Fact sheet: Spatially targeted strategy -a method for nitrogen load reduction from agriculture

dNmark research alliance

Summary

Reducing nitrogen (N) loads from agriculture to the aquatic environments in Denmark have so far been based on general measures to increase N use efficiency, but these have not been sufficient to achieve the environmental objectives without affecting agricultural production. A new spatially targeted regulation is under development that focuses on cost-effective use of measures according to spatial variability in groundwater N-reduction. A key analysis tool in this respect is spatially differentiated scenario analysis to explore reductions in N leaching from those arable lands, which contribute most to the N-loadings. This could be possible either through reducing the source N loading from the root zone or through enhancing the N reduction.

Aims

To address the possibilities of targeting measures to reduce N leaching losses from those parts of the landscape, which contribute most to the N-loadings.

To analyze the need for agricultural land-based measures under different spatial constraints and scales to achieve targeted N-load reduction of 20% and 40% to coastal waters.

Spatially differentiated approach

A method for two Danish catchments was developed comprising (i) Relocation of existing agricultural practices based on the total N-reduction (i.e. groundwater and surface water N-reduction) and available spatial constraints. In this way, highest N-leaching value is relocated to the area with highest N-reduction and vice versa (Fig.1A). (ii) Cover crops (CC) application on potential areas based on Danish N-leaching reduction values specified for CC (Table 1, Fig 1.B), (iii) Set-a-side application on areas with high N-load by replacing the N-leaching value with the Danish standard value for set-a-side of 12 (kg N/ha) (Fig 1.C). Total N-reduction maps were used in two scales for N-load calculation; at sub catchment scale and at grid unit scale.

Table 1. Danish standard values of N-leaching reduction (kg N/ha) specified for CC based on soil type and livestock density (LU/ha)

	LU/ha			
	<0.8		>0.8	
Soil type	Clay	Sand	Clay	Sand
N-Leaching reduction	16	34	28	46
Average value	25		37	

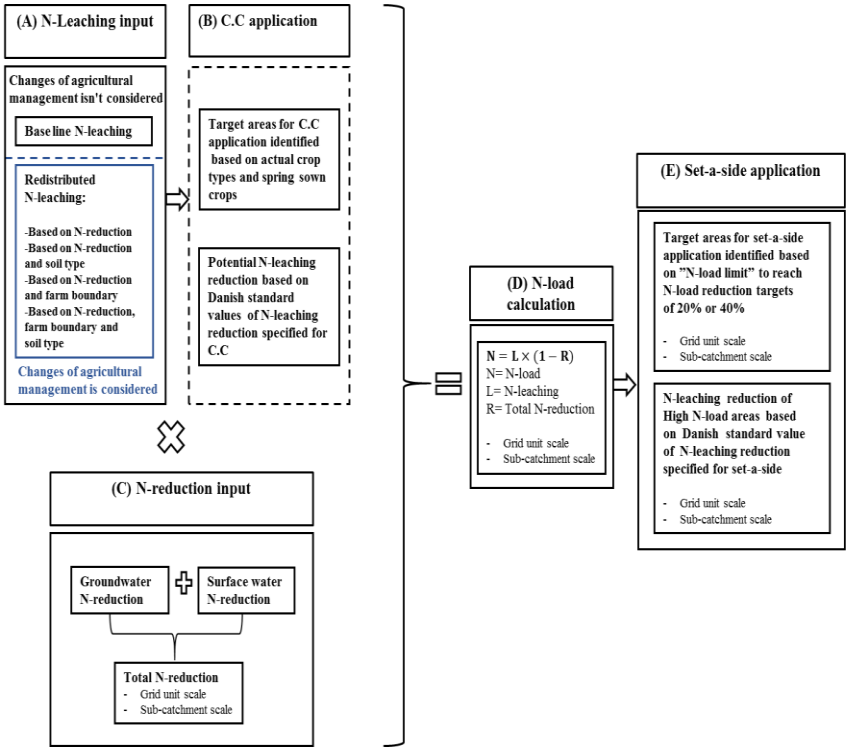

Figure 1. Components of spatially targeting approach

Scenario design

To construct the scenarios, N-leaching input as main target to change was considered and resulted in 10 spatially targeted scenarios (Table 2). Scenario I includes spatially targeted measures on baseline N-leaching and scenario II considers application of measures on relocated N leaching.

Results

Spatial constraints for N-leaching relocation will affect the effectiveness of N-load reduction, and the highest N—load reduction was achieved where less constraints were considered (Fig. 2). The effectiveness of spatially differentiated measures in term of set-a-side area in Odense catchment were relatively greater compared to Norsminde catchment (Fig. 3). Investigation of each scenario individually indicated using fine spatial N-reduction map is more effective compared to using sub-catchment scale N-reduction map in terms of N-load reduction using set-a-side.

Recommendations

The extent to which more knowledge on N-reduction map can be used to assess the consequences on set-a-side to achieve targeted N-load reductions and to be used in future N-regulation is an open question. Therefore, it has been suggested to clarify the uncertainty in N-load reductions and set-a-side from scenarios analyzed based on N-reduction maps.

More information

Fatemeh Hashemi
fatemeh.hashemi@agro.au.dk

Jørgen Eivind Olesen
jeo@agro.au.dk

Christen Duus Børgesen
christen.borgesen@agro.au.dk

Tommy Dalgaard
tommy.dalgaard@agro.au.dk

Anne Lausten Hansen
alha@geus.dk

InnovationsFonden
FORSKNING, TEKNOLOGI & VÆKST I DANMARK

Table 2. Description of spatially differentiated scenarios

Scenario		Spatial pattern in N-leaching based on different constraints			Targeted measure		N-load reduction target
		Groundwater N-reduction	Soil type	Farm boundary	Set- a-side	Cover crops	
Business as usual		-	-	-	-	-	-
I: Measures application on baseline N-leaching	1	No	No	No	Yes	No	20%- 40%
	2	No	No	No	Yes	Yes	20%- 40%
II: Measure application on spatially relocated N-leaching	1	Yes	No	No	Yes	No	20%- 40%
	2	Yes	No	No	Yes	Yes	20%- 40%
	3	Yes	Yes	No	Yes	No	20%- 40%
	4	Yes	Yes	No	Yes	Yes	20%- 40%
	5	Yes	No	Yes	Yes	No	20%- 40%
	6	Yes	No	Yes	Yes	Yes	20%- 40%
	7	Yes	Yes	Yes	Yes	No	20%- 40%
	8	Yes	Yes	Yes	Yes	Yes	20%- 40%

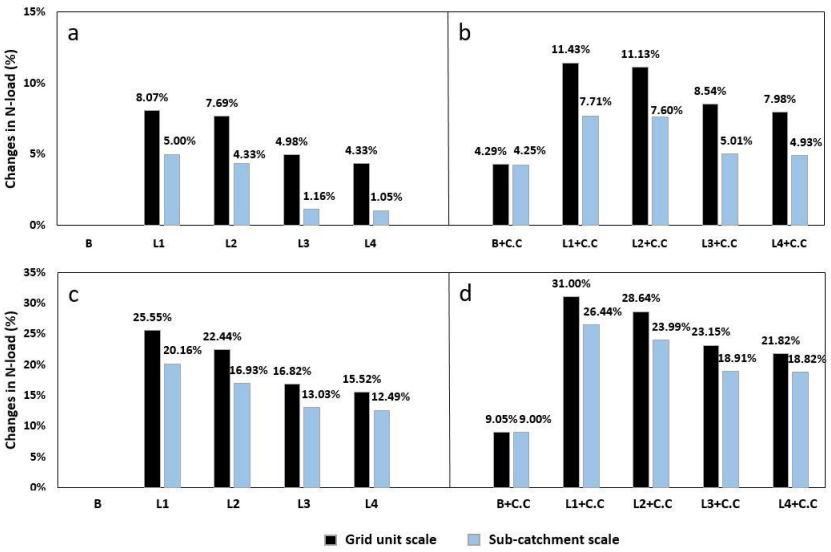

Figure 2. Effects of N-leaching relocation (a for Norsminde and c for Odense) and N-leaching relocation with C.C application (b for Norsminde and d for Odense) on N-load reduction compared to baseline. Leaching of B, L1, L2, L3 and L4 respectively refer to baseline N-leaching, N-leaching relocated based on N-reduction, N-reduction within each soil type, N-reduction within each farm boundary and N-reduction within each soil type of each farm.

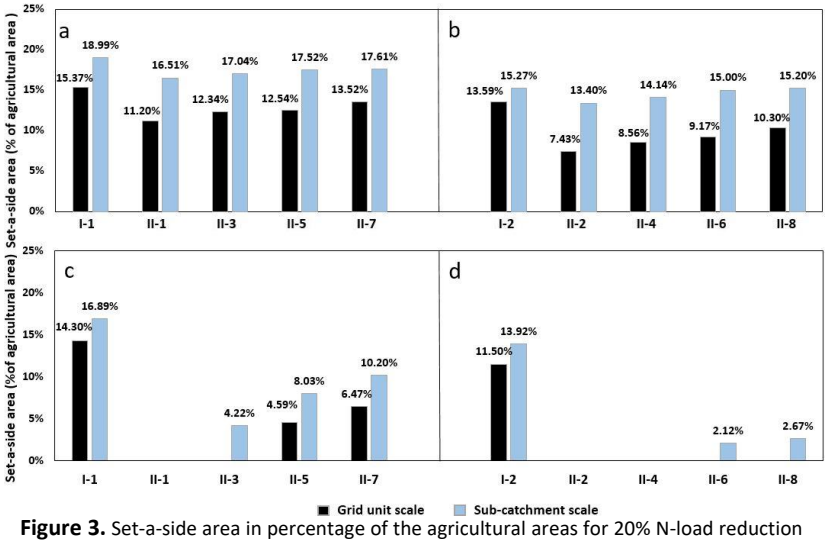

Figure 3. Set-a-side area in percentage of the agricultural areas for 20% N-load reduction target (a and b for Norsminde and c and d for Odense catchments). In some of the scenarios only set-a-side measure was considered (Left) and in some others both set-a-side and C.C (Right)