NUTRIENT STATE AND TREND FOR THE DANISH WATER BODIES FROM 35 YEARS WITH NATIONAL MONITORING

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NOVANA -HISTORY

1987:	1st National Aquatic Environment Monitoring Programme (Nutrients, a comprehensive groundwater program, metals in air)
1993-1997:	2nd National Aquatic Environment Monitoring Programme
1998-2003:	NOVA-2003 (Hazardous substances in surface waters)
2004-2010:	NOVANA (Nature and species included)
2011-2016:	NOVANA (Water Framework- and Habitat-directive obligations)
2017-2022:	NOVANA (Focus streamlining and WFD)
2023-2027:	NOVANA (Focus WFD, new technology and Hazardous substances)

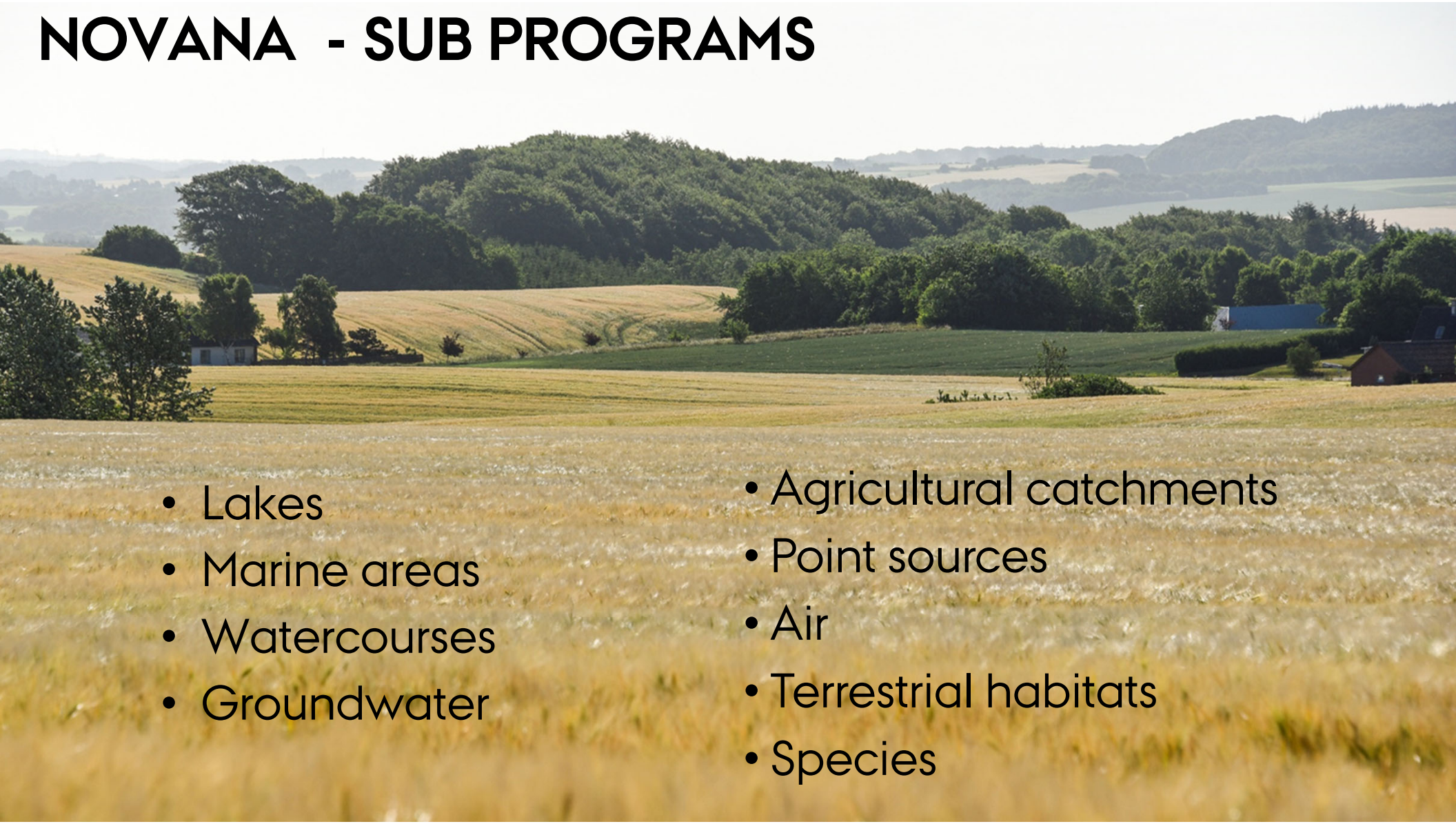
NOVANA - OBJECTIVES

- Meet Denmark's obligations in relation to EU legislation and national legislation and political needs for knowledge
- Monitoring state and trends of nature, aquatic environment and air quality
- Document the **effect** of national action plans and measures
- Monitoring according to **international conventions** concerning nature and environment

Other elements

- Standards for data quality, data flow and public availability of data
- Annual report for the public and political system

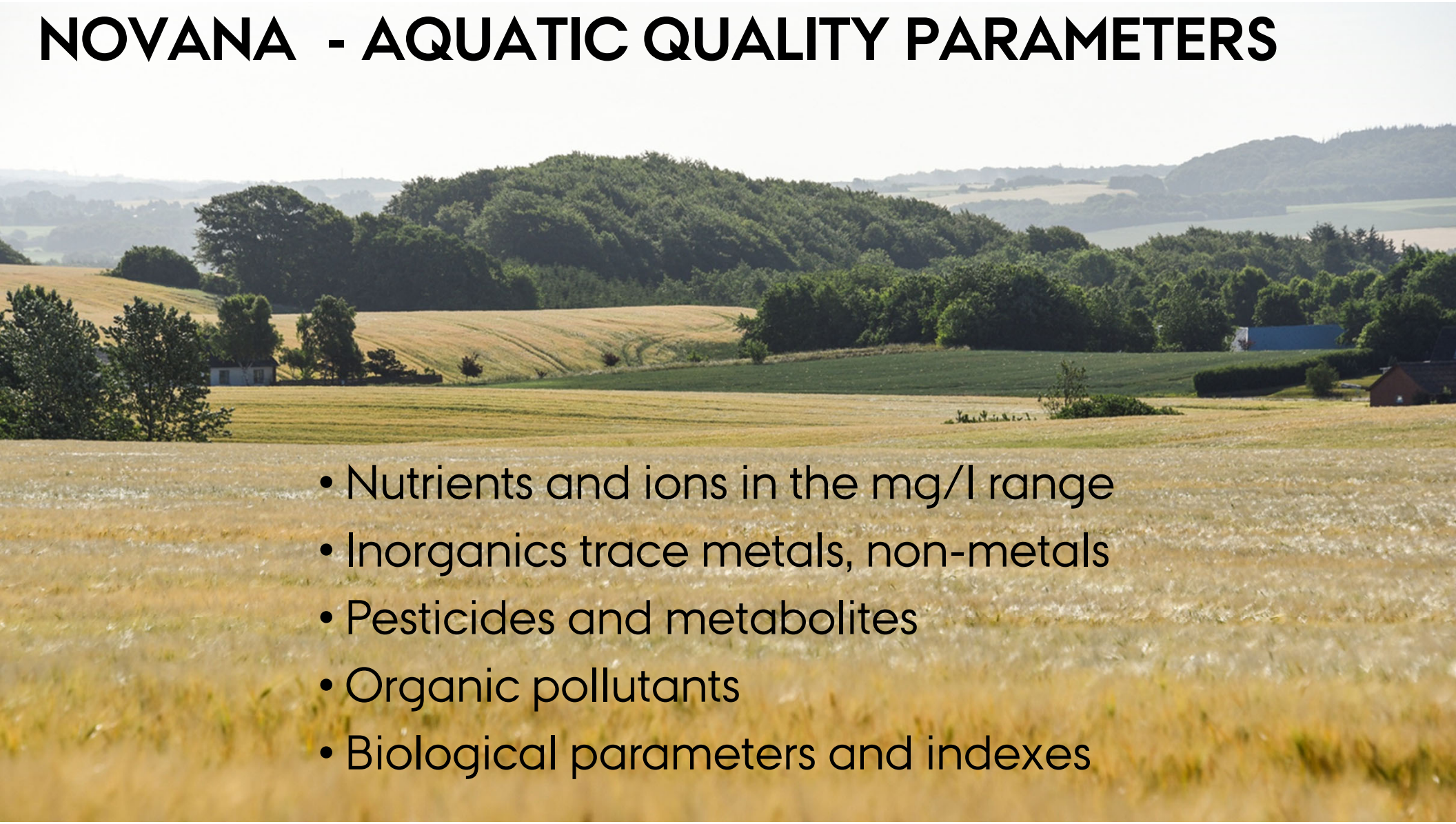
NOVANA - SUB PROGRAMS



- Lakes
- Marine areas
- Watercourses
- Groundwater

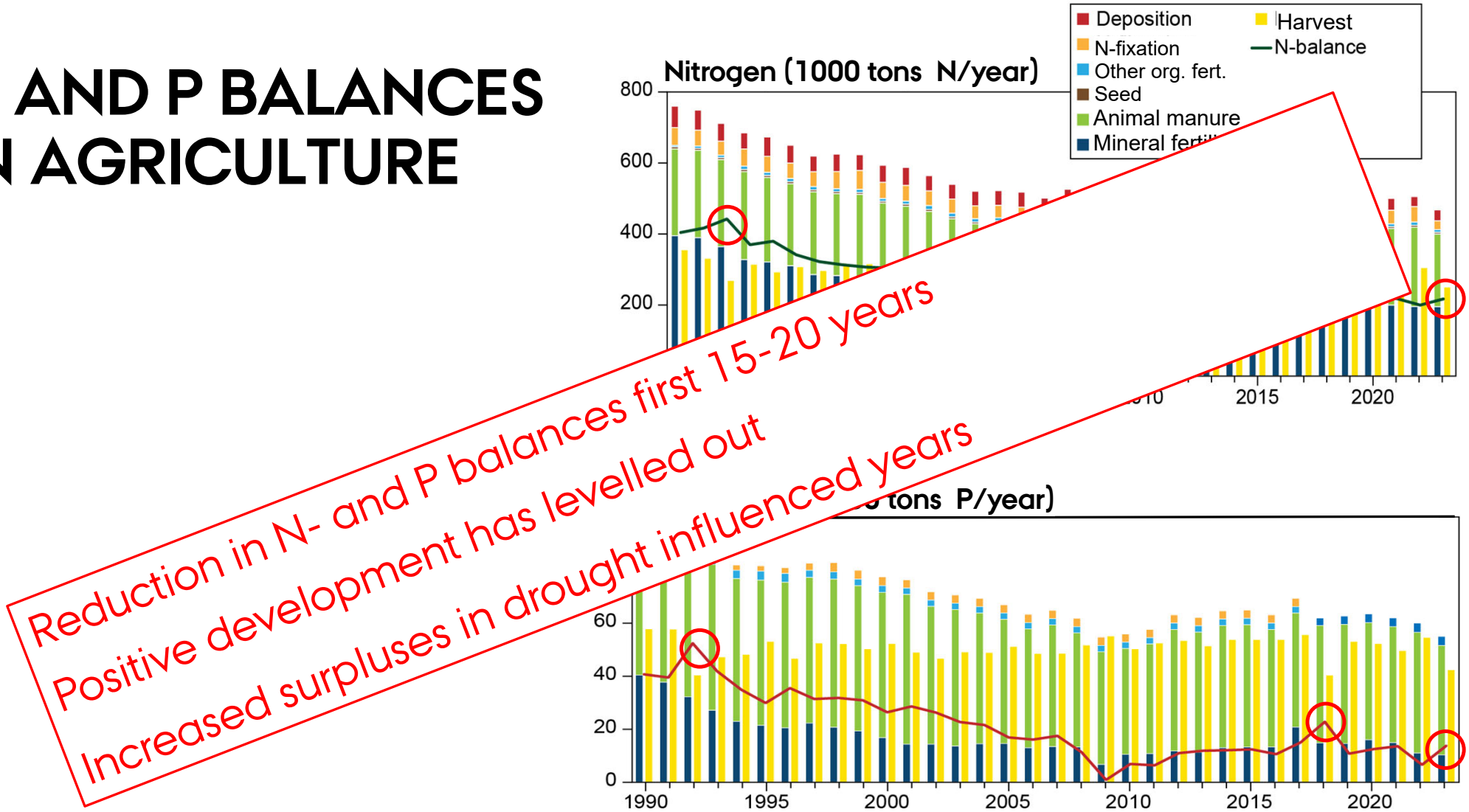
- Agricultural catchments
- Point sources
- Air
- Terrestrial habitats
- Species

NOVANA - AQUATIC QUALITY PARAMETERS



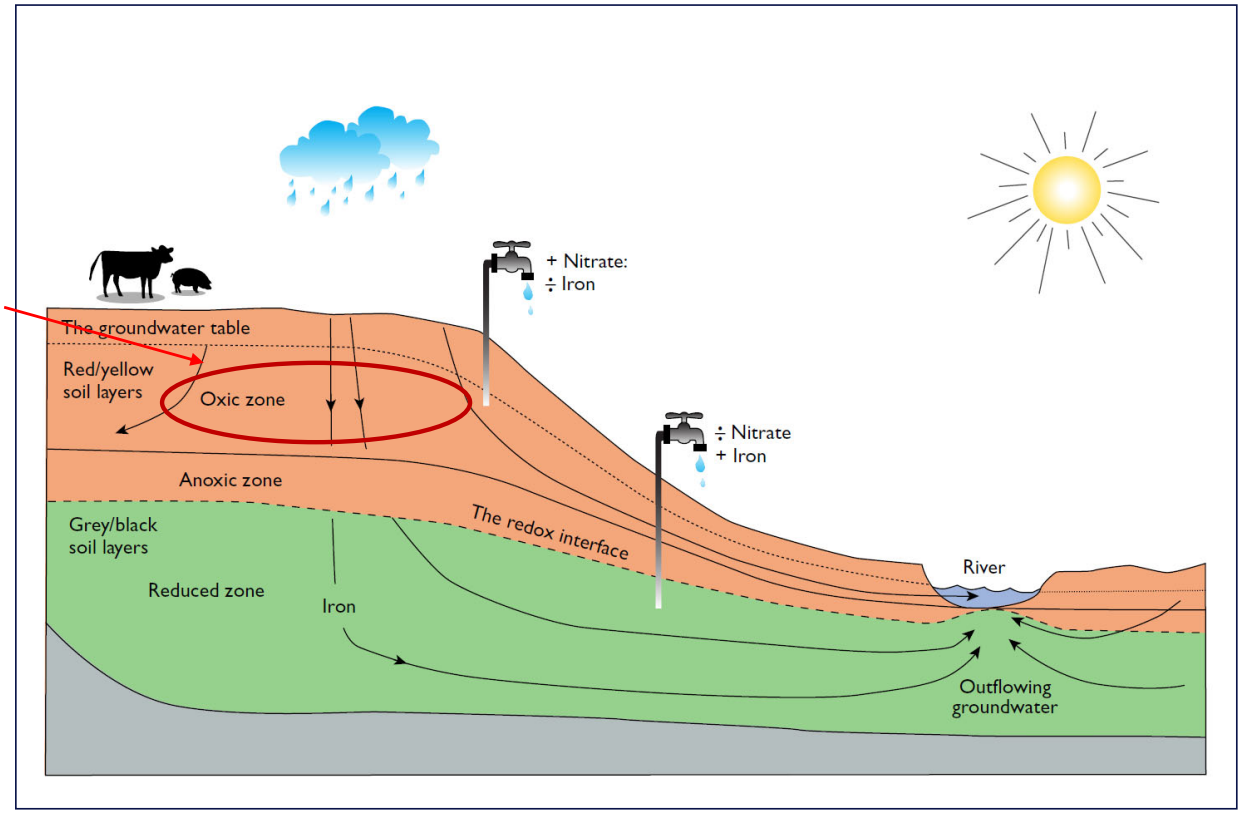
- Nutrients and ions in the mg/l range
- Inorganics trace metals, non-metals
- Pesticides and metabolites
- Organic pollutants
- Biological parameters and indexes

N AND P BALANCES IN AGRICULTURE



NITRATE IN OXIC GROUNDWATER

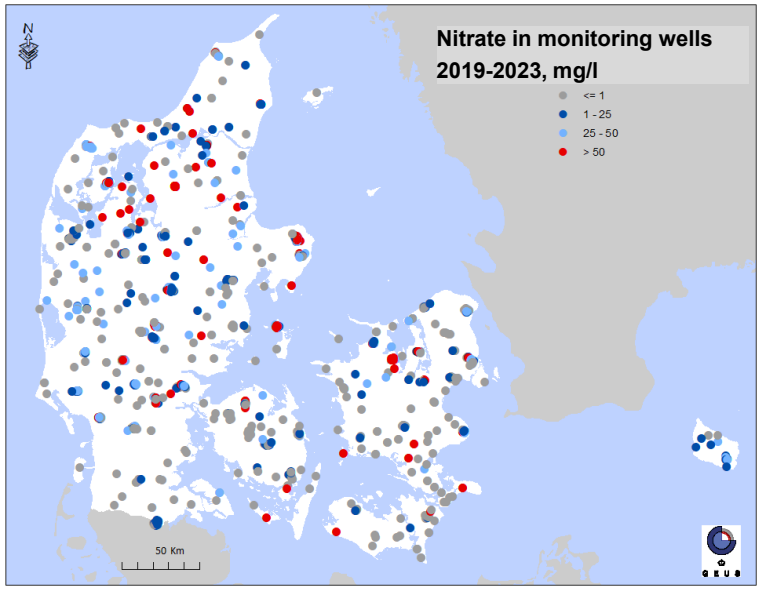
Information on nitrate status and trend

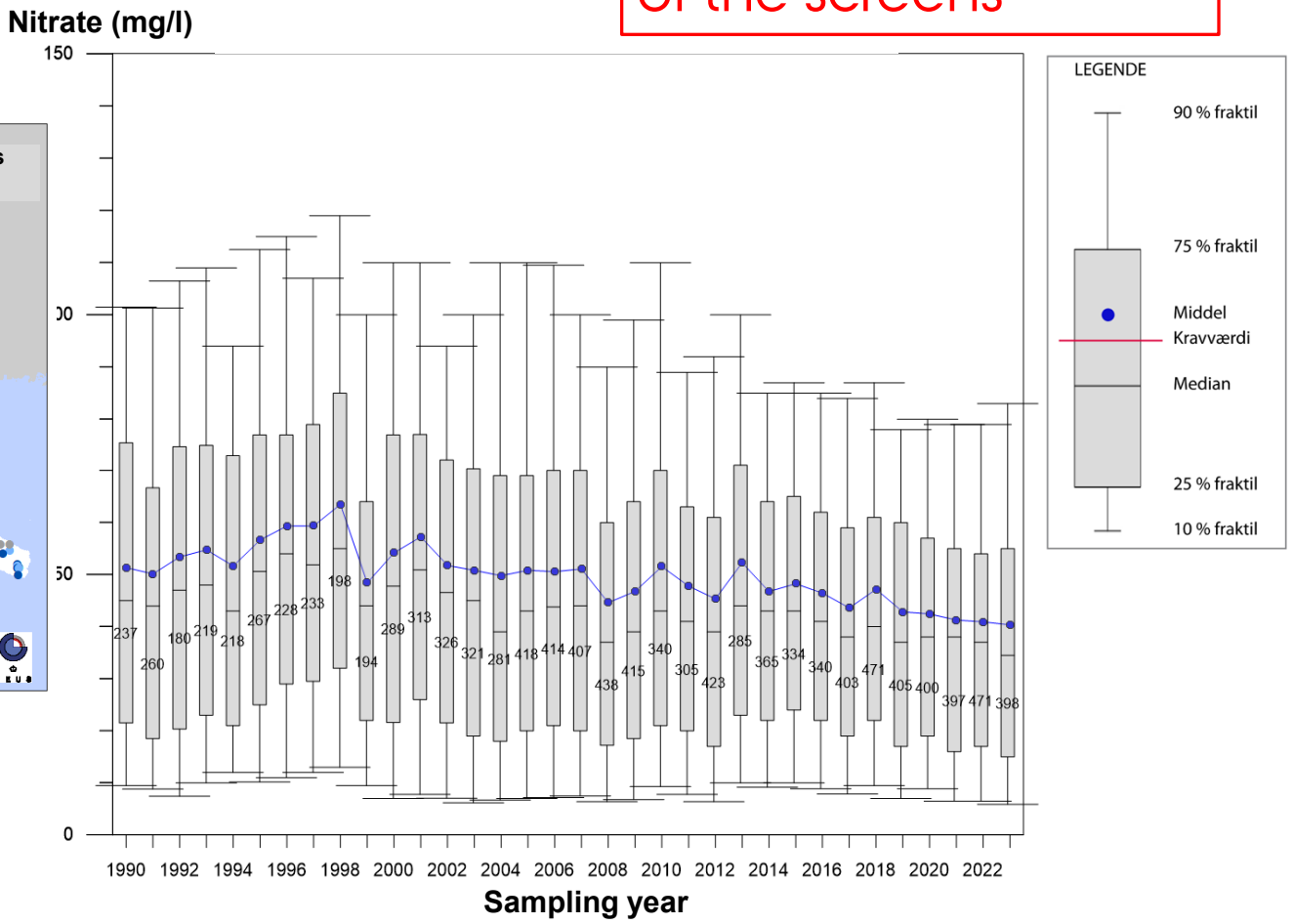


Nitrate concentrations in oxic groundwater directly response to land-use and nitrate leaching

NITRATE IN OXIC GROUNDWATER ACCORDING TO SAMPLING YEAR

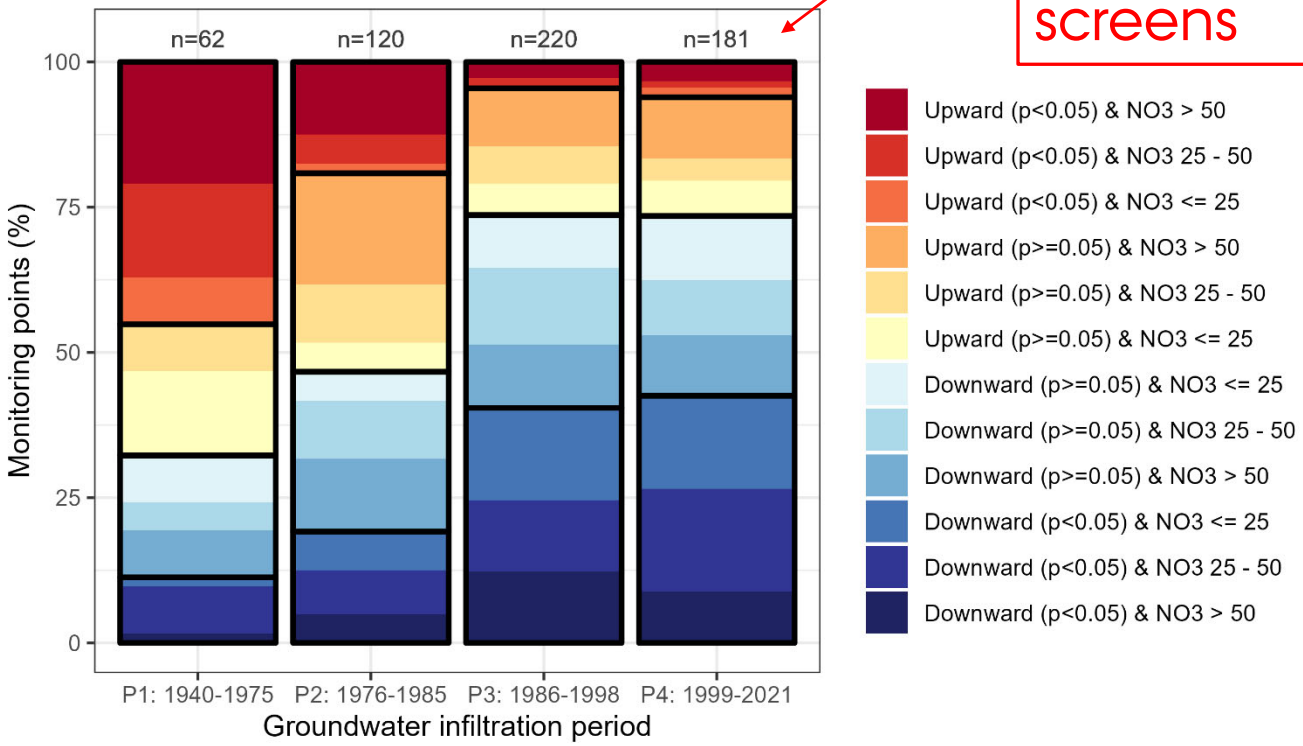
Sampling year 2023:
> 50 mg/l in ca. 29 % of the screens



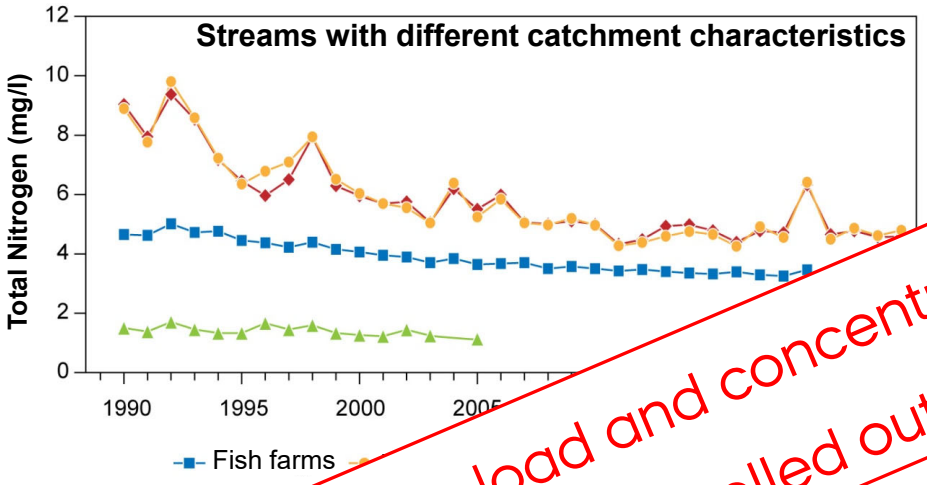


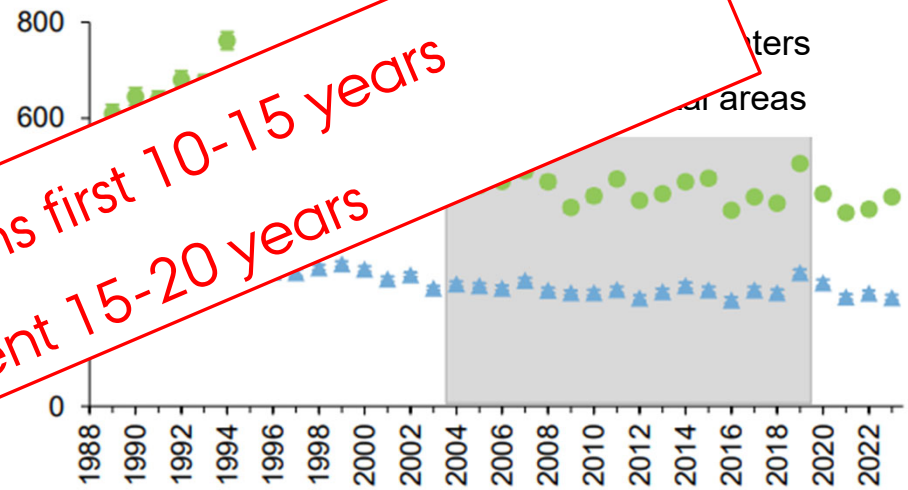
NITRATE IN OXIC GROUNDWATER BASED ON GROUNDWATER AGE

Groundwater infiltration year 2021:
Critical status in ca. 24 % of the screens



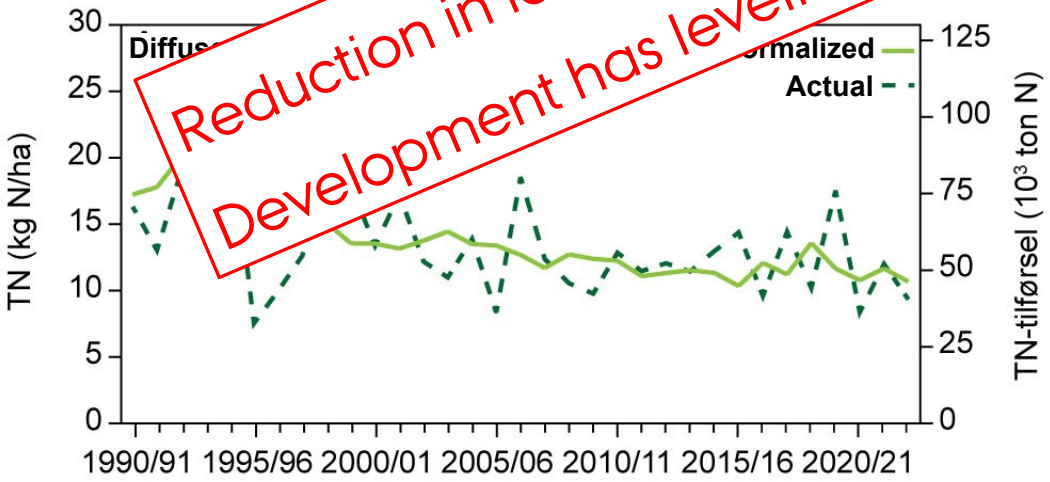
TIME SERIES EXAMPLES - NITROGEN



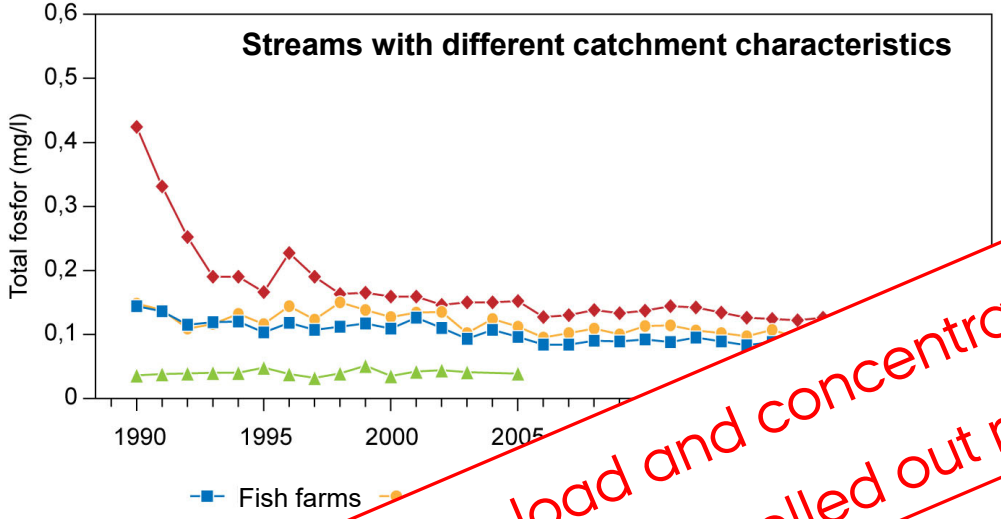


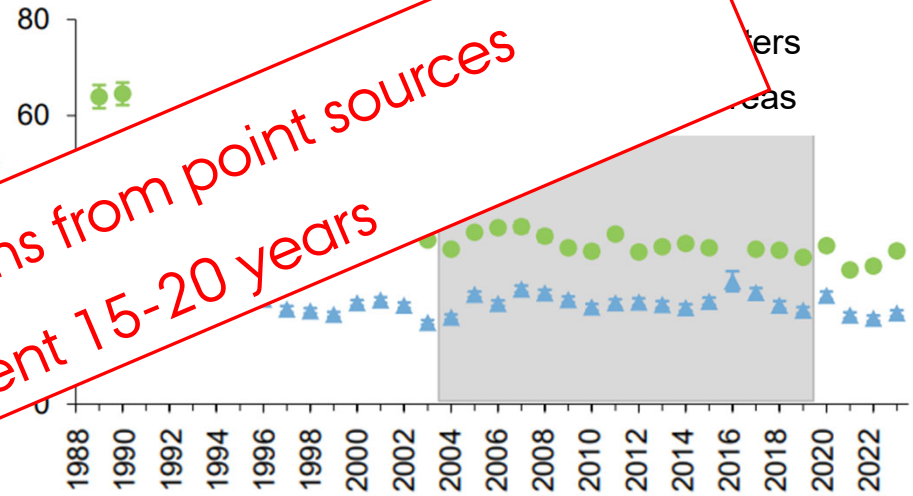
Reduction in load and concentrations first 10-15 years

Development has levelled out recent 15-20 years



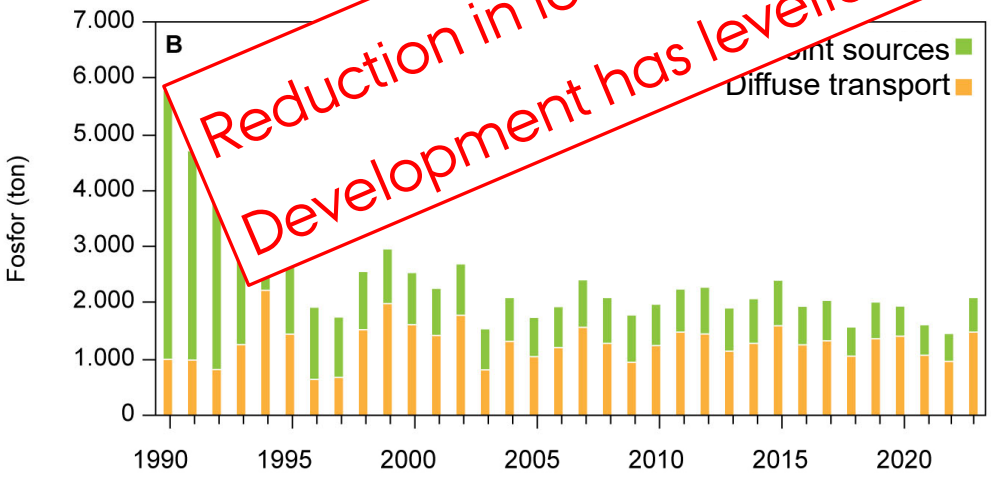
TIME SERIES EXAMPLES - PHOSPHOROUS





Reduction in load and concentrations from point sources

Development has levelled out recent 15-20 years



NOVANA Conclusions

Trends for the period 1990-2023

- Significant reduction in nitrogen loss from agriculture and concentration in the aquatic environment since 1990
- Significant reduction in point source losses of phosphorus since 1990, however no significant change in diffuse phosphorus losses
- Positive development has leveled out in recent 15-20 years
- The environmental goals for reduction of nutrients are not yet met in the different water bodies such as groundwater and marine areas.
- Other data indicates of deterioration for some parameters in groundwater, lakes and marine areas in the last 10-15 years

CLIMATE CHANGE IMPACTS ON THE AGRICULTURAL SECTOR IN EUROPA

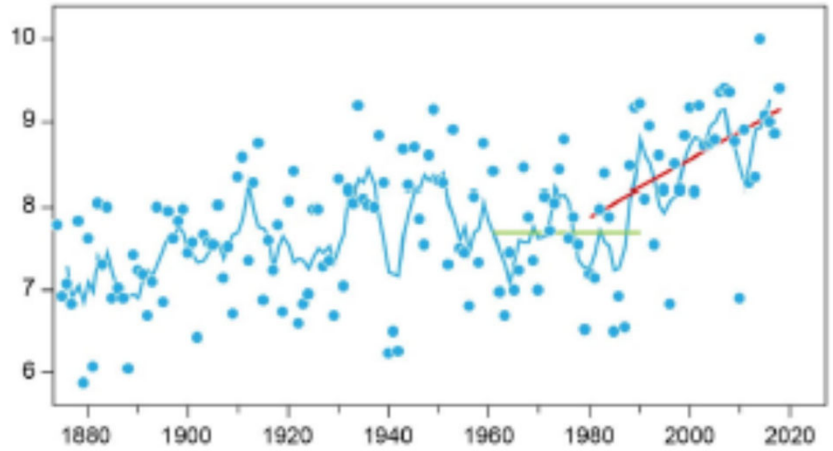
Boreal region
Increase in heavy precipitation events
Increase in precipitation
Increasing damage risk from winter storms
Increase in crop yields

Atlantic region
Increase in heavy precipitation events
Increasing risk of river and coastal flooding
Increasing damage risk from winter storms

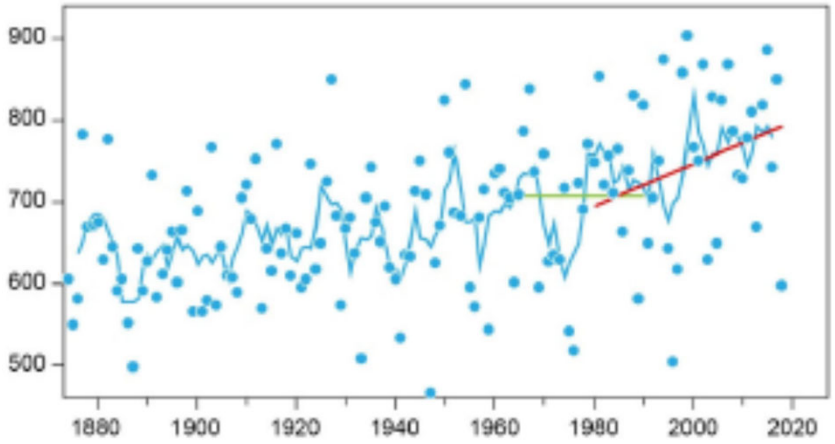
Continental region
Increase in heat extremes
Decrease in summer precipitation
Increasing risk of river floods

Trend in temperature and precipitation in Denmark

Annual temperature (°C)



Annual precipitation (mm/yr)



In the past 50 years, the global annual temperature has increased by 0.8 °C

In Denmark :

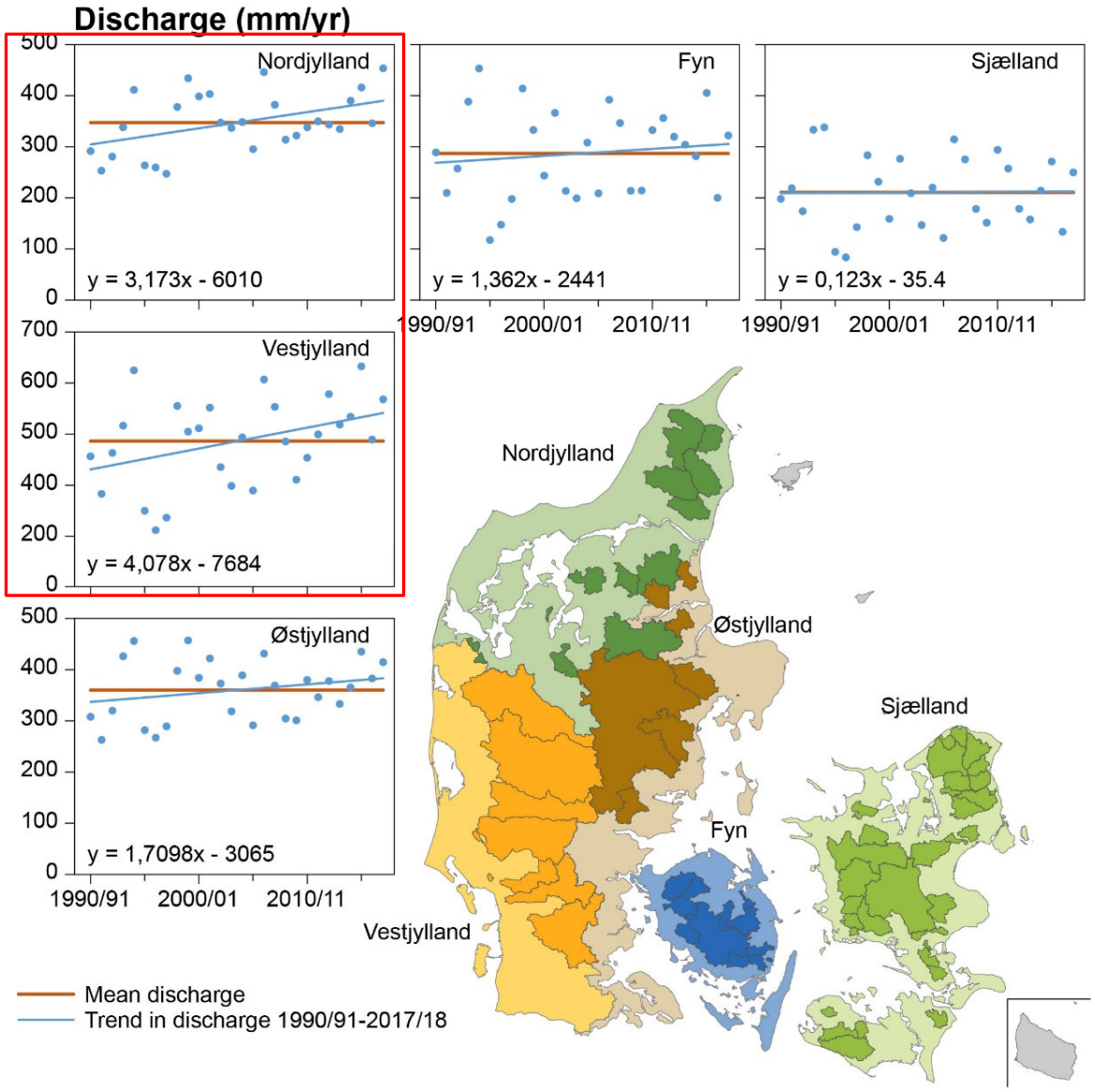
- Average annual temperature increased ~ 1.5 °C giving longer cropping season and warmer winters.
- Water temperature in marine areas increased ~2 °C giving longer periods with risk of oxygen depletion

In the same period annual precipitation increased by ~ 100 mm, mainly during winter.

Legend:

Mean for 1960-1990

Running mean for 5 years

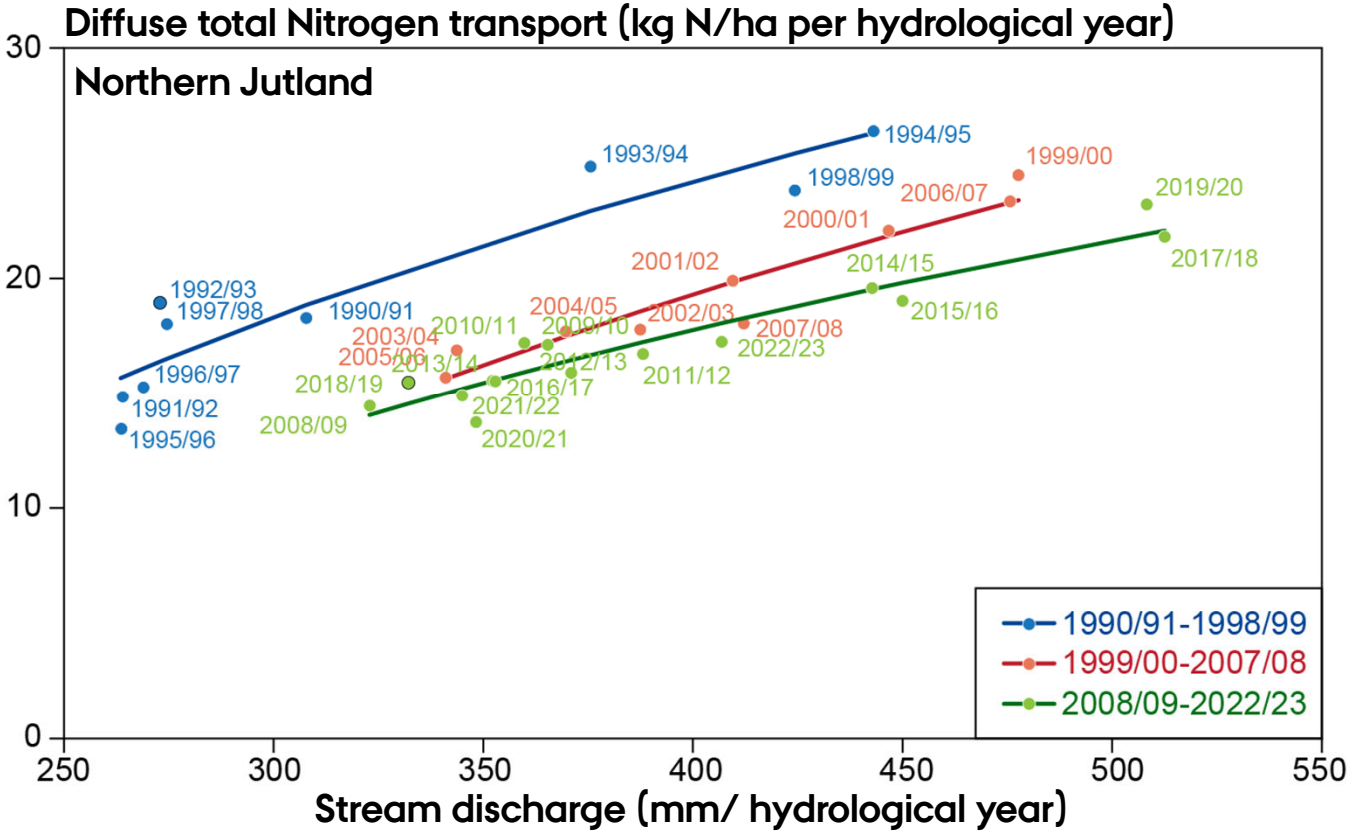


Trend in measured discarge for 5 Danish regions

	Linear reg.		Mann-Kendall	
	Trend	**95 % CL**	**Trend**	**95 % CL**
	(mm/yr)		(mm/yr)	
Nordjylland	3.2^{**}	2.6	3.5^{*}	3.3
Vestjylland	4.1*	3.9	4.6*	4.5
Østjylland	1.7^{NS}	0.6	1.9^{NS}	2.0
Fyn	1.4^{NS}	4.2	1.4^{NS}	5.0
Sjælland	0.1^{NS}	3.4	0.02^{NS}	4.0
*: p<0.05, **:p<0.01				

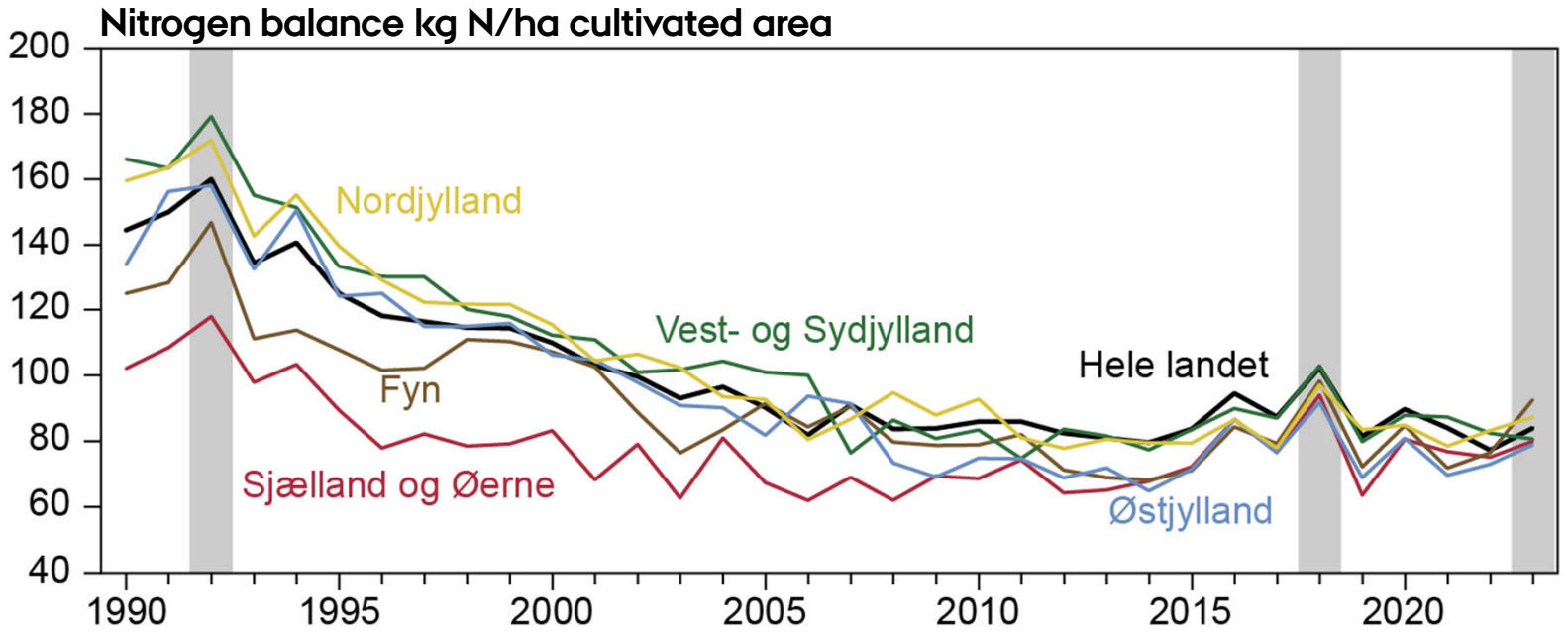
RELATION BETWEEN DISCHARGE AND N TRANSPORT

Relation change towards lower transport independent of discharge
– effect of implemented measures



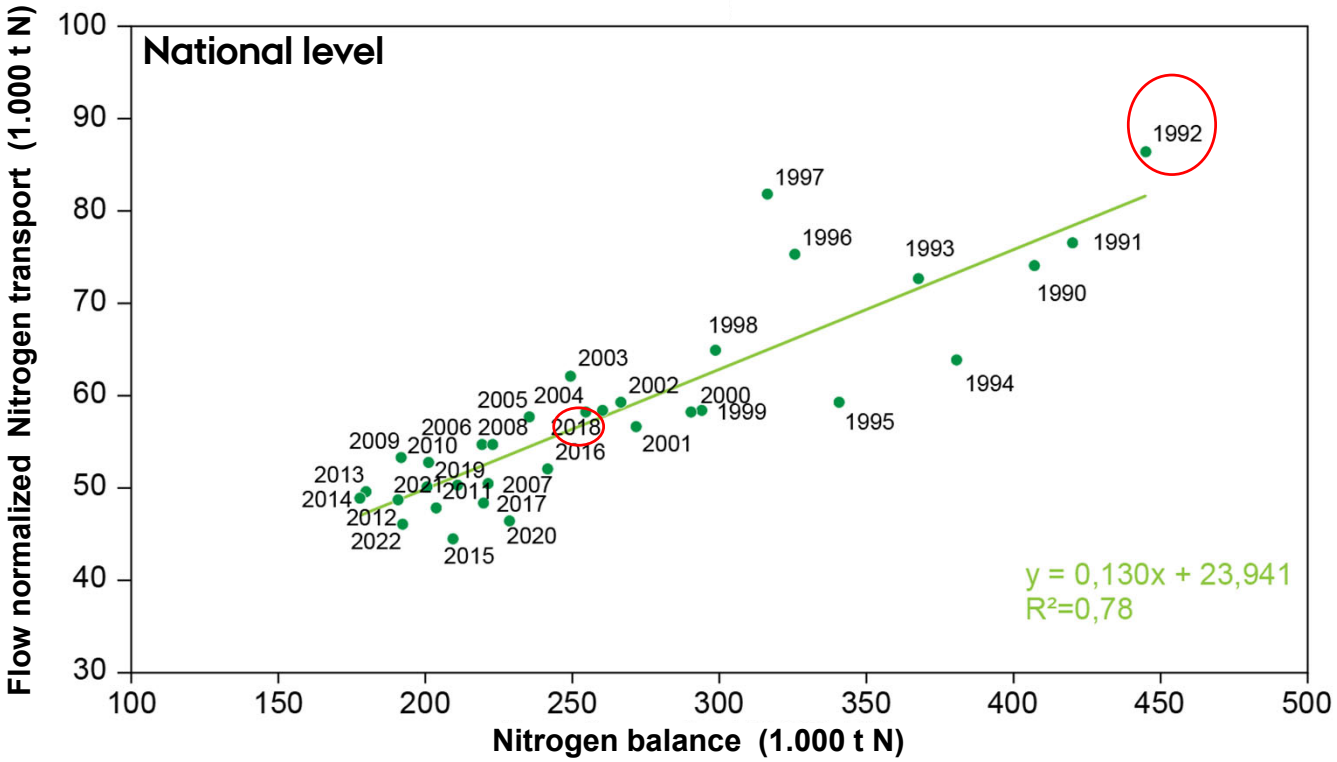
Nitrogen balances influenced by drought in 1992, 2018 og 2023

Harvest is influenced in all five regions in Denmark



*Grey shadow show years influenced by drought in growing season

Relation between Nitrogen balance i agriculture and the flow weighted diffuse Nitrogen transport to coastal areas



Higher Nitrogen balance gives increased Nitrogen transport

In the hydrological year1992/93 og 2018/19 Nitrogen balance and transport increased due to drought in growing season

Climatic effects on Nitrogen loss

Increased precipitation in autumn and winter

→ **Increased** stream discharge

Increased stream discharge

→ **Increased nitrogen transport to coastal areas**

Increased frequency of drought in growing season with reduced harvest

→ **Increased nitrogen balance** → **Incresased Nitrogen transport**

Regional variation in climatic effect:

More dry climate in eastern part of Denmark combined with low possibility for irrigation

→ higher risk of severe drought than in Western part of Jutland

Discussion
Adapting regulation to climatic changes?

Changes in climatic conditions are already counteracting expected improvements, e.g. increased temperatures in lakes and coastal waters

At present regulation aiming to fulfill WFD is not adapted to climatic changes

How to ensure cultivation safety in agriculture? What are the drivers?

How to ad adapt regulation to future climatic situations?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