A proxy for nitrogen concentrations in Danish streams around year 1900

Brian Kronvang, Mette Vodder Carstensen, Søren E. Larsen,
Henrik Tornbjerg, Gitte Blicher-Mathiesen, Jens Bøgestrand, Hans
Thodsen og Jørgen Windolf

AARHUS
UNIVERSITY
DCE - NATIONAL CENTRE FOR ENVIRONMENT AND ENERGY

YEAR 1900 WORKSHOP
15. NOVEMBER 2016

Setting the scene

In Denmark we are lacking data from measurements of nitrogen concentrations in Danish streams for the period around year 1900.

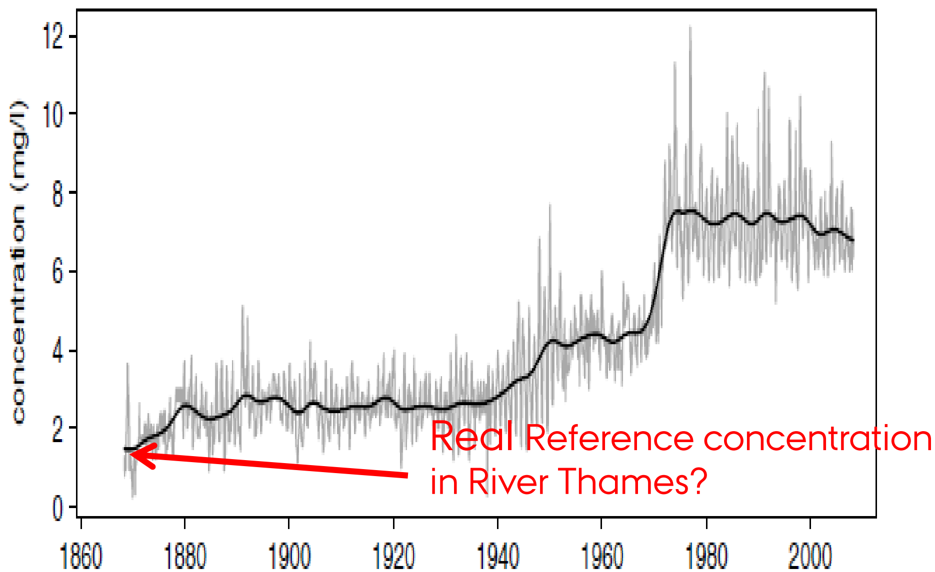


Figure 1. Time series plot of monthly nitrate concentration (mg NO_3–N/l), with an approximate 1-year moving average (Watson, 1966)

Howden et al., 2010

Trends in monthly nitrate concentration in river Thames upstream London – a catchment with chalk geology and long residence times in groundwater for most waterborne nitrate

Establishing a Danish Expert Judgement – N concentrations in streams around year 1900

- DCE, AU made a brief review of the relevant existing international literature in autumn 2014 as a way to reach a qualified expert judgement on a proxy for the nitrogen concentrations in Danish streams around year 1900 (Bøgestrand et al., 2014).

- The expert judgement must also consider the changes occurring in climate (precipitation, temperature), agricultural surplus and agricultural practices.

- A model exercise on DK data could not be conducted at the time – but it was suggested in the report as a way forward to achieve a higher confidence on the expert judgement.

Næringsstofbelastningen til vandområder omkring år 1900

Notat fra DCE - Nationalt Center for Miljø og Energi

Dato: 15. december 2014

Jens Bøgestrand, Jørgen Windolf & Brian Kronvang

Institut for Bioscience

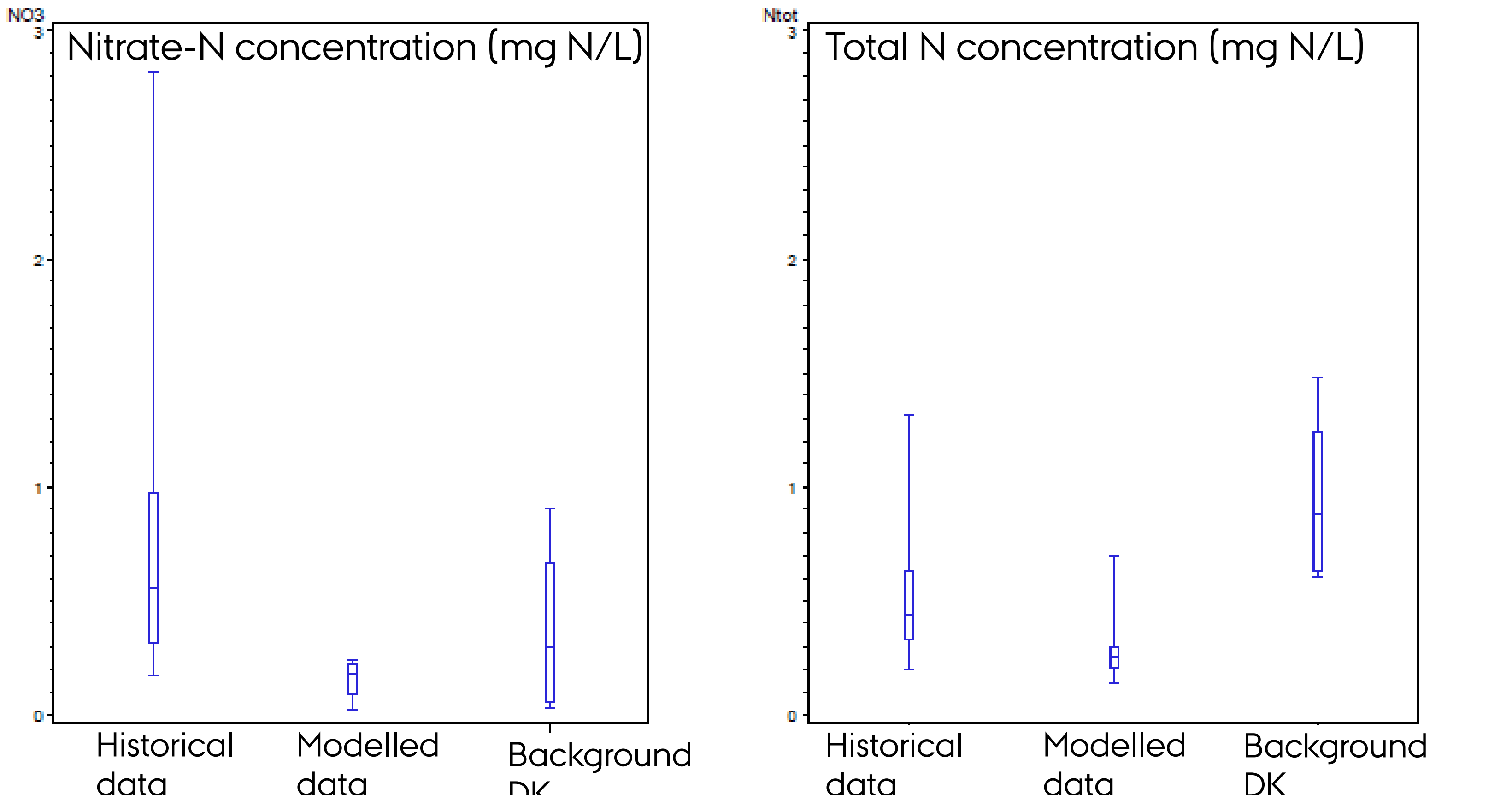
Rekvirent:
Naturstyrelsen
Antal sider: 9

Faglig kommentering:
Internt i forfattergruppen
Kvalitetssikring, centret:
Poul Nordemann Jensen

AARHUS UNIVERSITET
DCE - NATIONALT CENTER FOR MILJØ OG ENERGI

Tel.: +45 8715 0000
E-mail: dce@au.dk
http://dce.au.dk

Nitrogen concentrations in streams – international data - historical and modelled as compared to background concentrations measured in 19 Danish streams draining small relatively 'undisturbed' catchment in 2011



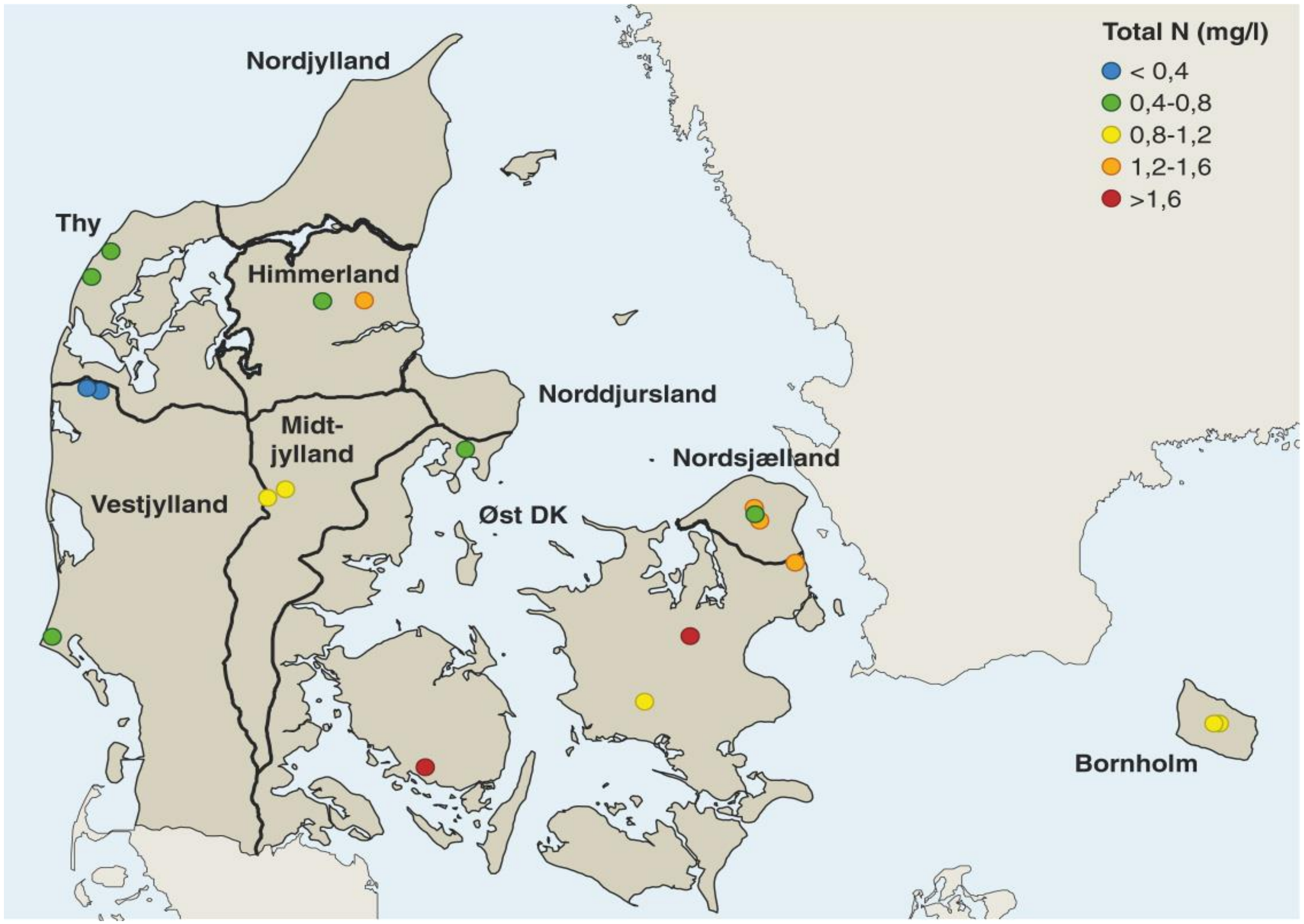
Figur 1. Koncentrationer af nitrat og total kvælstof som henholdsvis er målt i upåvirkede vandløb fra litteraturen (Historisk) (Hirt et al., 2013), modellerede koncentrationer i vandløb fra den tyske MONERIS model (Modelleret) (Hirt et al., 2013), samt DCE's nyligt beregnede baggrundskoncentrationer fra målinger i upåvirkede danske vandløb i 2011 (DCE) (Bøgestrand et al., 2014). Box-whiskers repræsenterer median, 25/75-percentiler og max/min-værdier.

Nitrate concentrations in world rivers around year 1900 – screened for not being downstream major cities

Location	n	Median (min-max) (period)
		Nitrate (mg/L)*
Rhinen+tributaries	4	2.1 (1.4-2.9) (ca. 1880)
Elben+tributaries	4	0.5 (0.2-1.4) (ca. 1890)
Danube+tributaries	7	0.3 (0.2-0.5) (ca. 1880)
Rhone+tributaries	2	0.6 (0.5-0.6) (1850-1880)
Mississippi+tributaries	5	1.8 (0.7-2.8) (1906-07)
Tributaries to Ohio River	1	1.2 (1906-07)
Tributaries to St. Lawrence	1	1.9 (1906-07)
Arkansas river and other rivers	1	0.4 (1906/07)
Rivers of California	4	0.9 (0.6-1.8) (1906-08)
Columbia+tributaries	3	0.6 (0.6-1.1) (1911-12)
Rivers near Oregon and Washington	3	0.3 (0.3-0.6) (1910-11)
Missisouri river+tributaries	3	2.3 (1.8-2.9) (1906-07)
Sweden	2	0.17 (0.1-0.5) (1905)

*We assume that Nitrate is regarded as Nitrate-N. However, this information is not stated clearly in the article – so some could be shown as nitrate – more inspections is needed for clarifying this.

Total N in the 19 streams screened where agriculture occupies < 10% of the catchment (Average N input/surplus in catchments = ca. 15 kg N/ha)

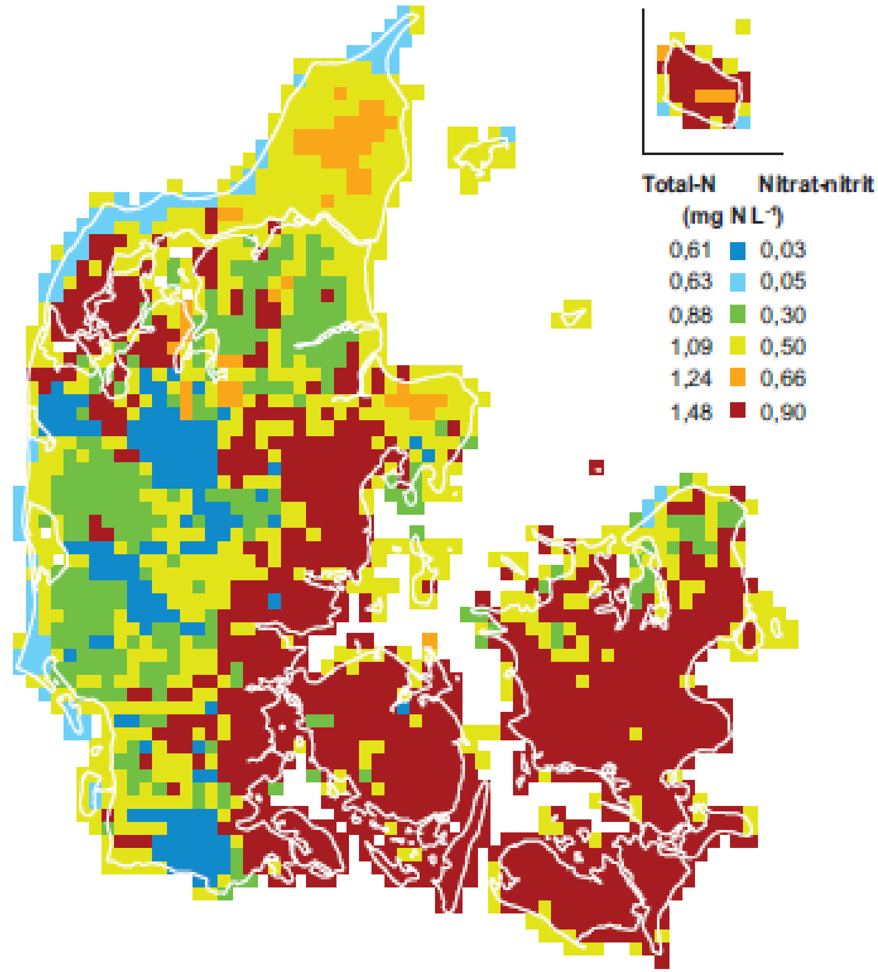


The suggested proxy for Total N and Nitrate N concentrations in small streams

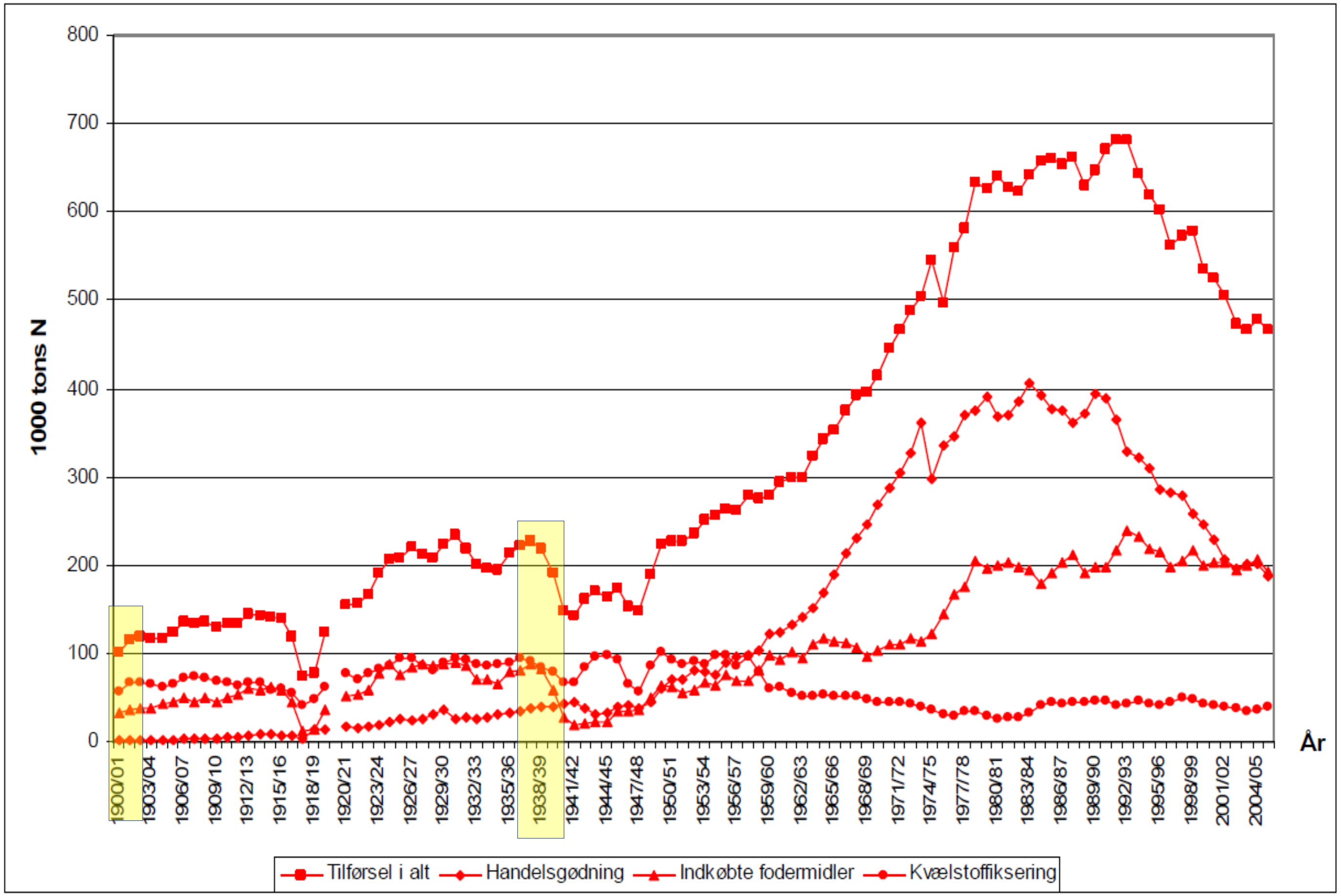
The model estimated N concentrations in Danish streams (NO3-N and Total N) around year 1900 (from Bøgestrand et al., 2014)

A spatial variation that to some extent also depict the variation found today in the monitoring data from NOVANA – maybe minus the chalk dominated regions

Figur 3. Kort over baggrunds-koncentrationer af total N og nitrat-/nitrit-N.

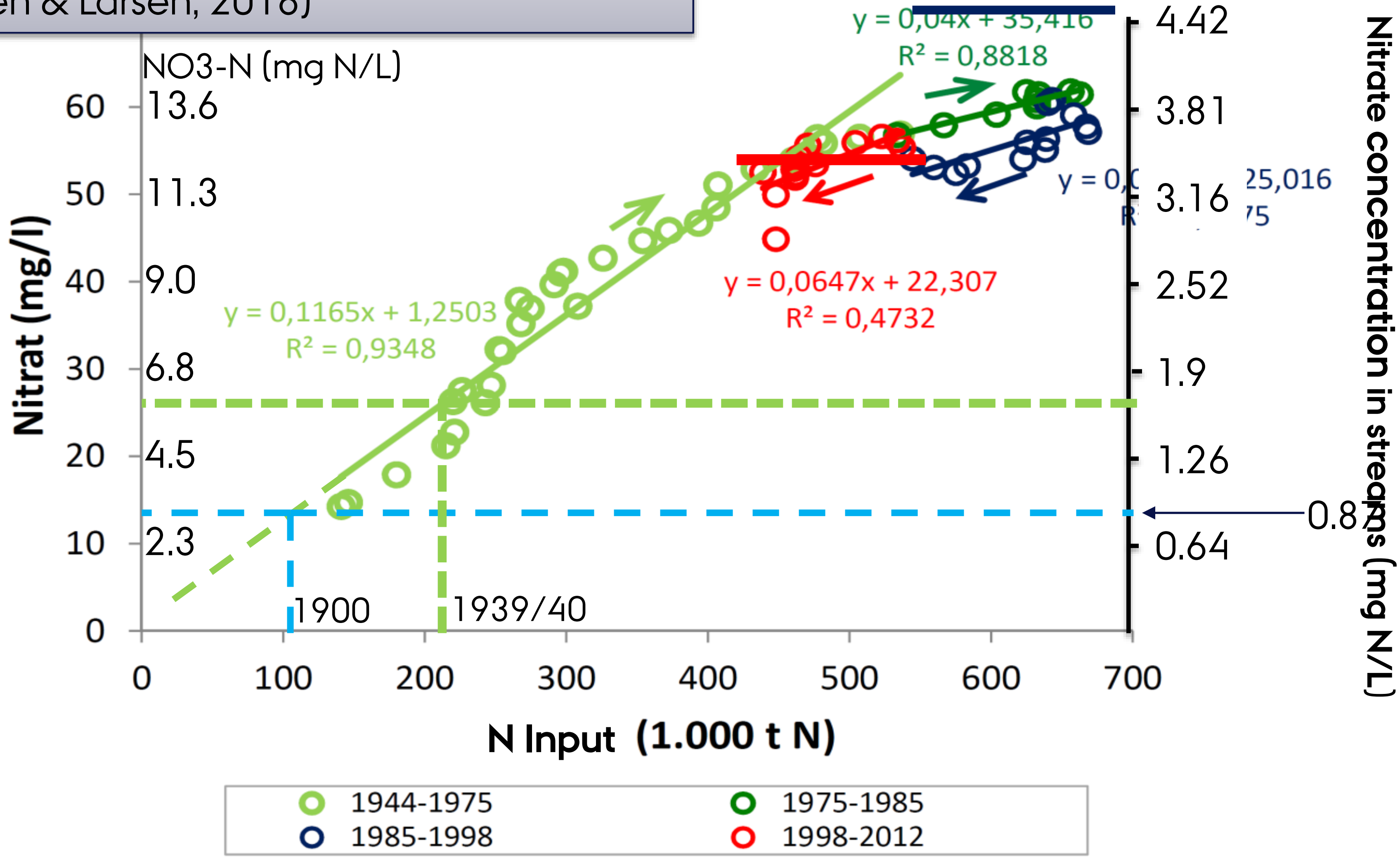


Nitrogen input to agricultural land in Denmark
(from Kyllingsbæk, 2005)
N-surplus in year 1900 is approx. 20 kg N/ha catchment area)



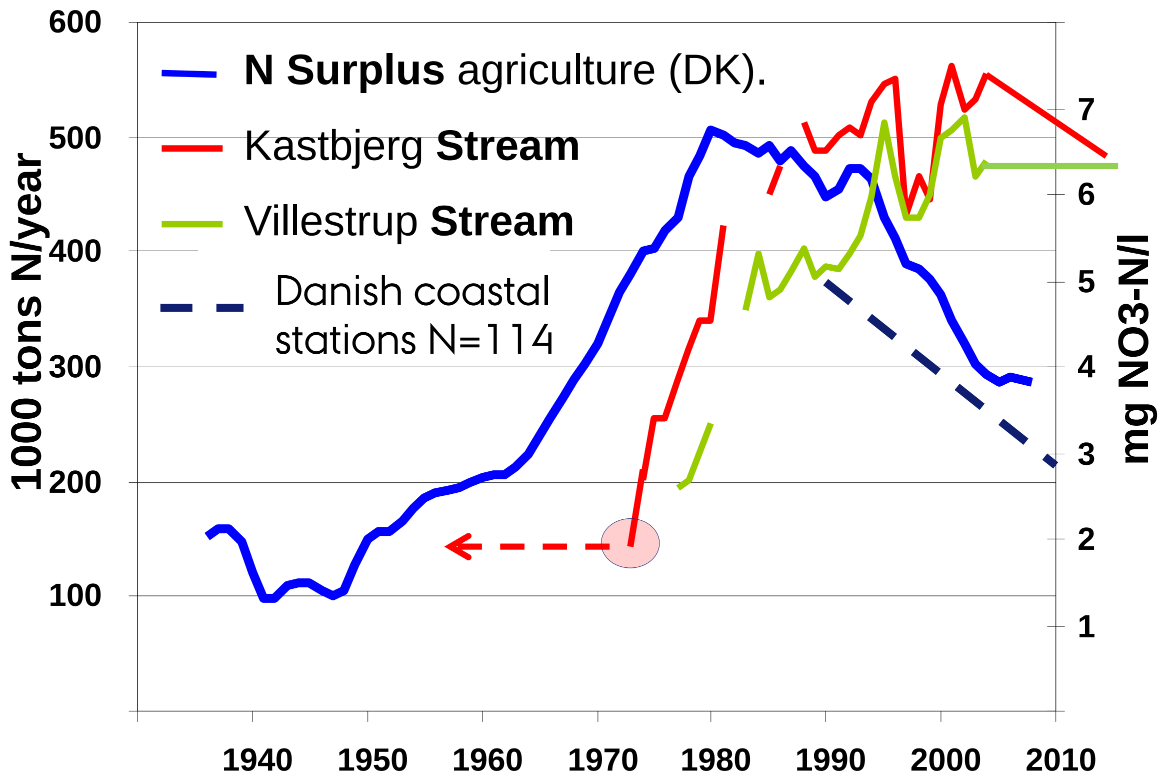
Figur 1. Tilførsel af kvælstof i alt og fra forskellige kilder

Nitrate in oxic groundwater in relation to nitrogen input in agriculture in Denmark (Hansen & Larsen, 2016)



Measured N in streams in chalk catchment vs. N surplus in Danish agriculture

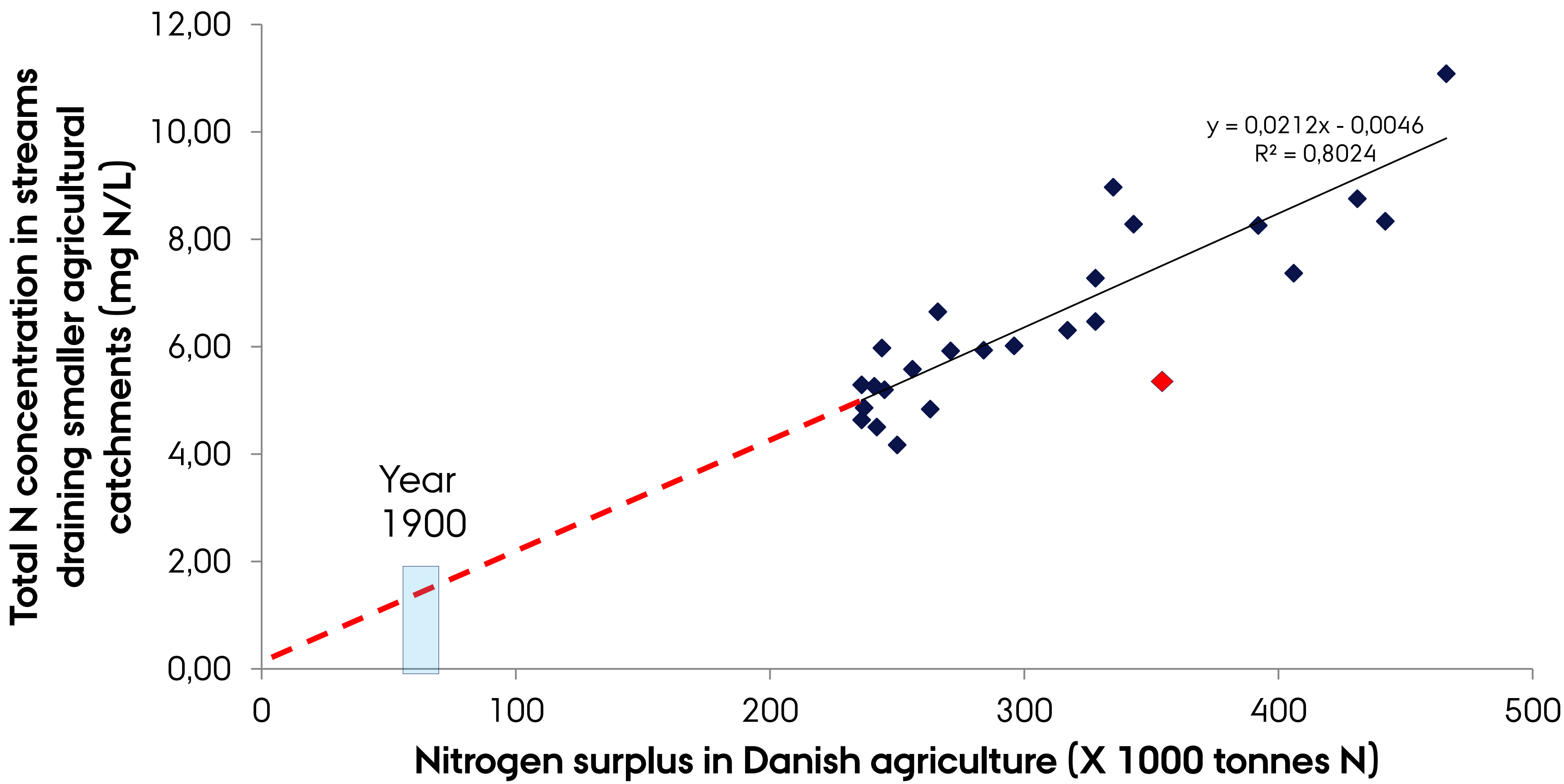
(source: Wiggers-Nielsen)



Delay in N response … oxidized deep groundwater

A low starting concentration in Kastbjerg stream that has been derived from leaching in the 1950'ies

Total N concentration in streams draining 44 smaller agricultural catchments (> 60% farmed) against N surplus in agriculture 1990-2014

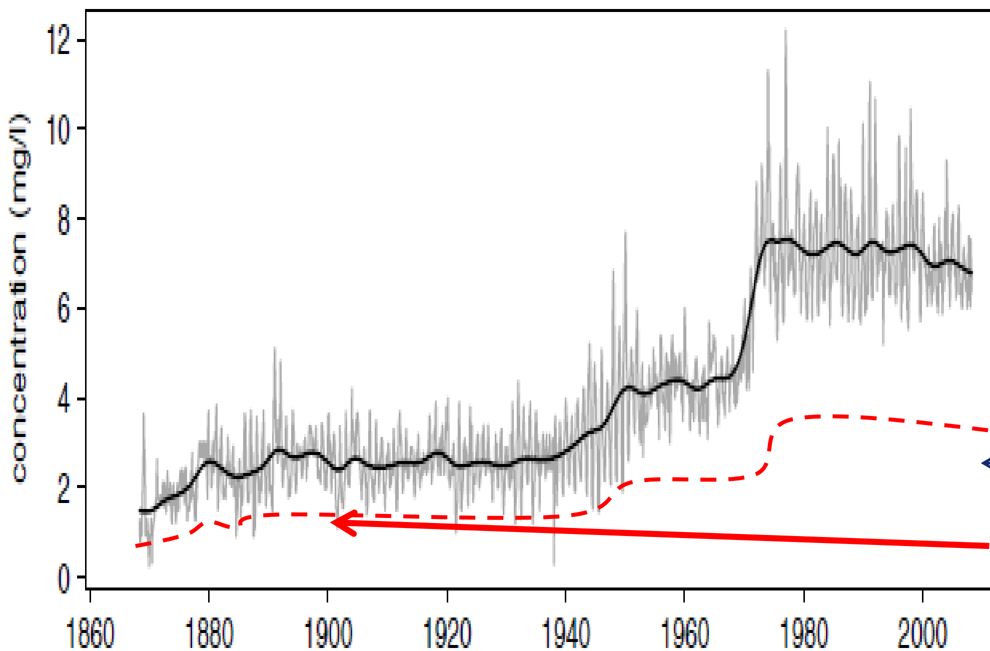


Conclusions

The expert judgement from 2014 about nitrogen concentrations in Danish streams around year 1900 has not in general been outdated based on our recent findings about:

- Literature review
- Historical nitrogen concentration data from streams and in oxic groundwater
- Analysis of historical N retention in the landscape around year 1900 (later to be presented by Hans Thodsen)
- Historical development in hydrology (later to be presented by Jane R. Poulsen)
- A problematic region is, however, catchments around Mariager Fjord and parts of Limfjorden where the low nitrate removal in the chalk like in the River Thames historically might have given rise to higher nitrate concentrations around year 1900.

River Thames nitrate concentrations if transferred to a typical Danisk landscape with high N removal in groundwater



Assumed nitrate concentration with the ‘normal’ N retention in Danish groundwater and surface waters

Figure 1. Time series plot of monthly nitrate concentration (mg NO_3–N/l), with an approximate 1-year moving average (Watson, 1966)

AARHUS
UNIVERSITY