



Science to address multiple causes of N pollution from source to sea

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Population: 5,6 milion

Area 43.000 km²

Agricultural area: 66%



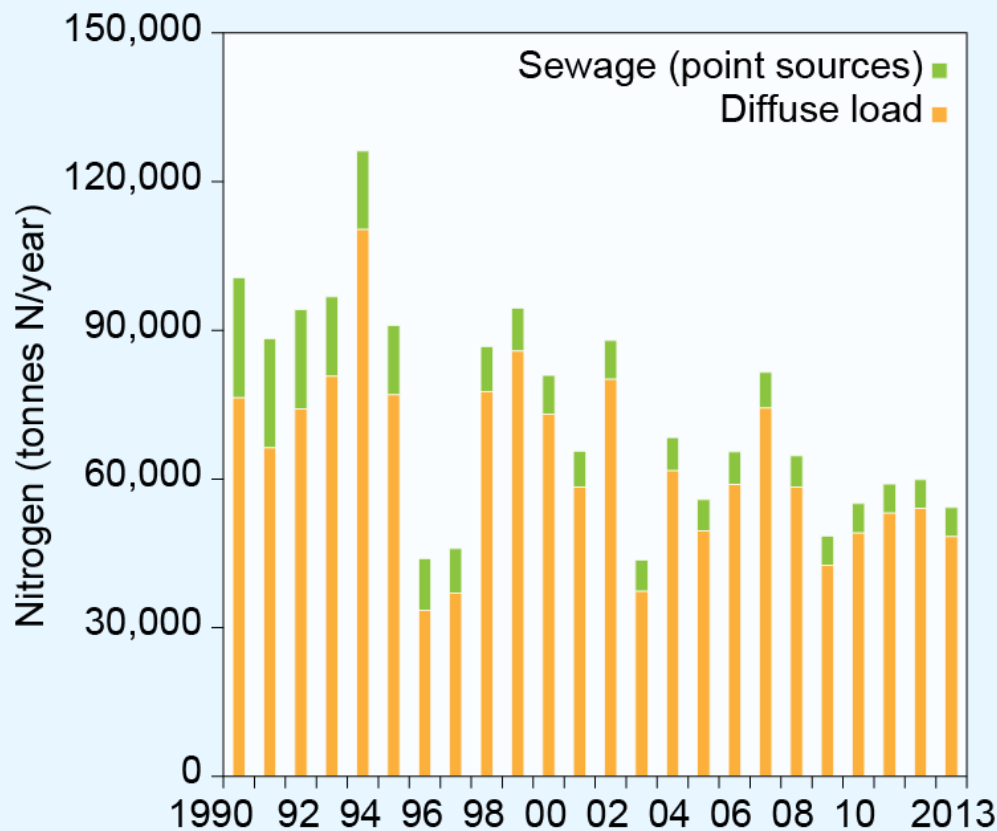
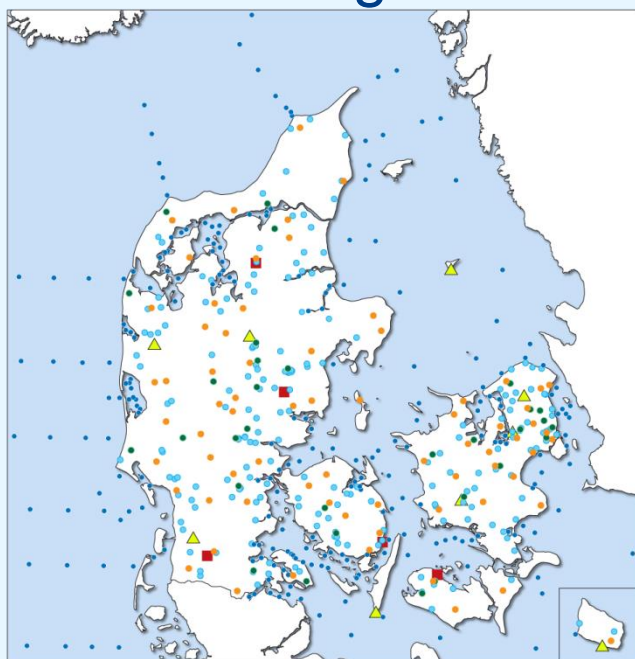
Danish
Coastal
Waters





World best in N-management: Land based **N emissions** to coastal waters in Denmark reduced with *ca. 50%* since 1990. **National rules regulating point source emissions and agricultural N utilization** (*Six national Nutrient Action Plans*).

25 Years of Monitoring: The backbone in N management !





Detailed and **integrated** monitoring in 5 small agricultural catchments (5-15 km²). Sources, Sinks,

Trends, Processes

Measuring programme:

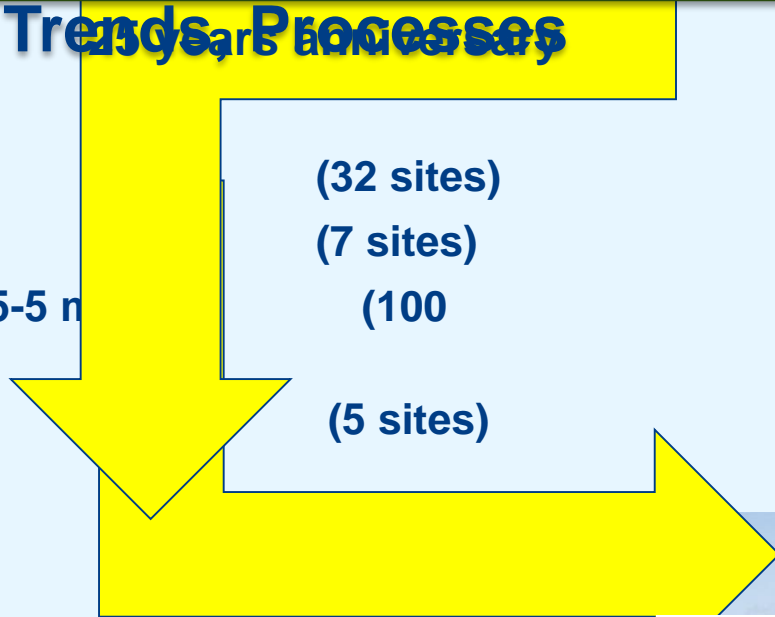
- > root zone water, 1 m
- > drainage water
- > upper-groundwater 1.5-5 m (100 sites)
- > streams (5 sites)

(32 sites)

(7 sites)

(100 sites)

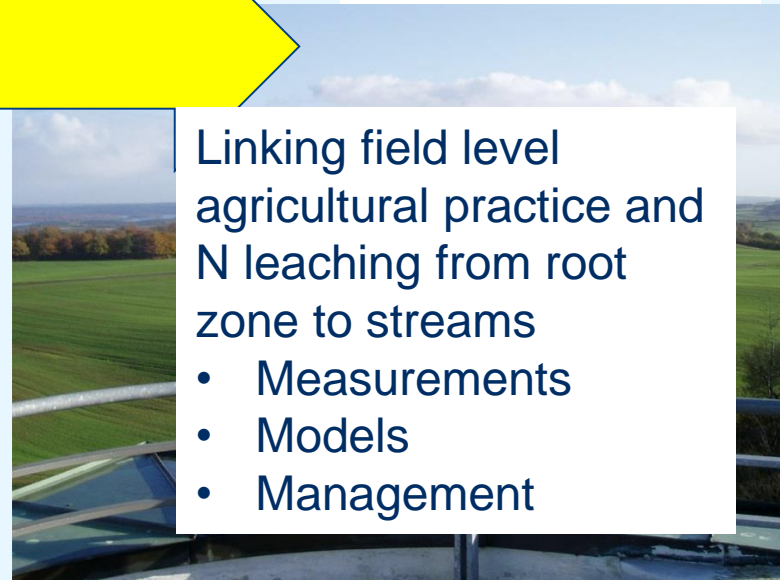
(5 sites)



Annual interviews with

farmers

crops
animals



Linking field level agricultural practice and N leaching from root zone to streams

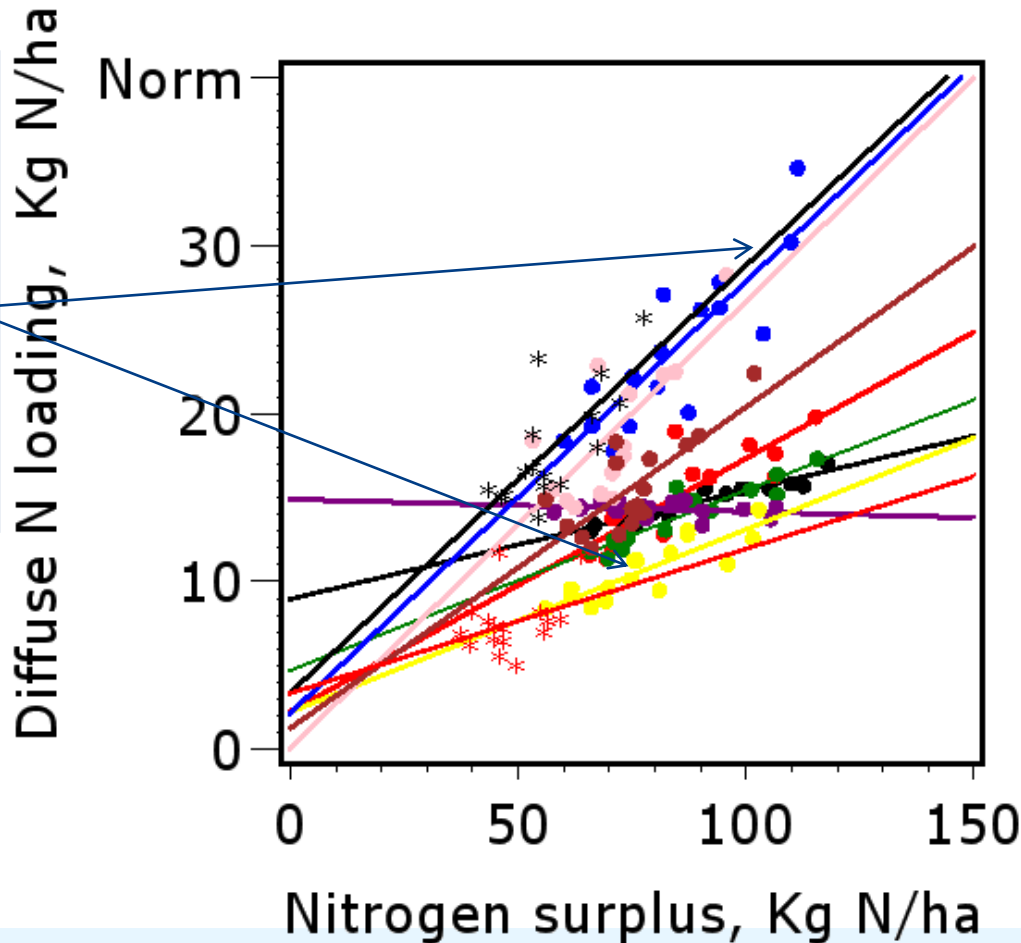
- Measurements
- Models
- Management

Annual N surplus and annual N loading from diffuse sources (normalized) from 10 catchments – 1990-2010

Catchment specific relations:

$$r^2 = 0.66$$

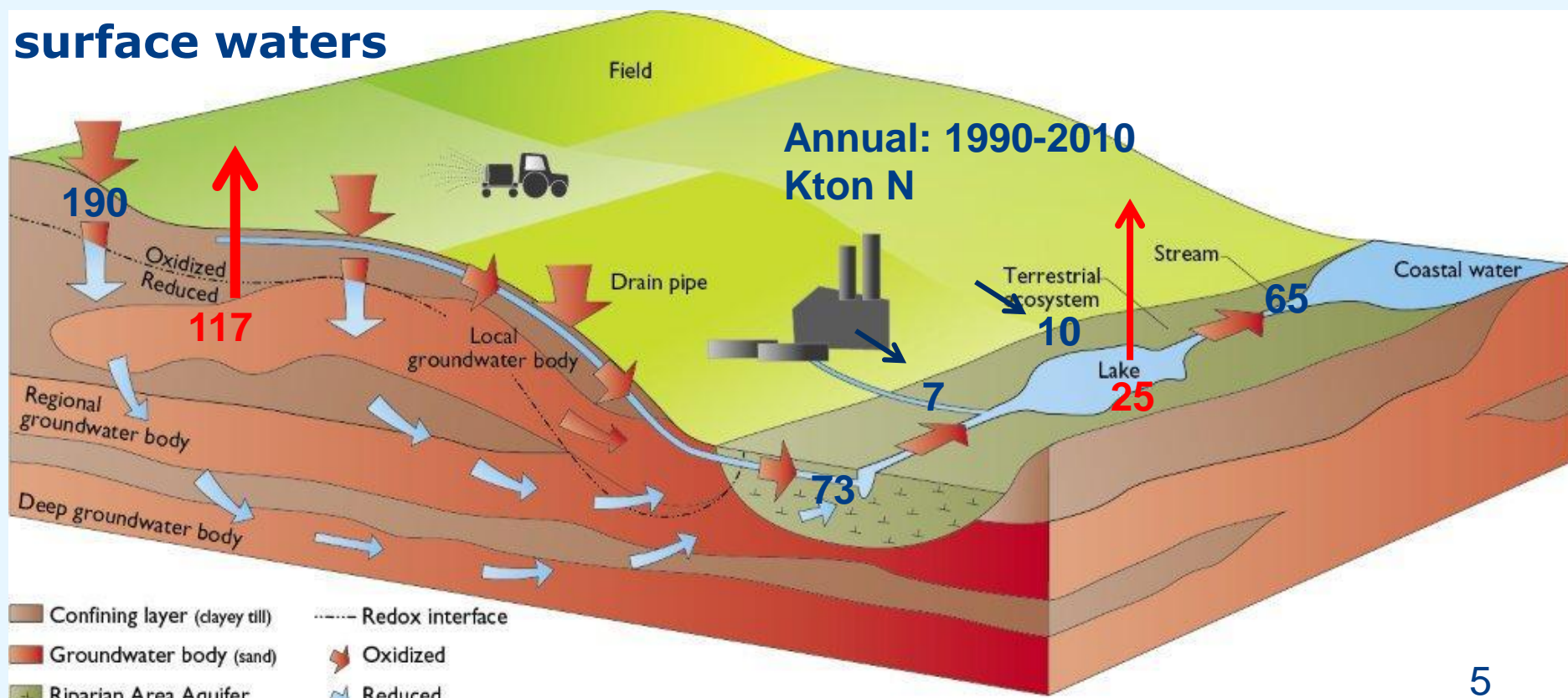
(mean for n=9)



Catchment specific costs of reducing diffuse Nitrogen loading:
24–94 Euro per kg N

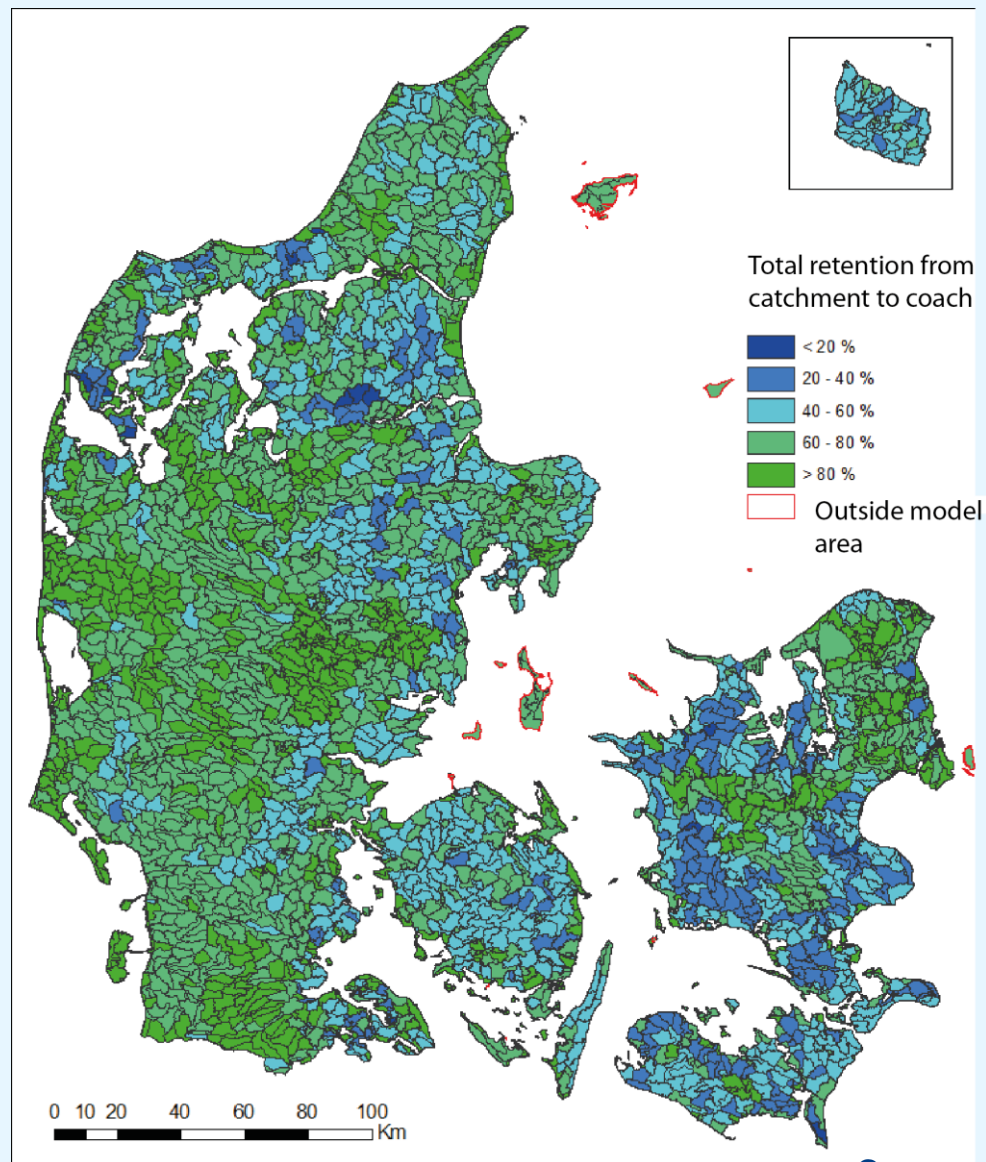
New national consensus model (3D MIKE SHE 0.5x0.5 km with particle tracing coupled with leaching and MIKE11 surface water models) (Developed 2013-15):

All sources and N reduction/retention in groundwater and surface waters

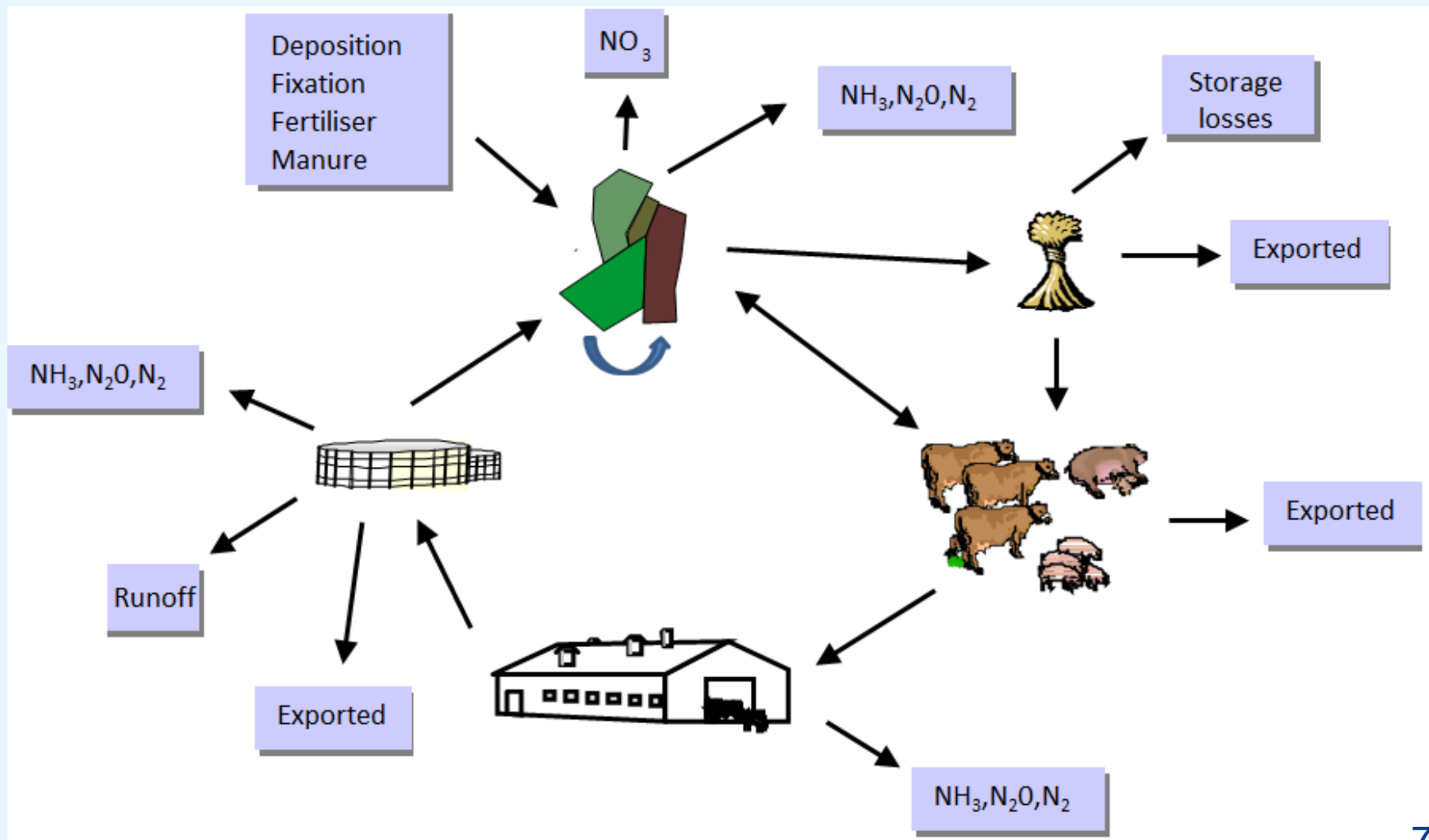


› Focus in Denmark is now towards targeted regulations, according to local N retention (reduction) conditions.

› A map of N retention (reduction) in DK has been developed in 2015 utilizing the national consensus N-model (scale: 1500 ha)



FarmAC – Farm C and N model – can describe consequences of mitigation for arable farming systems



Edit Management Parameters: Subbasin 8, Land Use AGRL, Soil DK5018, Slope 0-2

General Parameters | Operations | HRU Info

Add Year | Delete Year | Add Operation | Delete Operation | Edit Operation

Current Management Operations					
Year	Month	Day	Operation	Crop	
3	3	15	Fertilizer application	(null)	
3	3	16	Tillage operation	(null)	
3	4	2	Fertilizer application	(null)	
3	4	2	Fertilizer application	(null)	
3	4	4	Plant/begin. growing se	DKBA	
3	5	1	Fertilizer application	(null)	
3	8	15	Harvest and kill operati	(null)	
3	9	18	Tillage operation	(null)	
3	9	20	Plant/begin. growing se	DKVW	
4	3	15	Fertilizer application	(null)	

Load Schedule | Save Schedule

Fertilizer Application Parameters

Schedule by Date | Schedule by Heat Units

DK-SWAT

catchment model

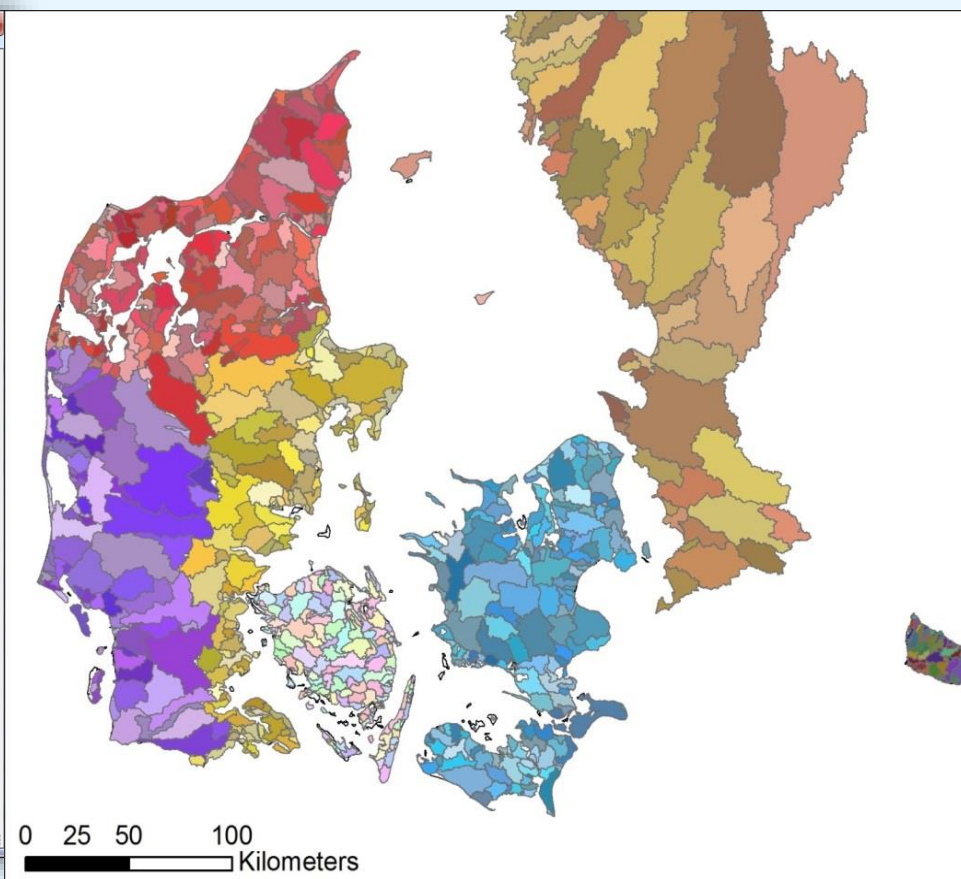
Edit Values | Cancel Edits | Save Edits | Exit

Extend Parameter Edits

- Extend ALL MGT General Parameters
- Extend Management Operations
- Extend Edits to Current HRU
- Extend Edits to All HRUS
- Extend Edits to Selected HRUS

Selected HRUs

Subbasins | Land Use | Soils | Slope



Tillage



Sowing



Harvest



Sowing



Fertilizer



Fertilizer



Fertilizer



Tillage



New **targeted management** of agricultural production: Needs for new mitigation Measures – **current research on several technologies**

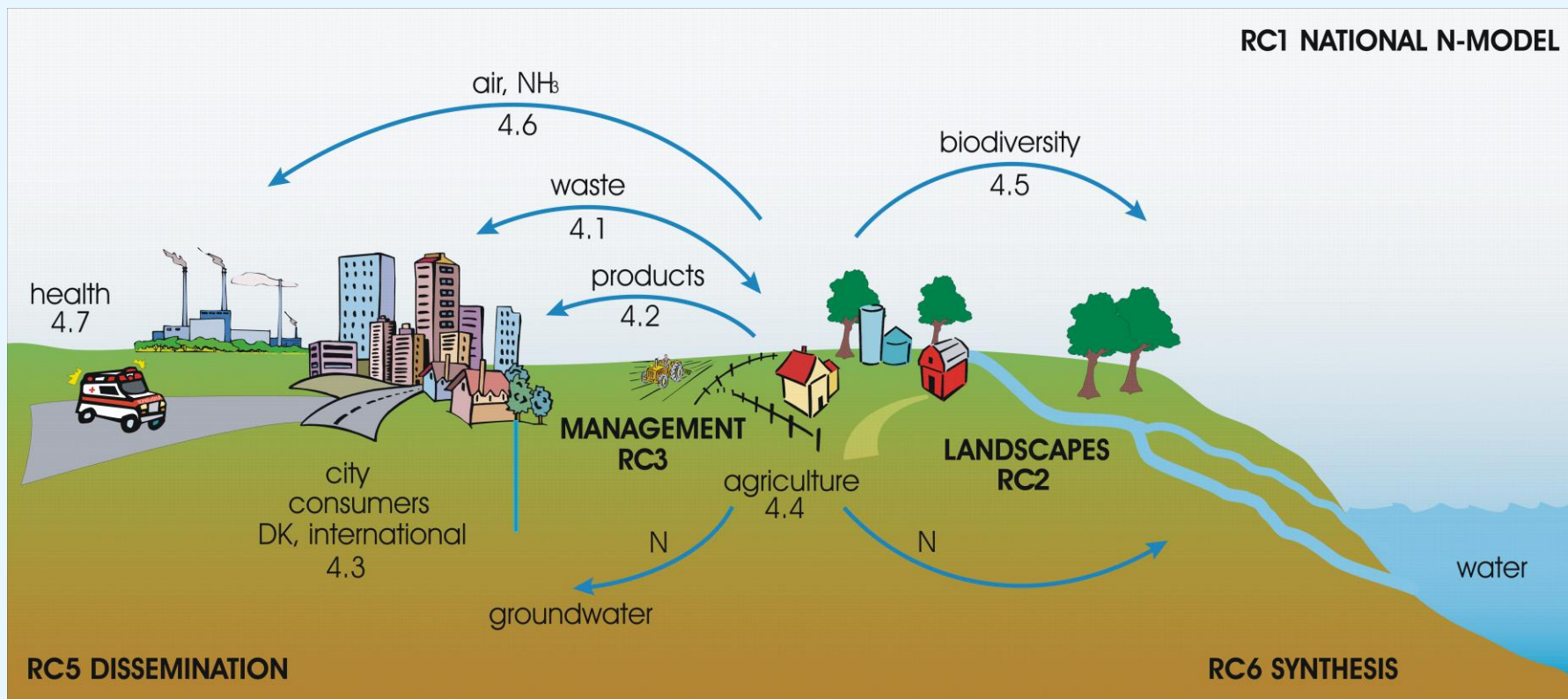




A national research alliance: Studying the components of Danish nitrogen landscapes



Research components:



Thank you for your attention

www.dNmark.org