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

Update 2017: preliminary results

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

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

LRTAP Long-range Transboundary Air Pollution

eLTER H2020

SYKE

Previous study at ICP IM sites

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

SYKE

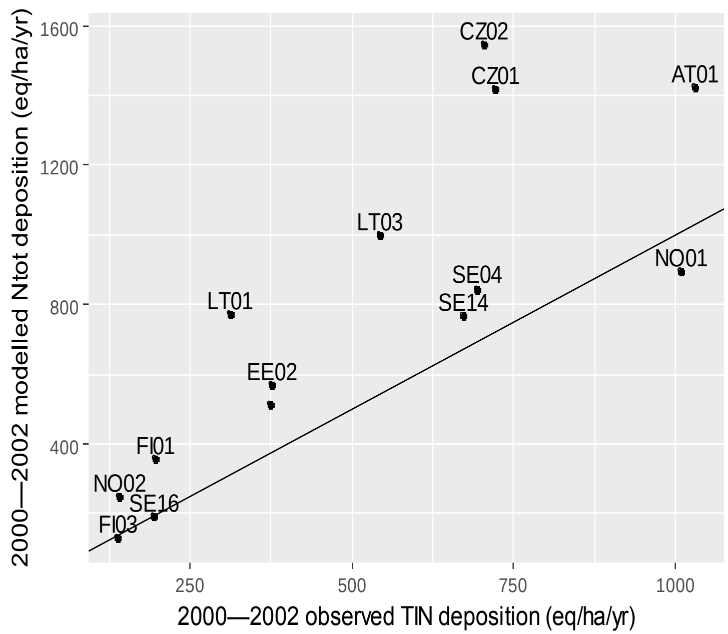
Material and methods

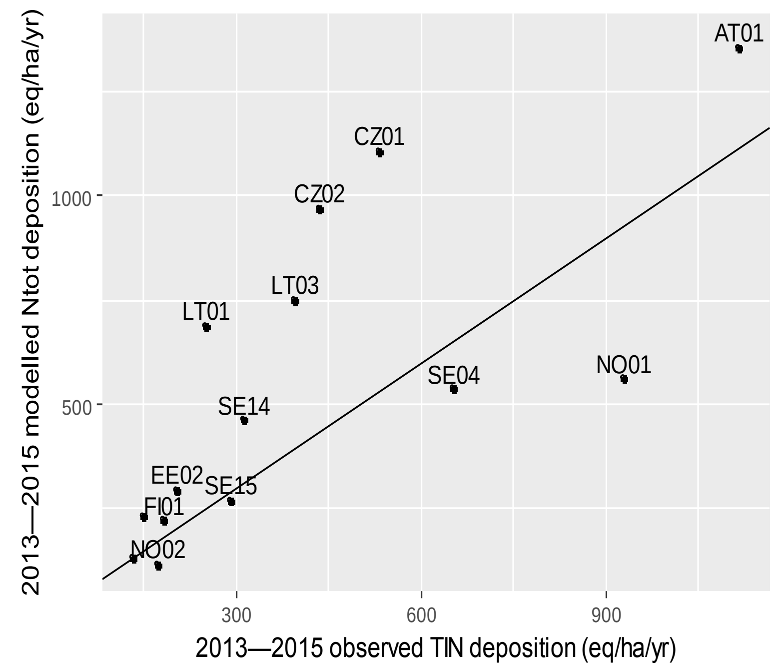
- Previous study with modelled N deposition data of 2000 and empirical TIN data of 2000-2002 **was revisited with new data on modelled N deposition (2010) and empirical TIN RW (2013-2015)**.
- Critical loads for eutrophication, their exceedances and concentrations and fluxes of total inorganic nitrogen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

SYKE

N in deposition #1.

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

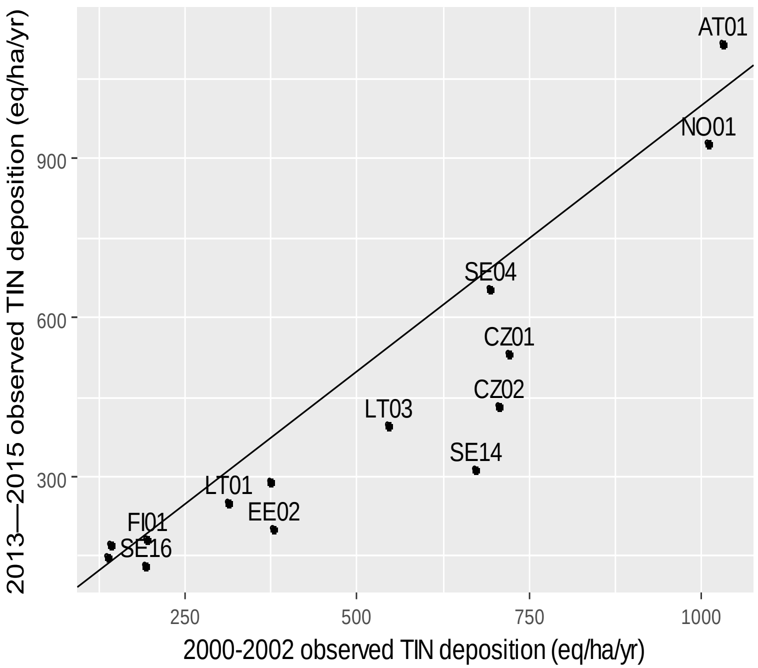


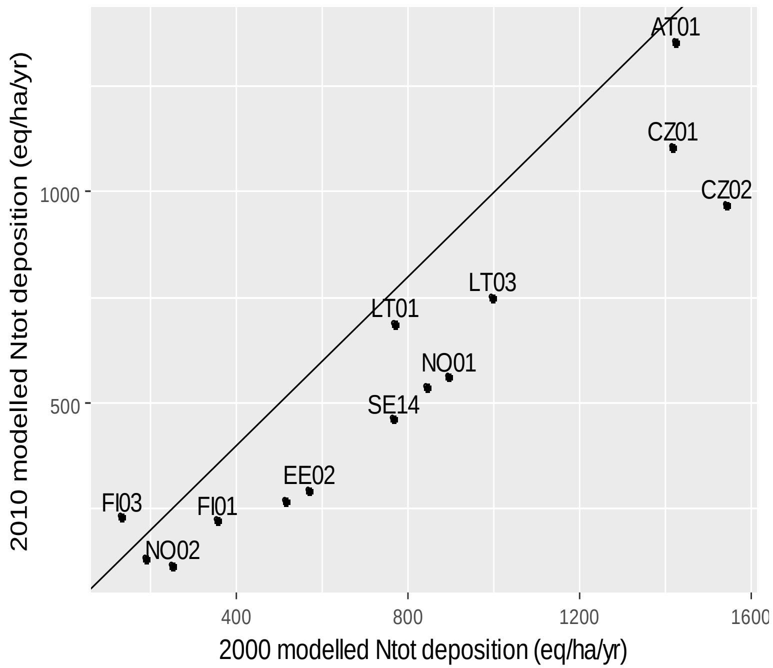


For most sites, the modelled N deposition > observed flux in bulk deposition

N in deposition #2.

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



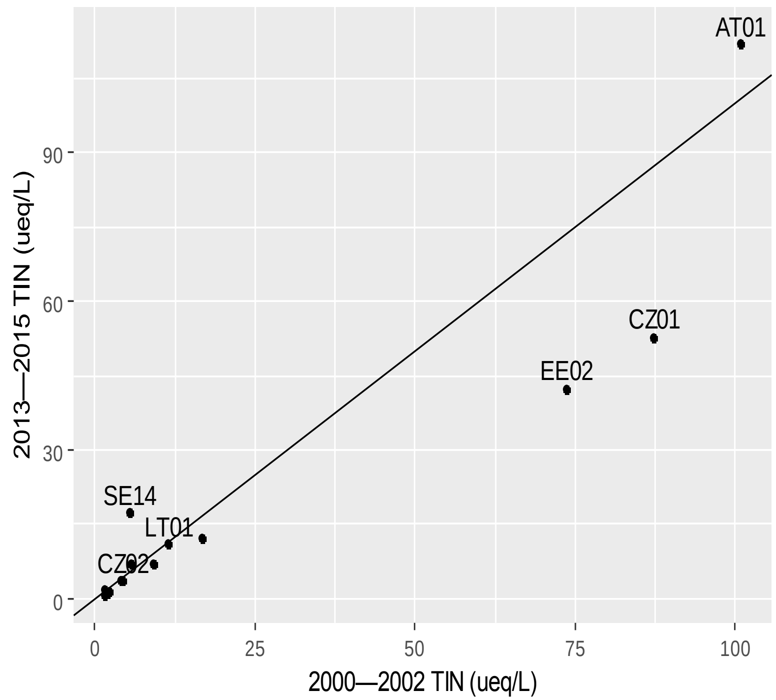


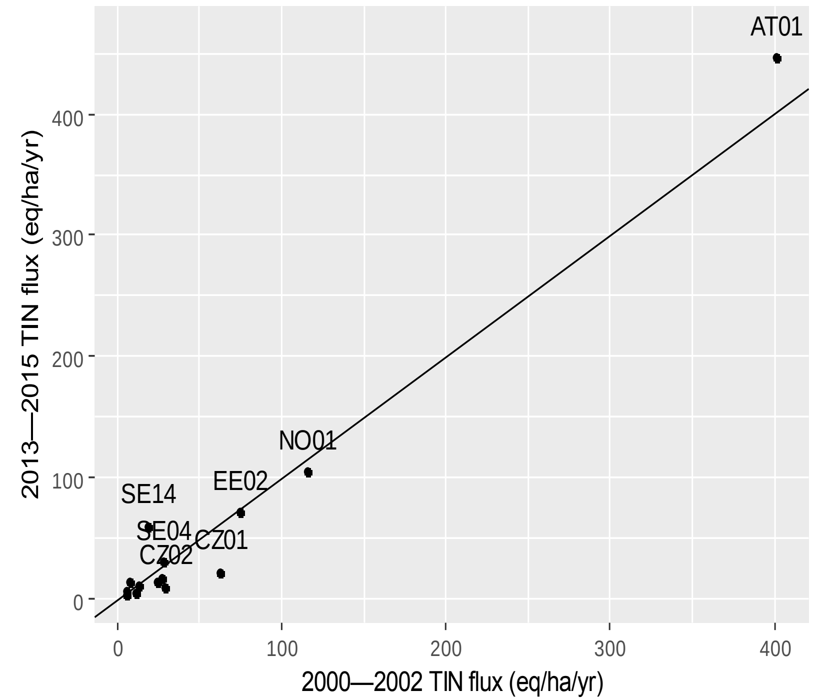
Both the observed and the modelled estimates for N input to the sites have decreased for almost all sites between the two observation periods.

SYKE

N in runoff #1

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





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

SYKE

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

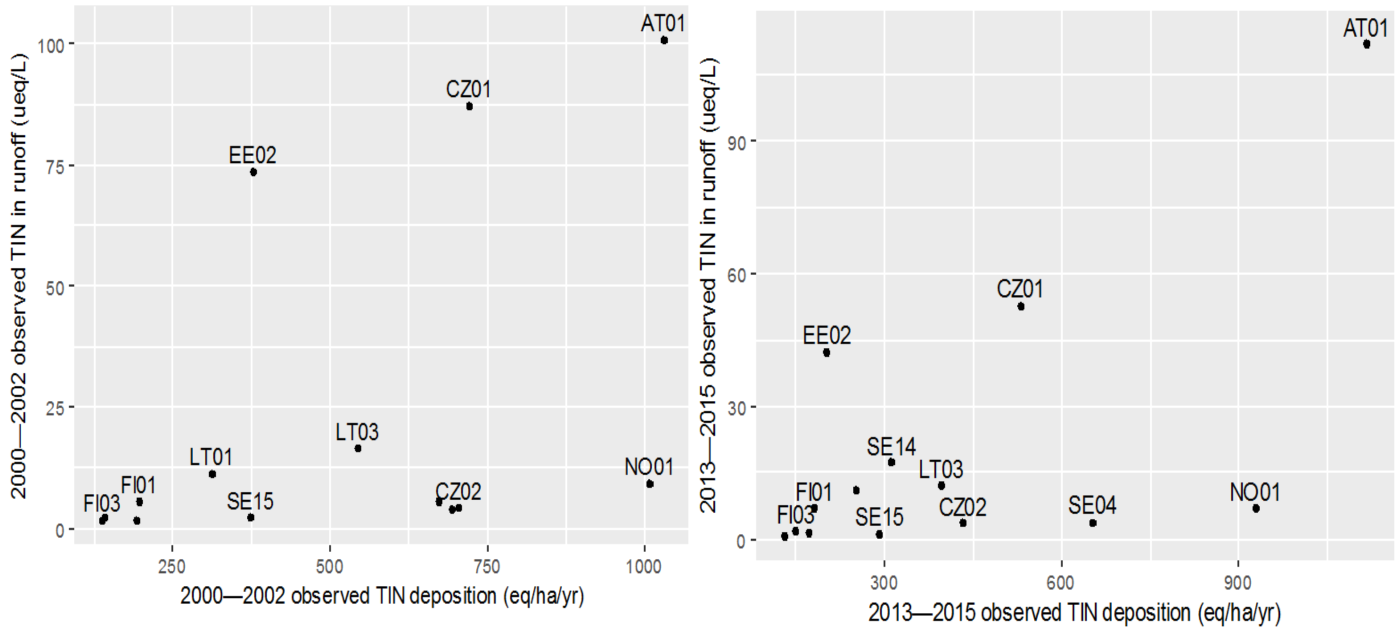
Country	IM Site code	Site	TIN conc. (µeq L^{-1}) 2000-2002	TIN flux (eq ha^{-1} yr^{-1}) 2000-2002	Ntot dep. (eq ha^{-1} yr^{-1}) (modelled) 2000	ExCLnutN (eq ha^{-1} yr^{-1}) 2000	TIN conc. (µeq L^{-1}) 2013-2015	TIN flux (eq ha^{-1}yr^{-1}) 2013-2015	Ntot dep. (eq ha^{-1} yr^{-1}) (modelled) 2010	ExCLnutN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

No change or increased, decreased

SYKE

N in runoff #2

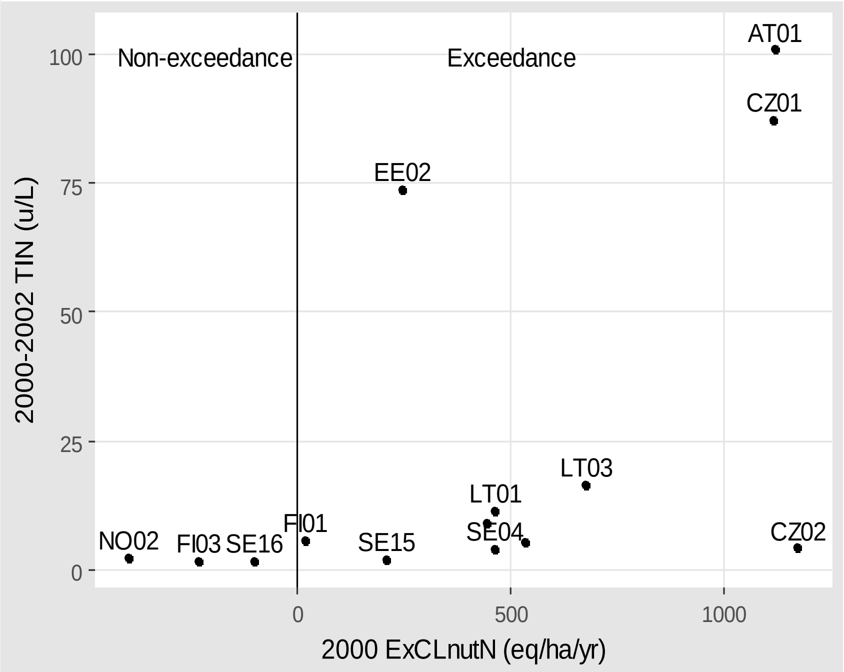
The observed concentration of TIN in runoff (y-axis) versus the observed deposition flux of TIN (x-axis). Period 2000 – 2002 in left panel, period 2013 – 2015 in right panel.

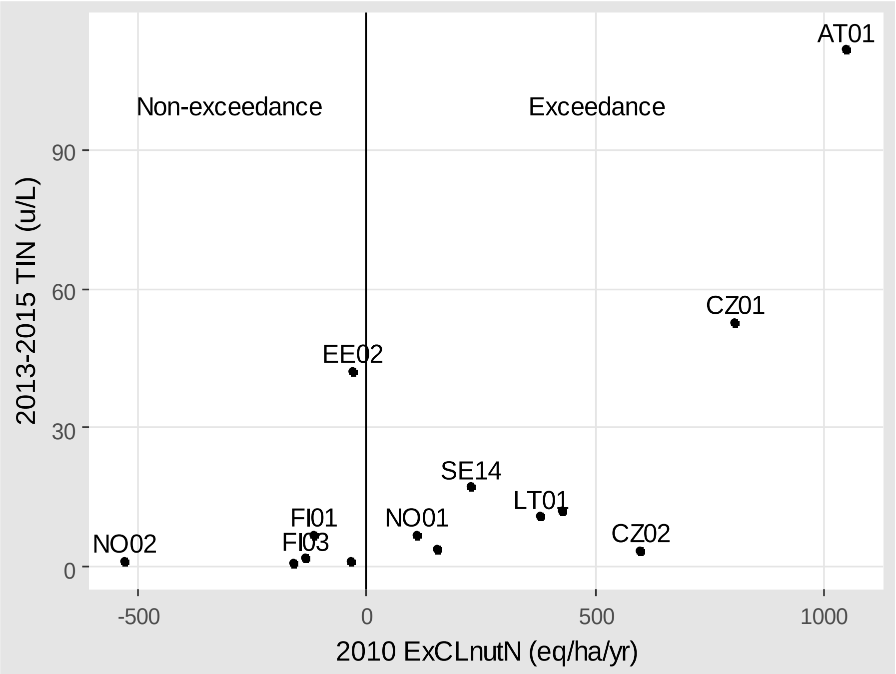


In general, concentrations of TIN in output increase with increasing TIN deposition

SYKE

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



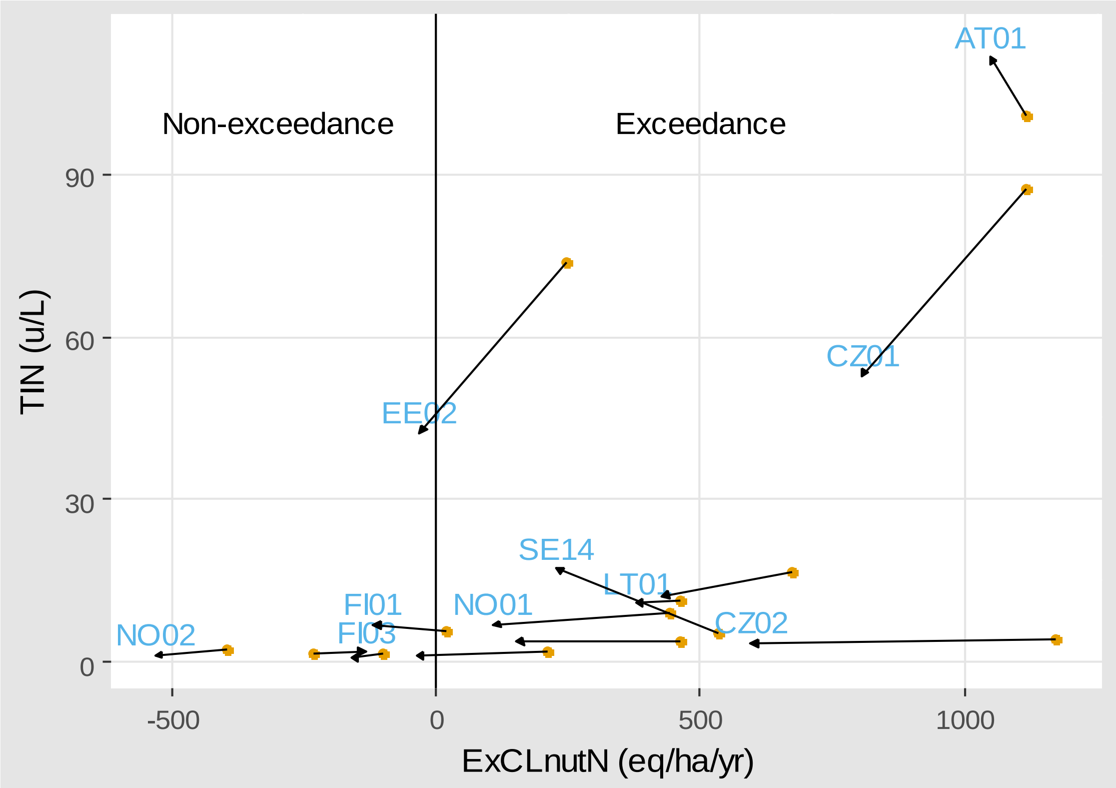


SYKE

CLnutN exceeded -> higher TIN concentrations in runoff

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

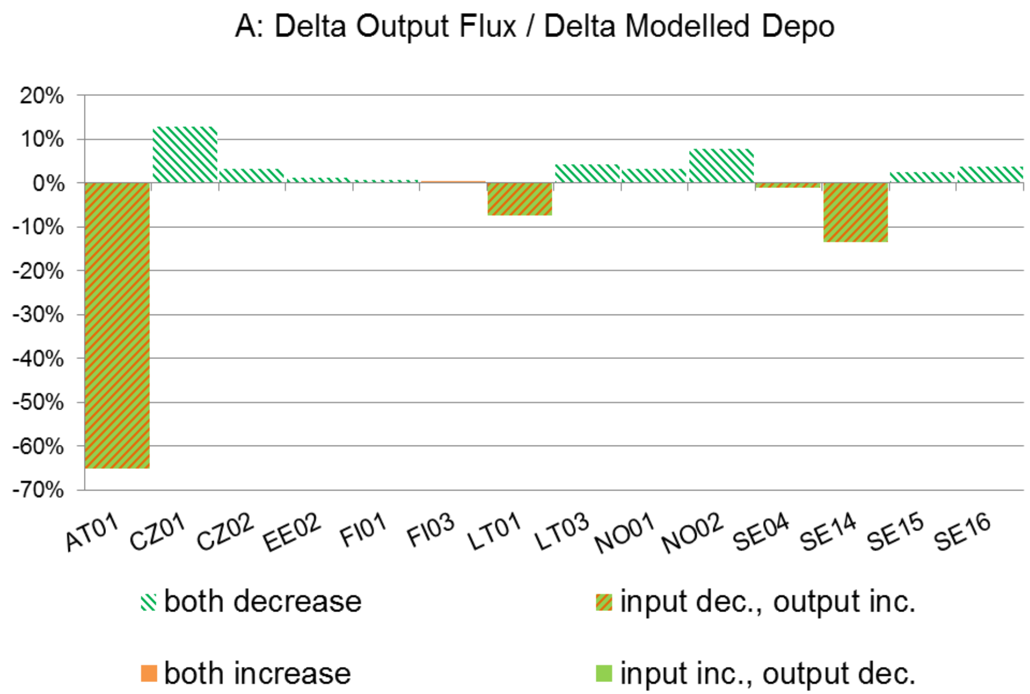
The arrows begin at the locations of the data points for the period 2000-2002 and end at the locations of the data points for the period 2013–2015.



Shift towards less exceedance and lower TIN concentrations in runoff

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

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



SYKE

To summarize...

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

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

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

SYKE

Thank you

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

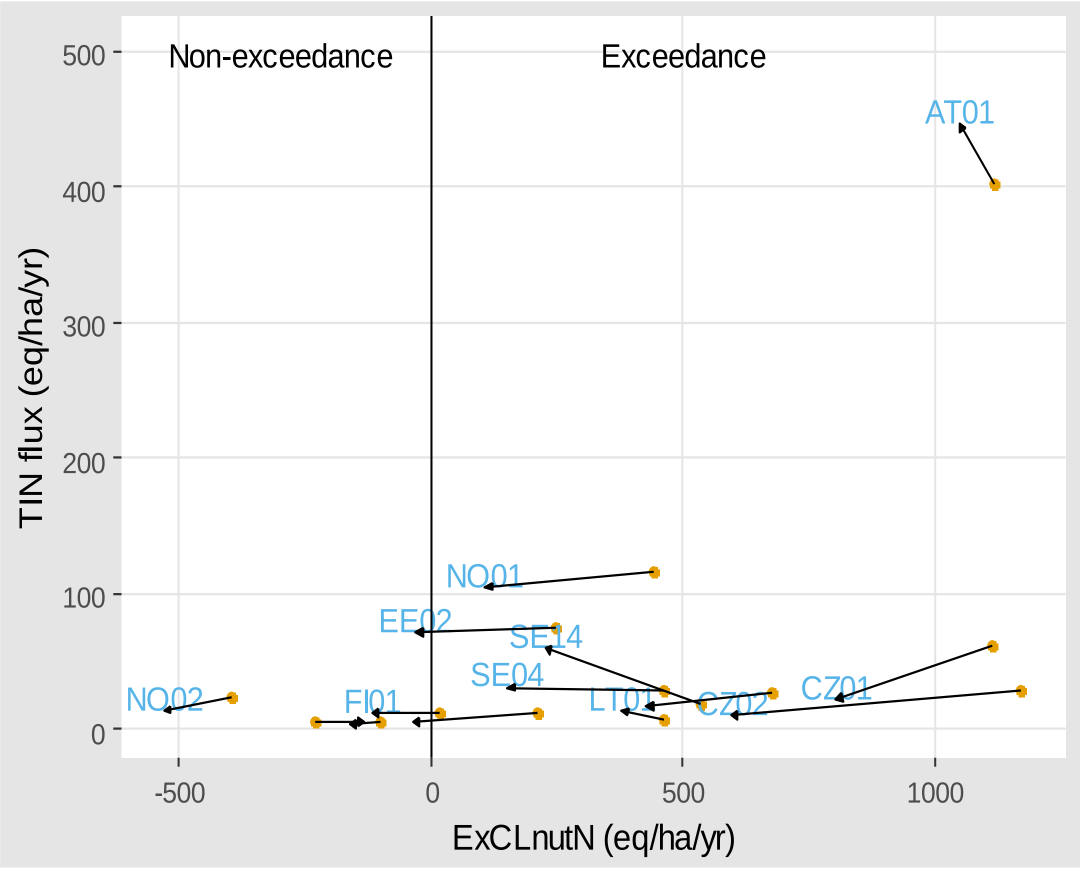


Figure 5b. The observed flux of TIN in runoff (y-axis) versus the calculated exceedance of critical loads of nutrient N (x-axis), using modelled deposition values. The arrows begin at the locations of the data points for the period 2000–2002 and end at the locations of the data points for the period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

S Y K E

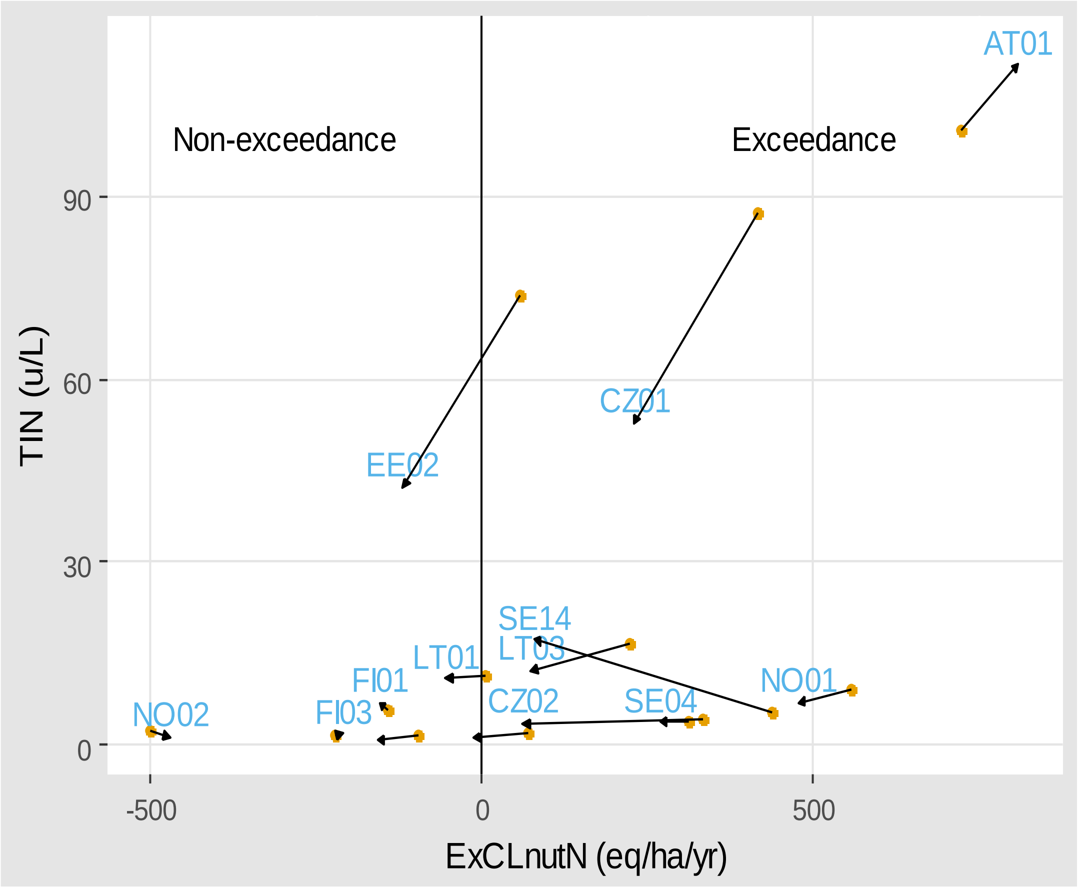


Figure 5c. The observed concentration of TIN in runoff (y-axis) versus the calculated exceedance of critical loads of nutrient N (x-axis), using observed input fluxes for deposition values. The arrows begin at the locations of the data points for the period 2000–2002 and end at the locations of the data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

SYKE

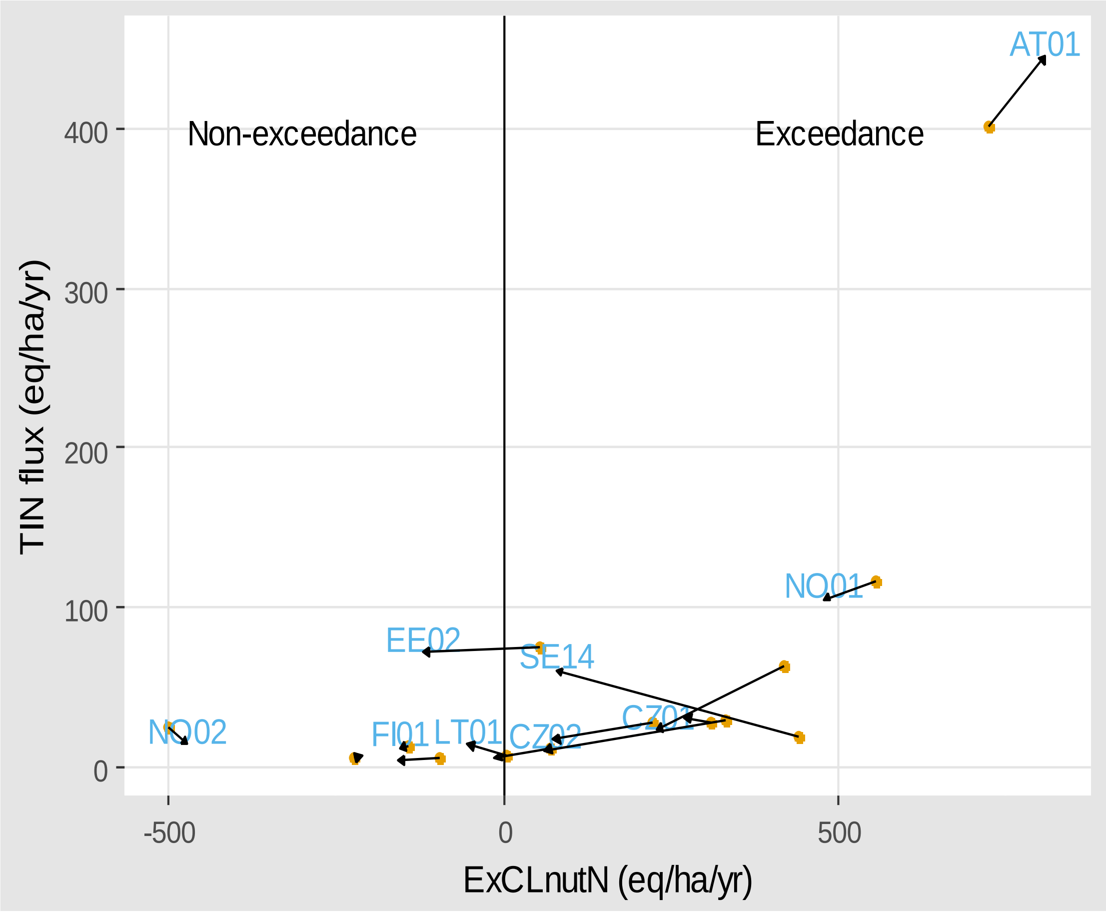


Figure 5d. The observed flux of TIN in runoff (y-axis) versus the calculated exceedance of critical loads of nutrient N (x-axis), using observed input fluxes for deposition values. The arrows begin at the locations of the data points for the period 2000–2002 and end at the locations of the data points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

SYKE