UNIVERSITY OF COPENHAGEN

Site-specific N-regulation in Denmark - a follow up on NLK recommendations

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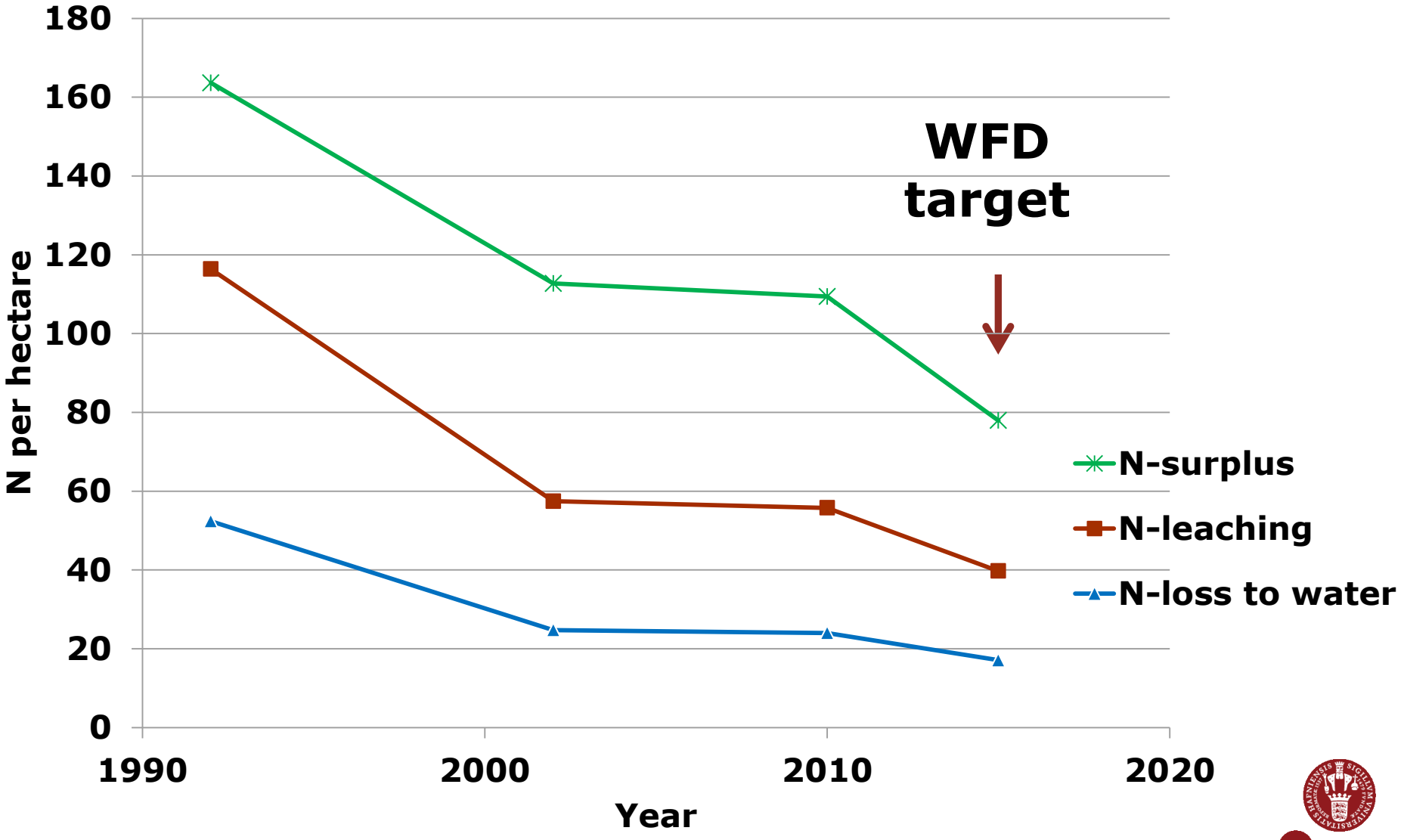
Content

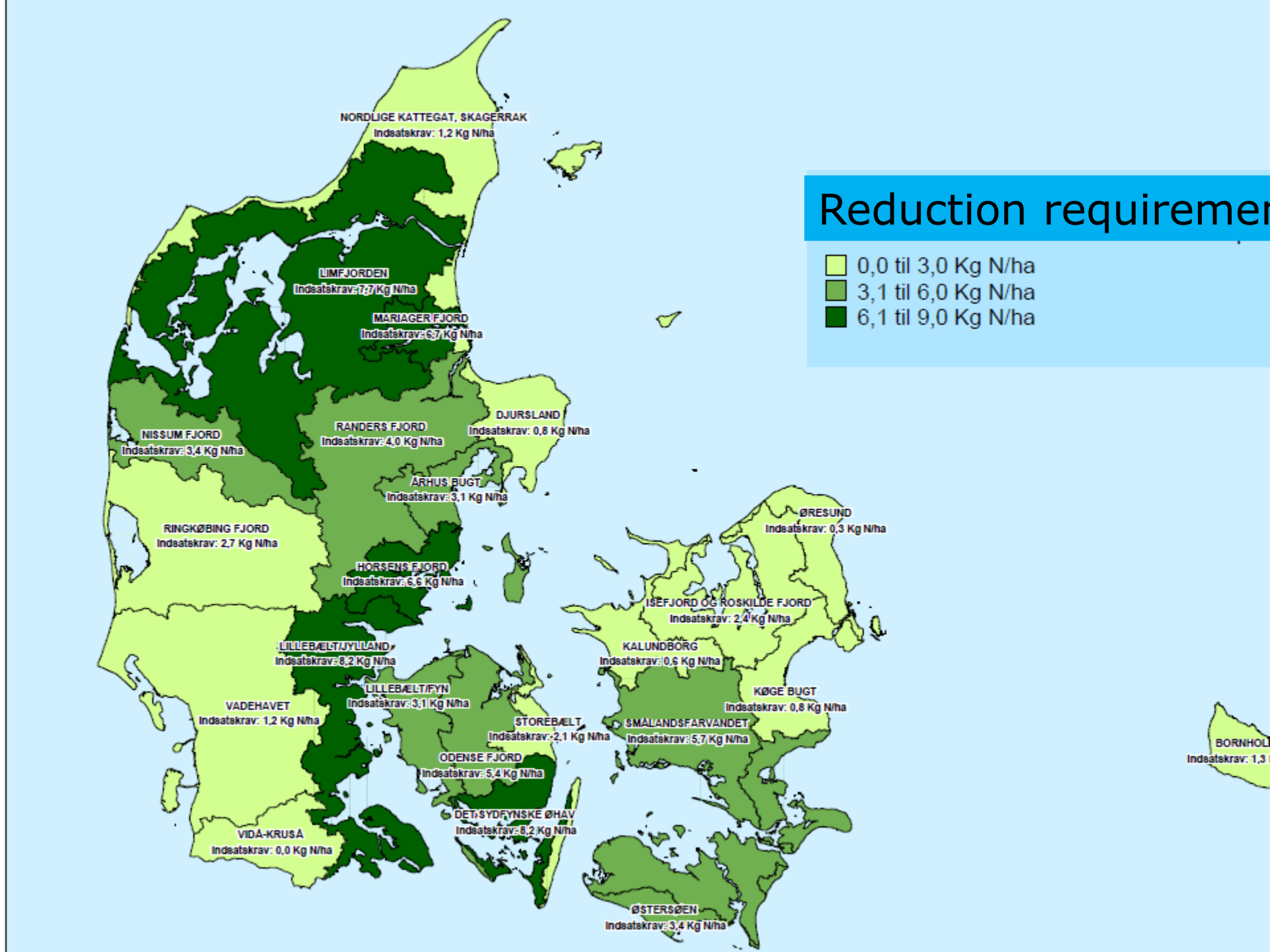
- ✓ **Present legislation**
- ✓ **2 models for future regulation**
- ✓ **Environmental economic norms in Limfjorden**
- ✓ **National analysis of specific regulation**

N-surplus, N-leaching and N-loss in DK



Where are we today ?

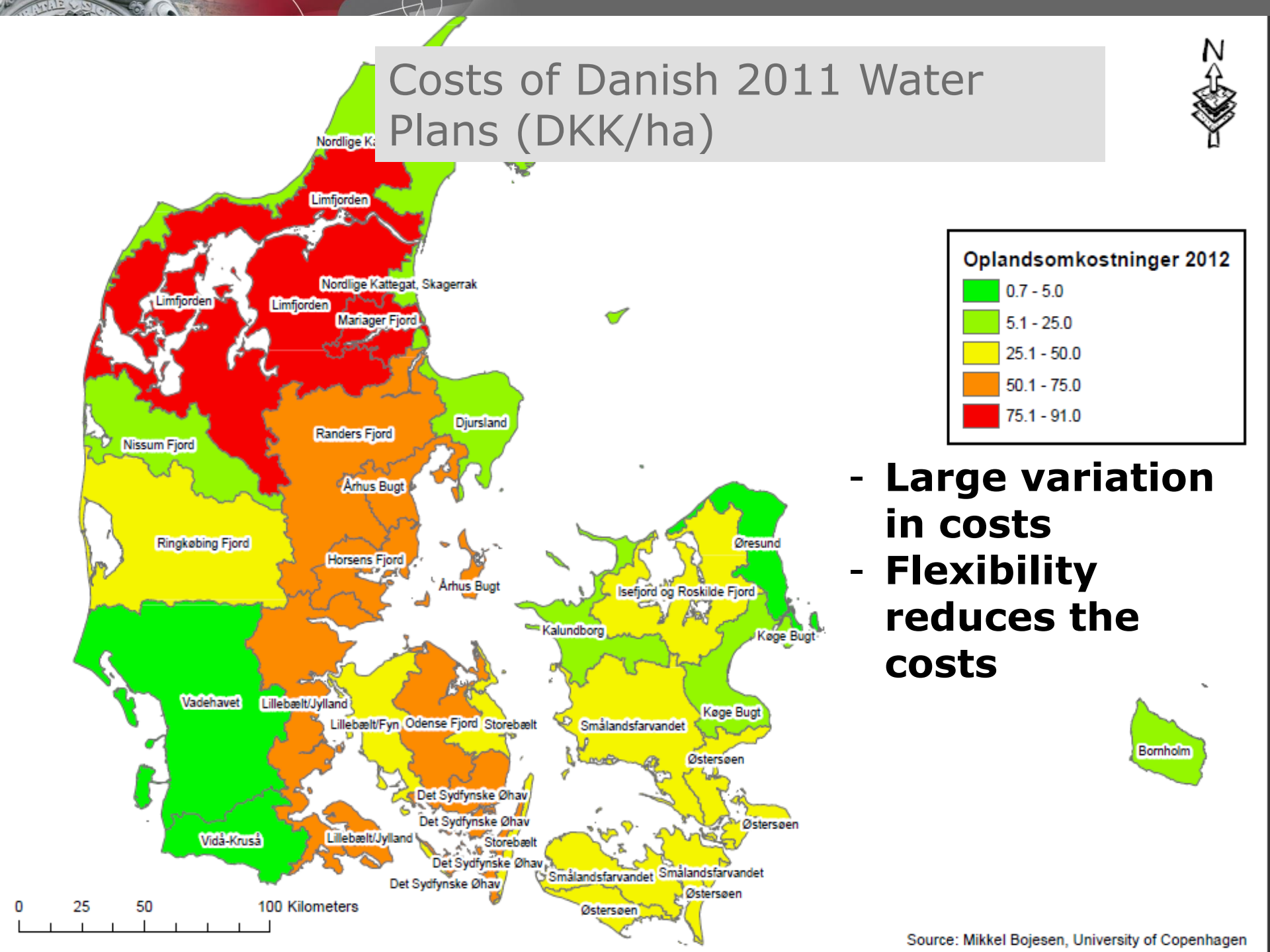
- ✓ **Current regulation is based on total N-norms which vary with crop, soil type and use of irrigation**
- ✓ **The N-norm is given at the farm level and so exchange between fields do occur**
- ✓ **The variation in marginal value between farms is relative limited and so the incentive for exchange/fraud is limited.**
- ✓ **Under optimal N-norms have increased utilisation of N in organic manure (high requirements)**


Reduction requiremen
0,0 til 3,0 Kg N/ha
3,1 til 6,0 Kg N/ha
6,1 til 9,0 Kg N/ha
NORDLIGE KATTEGAT, SKAGERRAK
Indsatskrav: 1,2 Kg N/ha
LIMFJORDEN
Indsatskrav: 7,7 Kg N/ha
MARIAGER FJORD
Indsatskrav: 6,7 Kg N/ha
NISSUM FJORD
Indsatskrav: 3,4 Kg N/ha
RANDERS FJORD
Indsatskrav: 4,0 Kg N/ha
DJURSLAND
Indsatskrav: 0,8 Kg N/ha
ÅRHUS BUGT
Indsatskrav: 3,1 Kg N/ha
RINGKØBING FJORD
Indsatskrav: 2,7 Kg N/ha
HORSENS FJORD
Indsatskrav: 6,6 Kg N/ha
ØRESUND
Indsatskrav: 0,3 Kg N/ha
ISEFJORD OG ROSKILDE FJORD
Indsatskrav: 2,4 Kg N/ha
KALUNDBORG
Indsatskrav: 0,6 Kg N/ha
LILLEBÆLT/JYLLAND
Indsatskrav: 8,2 Kg N/ha
LILLEBÆLT/FYN
Indsatskrav: 3,1 Kg N/ha
VADEHAVET
Indsatskrav: 1,2 Kg N/ha
STOREBÆLT
Indsatskrav: 2,1 Kg N/ha
SMÅLANDSFARVANDET
Indsatskrav: 5,7 Kg N/ha
KØGE BUGT
Indsatskrav: 0,8 Kg N/ha
ODENSE FJORD
Indsatskrav: 5,4 Kg N/ha
DET SYDFYNSKE ØHAV
Indsatskrav: 8,2 Kg N/ha
VIDÅ-KRUSÅ
Indsatskrav: 0,0 Kg N/ha
ØSTERSØEN
Indsatskrav: 3,4 Kg N/ha

Omkostninger ved Vandplaner (mio. kr.)

Virkemiddel	Areal	Tons N	Omk. Erhvev (mio. kr.)	Omk. stat (mio. kr.)	Kr./ kg N
Efterafgrøder	50.000	690	24		35
Nye efterafgrøder	140.000	1.706	68		39
Ingen jordbearbejdning	110.000	740	1		1
Omlægning af græs	15.000	230	7		30
Normsystemet		1.008	35		35
Randzoner	50.000	2.500		96	37
Vådområder	10.000	1.131		62	55
Reduceret grødeskæring	30.000	--		52	--
I alt		**8.034**	**135**	**210**	**43**

Costs of Danish 2011 Water Plans (DKK/ha)



- **Large variation in costs**
- **Flexibility reduces the costs**

Source: Mikkel Bojesen, University of Copenhagen

Model 1: Farm Economic model

Norm is based on :

Crop and Soil type

Retention groups

N-reduction required in a given catchment

Variation in crop N-leaching is not included

Same N-norm reduction for all crops in the region

N-norms will be e.g. 65-100% of economic optimum

Can be combined with farm specific measures (catalogue shows effect)

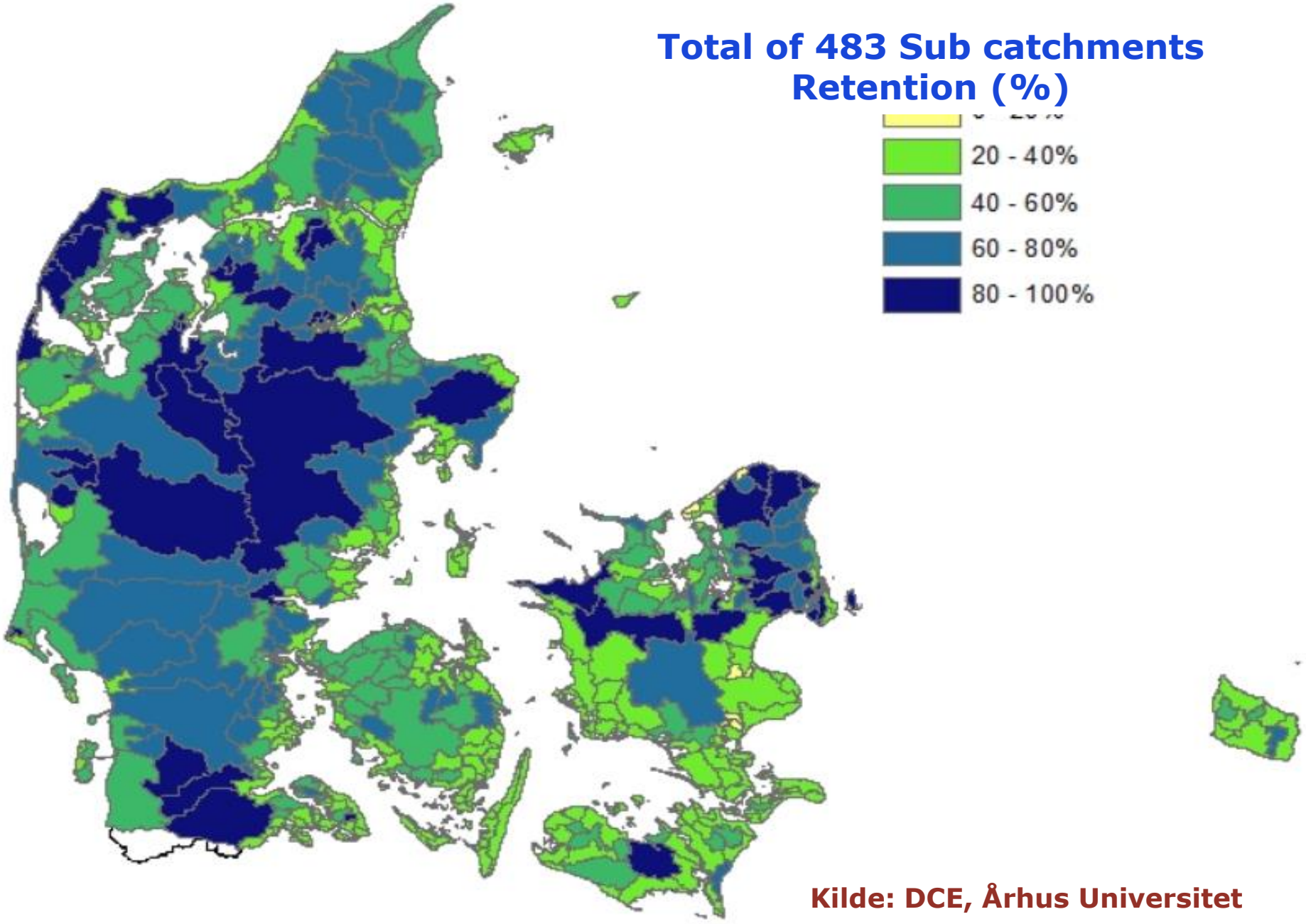
Easier administrative approach

The preferred road

Example of possible regulation based on retention (3 groups) and reduction requirement (3 groups)

Retention (%)	Large reduction requirement	Normal reduction requirement	No reduction requirement (V3)
0 - 50	*N-class 5 (e.g 65%)*	*N-class 2 (e.g. 80%)*	*N-class 0 (100 %)*
50 -75	*N-class 4 (e.g. 75%)*	*N-class 1 (e.g. 90%)*	*N-class 0 (100 %)*
75 - 100	*N-class 3 (e.g 85%)*	*N-class 0 (100 %)*	*N-class 0 (100 %)*

Levels need to be determined



Kilde: DCE, Århus Universitet

M2: Environmental economic norms

N-Norms are based on the same marginal cost of N-loss to the environment for all crops

Based on knowledge of :

N-loss from each crop

N-retention for each field / farm (see map)

Loss of income from each crop based on a production function

N-norms can be combined with additional measures (catalogue shows effect)

More difficult administrative approach

Calculations for NLK

- ✓ **Limfjorden analysis showing the difference between the current norm system and the possibilities in the M2 model (not with all area measures)**
- ✓ **Starting point is an N-loss of 12.900 tons**
- ✓ **Area 500.000 ha**
- ✓ **152 sup-catchments (3.400 ha each)**
- ✓ **11,000 farms and 23,000 units**
- ✓ **12 crops and 5 soil types**
- ✓ **Livestock, irrigation, organic farming and soil preparation methods not included**

Calculations for NLK - 2

- ✓ **N-leaching for the different crops are similar in the calculations (55 kg N/ha) although lower for grass and higher for wheat and barley after certain crops.**
- ✓ **Land can be taken out if the income is low and so a subsidy is given**
- ✓ **N-norms are applied were they are given !!**
- ✓ **Lower norms could replace the "loved" riparian zones along streams, but it is not easy as they have zero-retention.**

The effect of different models -30% N in Limfjorden

	Trad. Norm system	Env. Econ Norms
N-norm (kg N/ha)	38	71
Set a side (% of area)	7%	5%
Catch crops (% of area)	17%	13%
N-value (DKK/kg N)	14	11
DBII profit (DKK/ha)	519	802

Costly with both methods, but lower than benefits ! **(Jensen et al., 2013)**

Different reduction requirements using the same environmental cost (140 kr. pr. kg N)

	Sandjord				Lerjord			
	Hvede	Hvede	Vårbyg	Vinterbyg	Hvede	Hvede	Vårbyg	Vinterbyg
Norm i dag Kg N/ha	154	127	115	140	166	139	122	151
Retention 80%	-15%	-13%	-22%	-22%	-5%	-4%	-11%	-10%
Retention 25%	-63%	-65%	-82%	-78%	-43%	-42%	-56%	-51%

Marginal value DKK pr. kg N to the field with or without trading

	Sandjord		Lerjord	
Retention	80%	25%	80%	25%
Base line	**6,0**	**6,0**	**6,0**	**6,0**
Ideel	12,3	22,2	11,9	22,2
Trading	17,2	17,2	17,2	17,2

- **Increased difference in marginal value**
- **Trading will decrease farmers costs, but increase N-norm reduction requirement**

30% reduction in N-losses based on Norms

- Set-a-side is mainly on sandy soil
- N-norms are very low on low retention areas when using environmental norms.
- Large variation in value of N when using env. norms (20 – 0 DKK).
- N-application in areas with low retention is close to optimal (85%-95%).
- Some low retention areas will not be cropped
- Economic gain with environmental norms on high retention areas, but a loss on low retention areas.
- 20% will have a clear gain and 30% a loss and the rest a small gain.

National analysis Limfjorden

Measures	Average Retention in catchment (ha)	SMART Location according to retention (ha)
More energy crops (ha)	11.800	9.500
Wetlands (ha)	5.700	5.700
Reduced N-norms (10%) (ha)	475.000	324.000
Higher utillisation of N in manure after degistation (20%) (ha)	425.000	286.000
More catch crops (ha)	6.000	6.000
Mellemafgrøder (ha)	44.200	21.000
Set a side high land (ha)	**29.000**	**35.000**
Set a side – low areas (ha)	**48.000**	**25.000**
Total costs (mio. kr.)	**400**	**300**

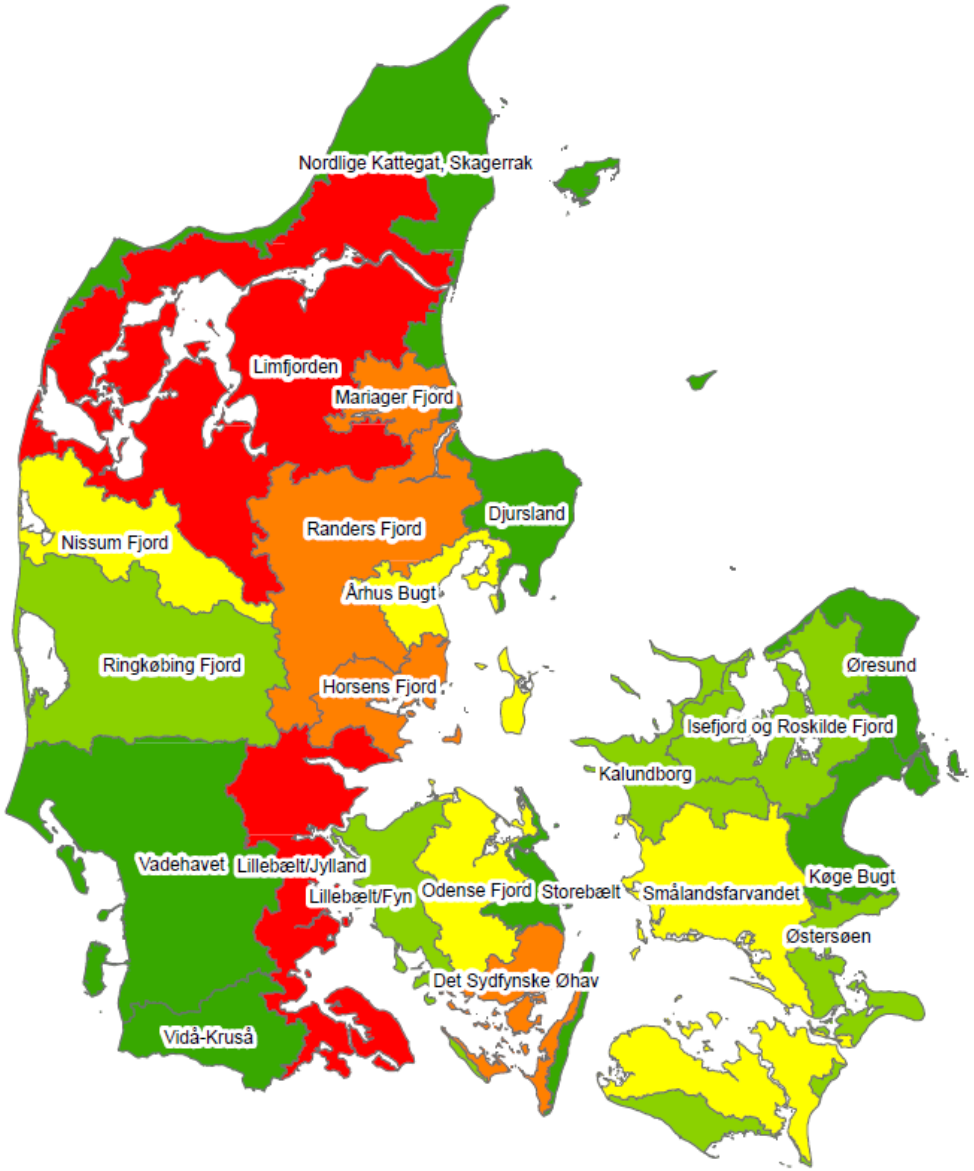
National analysis (further reduction of 10.000 tons N)

Measures	Average Retention in catchment (ha)	SMART Location according to retention (ha)
More energy crops (ha)	24.390	18.200
Wetlands (ha)	14.200	14.500
Reduced N-norms (10%) (ha)	1.320.400	906.900
Higher utillisation of N in manure after degistation (20%) (ha)	1.146.600	893.600
More catch crops (ha)	81.400	79.400
Mellemafgrøder (ha)	44.200	35.000
Set a side high land (ha)	**115.000**	**109.600**
Set a side – low areas (ha)	**91.300**	**55.450**
Total costs (mio. kr.)	**900**	**800**

Thought on national results

- ✓ **The first 9,000 tons N cost 130 million DK or 40 DKK/ kg N.**
- ✓ **The next 10,000 tons N cost around 800–1,000 million DKK or 80-100 DKK pr. kg N**
- ✓ **Some catchments are relative homogeneous why the SMART solution is almost the same as the average solution**
- ✓ **Measures in areas with a retention of 80-100% are often left out**
- ✓ **Low laying areas is not enough**
- ✓ **Set a side can affect livestock production in some areas**

Omkostninger (kr/ha) - SMART

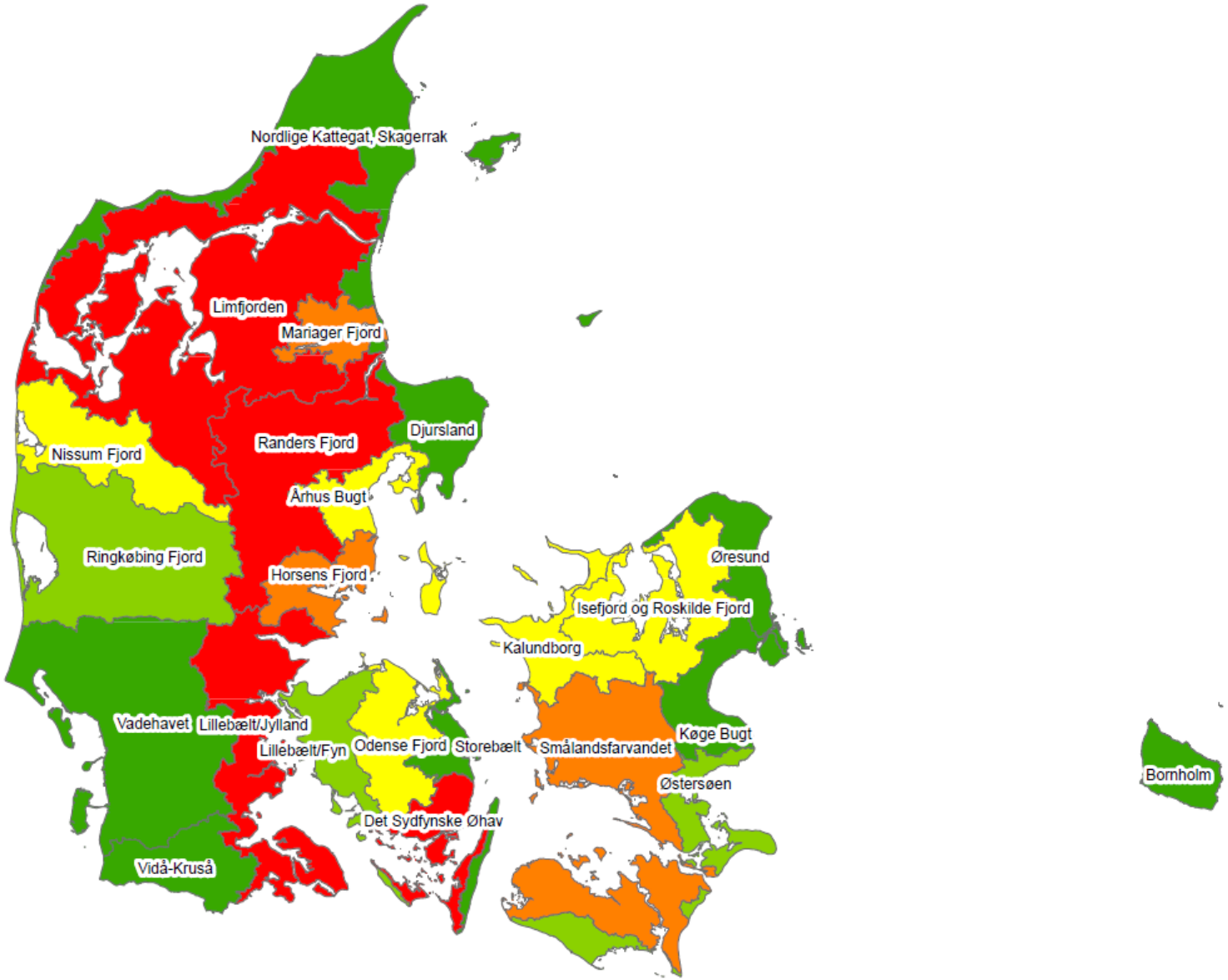


Kr/ha

- 0,00 - 20,00
- 20,01 - 90,00
- 90,01 - 340,00
- 340,01 - 550,00
- 550,01 - 858,82

Source: Mikkel Bojesen, Institute of Food and Resource Economics, mbo@foi.ku.dk

Omkostninger (kr/ha) - Gennemsnit



N

Kr/ha

- 0,00 - 20,00
- 20,01 - 90,00
- 90,01 - 340,00
- 340,01 - 550,00
- 550,01 - 900,36

0 25 50 100 Kilometers

Source: Mikkel Bojesen, Institute of Food and Resource Economics, mbo@foi.ku.dk

Thoughts about site specific regulation

- ✓ **Detailed regulation requires detailed data with an accepted level of certainty**
- ✓ **The data uncertainty has to be accepted by the farming sector (not lawsuits)**
- ✓ **The higher heterogeneity there is in a catchment the larger are the likely benefits**
- ✓ **In the NICA project we work with a 500*500 meter pixels (25 ha)**
- ✓ **..but the larger retention groups (1.500 ha) the larger certainty that the retention is right – lower farm effect.**

Thoughts about site specific regulation

- ✓ **Detailed N-application at field level requires GPS technology to be used in practice (division of fields is not likely)**
- ✓ **Larger heterogeneity increases the variation in farm economic value of N and hence desire to redistribute N**
- ✓ **This redistribution can be legal or illegal**
- ✓ **The intention is to combine area specific N-norms with a catalogue of measures which effect will be farm specific.**
- ✓ **Positive attitude required – it will not be 100% perfect from the beginning ☺**

See more on www.IFRO.ku.dk