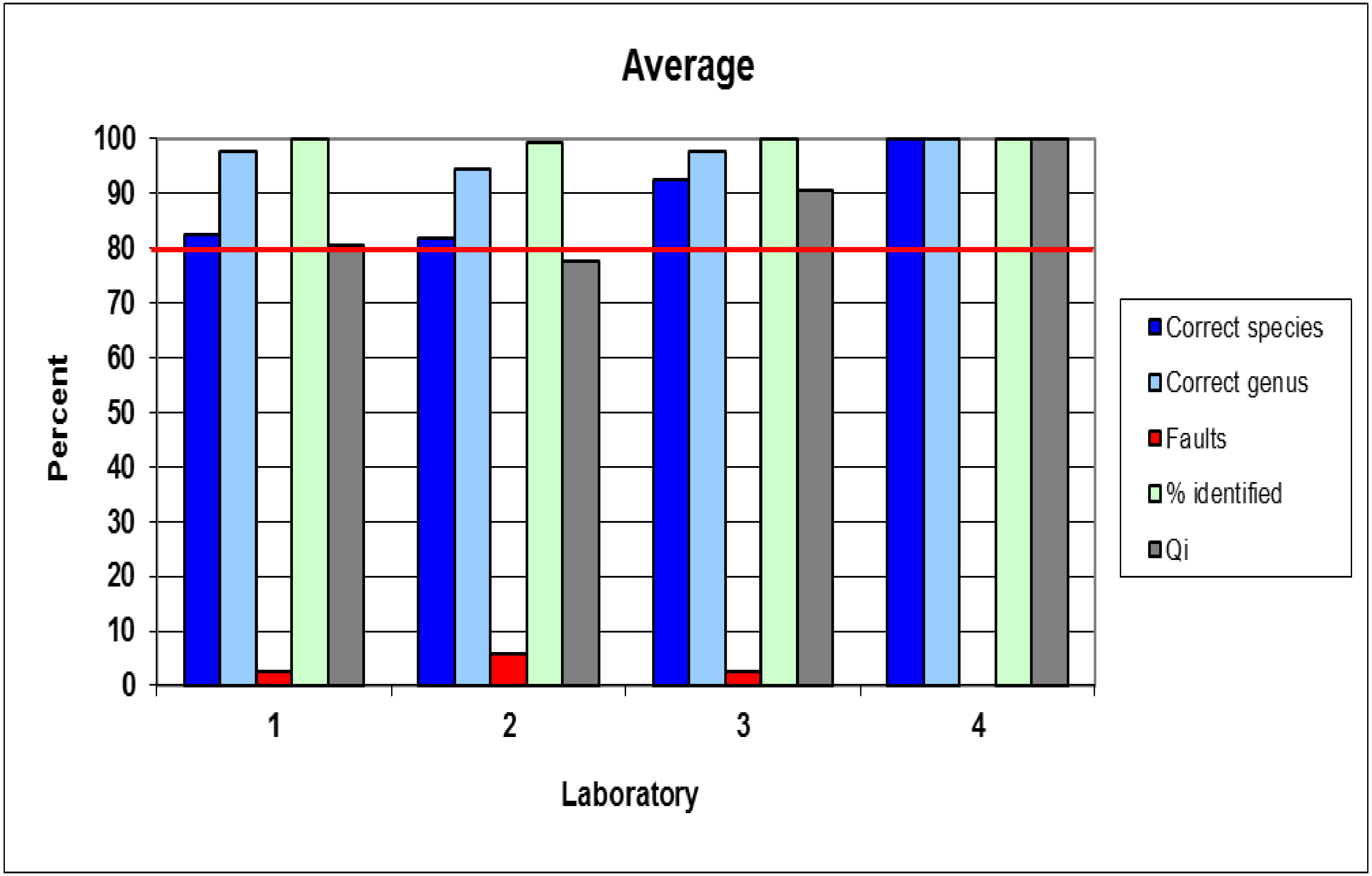


uni Research

Other groups



Average skill



uni Research

Conclusions

- Four laboratories participated in the biological intercalibration in 2017
- The average Quality index (Qi) was excellent for two laboratories. Laboratory 4 had all correct, and Laboratory 3 had a Qi of over 90, well above the limit for good taxonomic work

uni Research

Conclusions

- Laboratory 1 had an index value just over 80, indicating acceptable taxonomic work
- Laboratory 2 had an index value just below 80, indicating not acceptable taxonomic work
- This last result is caused by the stoneflies beeing correctly identified to genus only, and emphasizes the importance of trying to identify the EPT groups down to species level

Biological intercalibration 2017 Participants

- Sweden, Estonia, Germany, Switzerland

Planned participants 2018

- Norway, Sweden, Czech Republic, Ireland, Estonia and Latvia

Intercomparison 1731

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

Aims and objectives of ICP Waters

- Assess the degree and geographic extent of the impact of atmospheric pollution, in particular acidification, on surface waters
- Collect information to evaluate dose/response relationships
- Describe and evaluate long-term trends and variations in aquatic chemistry and biota attributable to atmospheric pollution
- Maintain and develop an international network of surface water monitoring sites
- Promote international harmonisation of monitoring practices by:
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  - Compiling a centralised database with data quality control and assessment capabilities
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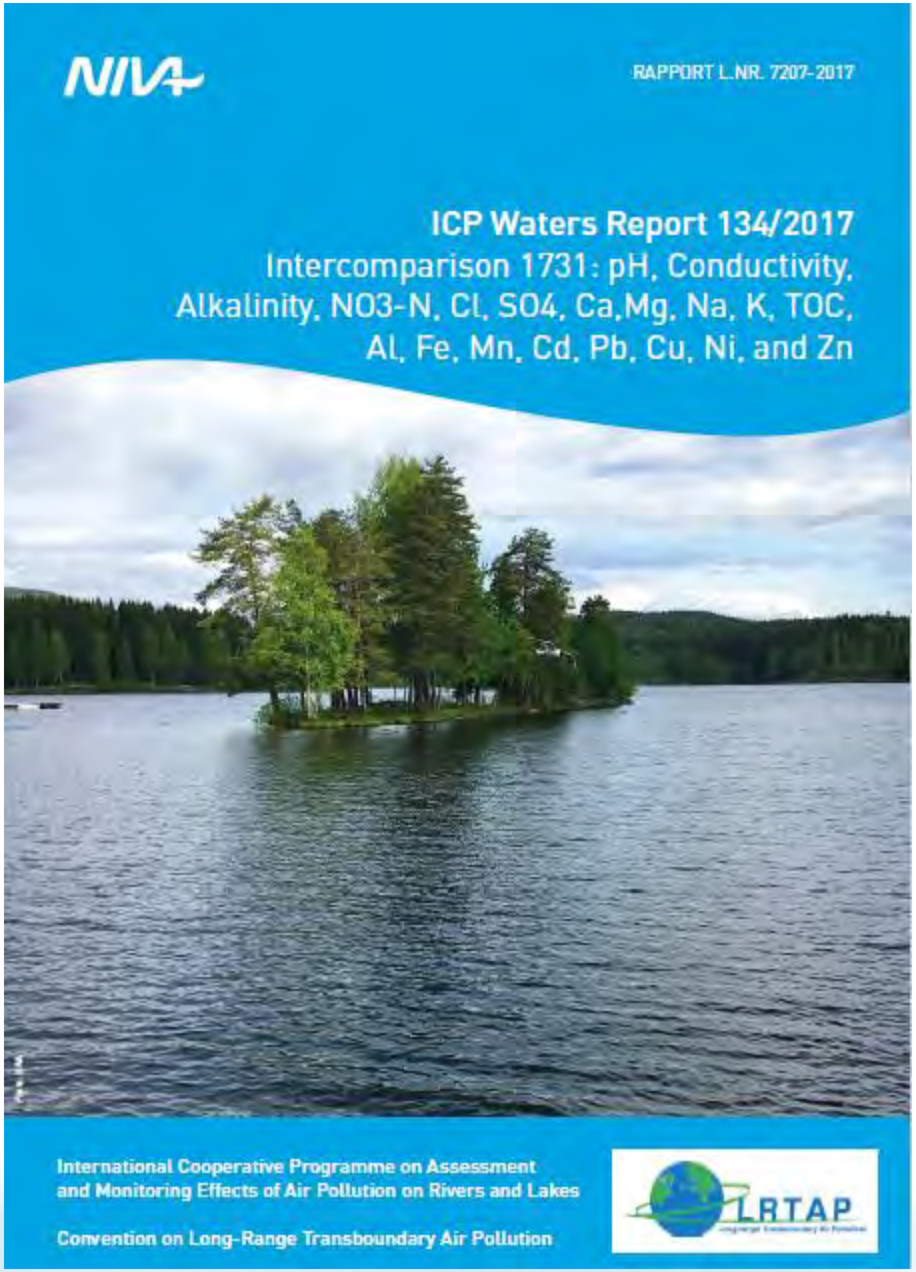
- Address water related questions in cooperation with other ICPs



Carlos Escudero-Oñate (NIVA) organised the intercomparison and wrote the report

Participation in intercomparison 1731

- 88 laboratories were invited to participate
- 38 laboratories from 21 countries accepted the invitation and submitted results for one or more parameters

Participation from 21 countries

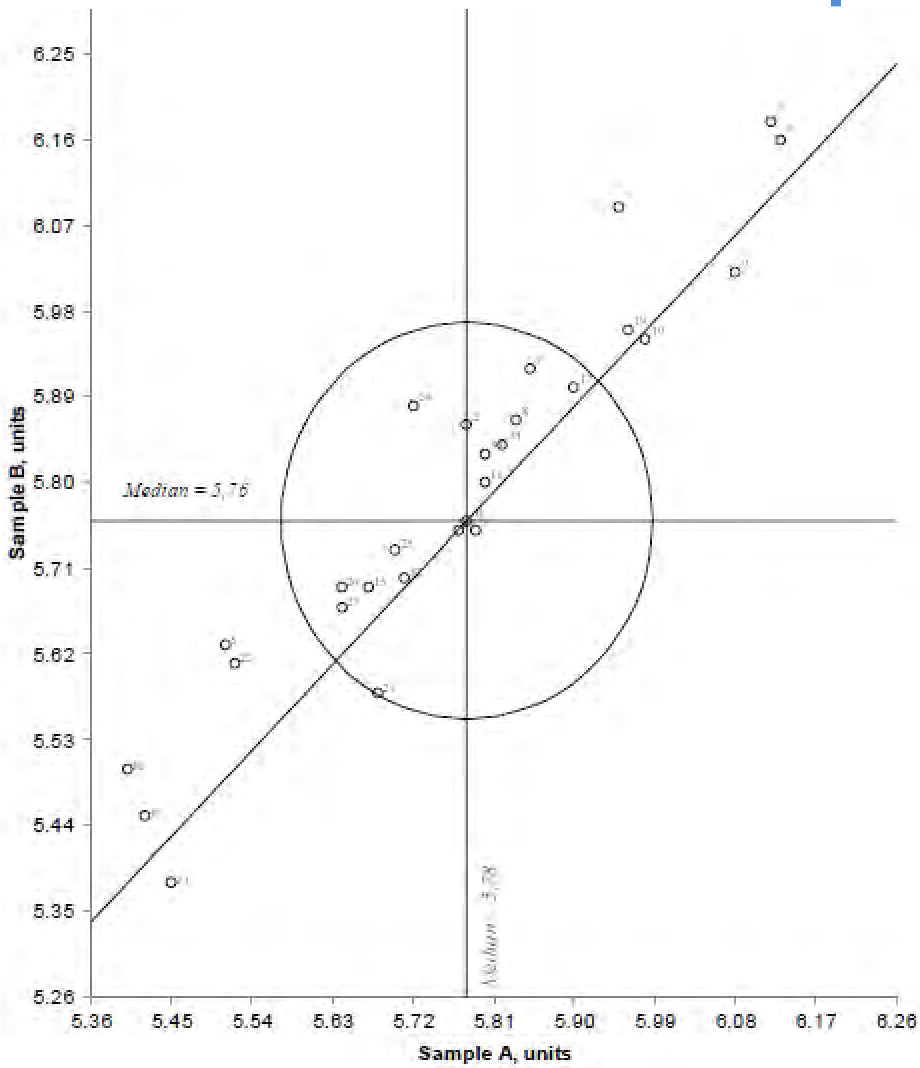
Country	No. of labs.	Country	No. of labs.
Austria	1	Netherlands	1
Belgium	2	Norway	1
Canada	1	Poland	2
Czech Republic	1	Moldova	1
Estonia	1	Russia	5
Finland	1	Serbia	1
France	1	Spain	1
Germany	6	Sweden	1
Ireland	4	Switzerland	1
Italy	2	UK	3
Lithuania	1		

Preparation of the samples

- Water from Lake Sognsvann
- Filtered (0,45 µm), stored at room temperature and equilibrated with atmosphere
- pH lowered with HCl and H_2SO_4 (sample set AB). TOC increased by adding humic acid. P was added as phytic acid.
- Sample set CD was spiked with metals and conserved (0.5 % HNO_3)

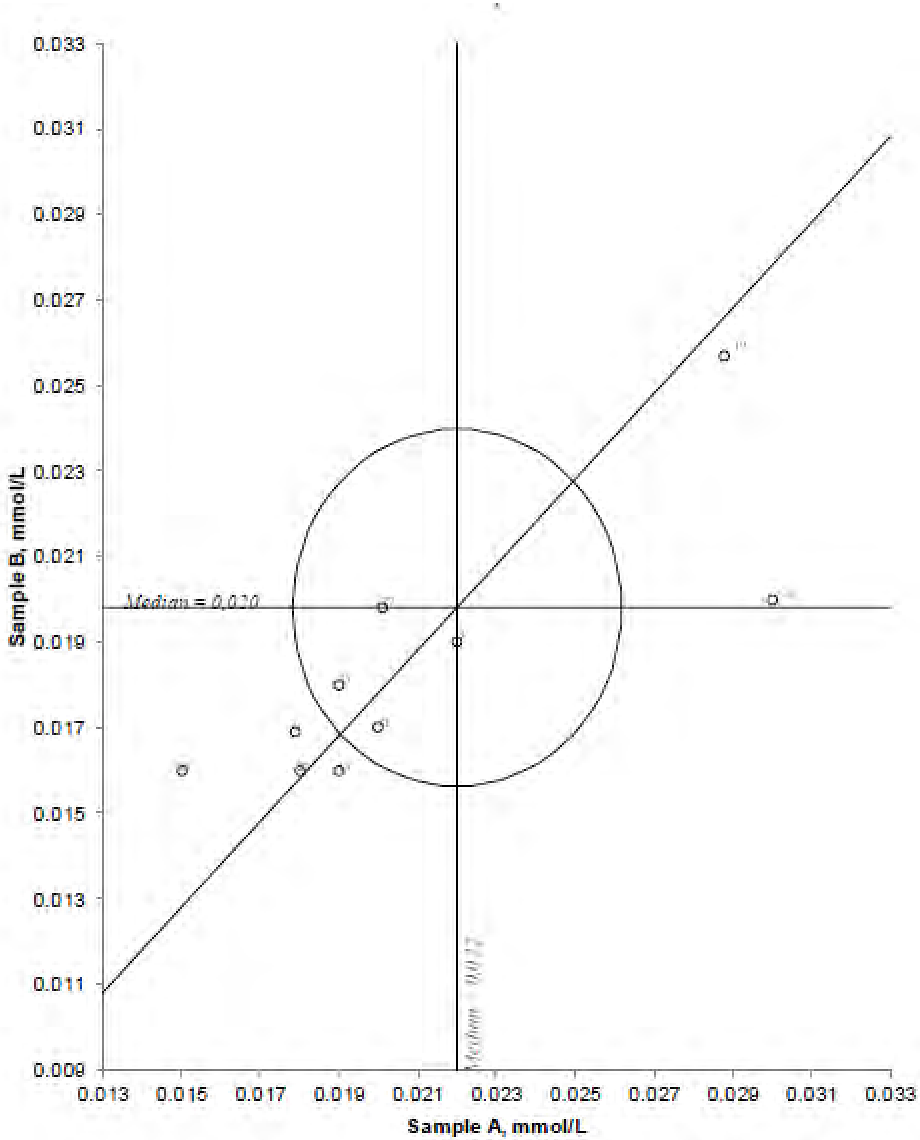
Results

pH



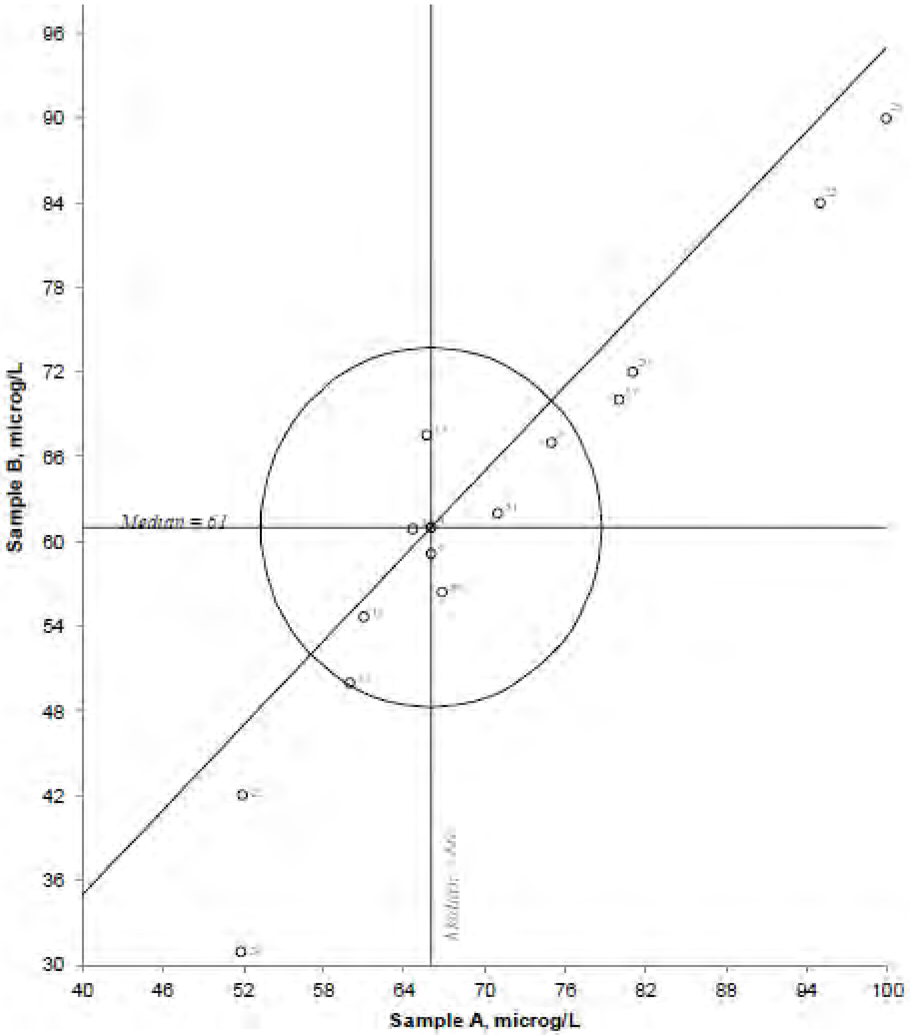
- 53 % of results were acceptable
- This is compareable to earlier results

Alkalinity



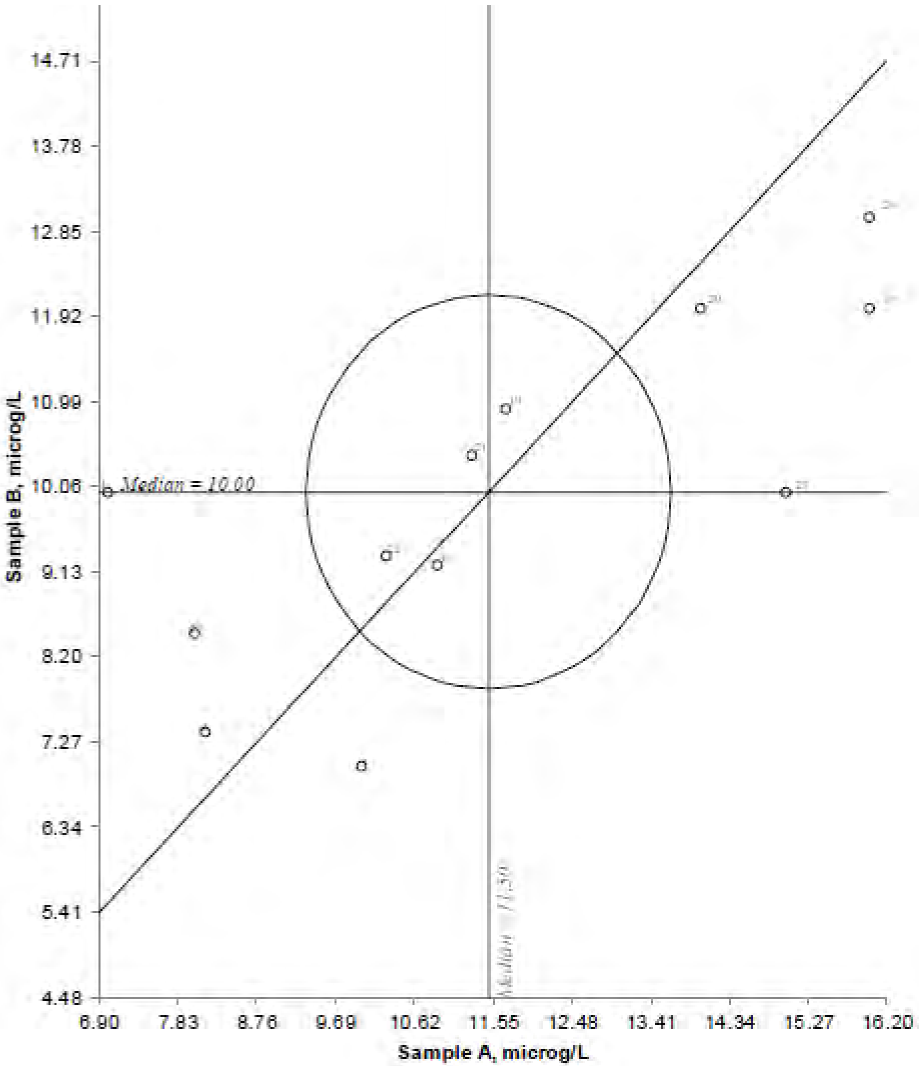
- 17 % of results were acceptable
- This is compareable to earlier results

Nitrate + nitrite



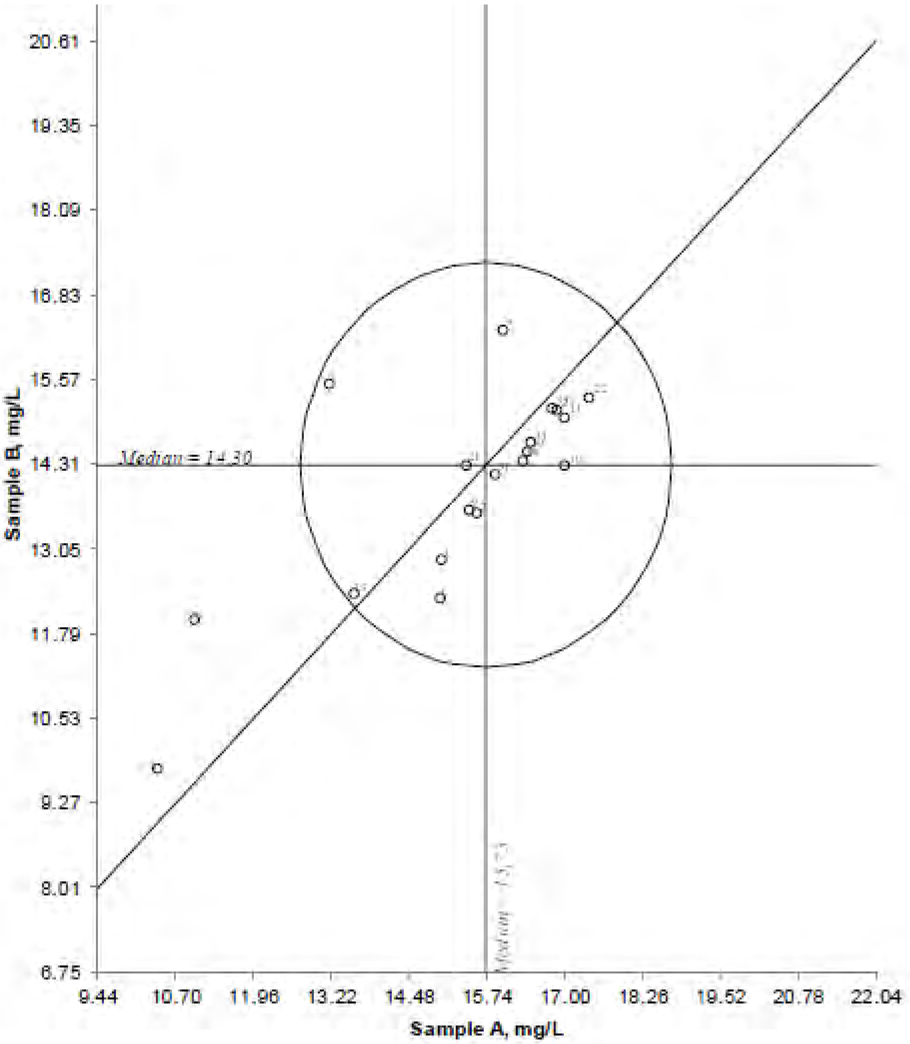
- 35 % of results were acceptable
- Percent acceptance each year depends on concentration

Total P



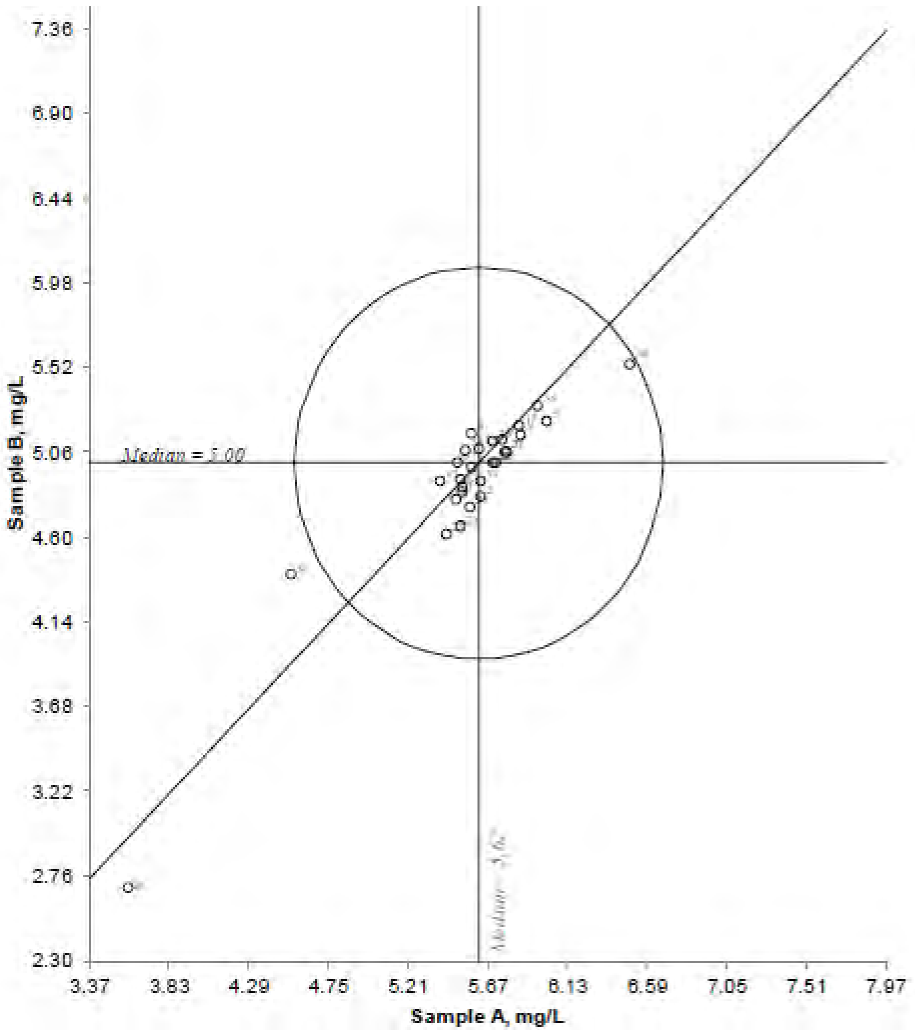
- 21 % of results were acceptable

TOC



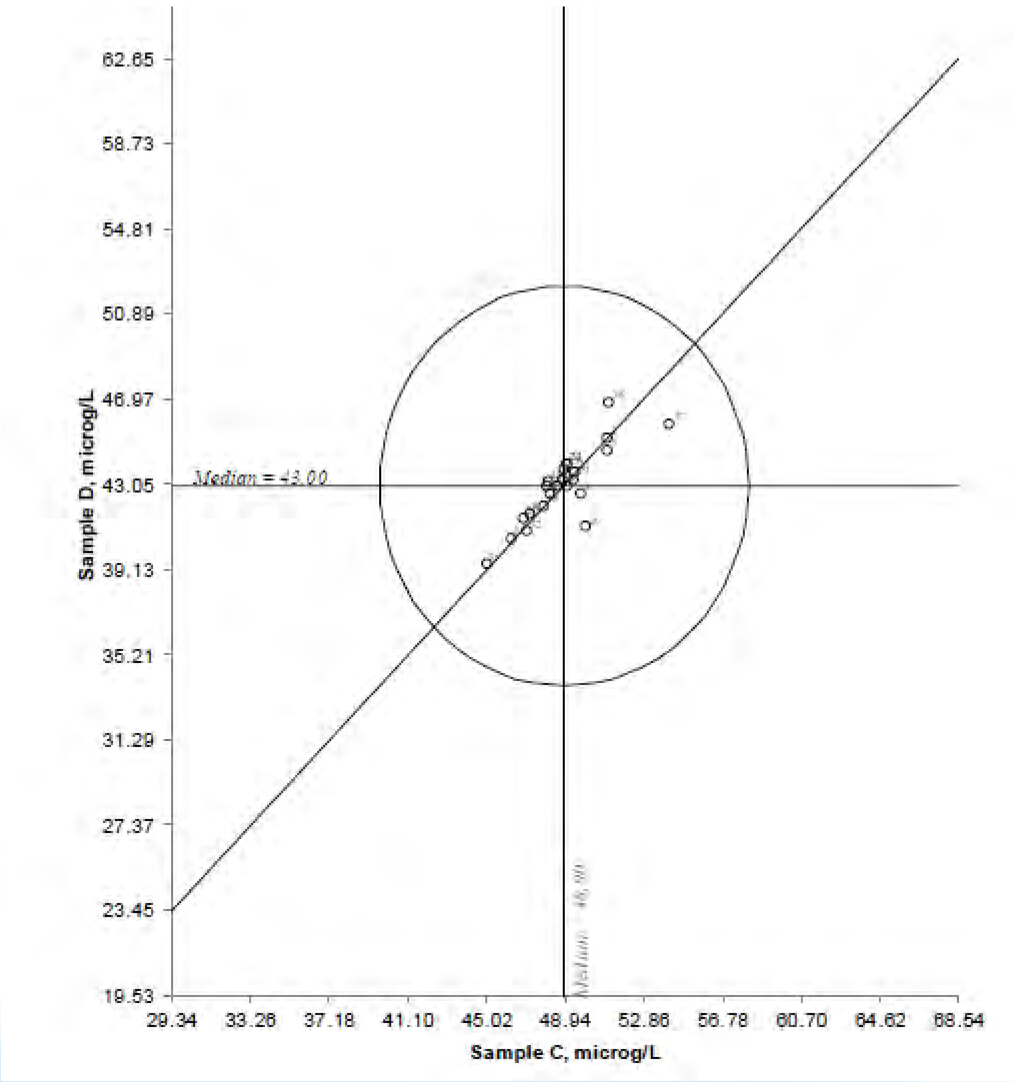
- 81 % of results were acceptable
- Same result as last year.

Sulphate



- 90 % of results were acceptable
- Similar to earlier years
- Other major ions show comparable results

Manganese



- 100 % of results were acceptable
- Good results also for other trace metals

But concentrations are very high....

Manganese,	CD	48.9	43
Cadmium,	CD	9.68	8.59
Lead,	CD	7.82	6.82
Copper,	CD	29.6	27.0
Nickel,	CD	14.3	12.7
Zinc,	CD	19.7	18.4

Conclusions

- Accuracy in determination of major ions and trace metals and TOC was very good(> 80 % had target accuracy < 20 %)
- Accuracy for pH, alkalinity NO3+NO2-N and Total P was poor (32 % or less had acceptable target accuracy)

Intercomparison 1832

- Samples have not yet been prepared
- Free for labs within UN-ECE and EECCA that deliver results to national monitoring programs. Others have to pay a minor fee
- It is still possible to participate
- Contact carlos.escudero@niva.no
- Suggestions for improvements/changes are welcome

Intercomparison 1731

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

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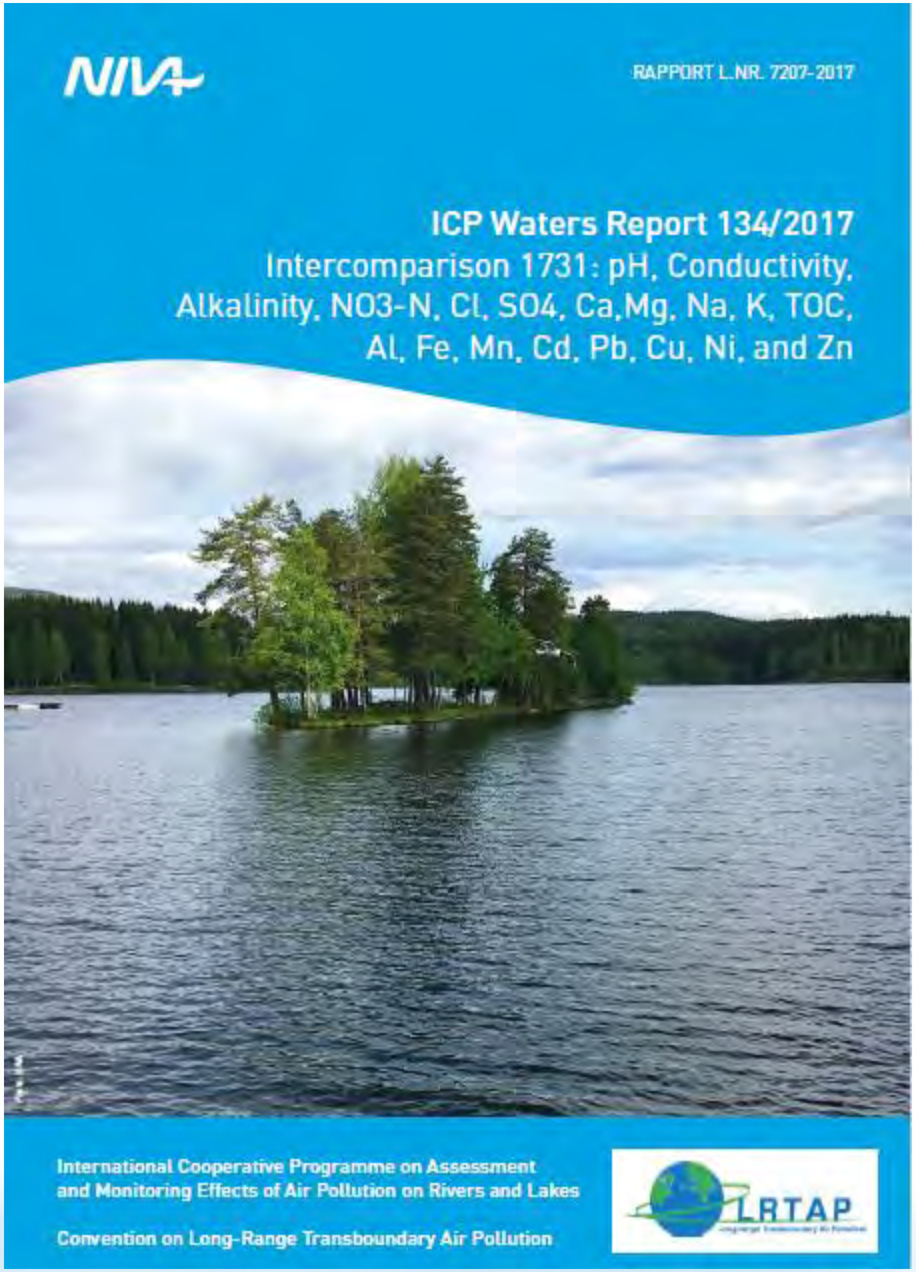

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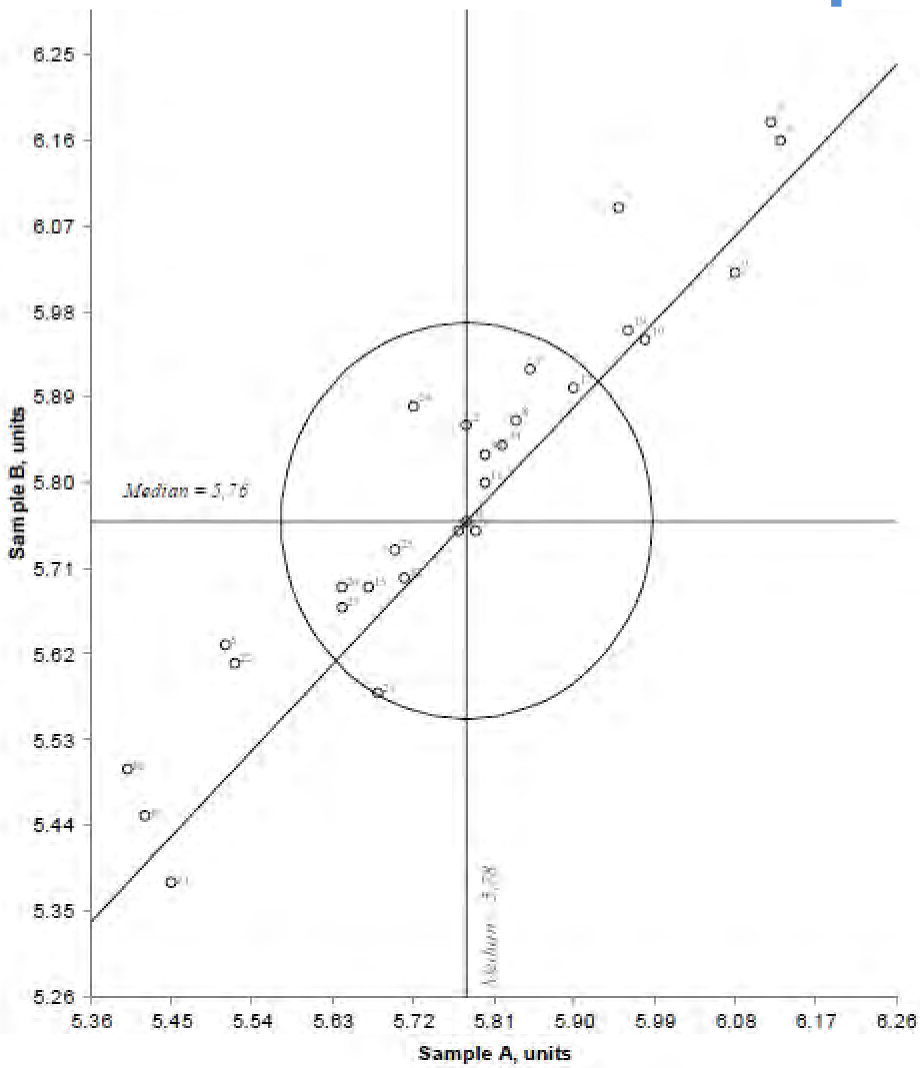
Results

pH



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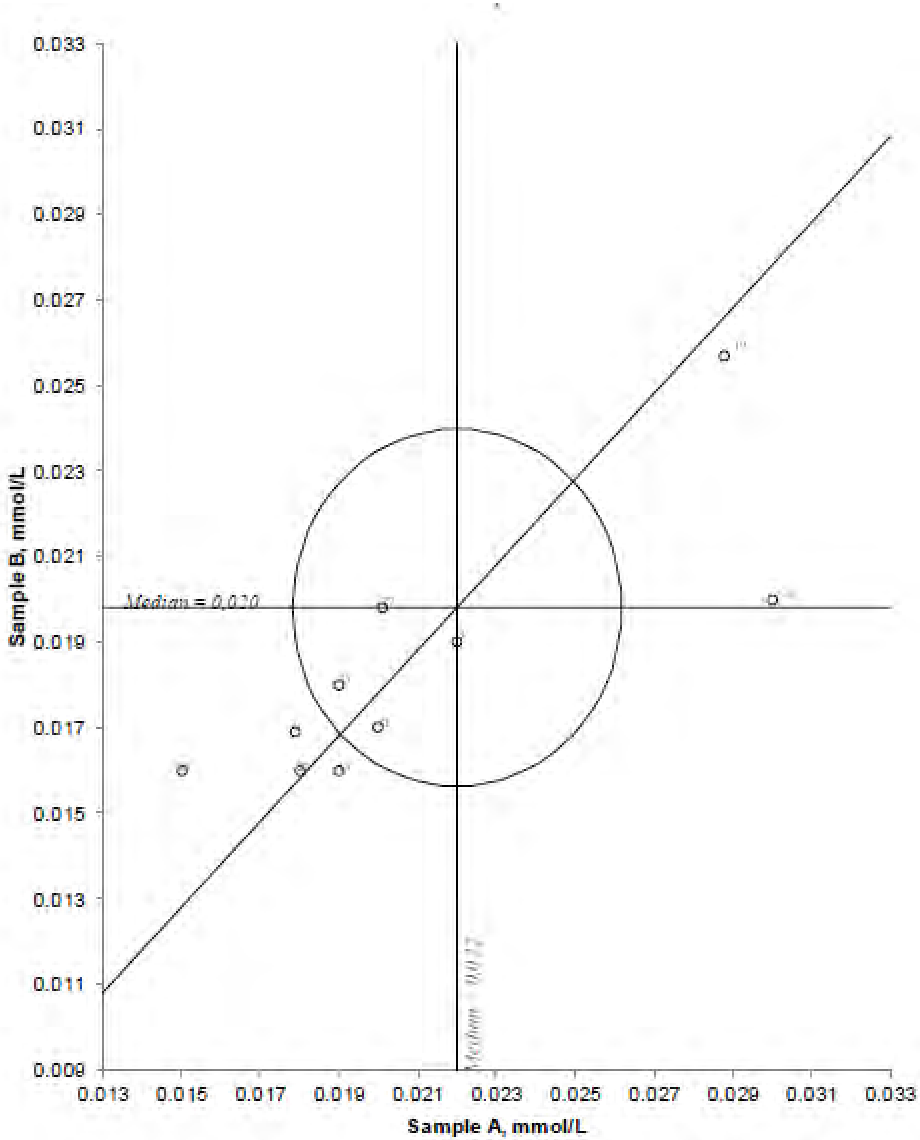
Alkalinity



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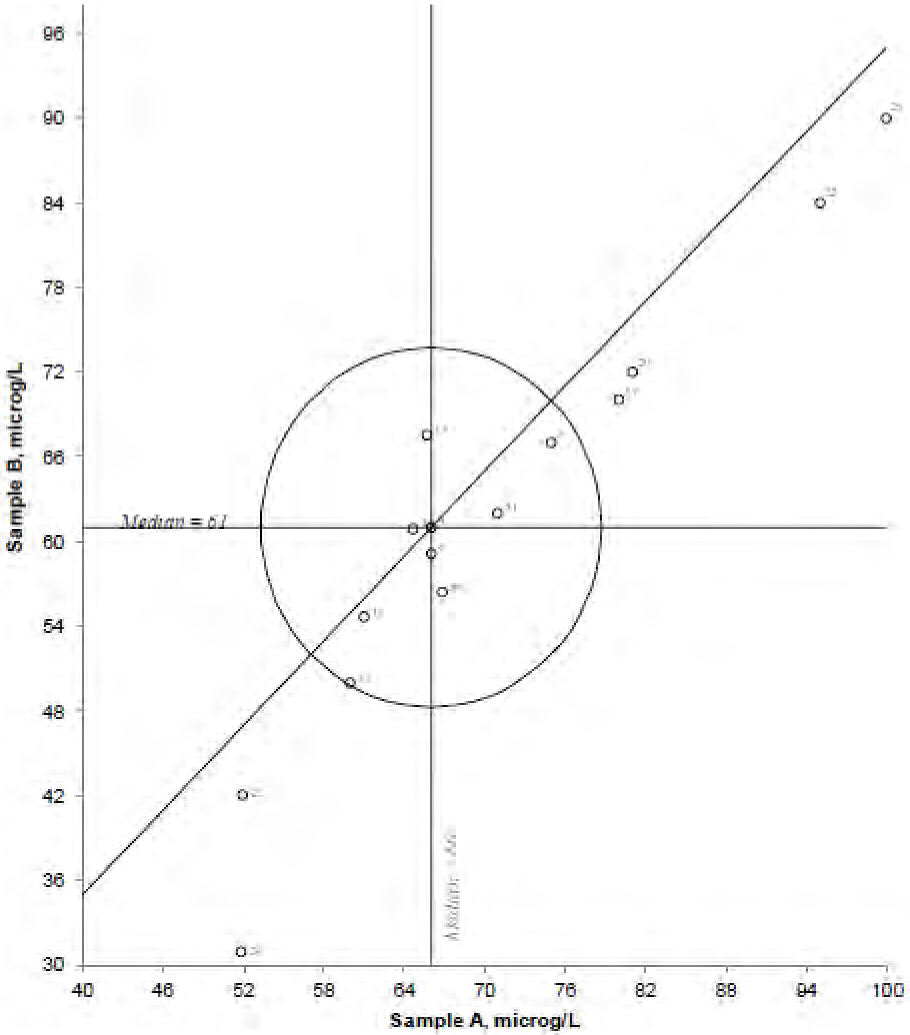
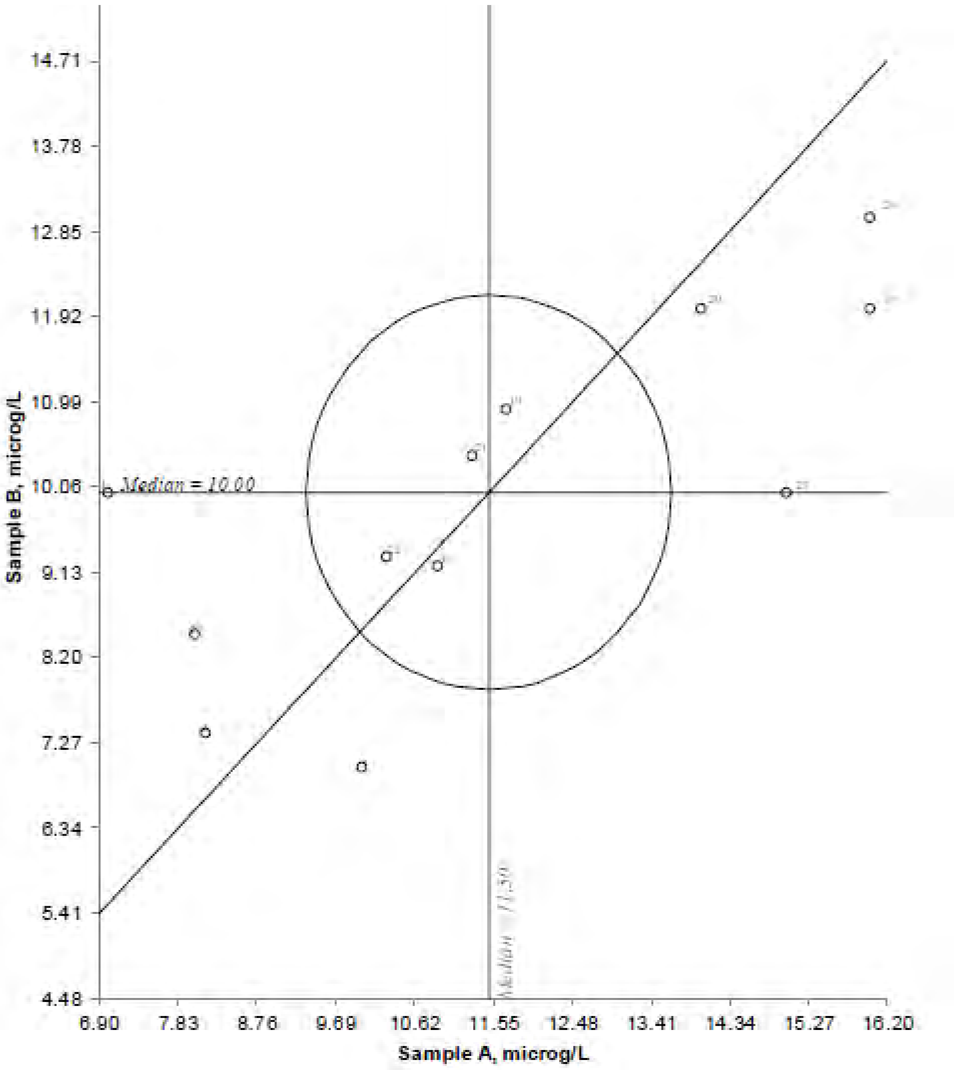
- This is compareable to earlier results

Nitrate + nitrite



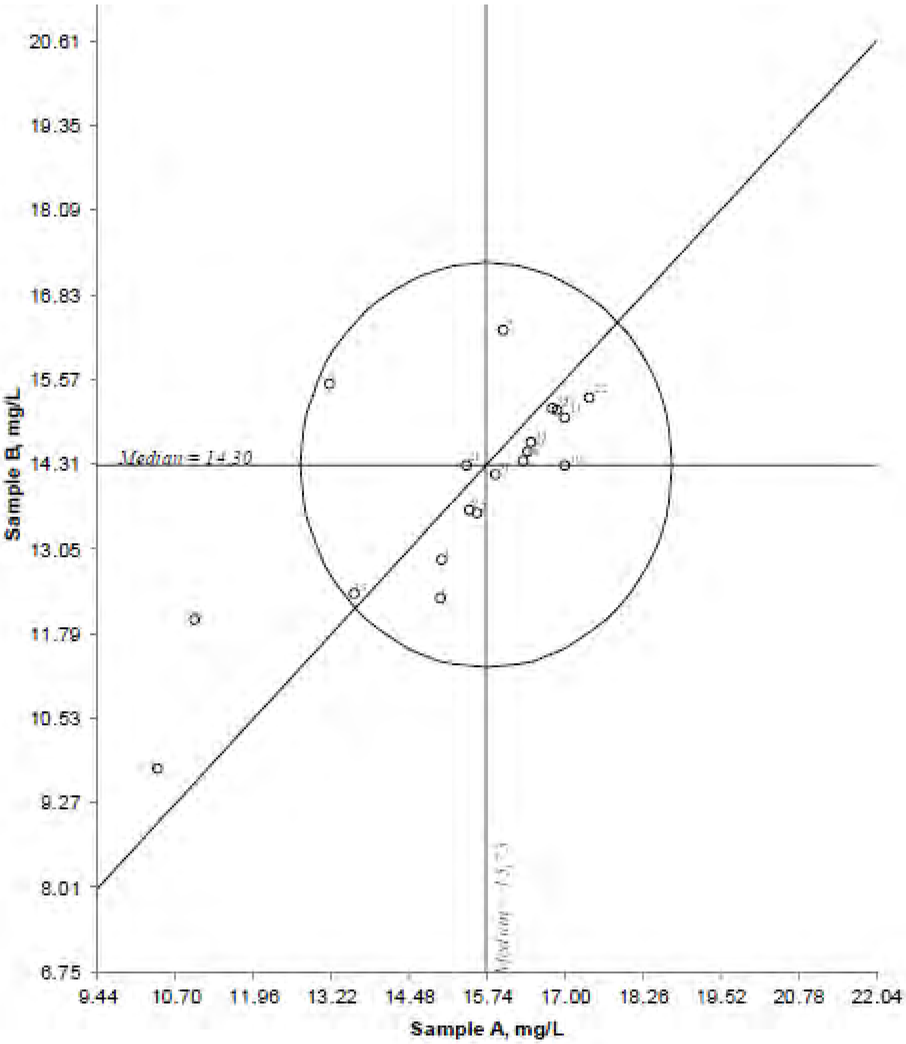
- 35 % of results were acceptable
- Percent acceptance each year depends on concentration

Total P



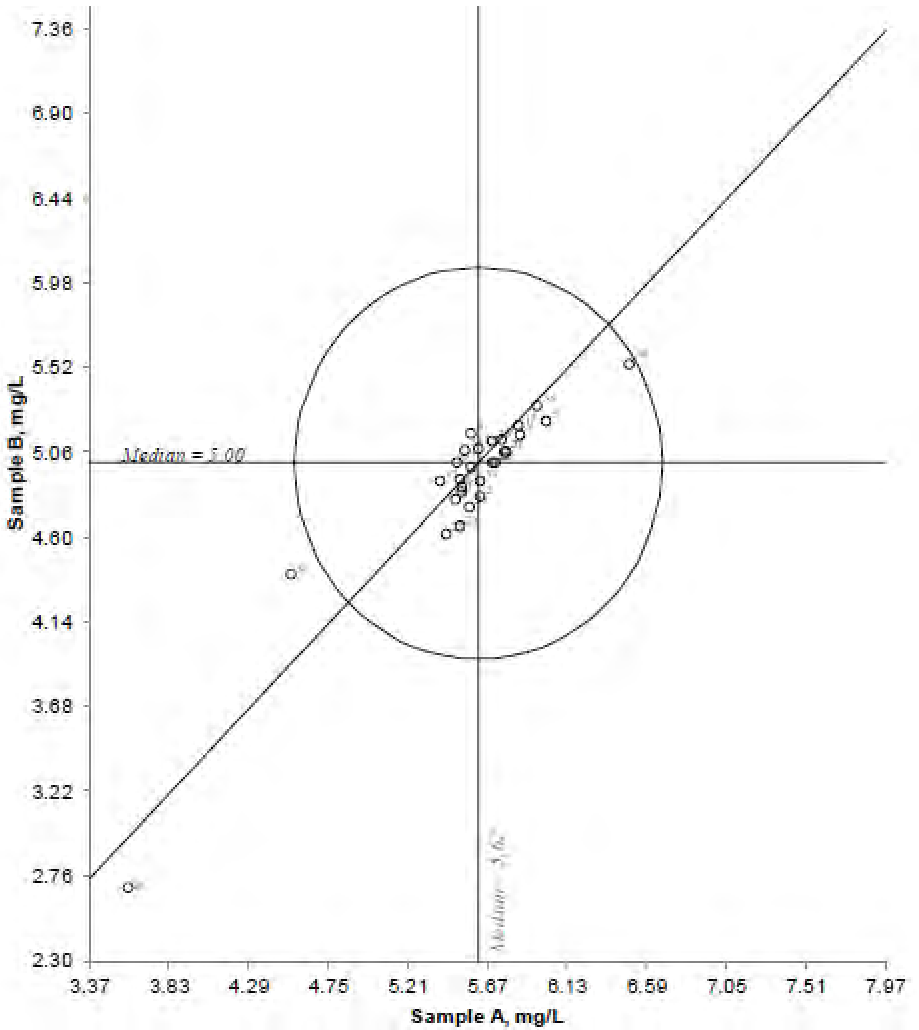
- 21 % of results were acceptable

TOC



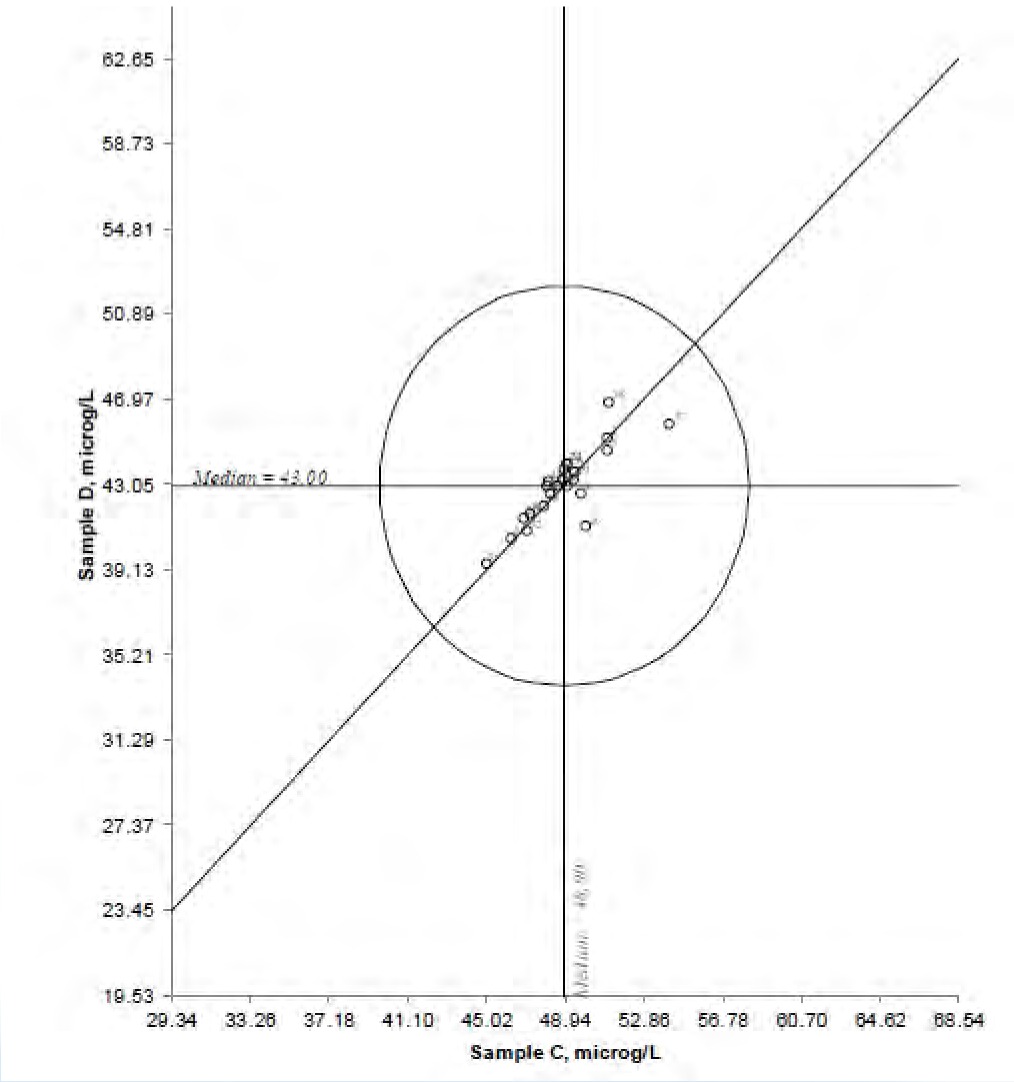
- 81 % of results were acceptable
- Same result as last year.

Sulphate



- 90 % of results were acceptable
- Similar to earlier years
- Other major ions show comparable results

Manganese



- 100 % of results were acceptable
- Good results also for other trace metals

But concentrations are very high....

Manganese,	CD	48.9	43
Cadmium,	CD	9.68	8.59
Lead,	CD	7.82	6.82
Copper,	CD	29.6	27.0
Nickel,	CD	14.3	12.7
Zinc,	CD	19.7	18.4

Conclusions

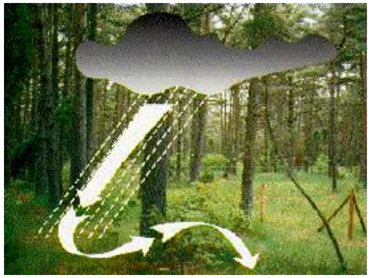
- Accuracy in determination of major ions and trace metals and TOC was very good(> 80 % had target accuracy < 20 %)
- Accuracy for pH, alkalinity NO3+NO2-N and Total P was poor (32 % or less had acceptable target accuracy)

Intercomparison 1832

- Samples have not yet been prepared
- Free for labs within UN-ECE and EECCA that deliver results to national monitoring programs. Others have to pay a minor fee
- It is still possible to participate
- Contact carlos.escudero@niva.no
- Suggestions for improvements/changes are welcome

LRTAP
Long-range Transboundary Air Pollution

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



ICP IM

Future plans

Martin Forsius

Finnish Environment Institute SYKE

NATUR VÅRDS VERKET
SWEDISH ENVIRONMENTAL PROTECTION AGENCY

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ICP IM draft work plan 2018-19

1. Reoccurring standard activities

Activity	Time frame	Responsible
ICP IM Task Force meeting 2019	tbd	IM chair and programme centre, NFP contributions
Submission of quality controlled results for year 2017	December 2018	National Focal Points
Submission of quality controlled results for year 2018	December 2019	National Focal Points
ICP IM Annual Report 2019	2019	Programme Centre in collaboration with NFPs
Reporting of ICP IM activities to WGE	2018 and 2019	Programme Centre and Chair

ICP IM draft work plan 2018-19

2. Cooperations and reports

Activity	Time frame	Responsible
Cooperation with other ICPs, particularly regarding dynamic modelling (all ICPs), cause-effect relationships in terrestrial systems (ICP Forests, ICP Vegetation), and surface waters (ICP Waters).	Tbd. TF meeting	According to decisions at the TF meeting
Cooperation with external organisations (International Long Term Ecological Research Network ILTER, GEO BON). Progress reports.	2019	Programme Centre and NFPs, eLTER EU-project activities
Develop concepts for multi pollutant – multi effect relationships (NOx, O3, acidity, heavy metals, POPs, etc). Progress reports/contributions to Annual Report OR presentations in Workshop	2019	Voluntary activities at National Focal Points
Report on dynamic modelling on the impacts of deposition and climate change scenarios on ground vegetation	2019	Programme Centre and NFPs of Austria and Sweden

ICP IM draft work plan 2018-19

3. Scientific papers

Activity	Time frame	Responsible
Scientific paper on dynamic modelling on the impacts of future deposition scenarios on soil and water conditions in ICP IM catchments (in review)	2018	Programme Centre and NFPs
Scientific paper on the relationship between critical load exceedances and empirical ecosystem impact indicators	2019	Programme Centre and NFPs of Austria and Sweden
Scientific paper on HM trends in concentrations and fluxes across ICP IM sites in Europe, cooperation with ICP Waters	2019	Programme Centre and individual researchers
Scientific paper on the impacts of catchment characteristics, climate and hydrology on N processes	2019	Programme Centre and individual researchers

LRTAP
Long-range Transboundary Air Pollution

wge
Working Group on Effects
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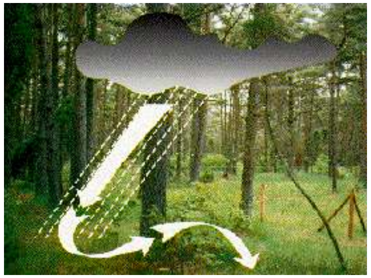

Scientific Strategy ICP IM

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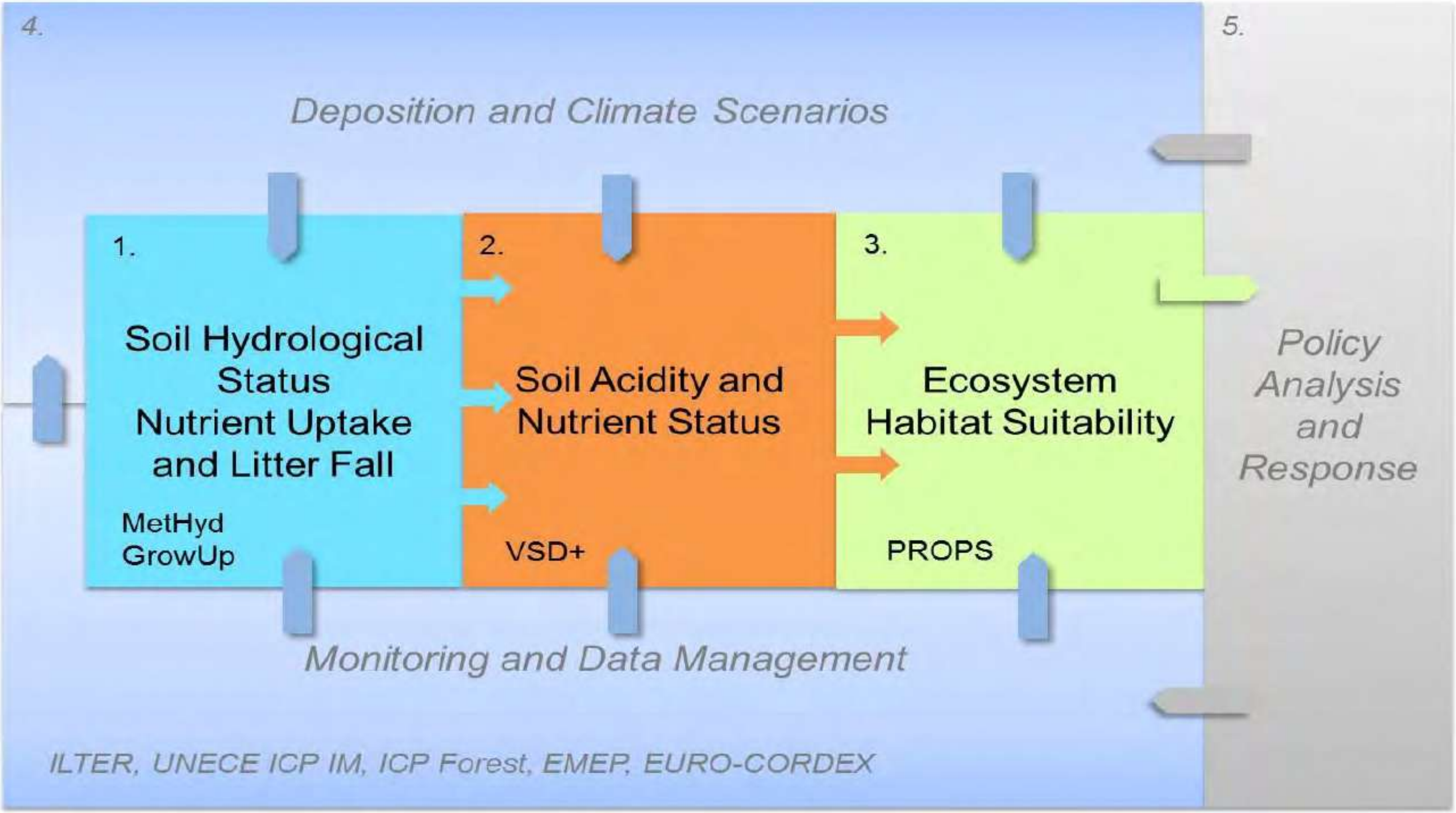
Highlights of proposed updates to the long-term strategy for the Convention on Long-range Transboundary Air Pollution

Ozone-nitrogen-climate-biodiversity interactions; para. 24



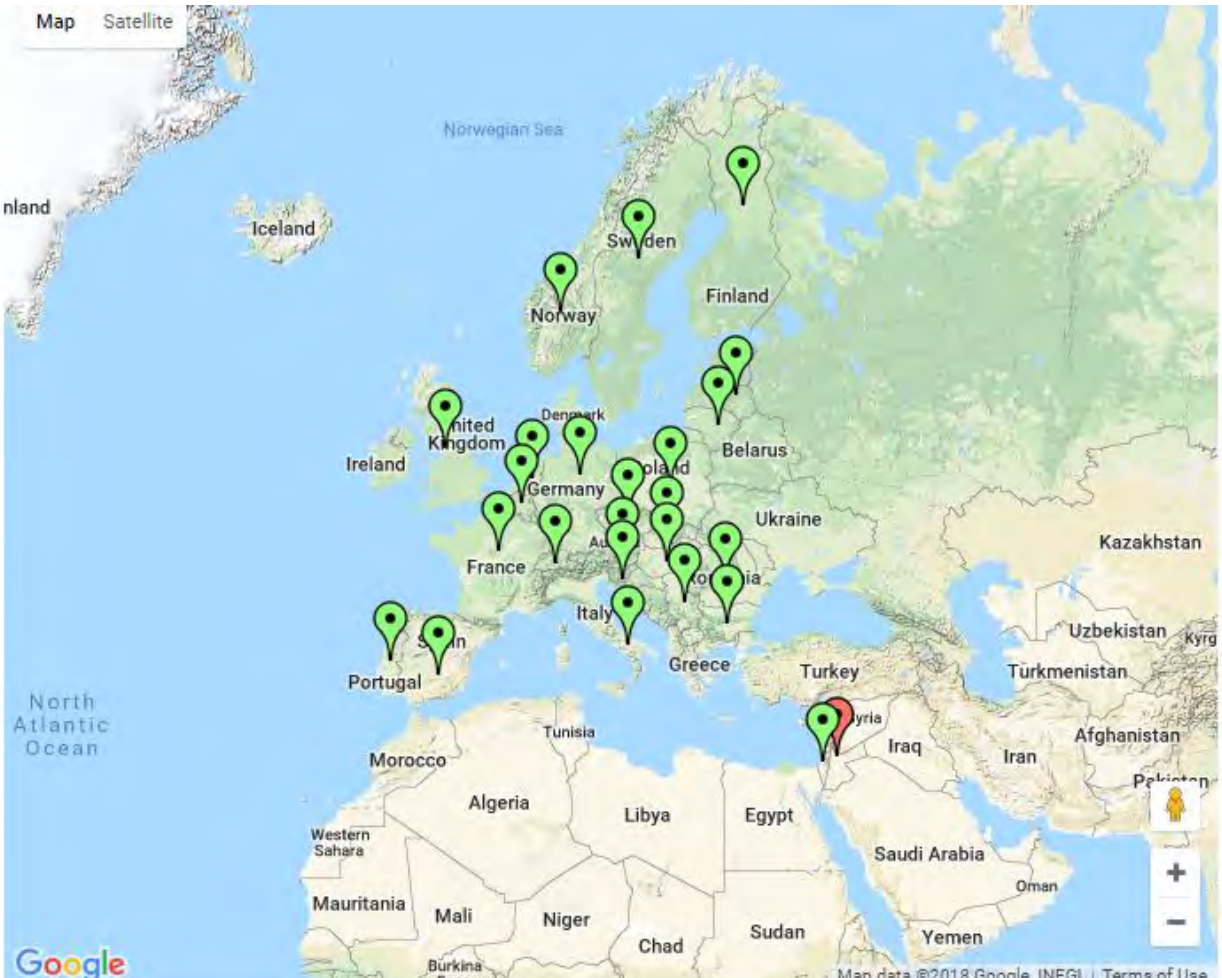
Holmberg et al, under review

Highlights of proposed updates to the long-term strategy for the Convention on Long-range Transboundary Air Pollution

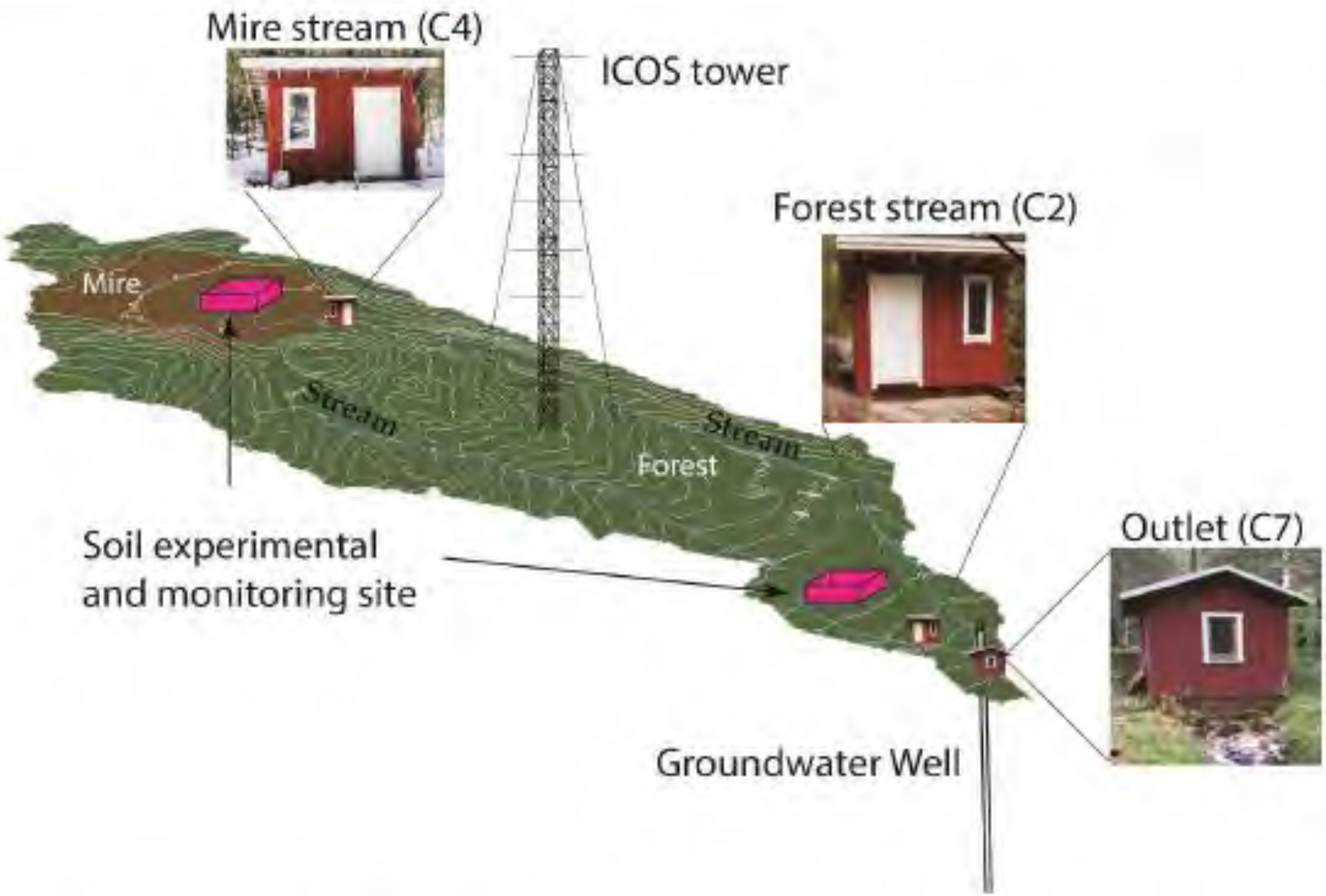
… It is recommended that the work under the Convention take every opportunity to make monitoring networks serve multiple clients (national and international)

para. 28

most IM sites part of the LTER network



The Svartberget Catchment



Above: The Svartberget catchment (C7) is the centre of Krycklan

ICP IM provided expertise and handbook

Ecosystem monitoring under Article 9 and Annex V of Directive 2016/2284 (NECD)

Draft Guidance

ICP IM and Waters provided data for Minimata convention

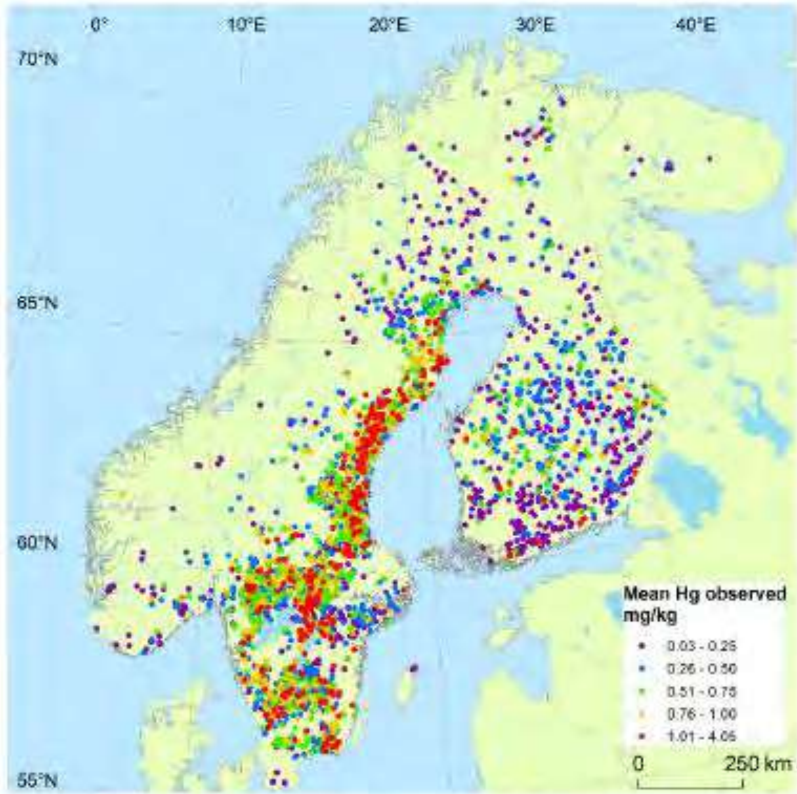


Figure 12 Median observed fish Hg concentrations per lake in the complete data set (1965-2015). Measurements are grouped based on concentration levels and include all the five main fish species, Arctic charr, brown trout, perch, pike and roach.

ICP waters report 132-2017

1. Opening of the 26th ICP IM Task Force
2. Approval of the agenda
3. Approval of minutes from 25th IM TF

4: Activities during 2017/18

- IM represented at 11 international meetings
- PC contributed to 2017 Joint WGE report
- 2 scientific papers
- Contribution to joint report on Hg
- IM participated in a joint coordinated exercise on dynamic modelling together with other ICPs

5: Work plan and future work priorities

a) Reports to be prepared /finalized in 2018/19

b) Co-operation with other ICP:s and organisations: e.g. LTER-Europe

c) Ongoing and future research projects and cooperation

d) General discussion: Future work under the Convention (Salar Valinia)

5a. Reports to be prepared /finalized in 2018/19

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

2019:

- Report on dynamic modelling on the impacts of deposition and climate change scenarios on ground vegetation.
- Scientific paper on the relationship between critical load exceedance and empirical ecosystem impact indicators

5b. Cooperation with other ICP:s and organisations

- The EU NEC directive
- UNECE activities
- LTER-Europe
- Participation in the European biodiversity monitoring system

- Initiatives from all ICP:s!

5c. Future projects and cooperation

The meeting is expected to discuss:

- inclusion of new tasks in the short-term or more long-term work-plan
- the role of ICP IM in relation to multi-effects evaluations and global change related topics, and how this work should be coordinated
- how IM can make further use of EMEP data

5d. General discussion:

Integrated environmental policy (5,6,7)

– Continue developing the multi-effect, multi-pollutant framework
– Ozone-nitrogen-climate-biodiversity interactions
- Further science and policy work is needed
- Communicate and cooperate with climate, biodiversity policies

Comparing WP and LTS

PRG recommendations

- Airborne effects of HMs and POPs, taking into account work under related global conventions *(4)*
- Empirical ecosystem **research on dose-response** functions for ozone and nitrogen *(6)*
- Which links between climate change, carbon and nitrogen biogeochemistry and POP/HM biogeochemistry are most policy relevant *(7)*

Our WP

- 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 hydro meteorological conditions.
- Scientific paper on dynamic modelling on the impacts of future deposition scenarios on soil and water conditions in ICP IM catchments.
- 2019:
- Report on dynamic modelling on the impacts of deposition and climate change scenarios on ground vegetation.
- Scientific paper on the relationship between critical load exceedance and empirical ecosystem impact indicators

Discussion

- Does we fullfil the recommendations from the PRG?
- Any ideas on relevant topics to put in our WP?
- Any ideas for cooperation with other ICP to adress issues related to biodiversity etc?

6. Financing/external applications

- Financed via national contributions and the Trust Fund.
- Some key actions of the EU Horizon 2020 framework programme are open for research proposals.
- The NFPs may report on any progress in this field.

7. Data submission and database status

Will be reported by Sirpa Klemola

8. Next task Force meeting

Main issue for ICP IM Task Force is if we want to continue to have joint TF meetings with ICP Waters.

If yes, decision on location will be taken by the joint meeting

9. Other business

10. End of meeting

IM data submission and database status

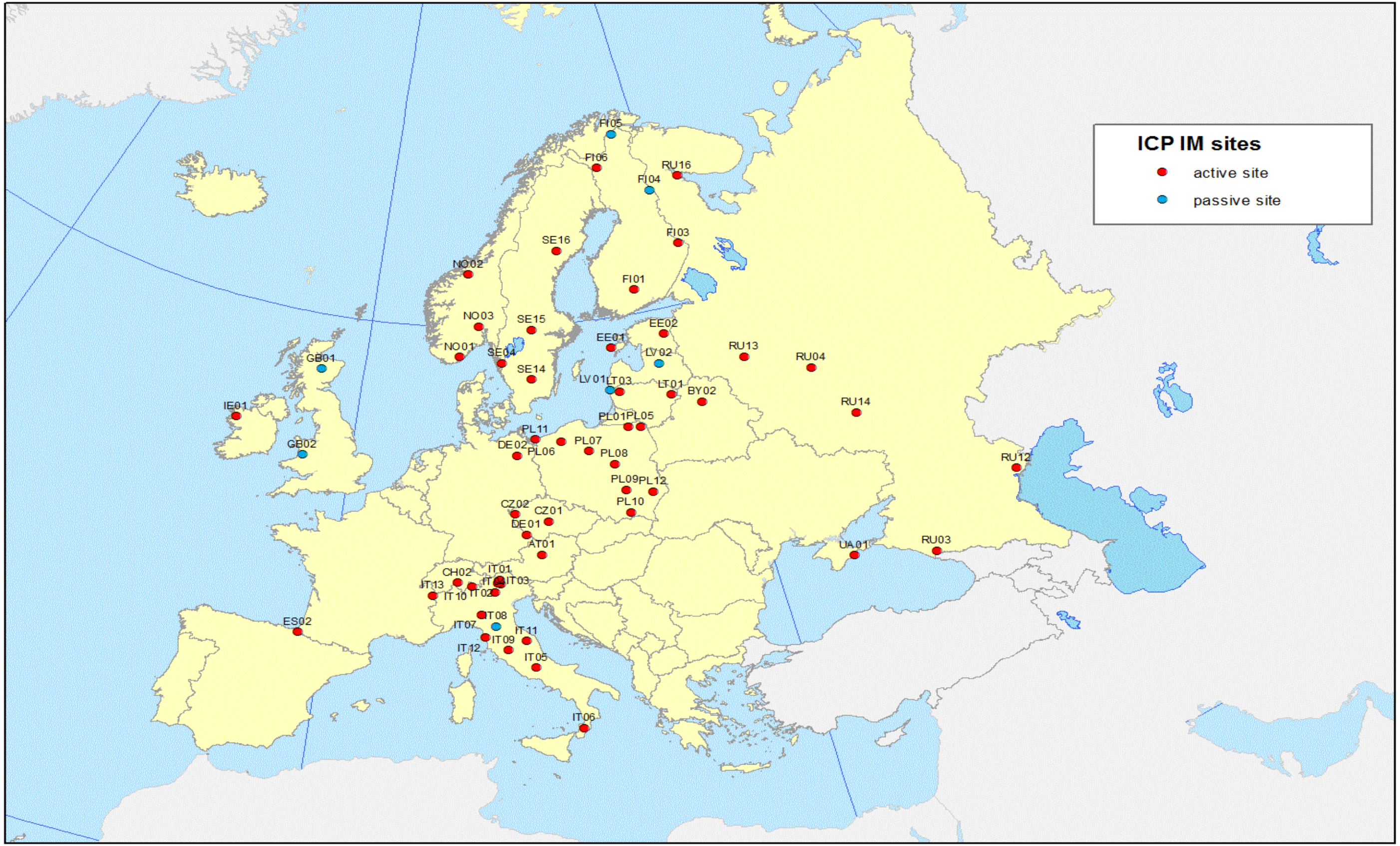
Sirpa Kleemola, SYKE
ICP IM Task Force meeting
7-9 May 2018, Warsaw, Poland

SYKE

ICP IM network

- data submission for at least part of the ‘data period’ 2012–2016: Austria, Belarus, the Czech Republic, Estonia, Finland, Germany, Ireland, Italy, Lithuania, Norway, Poland, the Russian Federation, Spain, Sweden, Switzerland and site on Crimean peninsula.
- Poland has included several sites to the network, part of the data is not yet stored.
- Total 44 sites from 16 countries.
  - Canada, Latvia and United Kingdom have not reported data for recent years

SYKE


ICP IM sites
active site
passive site
FI05
FI06
RU16
FI04
FI03
FI01
SE16
NO02
NO03
SE15
NO01
SE04
SE14
GB01
EE02
EE01
LV02
LV01
LT03
LT01
BY02
RU13
RU04
RU14
RU12
IE01
GB02
PL01
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PL10
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DE01
AT01
CH02
IT01
IT03
IT13
IT10
IT02
IT08
IT07
IT11
IT09
IT12
IT05
IT06
ES02
UA01
RU03

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Data reported in 2017/2018
- for data year 2016

- 14 countries have reported 2016 data so far
  - Austria, the Czech Republic, Estonia, Finland, Germany, Ireland, Italy, Lithuania, Norway, Poland, the Russian Federation, Spain, Sweden, Switzerland.
  - Some sites/subprogrammes missing from above mentioned countries
- For details please see Draft Annual Report 2018

SYKE

Data reporting in 2018

- Deadline 1st of December 2018 for 2017 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_2017.txt or FI01_RW_2017.xls

SYKE

Thank you for your attention!