

Water quality responses to changes in agricultural measures and practices

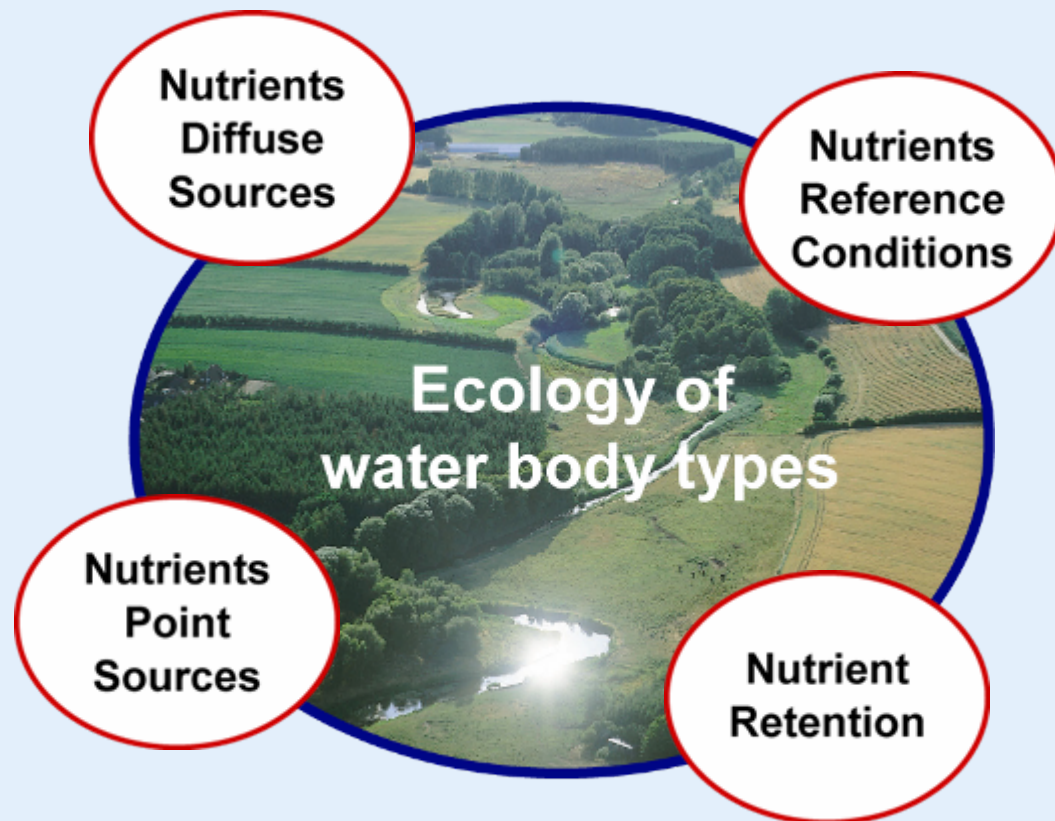


Content

- A brief introduction to Denmark
- The history of Danish Action Plans on the Aquatic Environment
- Trends in point source discharges of organic matter, nitrogen and phosphorus
- Regulations and trends in the diffuse losses of nitrogen
- Regulations and trends in the diffuse losses of phosphorus
- Conclusions and future perspectives for Danish regulations

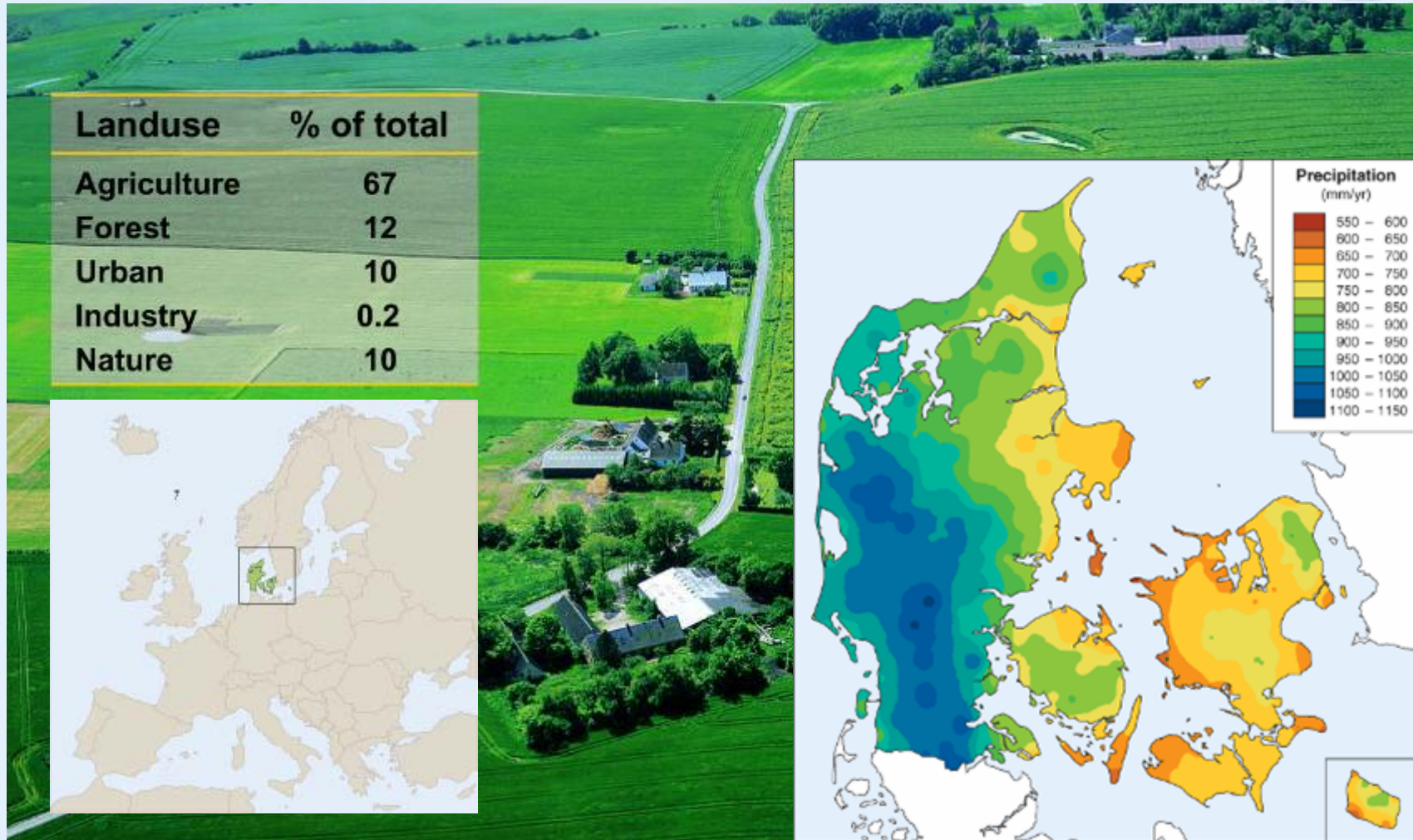


EU Directives as Urban Waste Water Directive, Nitrates Directive, Habitat Directive, Groundwater Directive and Water Framework Directive set new standards and requirements for our ability to describe the nutrient cycling in river basins and to apply management options considering all environmental threats including biodiversity and GHG's.



Land use and climate in Denmark

Permanent grassland is approx. 7 % of agricultural land

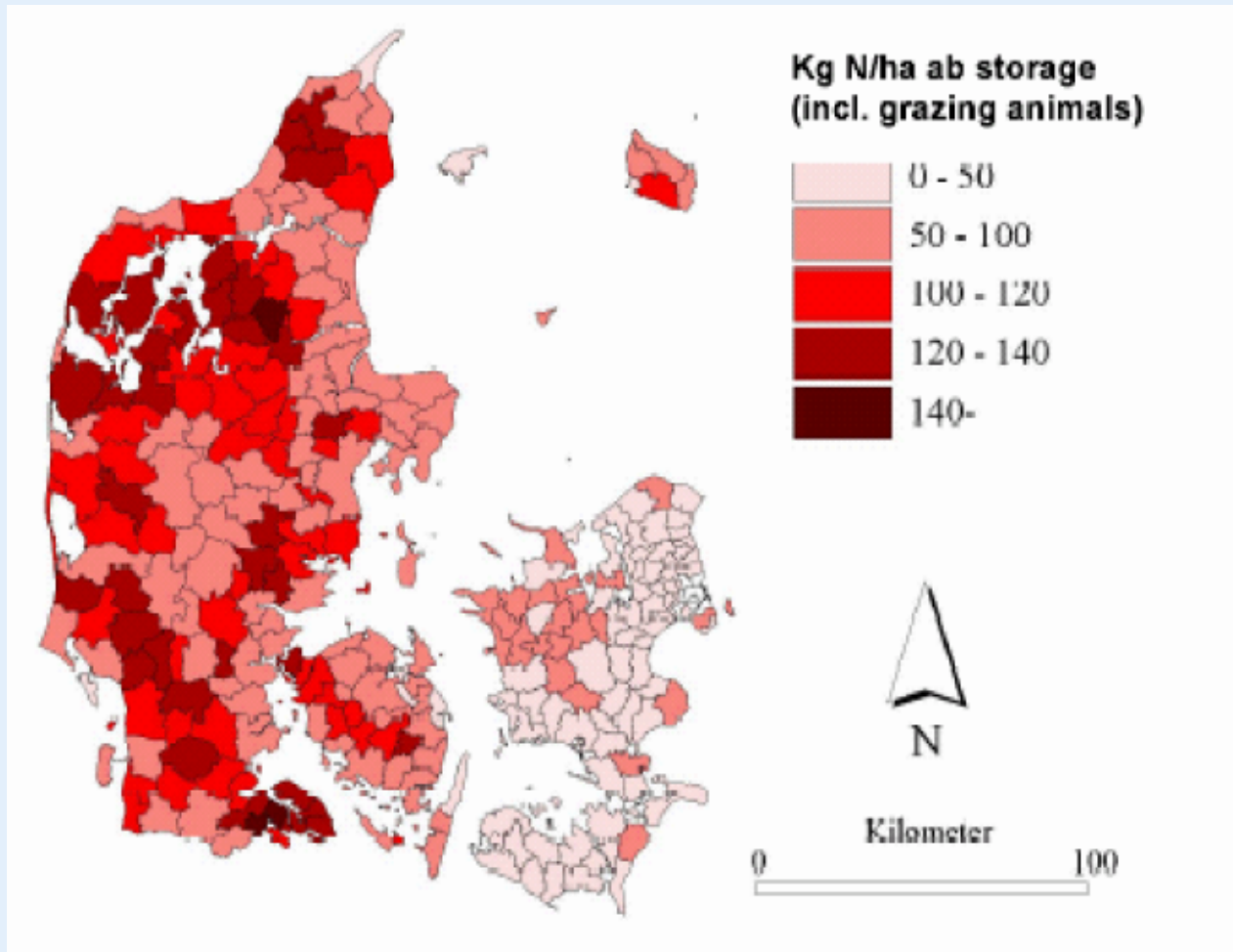


Danish Agriculture, 2004

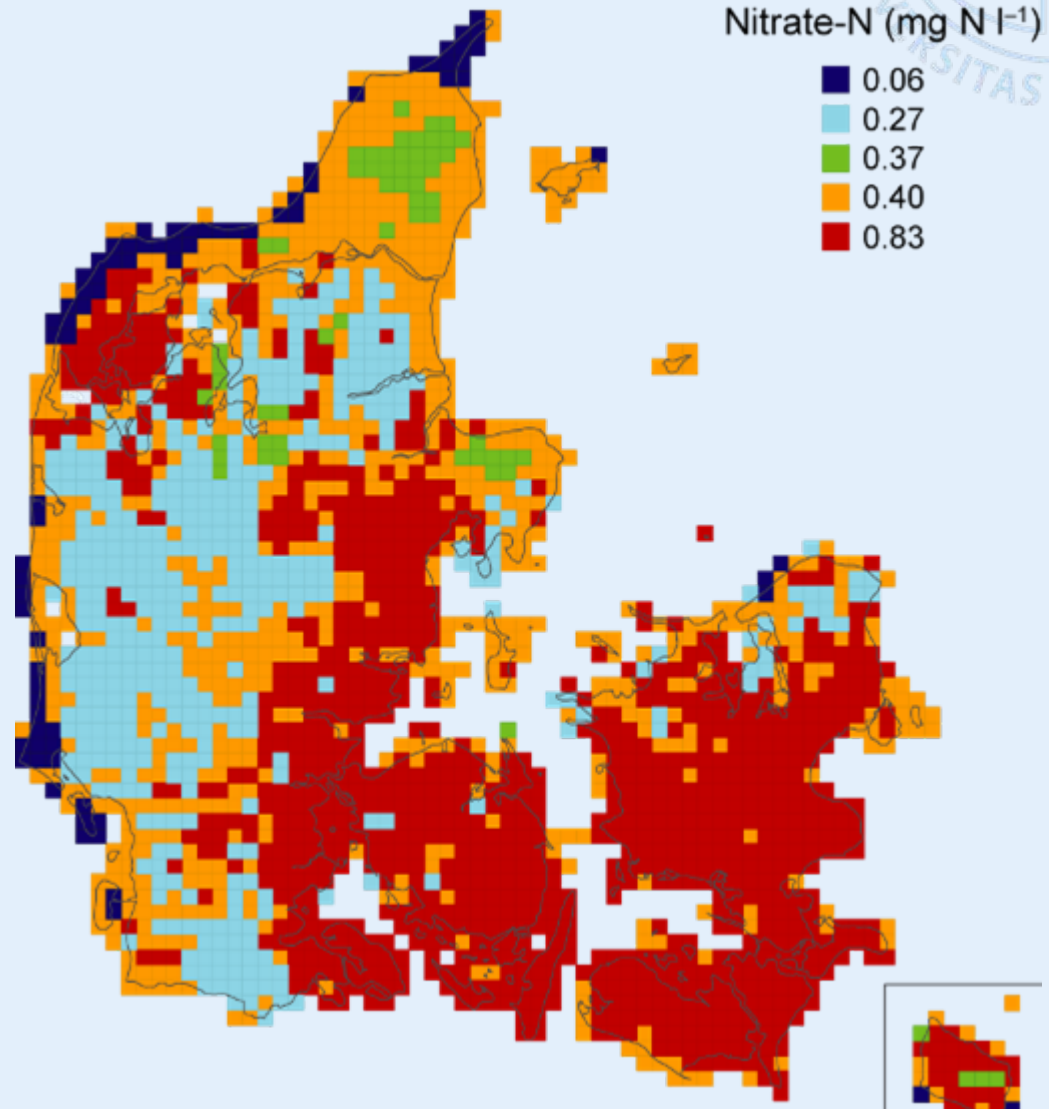
- Intensive agriculture – 60% of area
- Main crops
 - cereals 57%
 - maize 4%
 - rotation grass 8%
 - permanent grass 7%
 - set aside 8% (now 2%)
 - other crops 16%
- Average livestock density - 0.86



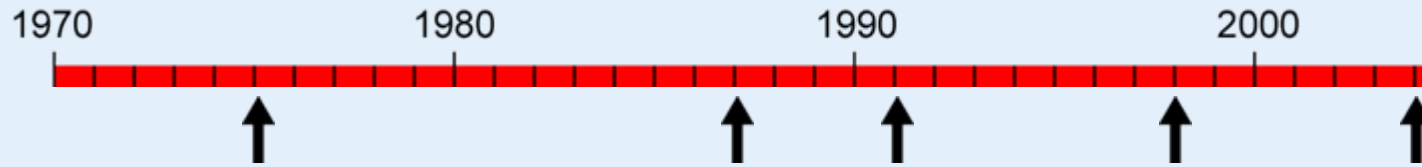
Manure application



We know what are the background concentrations of nitrate-N in surface waters – but how far away should we allow to be from the background levels ? Nitrates Directive thresholds are much too high for ecological conditions.



Historical Action Plans



Mid-1970s: Regional Action Plans

- Organic matter from Urban WWTP's

1987 National Action Plan I

- 80% P reduction from UWWTP's
- 50% N reduction from agriculture and point sources
- 9 month slurry storage capacity

1991 Action Plan for Sustainable Agriculture

- Ban on slurry spreading in winter (harvest to 1st February)
- Obligatory fertilizer budgets

1998 National Action Plan II

- Subsidies to establish 16,000 ha of wetlands
- Livestock density of maximum 1.7 Livestock Units
- Plant available N to crops 10% below economic optimum

2004 National Action Plan III

- 50% reduction of P surplus in agriculture
- 15% further reduction of N from agriculture
- 10 m wide buffer strips along all watercourses and lakes > 10 ha



Reduction targets of Danish Action Plans as established in 1987 (nitrogen)

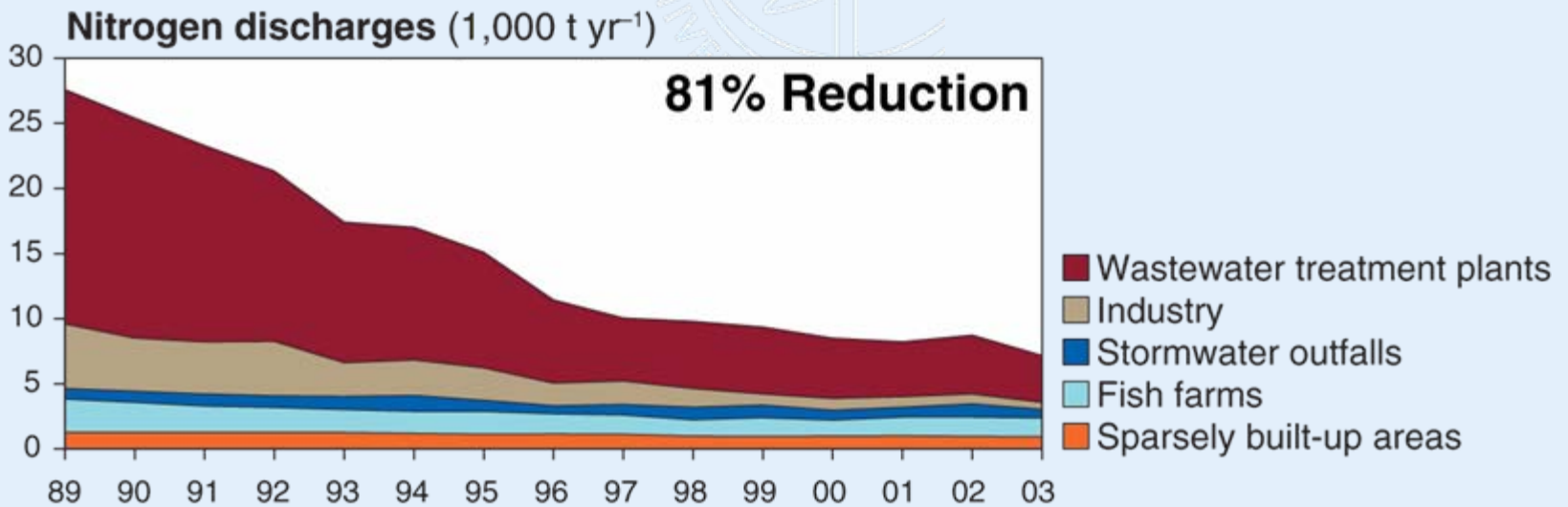
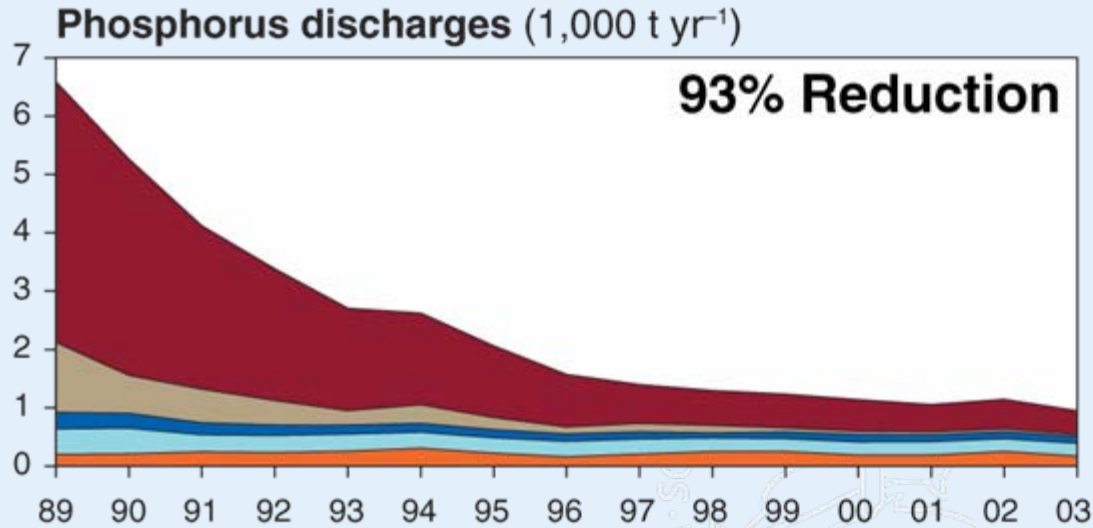
	Emissions mid.1980s	Reduction target	
	tonnes N	tonnes N	%
Agriculture, leaching from fields	230,000	100,000	43
Agriculture, point sources	30,000	27,000	90
Industry and sewage treatment plants	30,000	18,000	60
Total	290,000	145,000	50



Reduction targets of Danish Action Plans as established in 1987 (phosphorus)

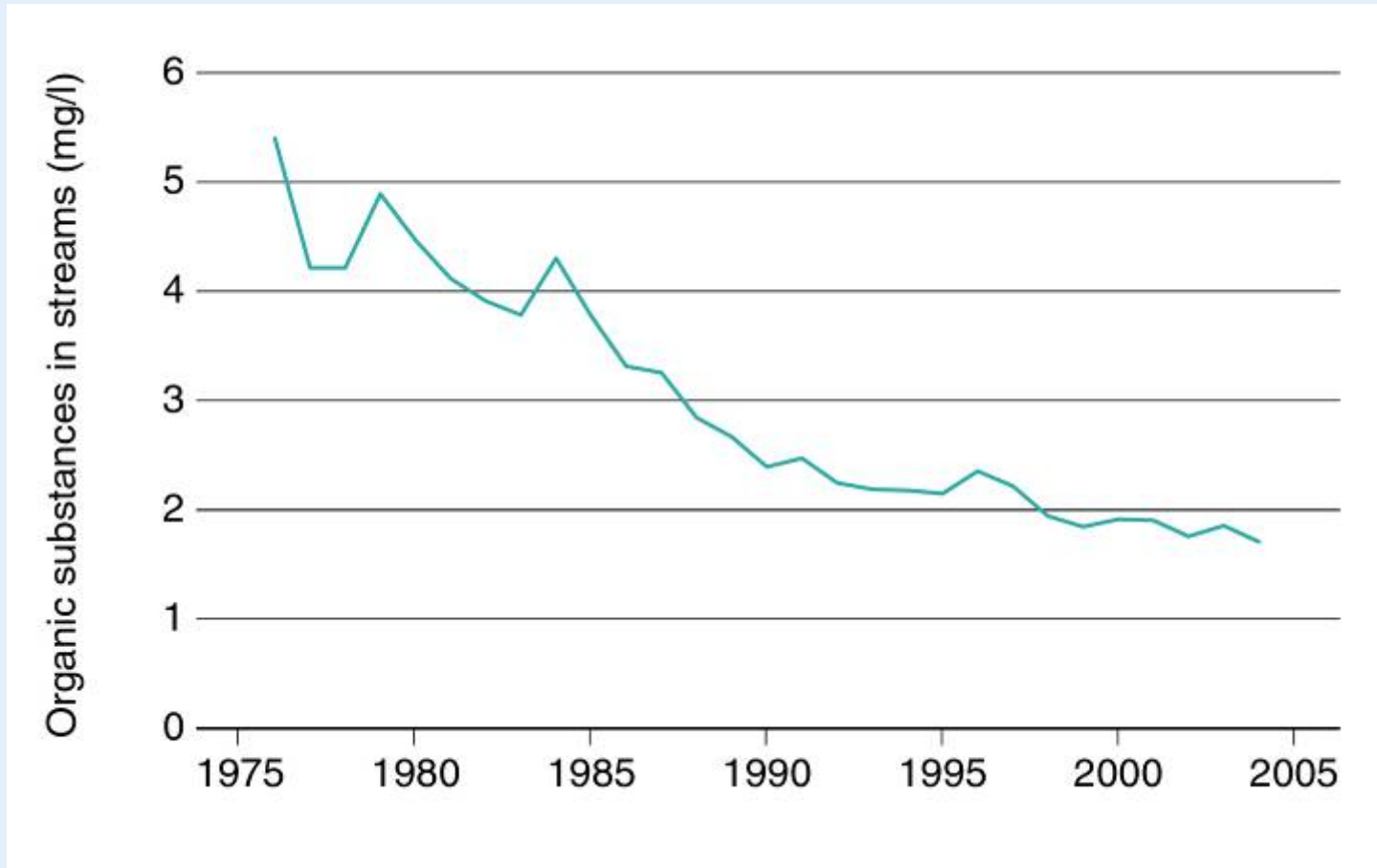
	Emissions mid.1980s	Reduction target	
	tonnes P	tonnes P	%
Agriculture, leaching from fields	400	-	0
Agriculture, point sources	4,000	4,000	100
Industry and sewage treatment plants	10,600	8,000	75
Total	15,000	12,000	80





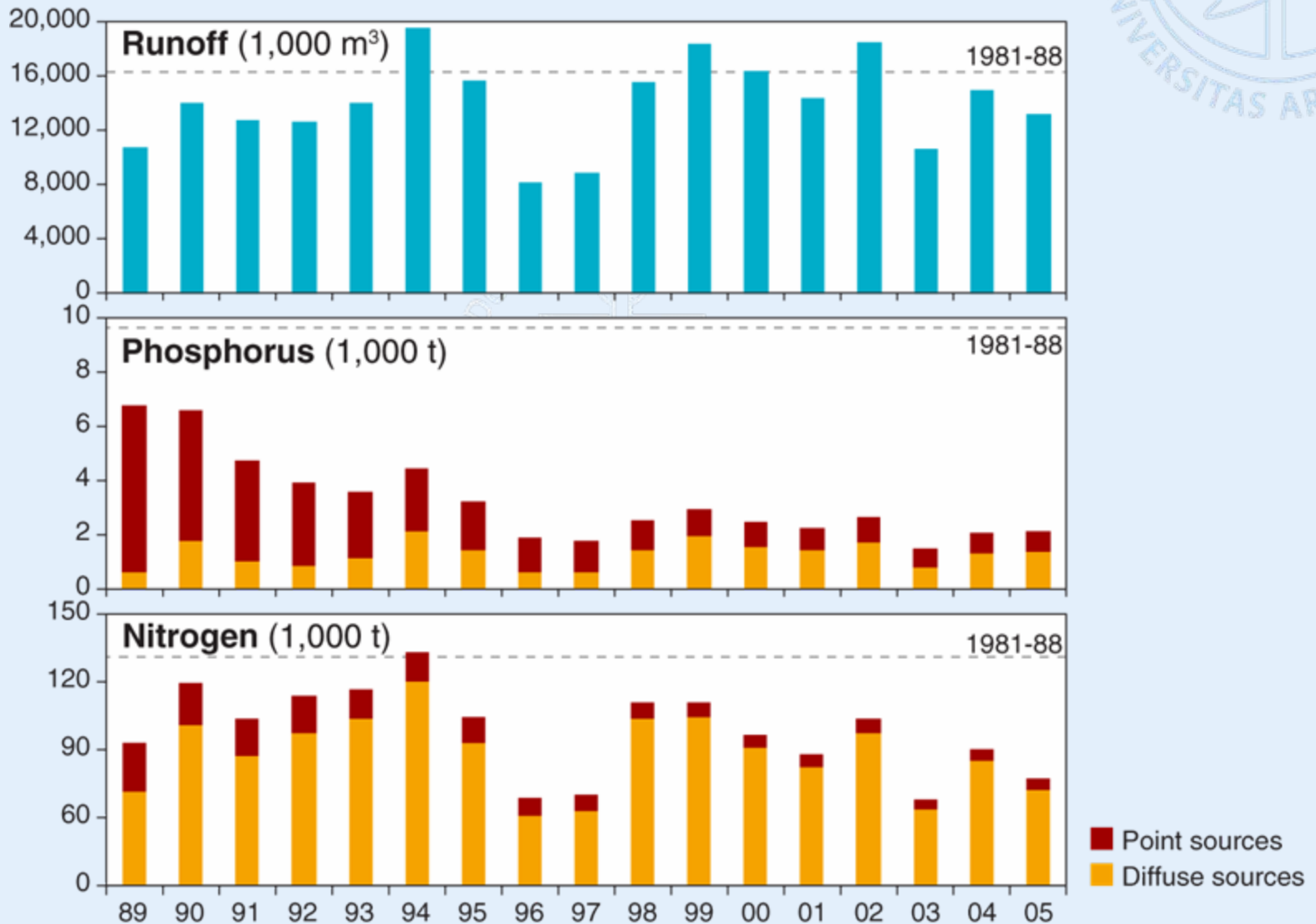
Water quality responses of cleaning up point sources in Denmark

Trends in the concentration of BOD in Danish streams 1975-2003





Water quality responses of cleaning up point source discharges of nitrogen and phosphorus

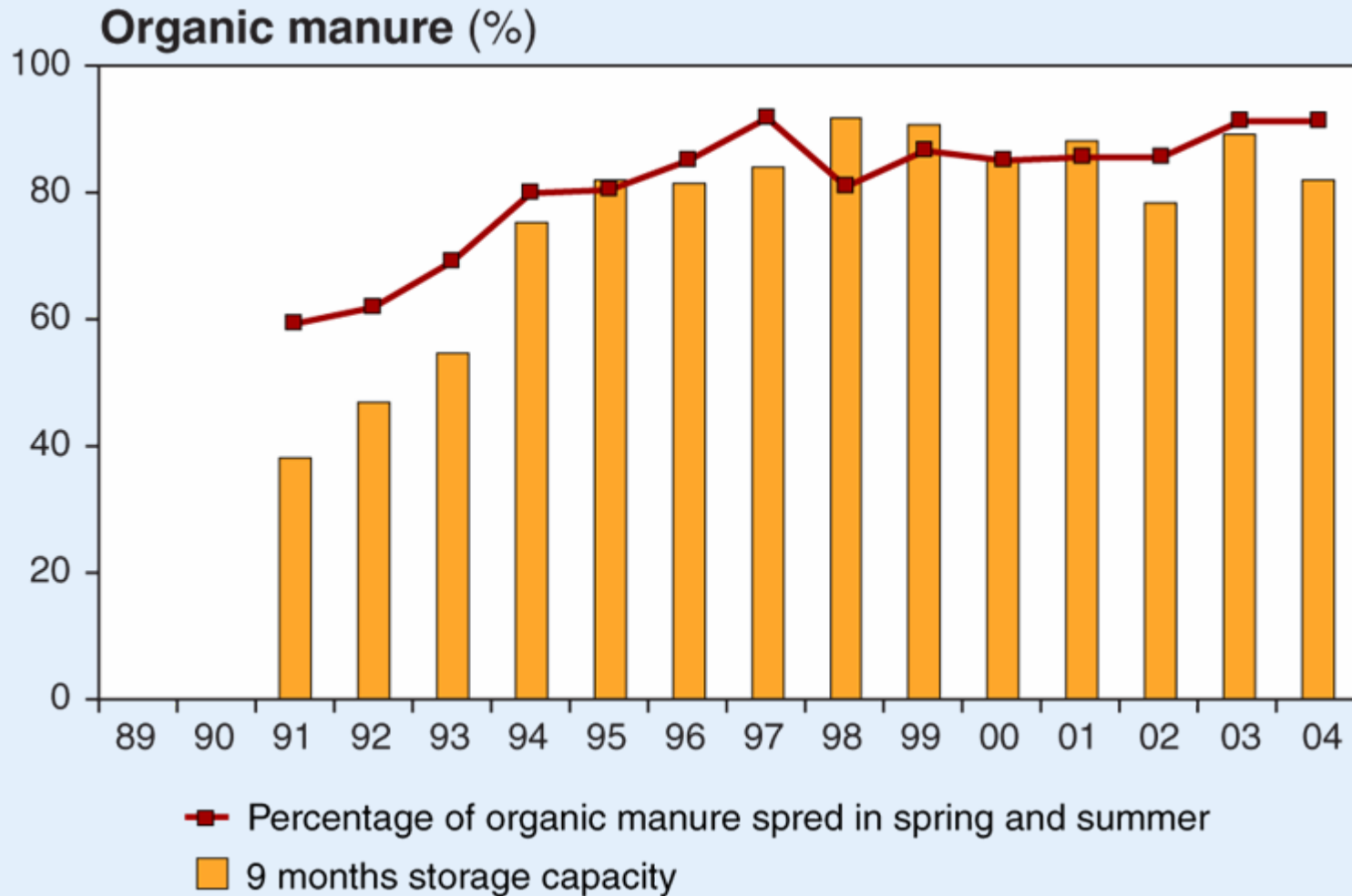


Mitigation of nitrogen leaching from agricultural fields – overview of measures applied at source in Denmark

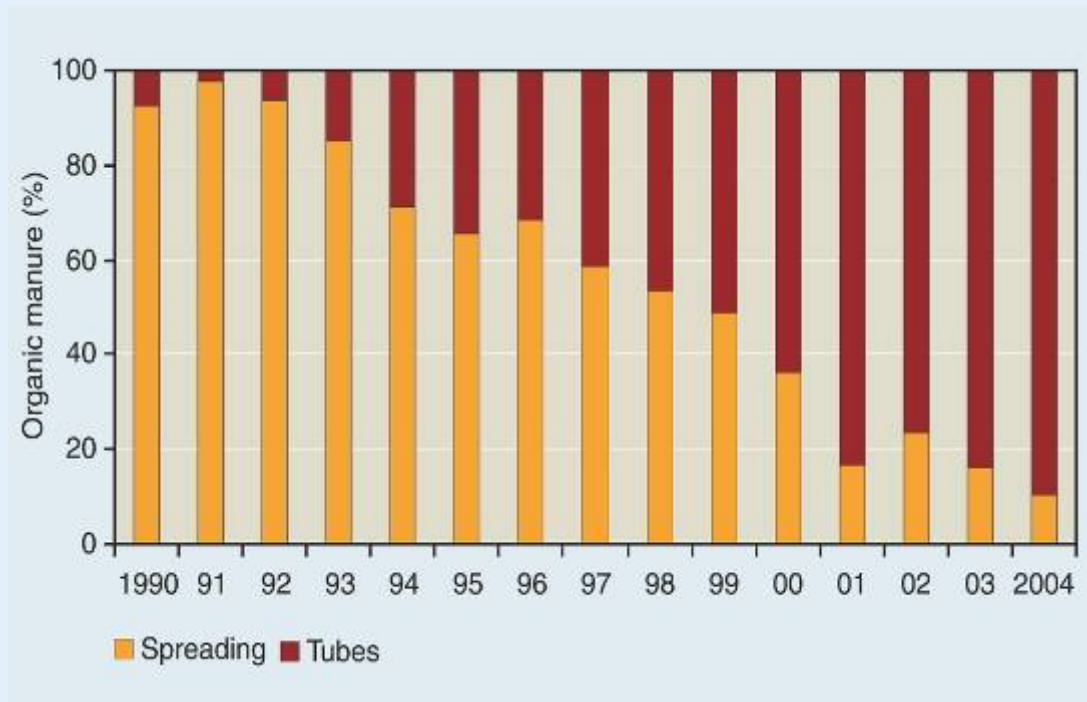
- **Green fields in winter**
- **Livestock harmony**
- **Demand for building of slurry tanks (6-9 months storage capacity)**
- **Crop and fertiliser plans**
- **Fertiliser accounts and levy system**
- **Nitrogen quota system**
- **Catch crops**
- **10 % reduction in nitrogen standards for crops**
- **required utilisation of nitrogen in animal manure (75 % for pig slurry, 70 % for cattle slurry and 65 % for manure)**



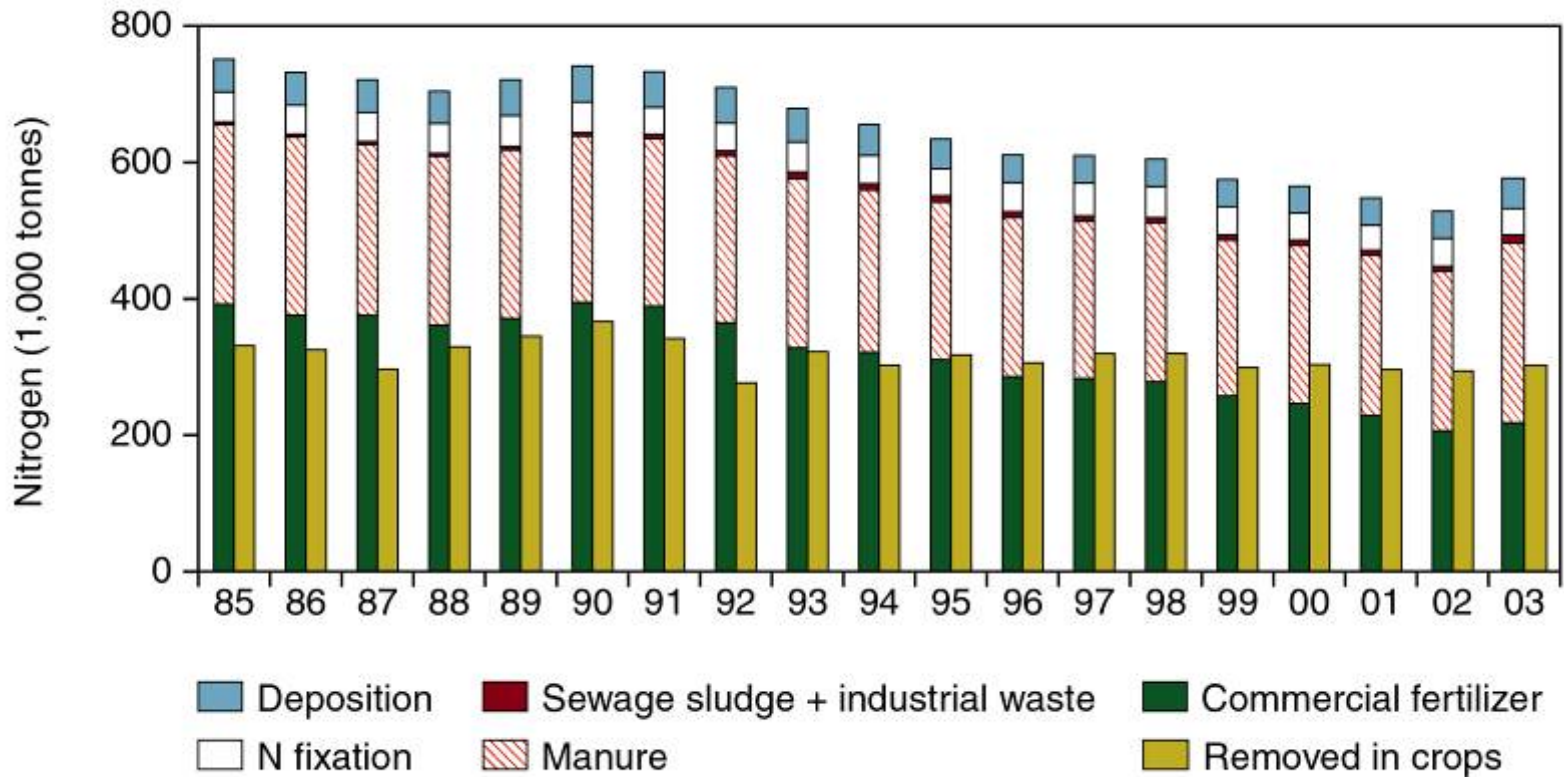
Storage capacity for liquid manure



Spreading technique for animal manure



Trends in the nitrogen balance in Danish agriculture

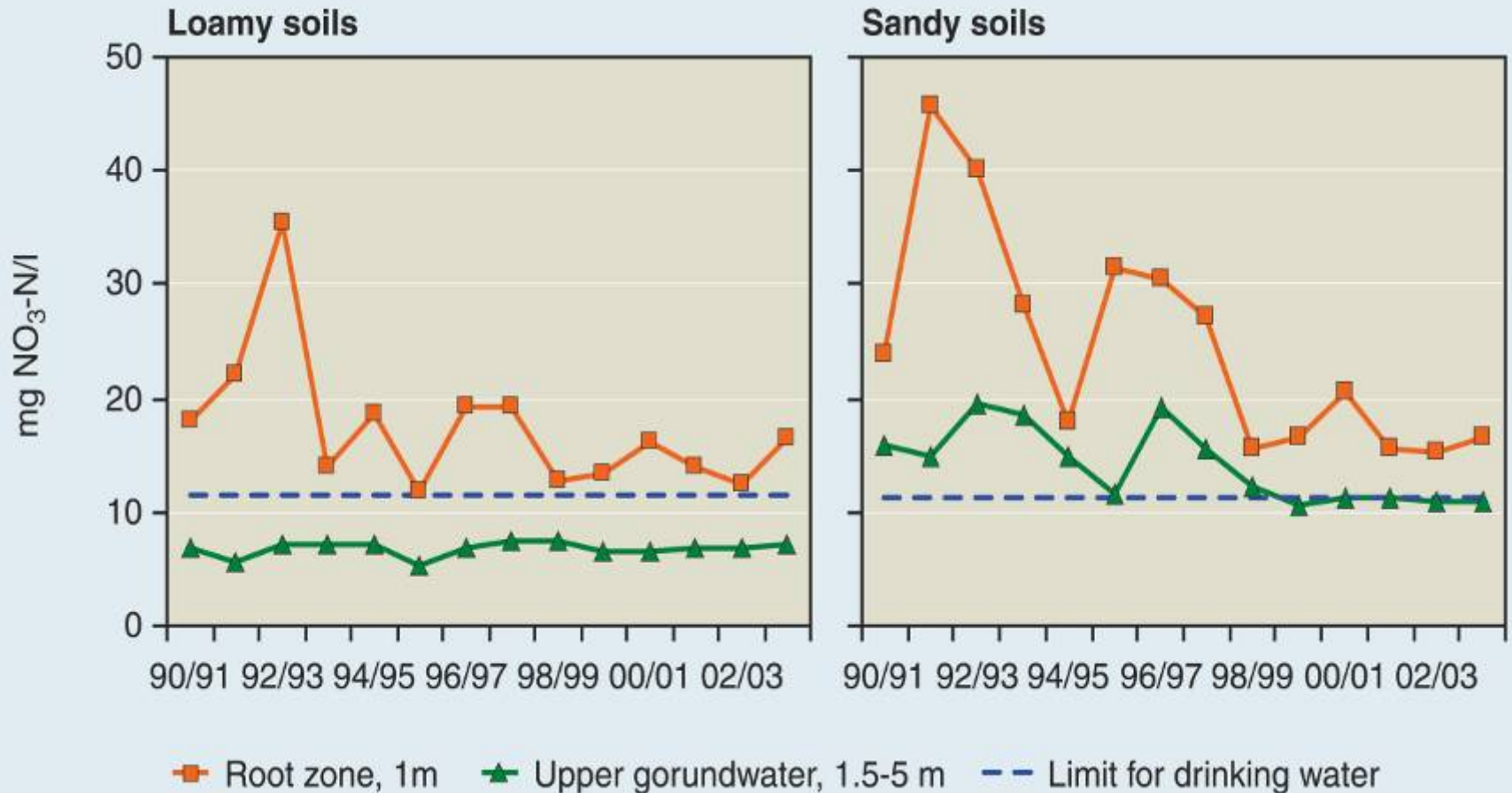


Trends in nitrogen consumption in Danish agriculture – 1989-2003

	1989	2003	Change
Chemical fertilizer	395.000 t	196.000 t	- 50%
Animal manure	244.000 t	237.000 t	- 3%
Surplus	375.000 t	247.000 t	- 31%



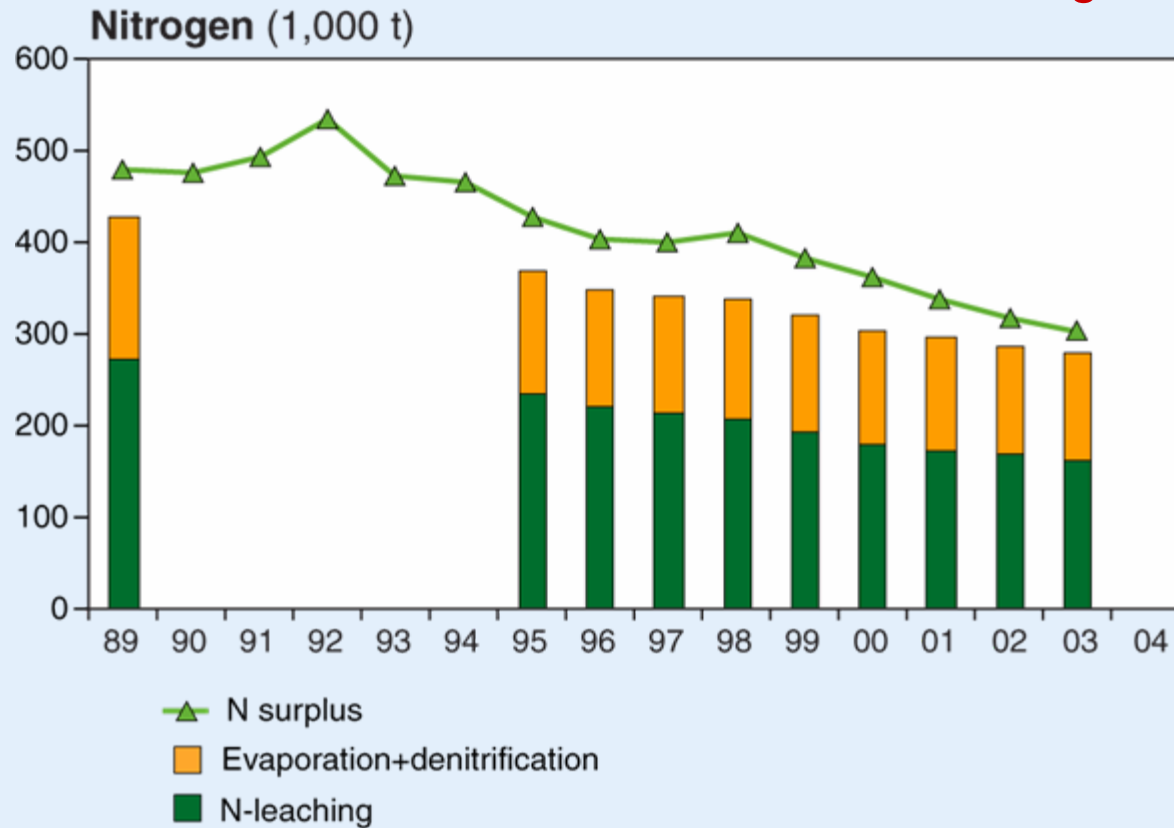
Monitoring results for nitrate in soil water and upper ground water, 1990-2004



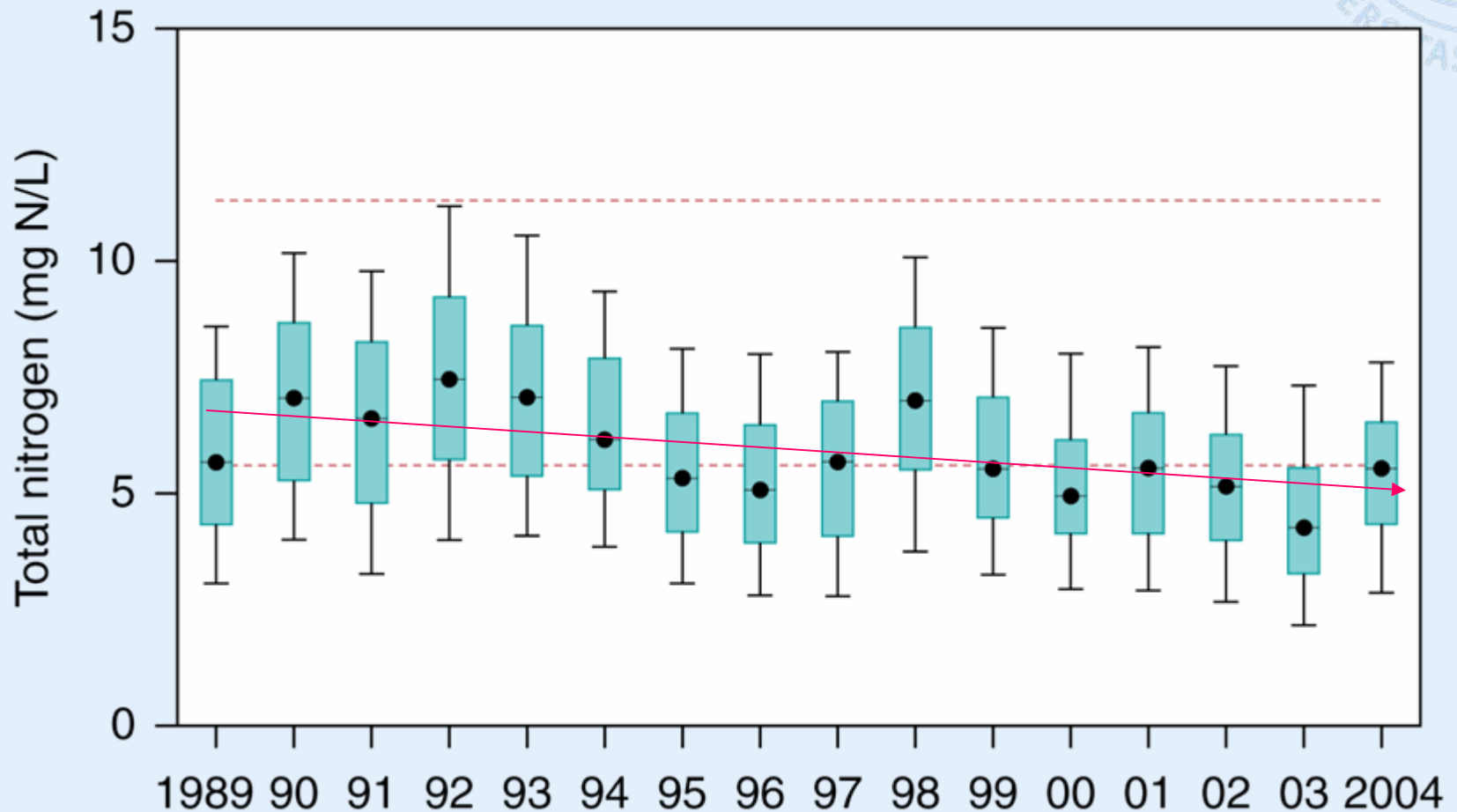
Model estimated development in nitrate leaching



Trend in N-leaching = - 33 %



Trends in total N in 86 Danish streams draining agricultural catchments = - 29 %



Mitigation of phosphorus losses from agriculture – overview of measures at source adopted in Denmark

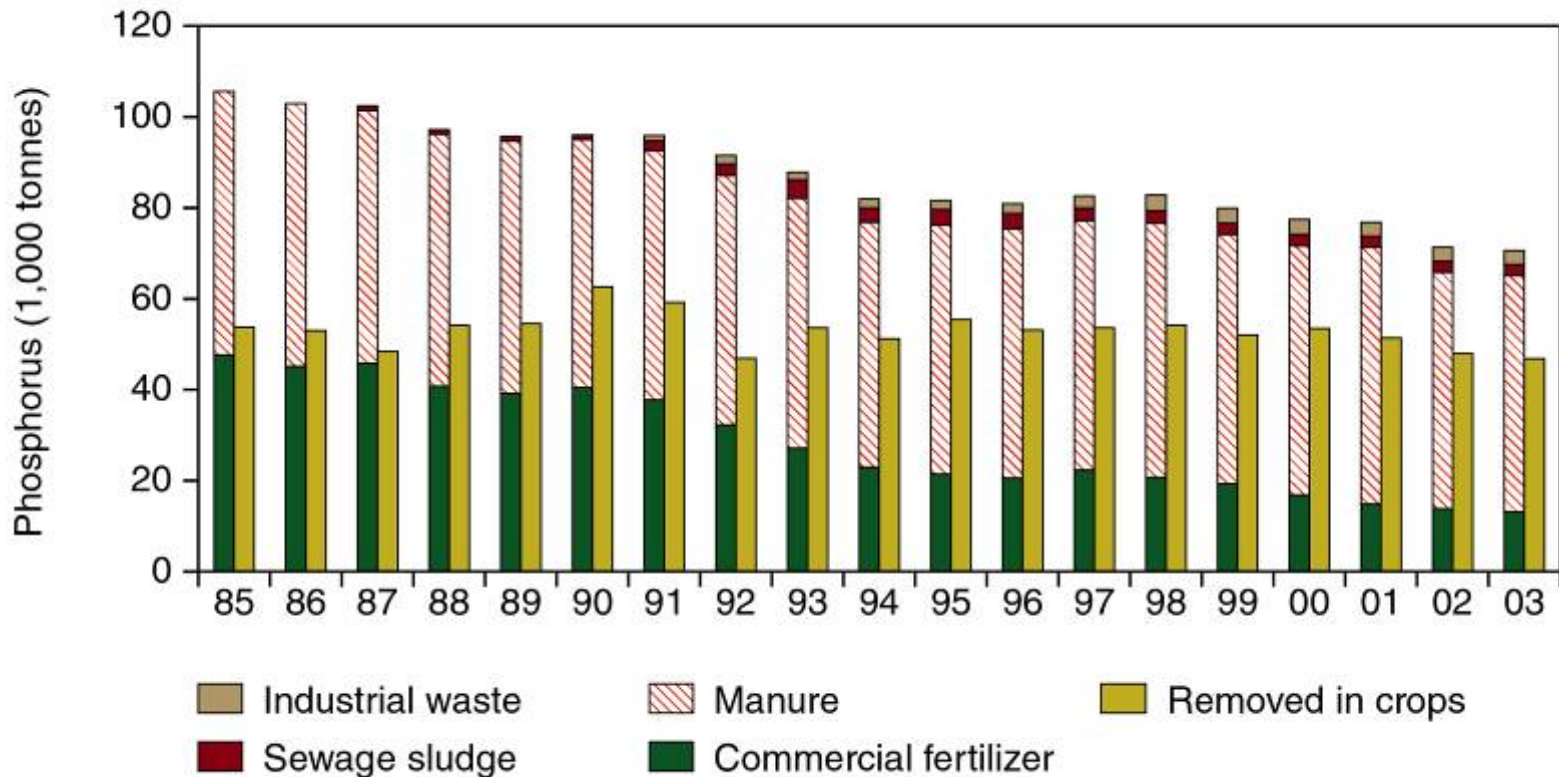
- Stop for farm effluents to surface waters (1987)

Regulations from Action Plan III in 2004

- The agricultural P-balance of $32.7 \times 10^6 \text{ kg yr}^{-1}$ must be halved by 2015.
- Improved utilisation of N and P in feed is assumed to reduce losses of N and agricultural surplus of P.
- A tax of DKK 4 kg^{-1} mineral P in feed.



Trends in the phosphorus balance in Danish agriculture



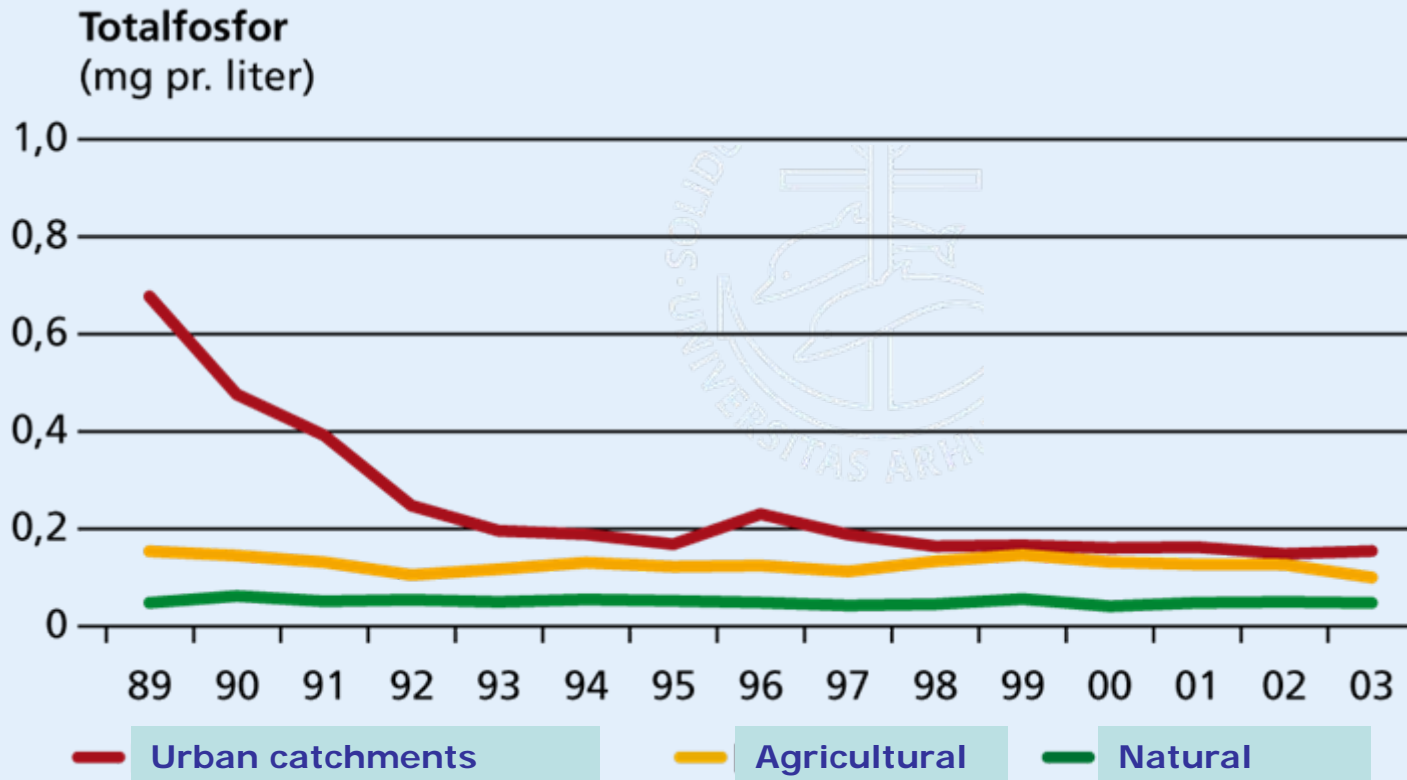


Trends in phosphorus consumption in Danish agriculture – 1989-2003

	1989	2003	Change
Chemical fertilizer	39.400 t	13.600 t	- 65%
Animal manure	55.500 t	52.100 t	- 6%
Surplus	41.300 t	21.400 t	- 48%



No trends in phosphorus concentrations in streams draining agricultural catchments can be detected !!!!



Area assignments – measures adopted during the three Action Plans

- Restored wetlands on up to 24,000 ha
- Ground water protection areas on up to 88,000 ha
- Subsidies for afforestation on up to 25,000 ha
- Subsidies for organic farming on up to 170,000 ha
- Establishment of 50,000 ha of buffer zones along streams and around lakes before 2015 to reduce losses of P from surface runoff, bank erosion and leaching



Wetland restoration – Denmark in the forefront



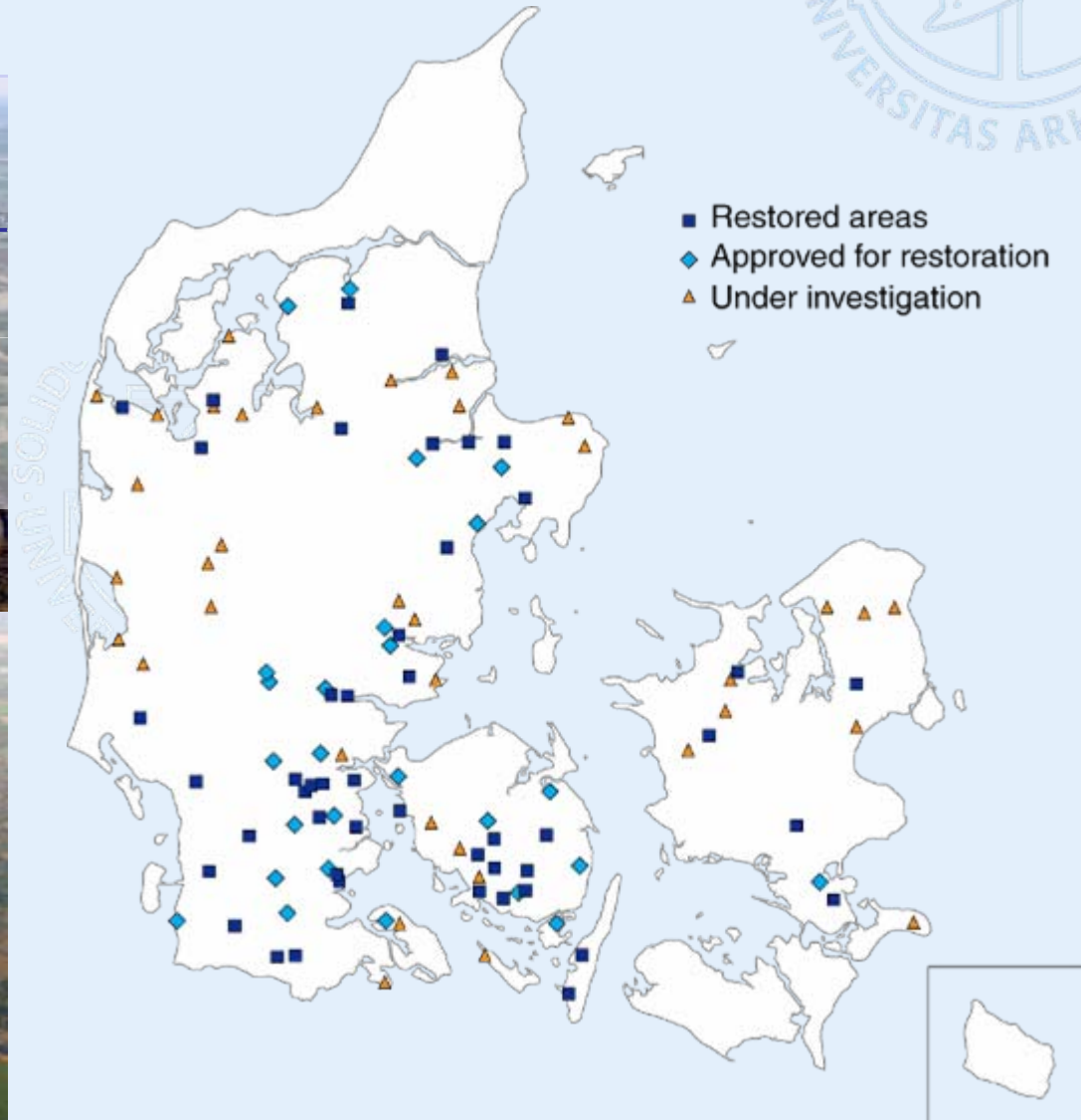
Project type	Hectares restored	Nitrogen retention (kg N ha ⁻¹ yr ⁻¹)
Restored Wetlands	2,985	264
Restored lakes	3,844	251
Total	6,829	259



River Skjern 2,200 hectares



Lake Bølling 750 hectares



Conclusions

- Denmark has been one of the most successful among the EU countries, to reduce point source pollution.
- Denmark has also been one of the most successful among the EU countries to reduce N-surpluses and N-losses maintaining at the same time crop yields and increasing livestock production.
- Denmark has utilised a combination of good agricultural practice, regulations on N (utilisation of N in manure), livestock regulations and area assignments (wetlands, afforestation, etc.)
- Denmark initiated with the last Action Plan III a regulation of phosphorus including halving of the P-surplus and implementation of 10 m wide bufferstrips along all streams and lakes.
- Nutrient responses of a changing climate is hidden as a signal in the time series but masked by the overwhelming trends observed due to changes in the anthropogenic pressures.
- A new holistic management approach is needed integrating needs in all Directives and considering climate change.



Thank you for your attention !

