N management in Denmark

-*trends, challenges & prospects for improved N efficiency*

By Tommy Dalgaard *et al.*
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TFRN-10 Task Force on Reactive Nitrogen meeting.
Session 3: National case studies. The Ministry of Environment (MAOTE)
Lisbon, Portugal. April 29-30 2015.

dNmark research alliance

Program

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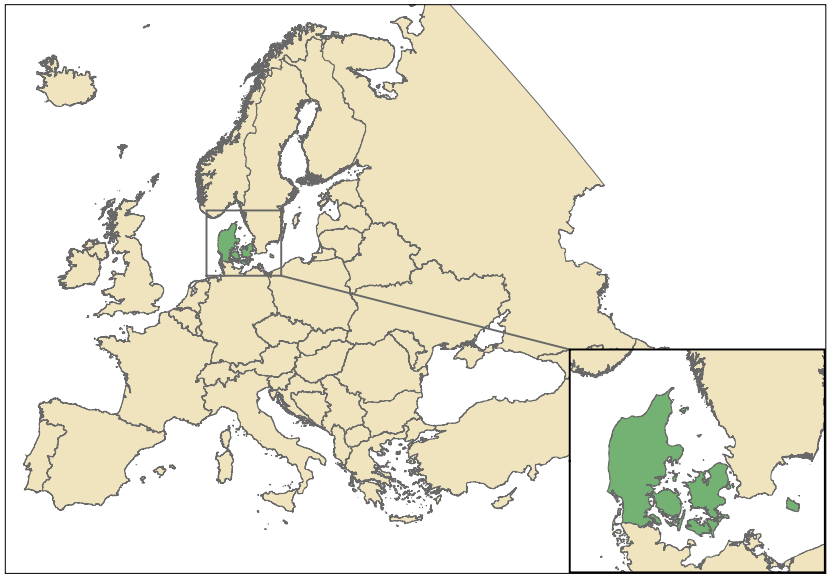
- **Introduction**
- **The Danish Nitrogen Alliance**
- **Trends, challenges and prospects for improved N management and N efficiency**
- **Conclusions**

Agriculture in Denmark

- **2.6 mio ha agricultural land (62% of total area)**
- **5.5 mio people – 4.5 mio t milk - 29 mio pigs/yr**
  - 9.7 t milk/cow/yr
  - 30 piglets/sow/yr
  - 7.5 t wheat/ha/yr
- **7500 km coastline**



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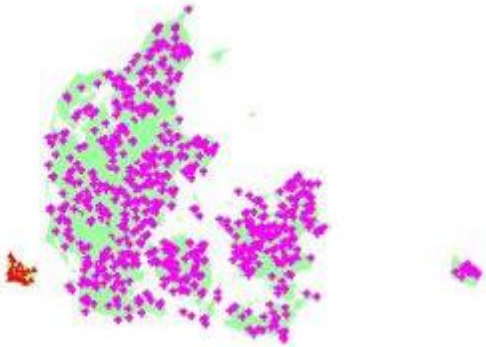
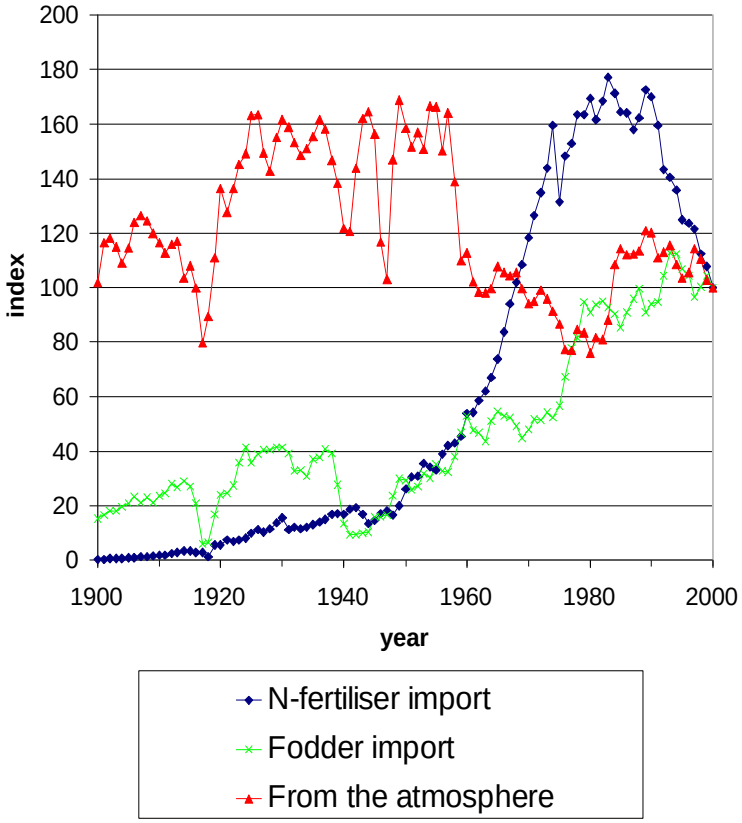
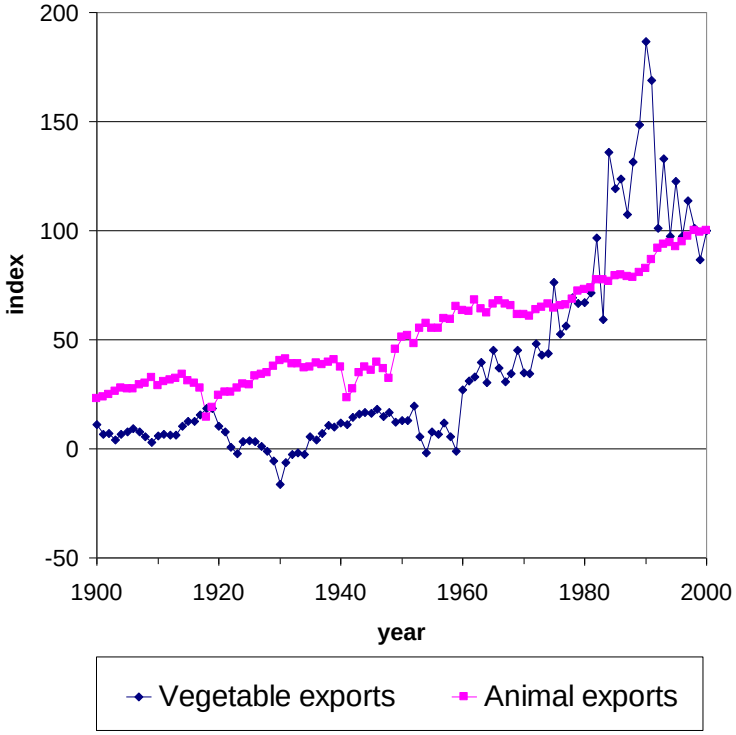
	Dairy Cows (1000's)	**Pigs** (1000's)	**Wheat cereals** (1000 ha)
1900			
1950			
2000			

Development phases

N-imports

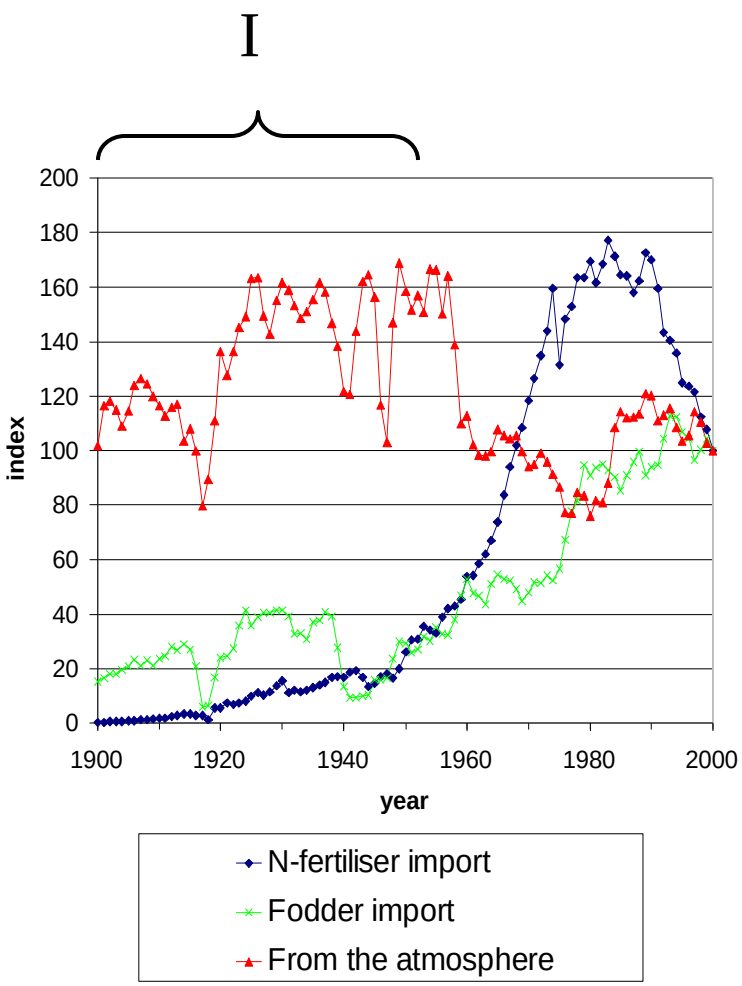


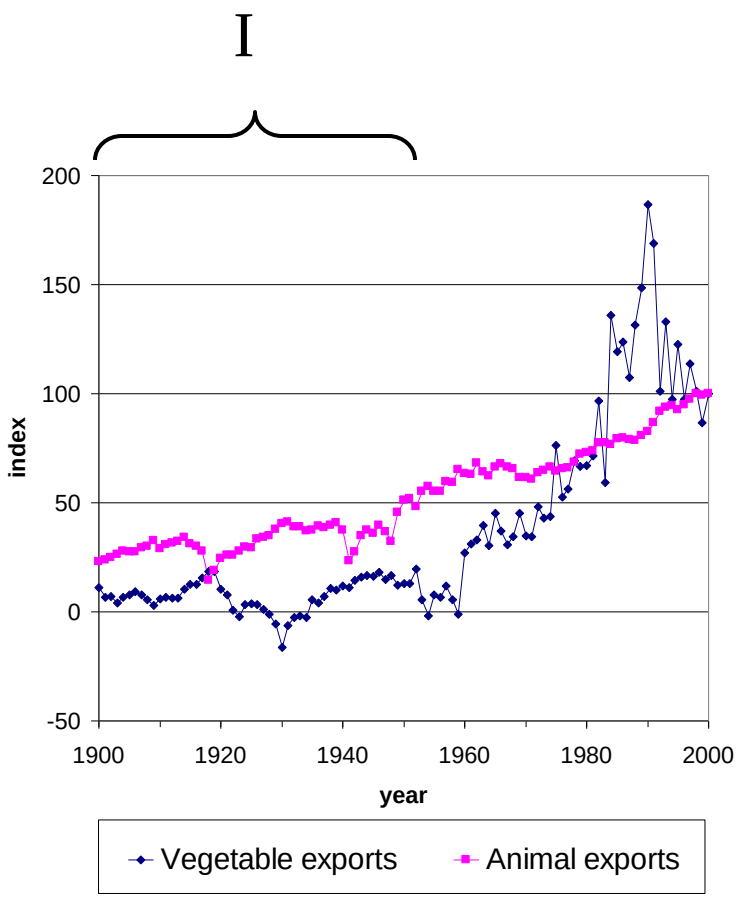
N-exports



NB: year 2000= index 100

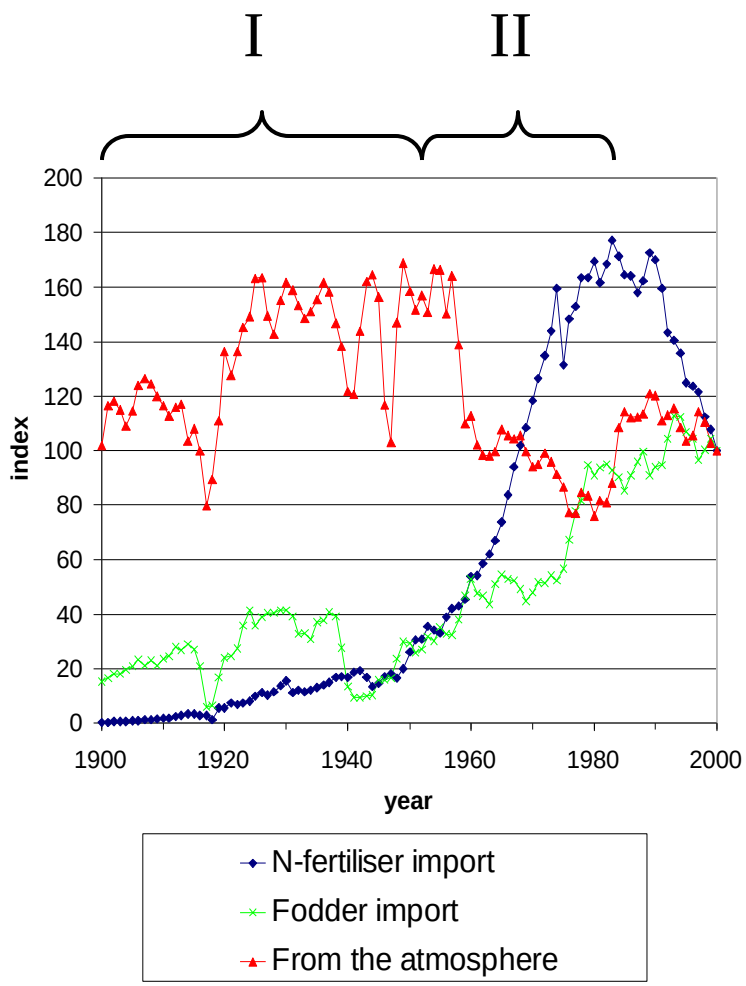
I: Traditional livestock farming (1900-1950)

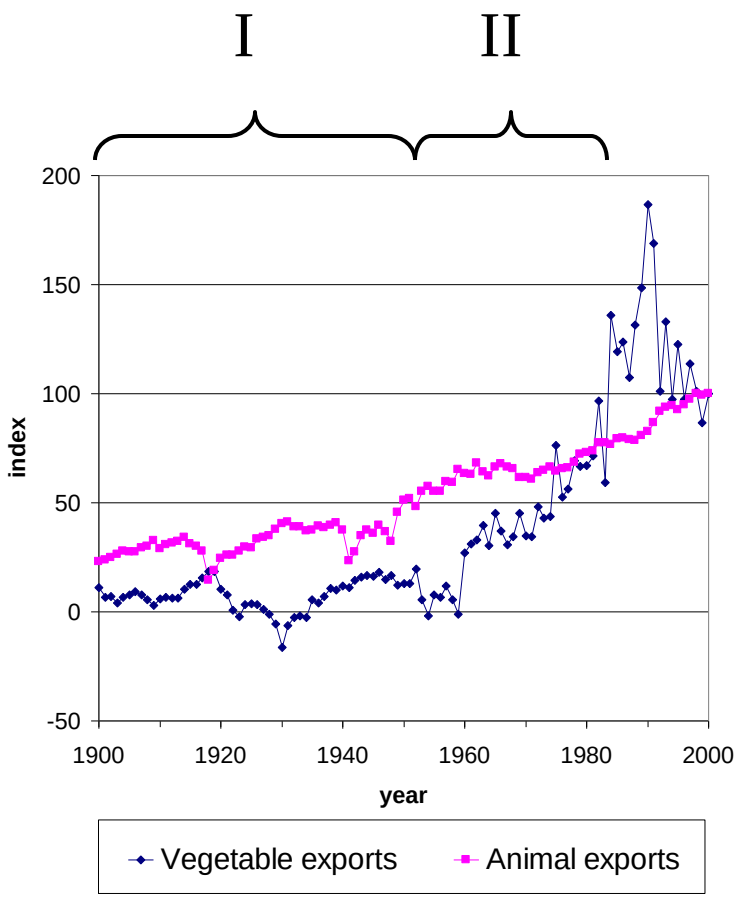




NB: year 2000= index 100

II: The "green" revolution (1950-1983)





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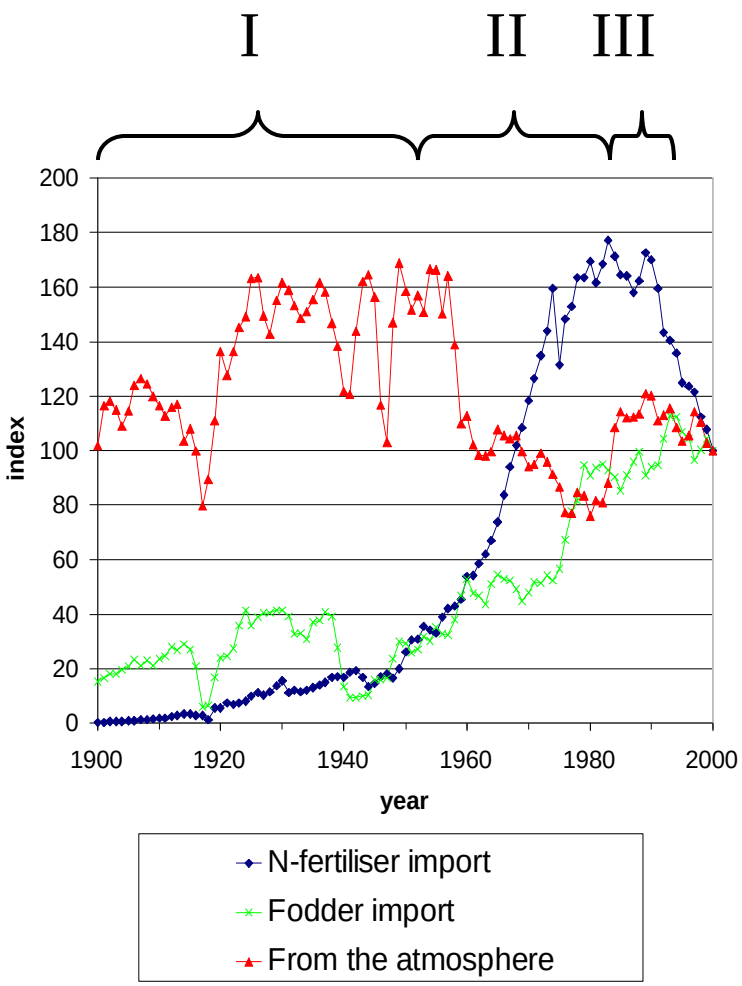
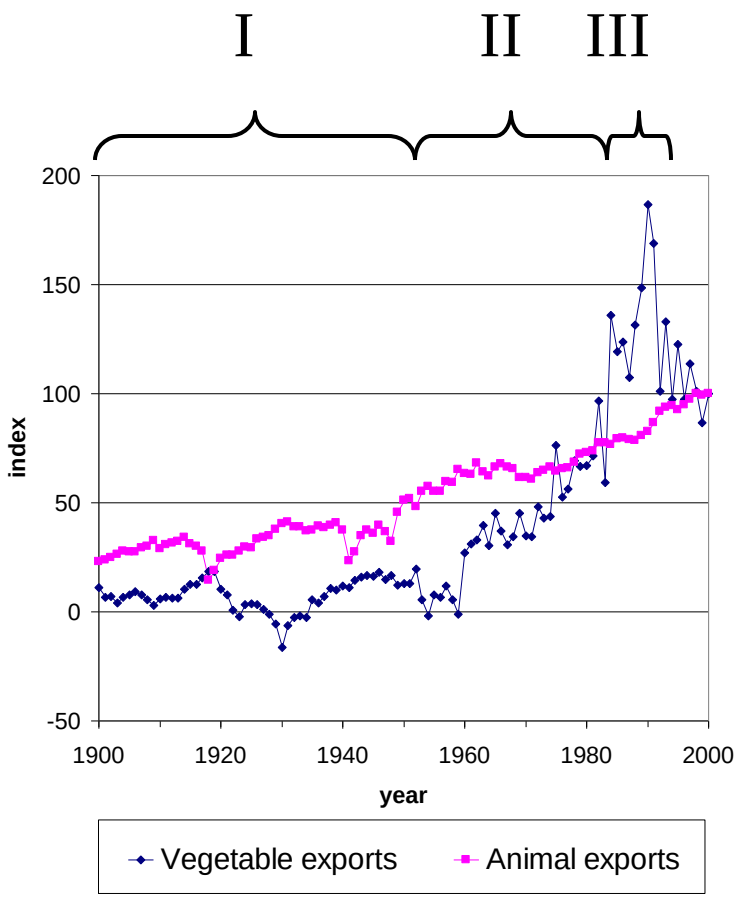
III: Limits to growth (1984-1993)





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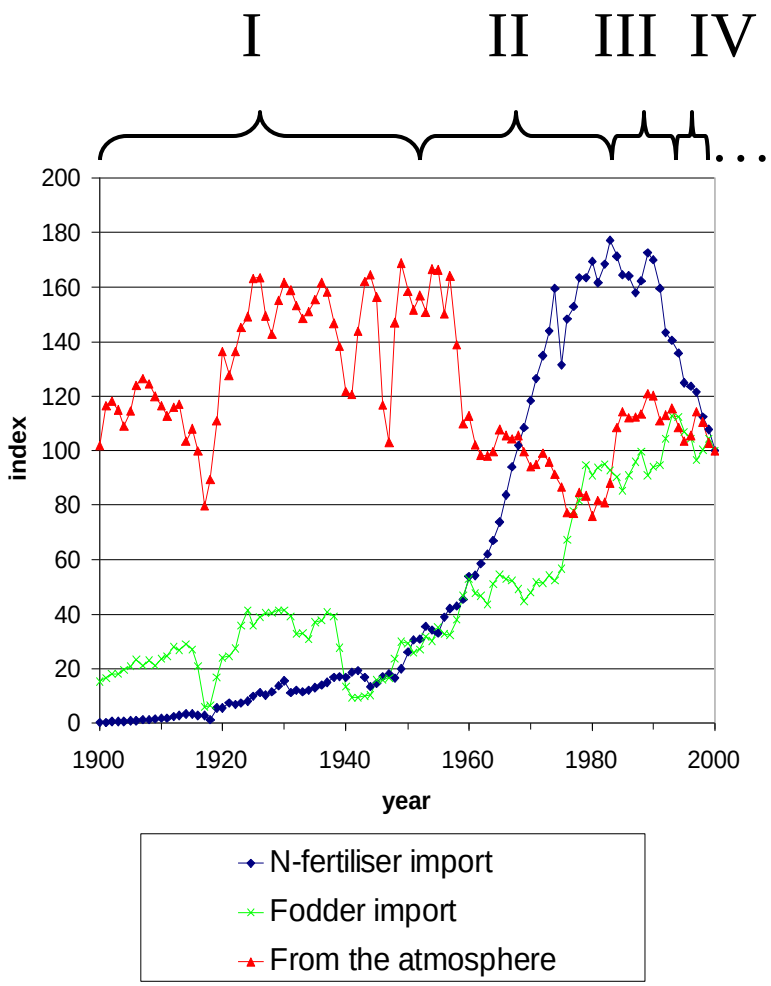
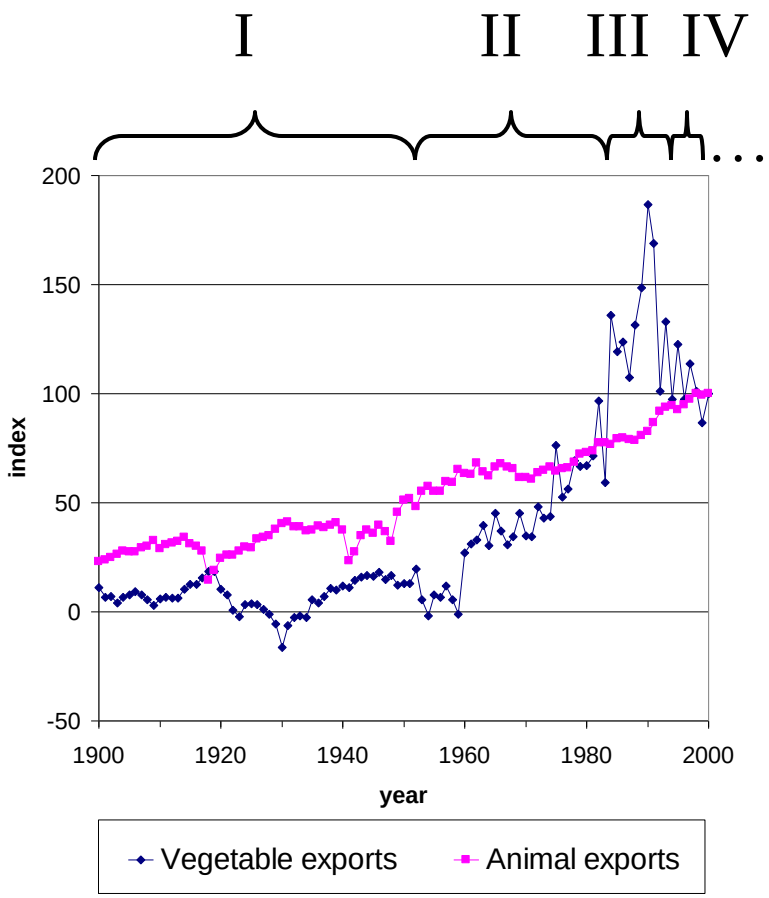
IV: Globalisation and sustain-able development? (1994-?)





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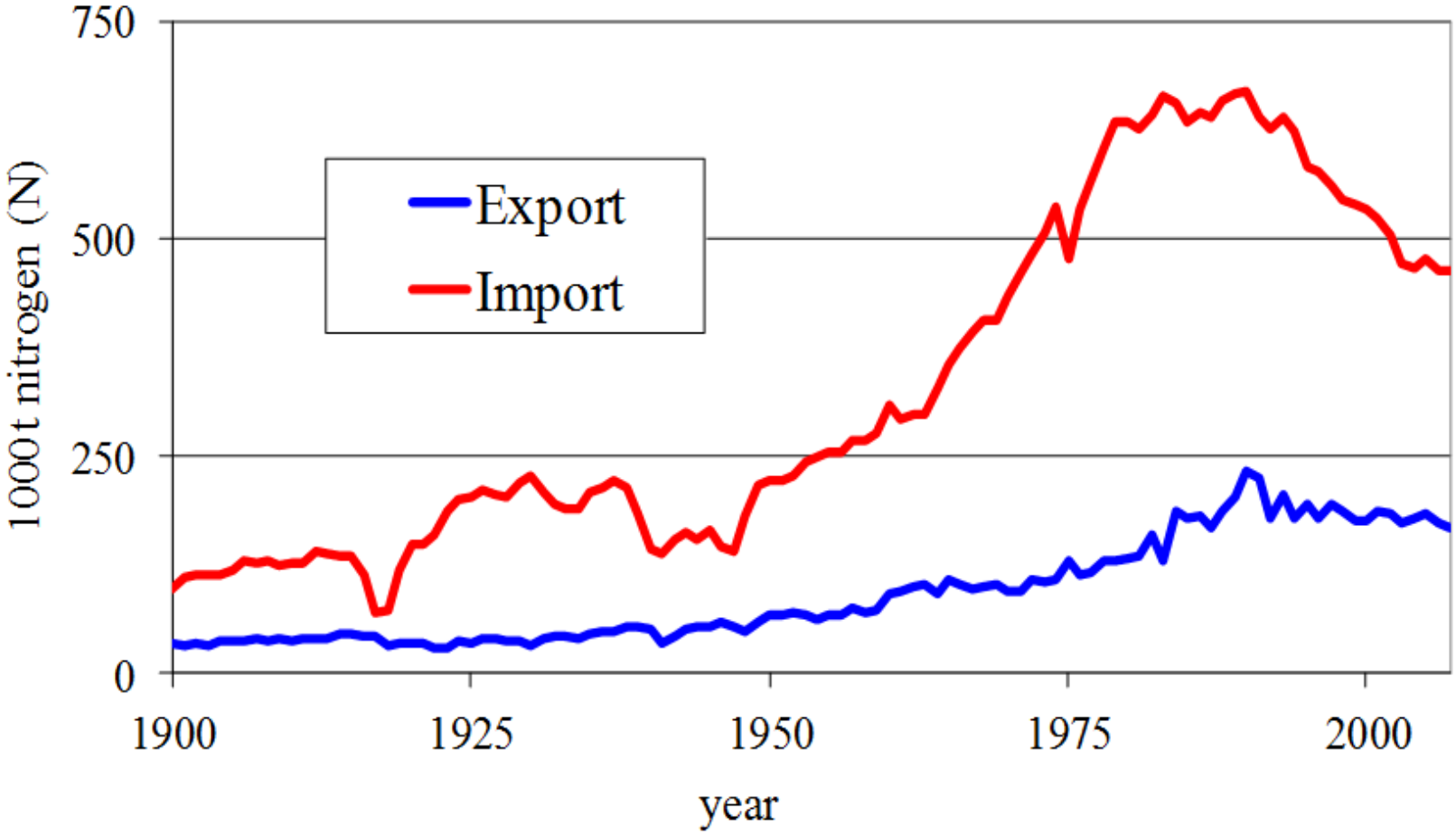
N-efficiency in Danish Agriculture



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Intensive agriculture near to the coast

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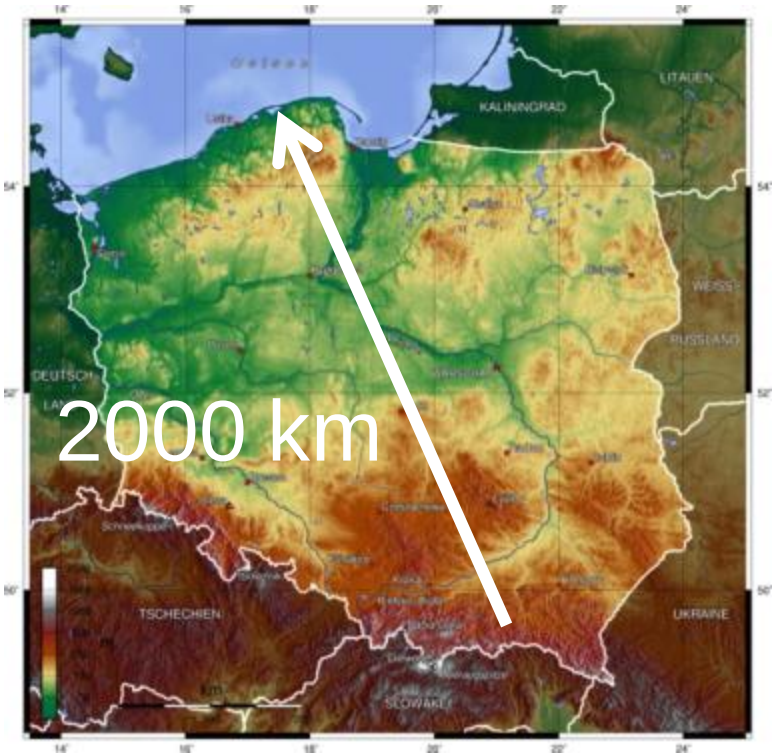
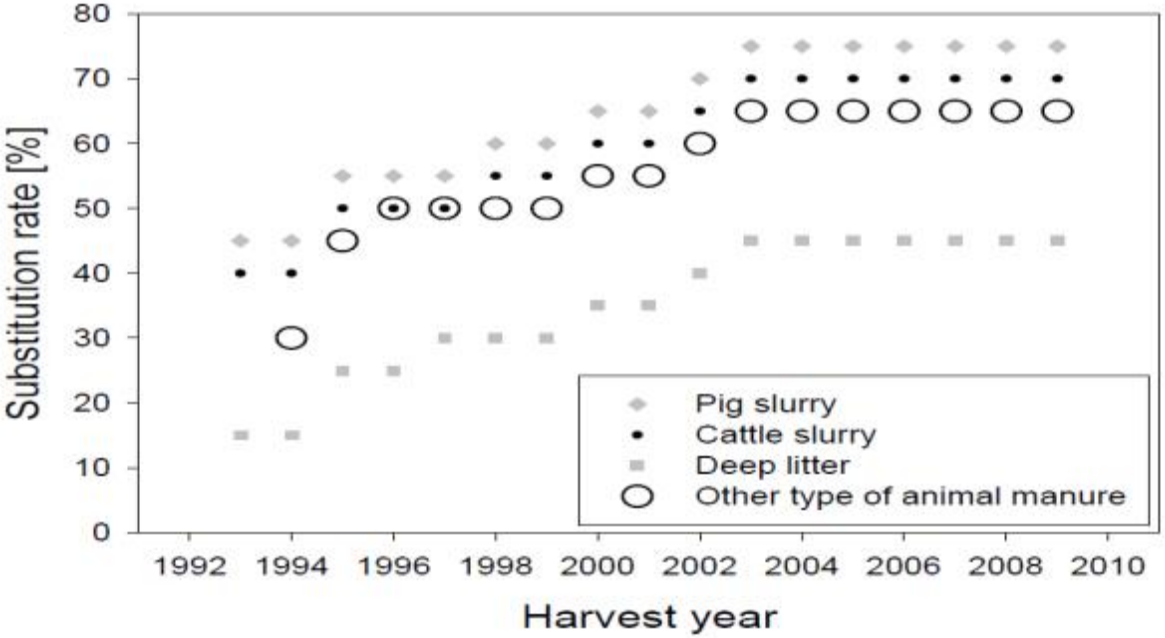


Action plans

- The 1985 Action Plan
- AP-I for the Aquatic Environment (1987)
- Action Plan for Sustainable Agriculture (1991)
- AP-II for the Aquatic Environment (1998, 2000)
- Ammonia Action Plan (2001)
- AP-III for the Aquatic Environment (2004)
- Green Growth (2009)
- EU Water-Framework Directive implementation (2010+)



Studying all components of Danish nitrogen landscapes

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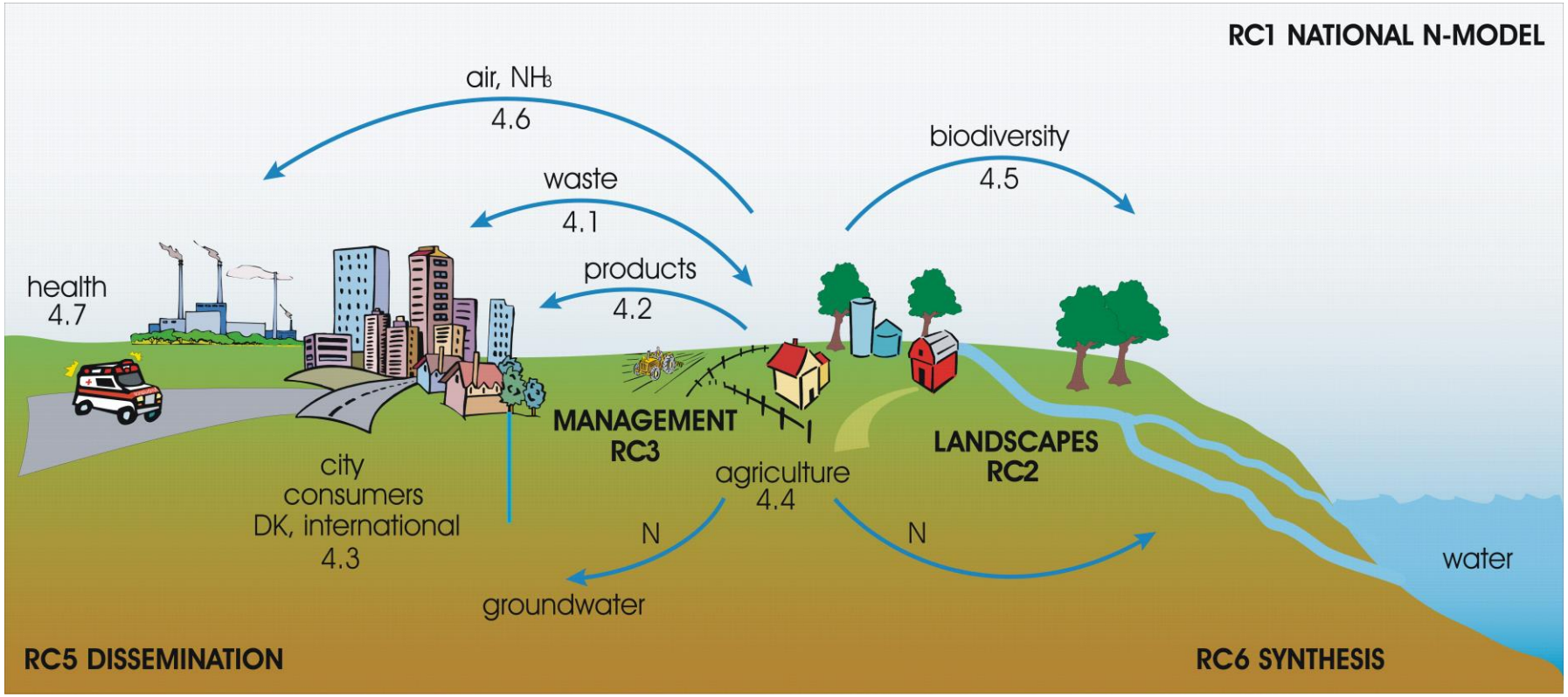
Research components:



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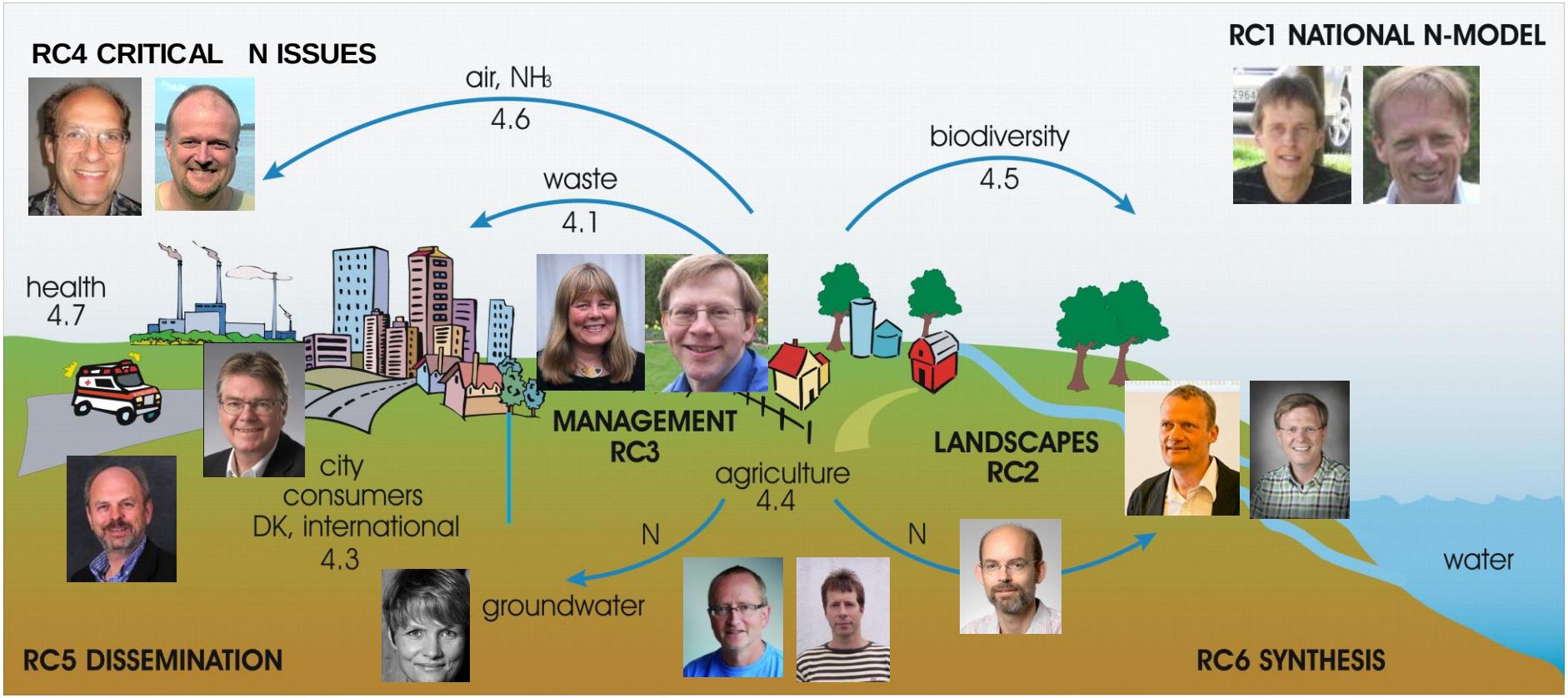

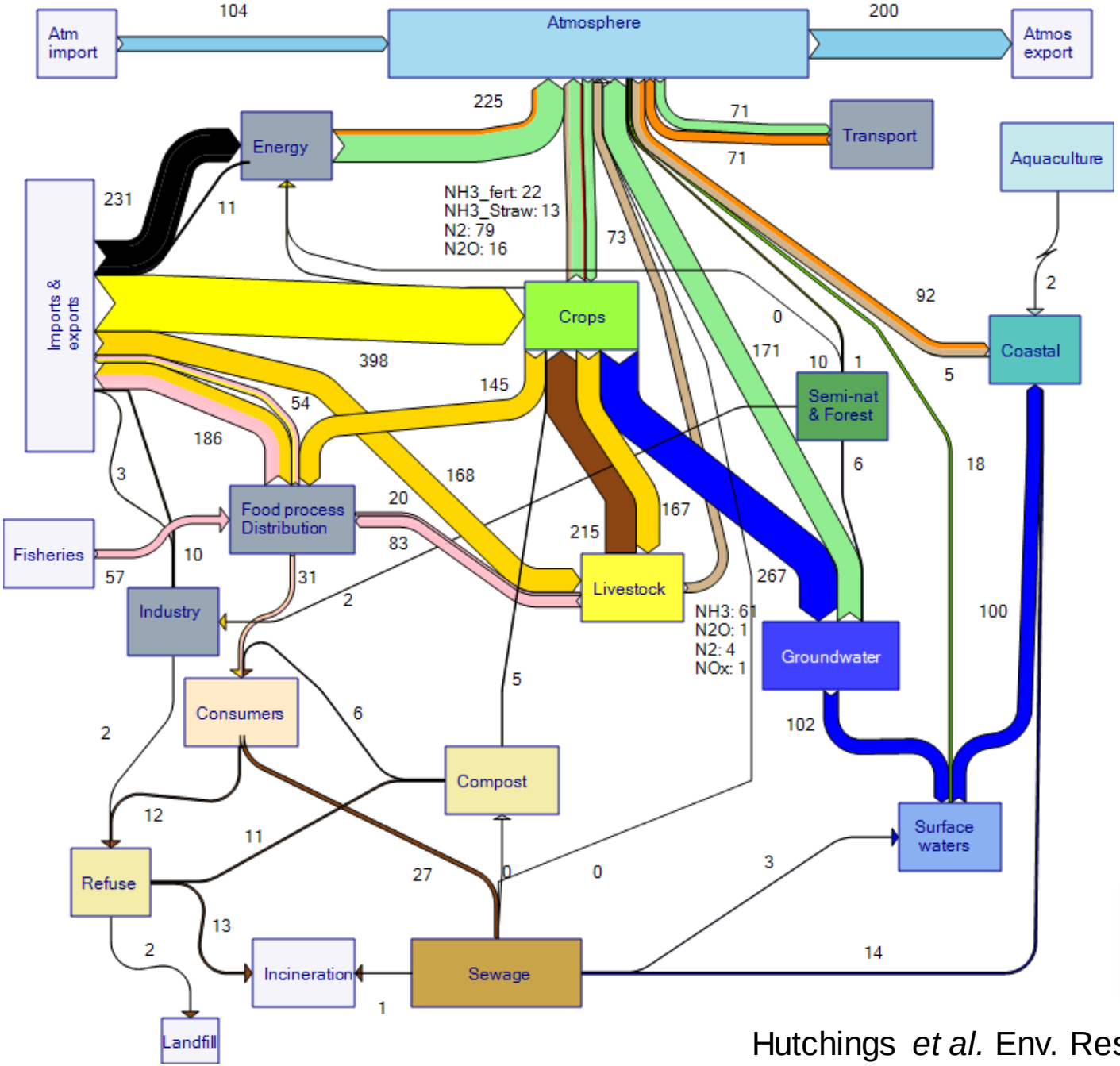

1990
kt N yr^{-1}

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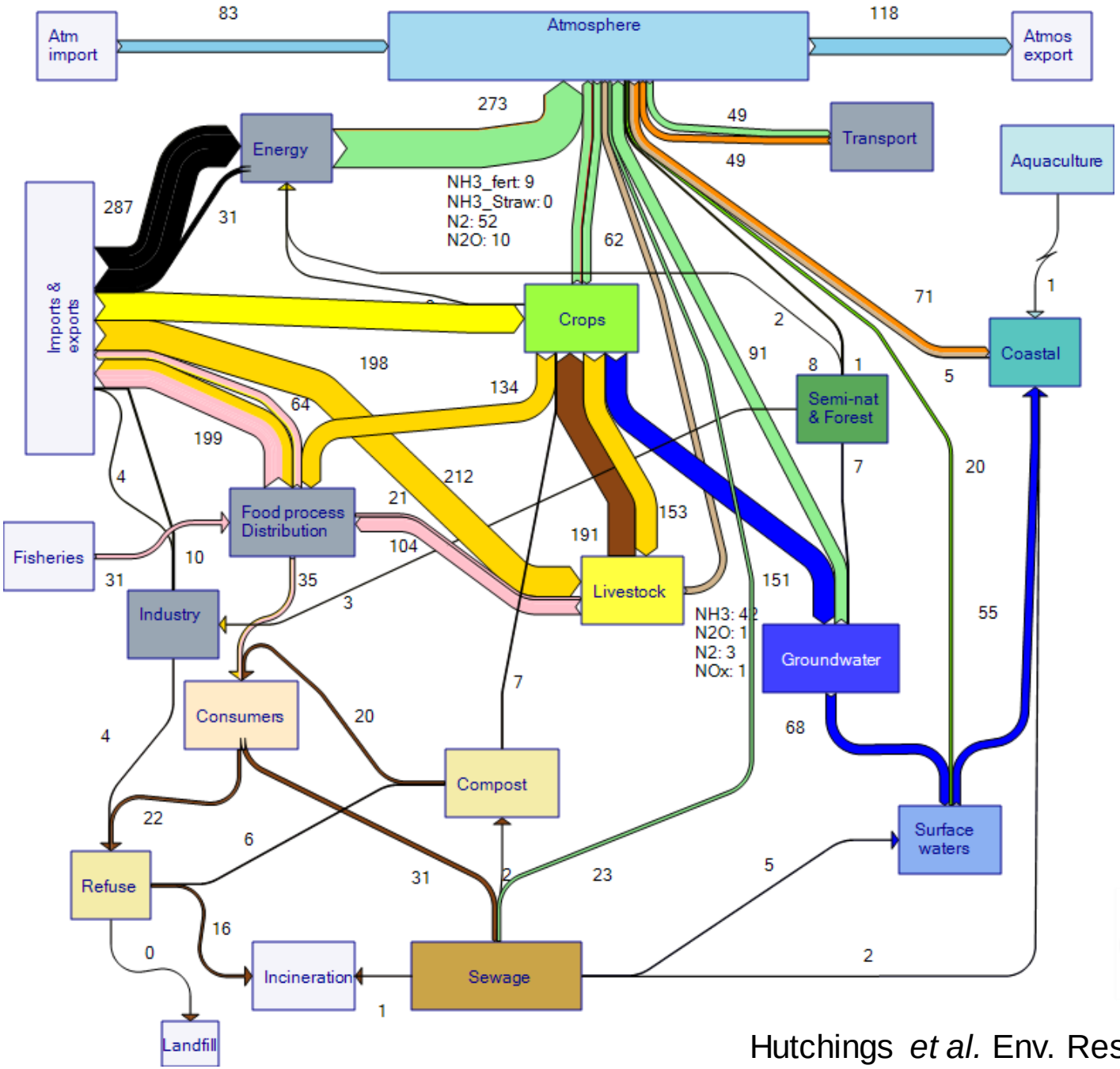

2010
kt N $år^{-1}$

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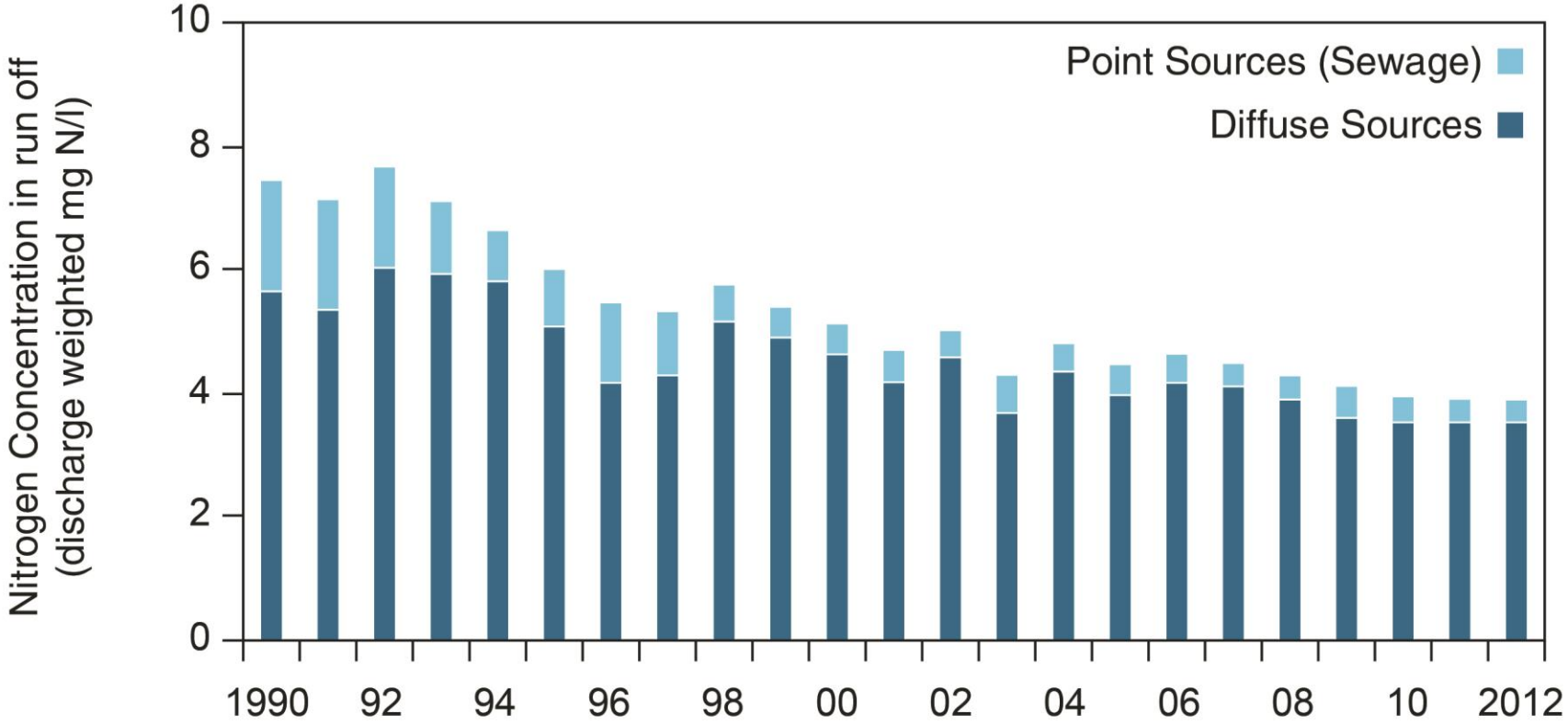
Surface water outflow to the sea



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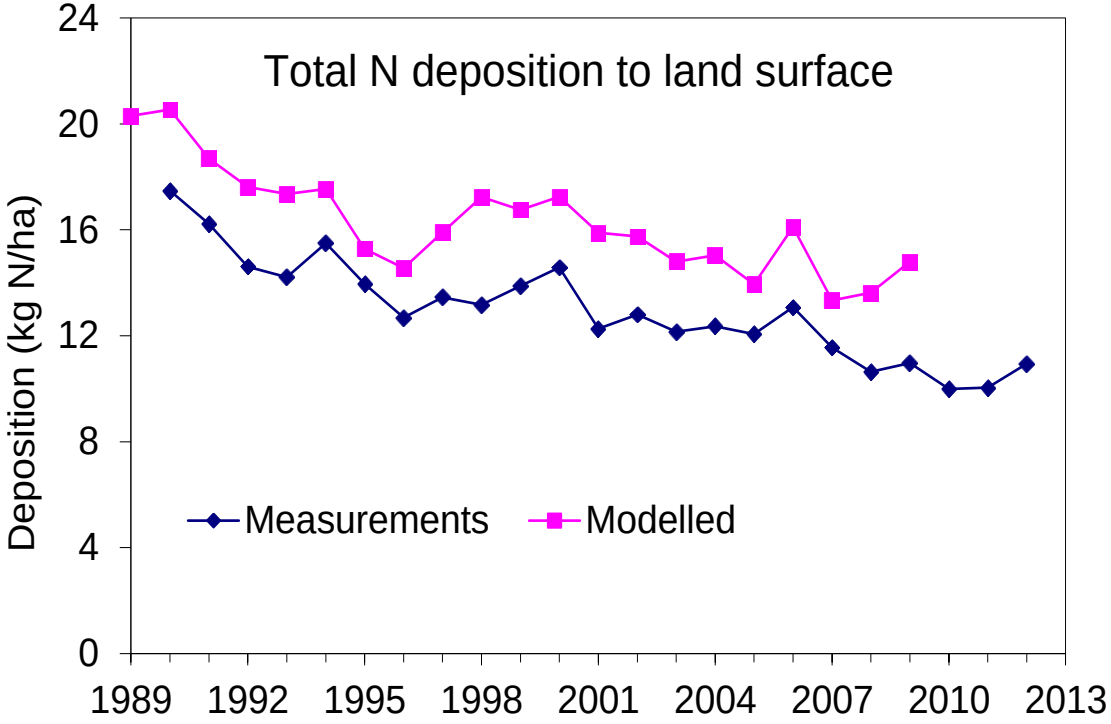
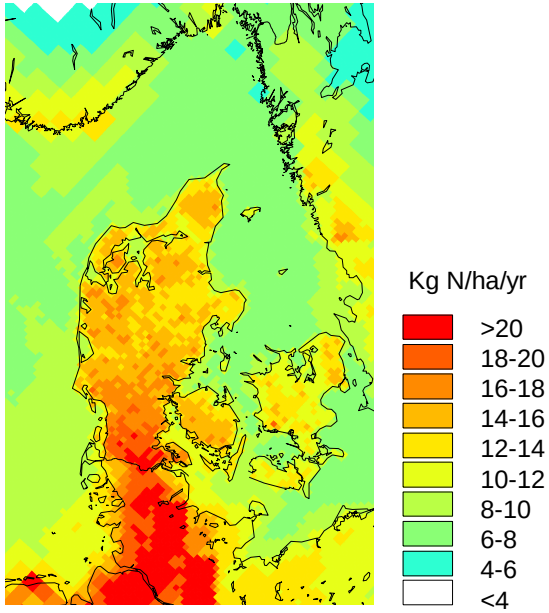
Atmospheric N deposition





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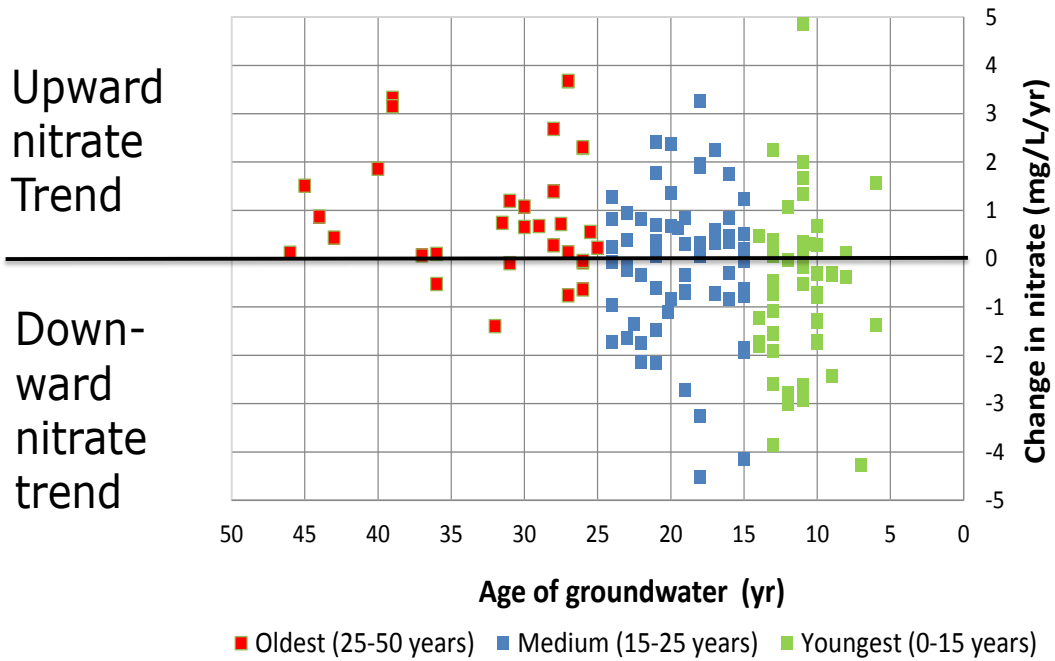
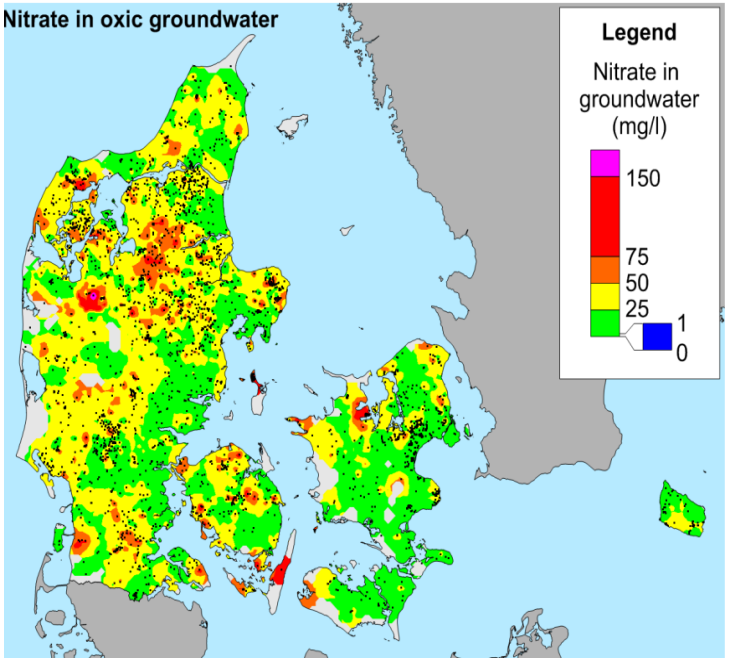
Groundwater concentration





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Danish Farm N surplus Development and Variation

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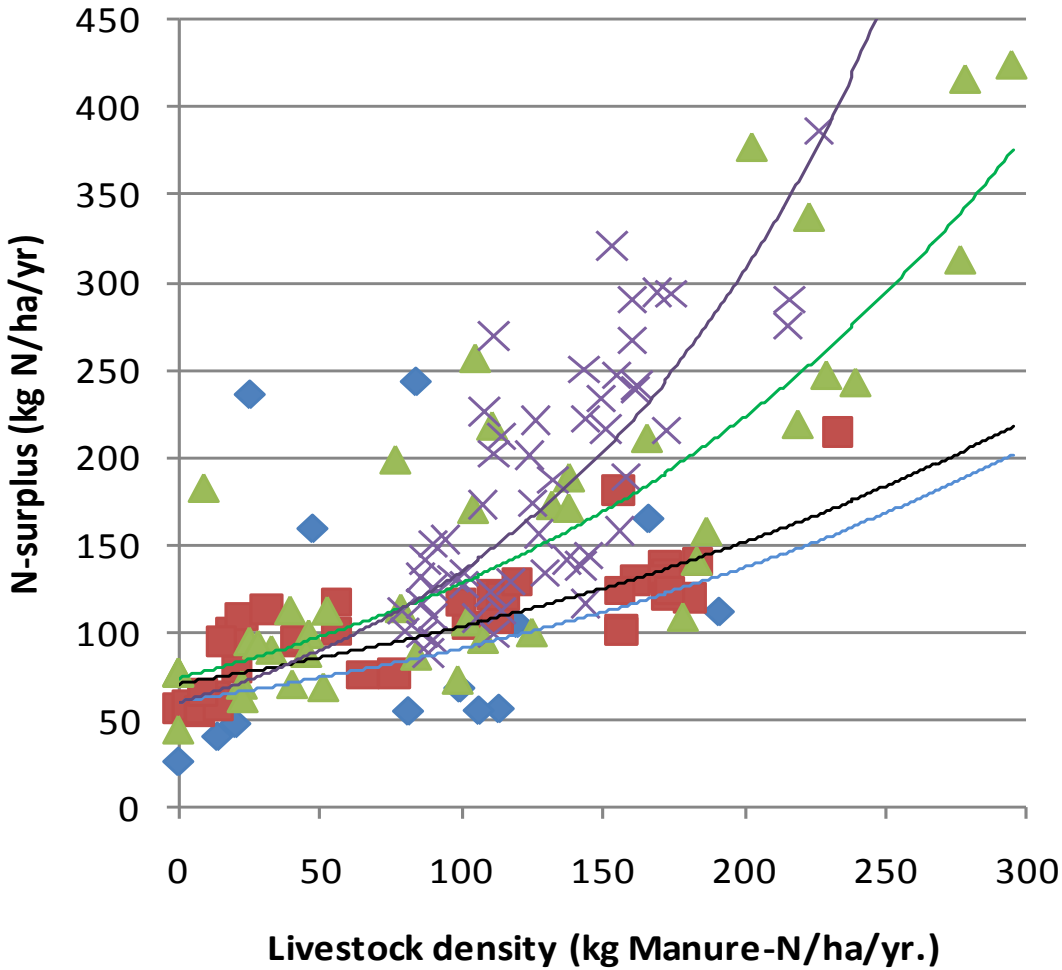
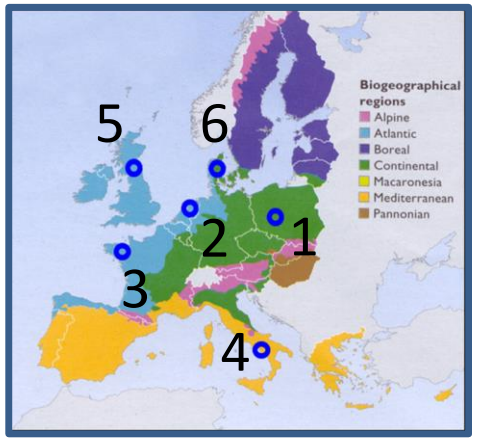


Nsurp2008

Nsurp2002

Nsurp1996

Nsurp1990



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FarmAC – farm C and N model

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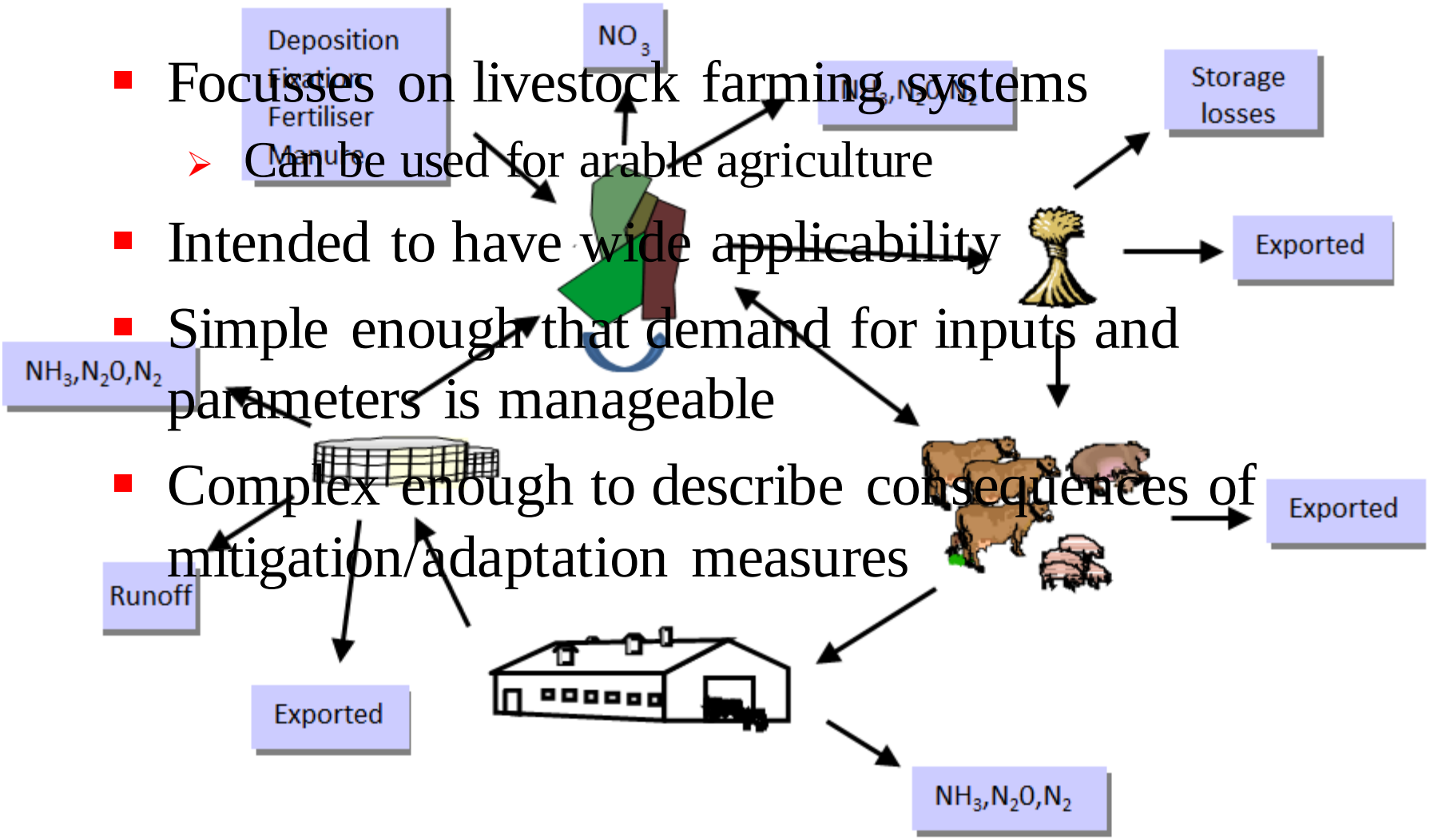
- Focusses on livestock farming systems
  - Can be used for arable agriculture
- Intended to have wide applicability
- Simple enough that demand for inputs and parameters is manageable
- Complex enough to describe consequences of mitigation/adaptation measures



Types of regulation

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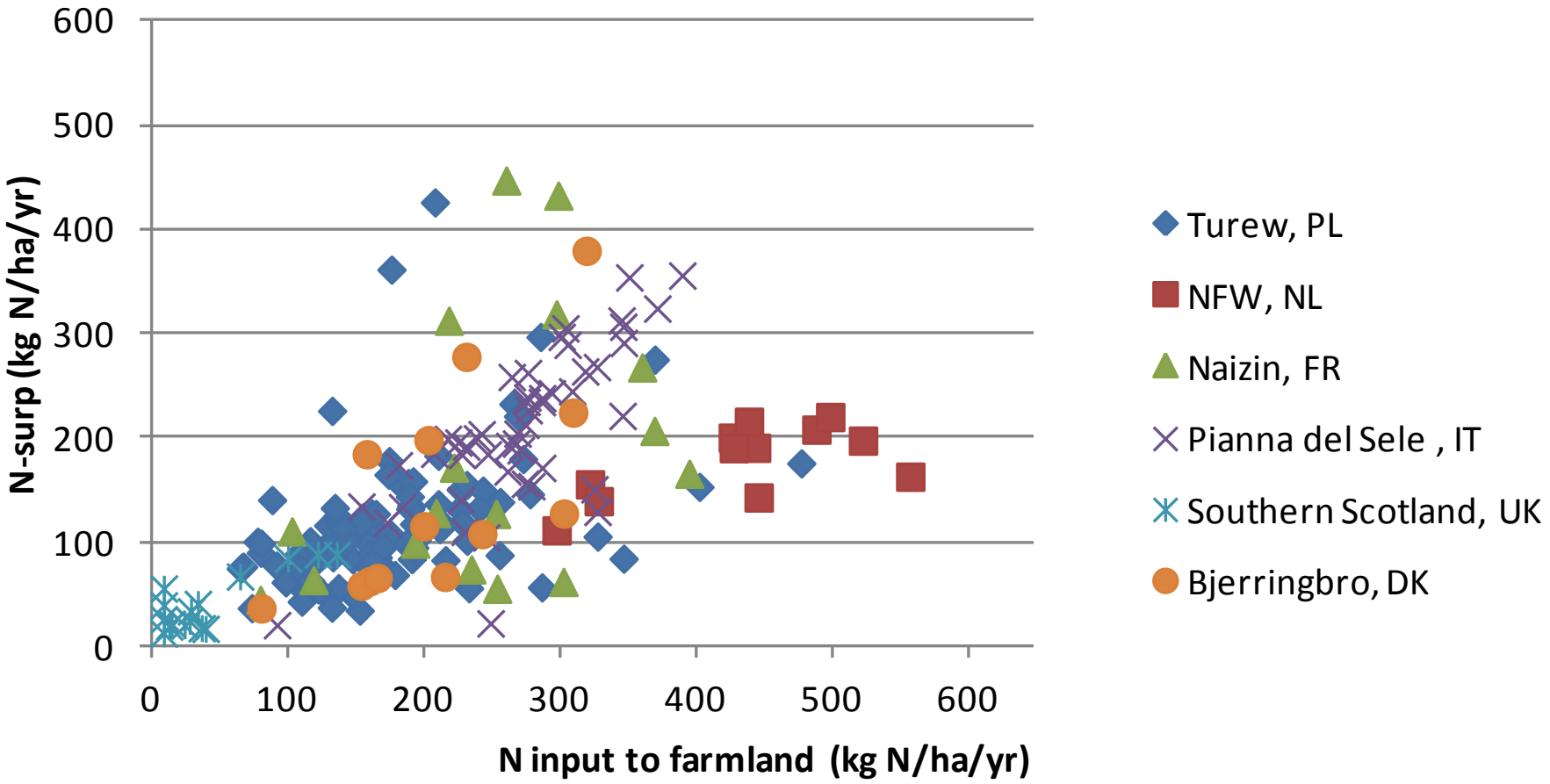
	General regulation		Geographically targeted regulation	
	Input based	Output based	Input based	Output based
Command and Control (C&C)				
Market-Based Regulation and Governmental Expenditure (MBR)				
Information and Voluntary Action (IVA)				

European farm N surplus



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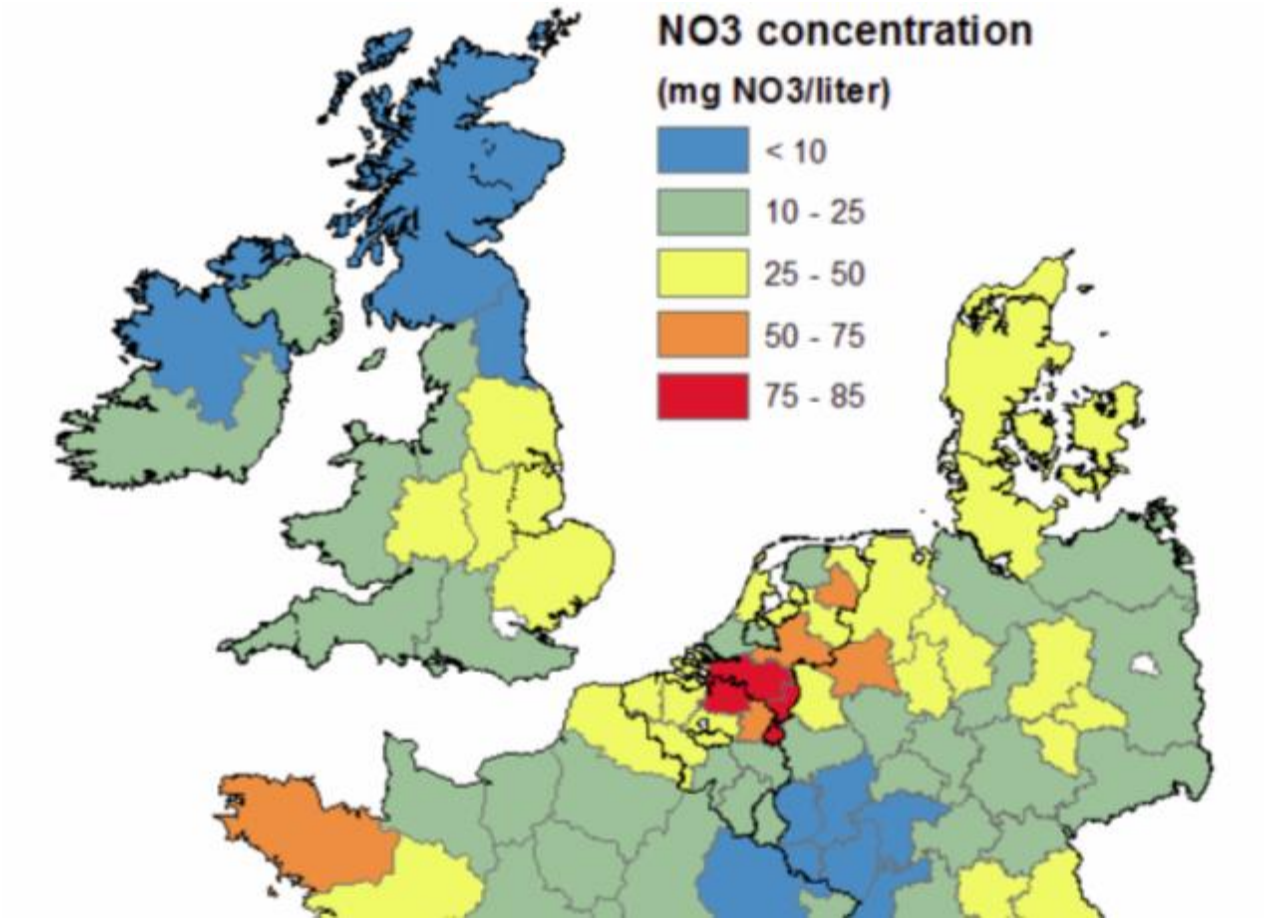
A general NW EU challenge



Van Grinsven HJM, ten Berge HFM, Dalgaard T *et al.* (2012) *Management, regulation and environmental impacts of nitrogen fertilization in northwestern Europe under the Nitrates Directive; a benchmark study.* Biogeosciences 9, 5143–5160, 2012.
http://www.biogeosciences.net/9/5143/2012/bg-9-5143-2012.pdf

The EU Waterframework directive challenge

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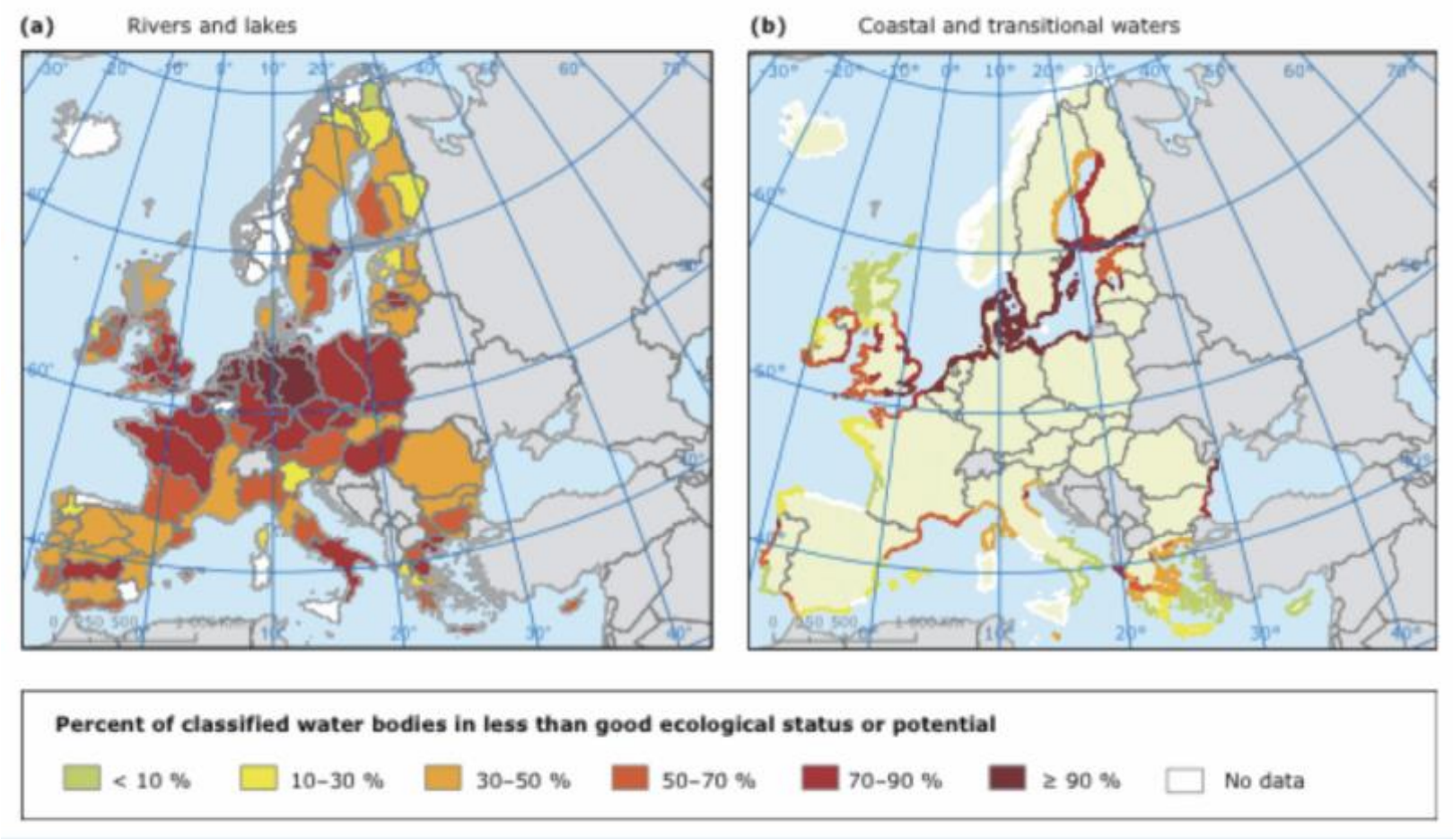
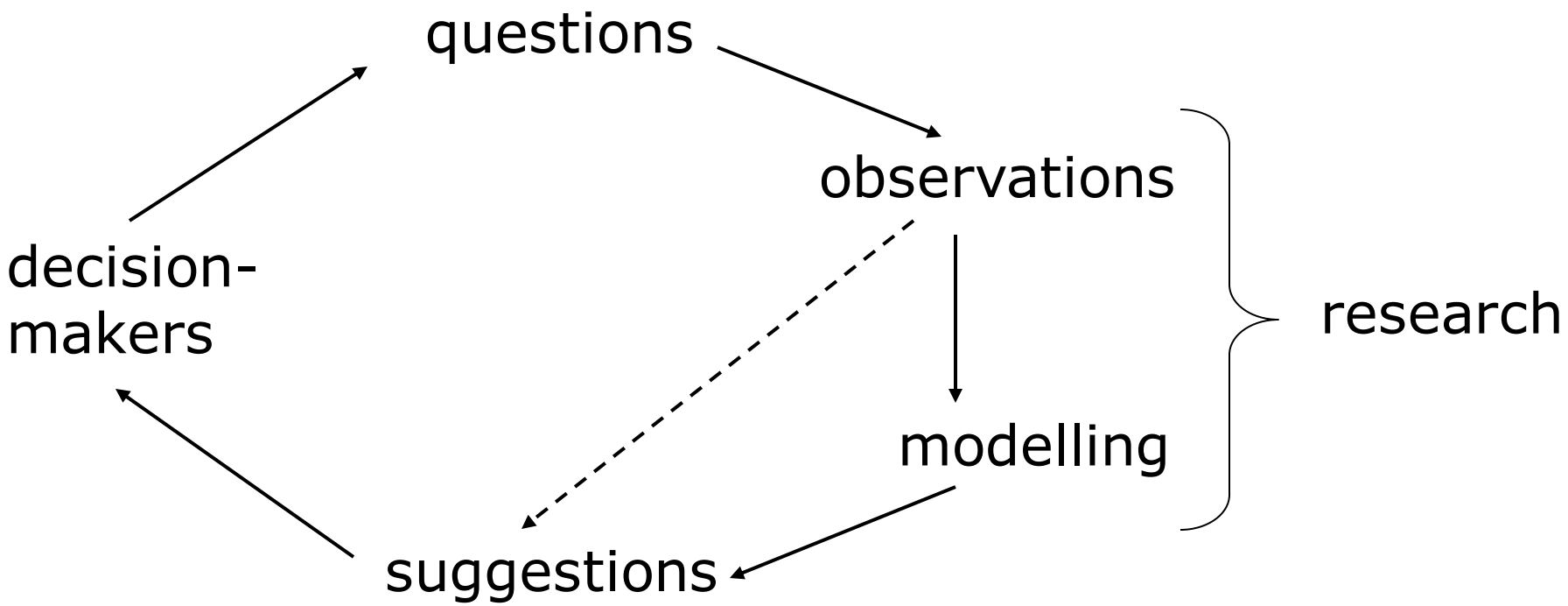


Source: EEA.eu

The cycle of applied research



Adapted from Bierkens (2000)

It is all about a balanced approach!

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The dNmark.org research alliance

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PhDs and post-docs

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- RC 4.2: The Welfare Economics of Environmental and Resource Costs in the Water Framework Directive
- RC 4.3: Philosophical-anthropological Perspectives on the Culture of Food in the City of Horsens, with Special Regard to Diminished Consumption of Meat Products
- RC 4.4a: Stakeholder involvement in sustainable management of nitrogen- a framework for integrated participatory modelling
- RC 4.4b: Methods for Assessing Spatially Differentiated Nitrogen Mitigation in Agriculture
- RC 4.5: Ecosystem services as a framework for sustainable natural resource management in Denmark
- RC 4.7: Groundwater N-pollution and public health effects – The example of gastrointestinal cancer

http://dnmark.org/?page_id=980&lang=en

PhDs and Post-docs

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- RC 2: Modelling N reduction effects in Danish agricultural landscapes based on local stakeholder suggestions of future landscape changes
- RC 3: Management strategies – Implementation of N reduction measures by use of policy instruments
- RC 4.1: Urban-rural N recycling for waste
- RC 4.6: Agricultural airborne N-Pollution, particle pollution and public health effects
- RC1/RC6: Geographically Targeted Solution Scenarios and Impact Assessment
- RC2/RC6: GIS platform for landscape scenarios

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doi:10.1088/1748-9326/9/11/115002

Policies for agricultural nitrogen management—trends, challenges and prospects for improved efficiency in Denmark

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