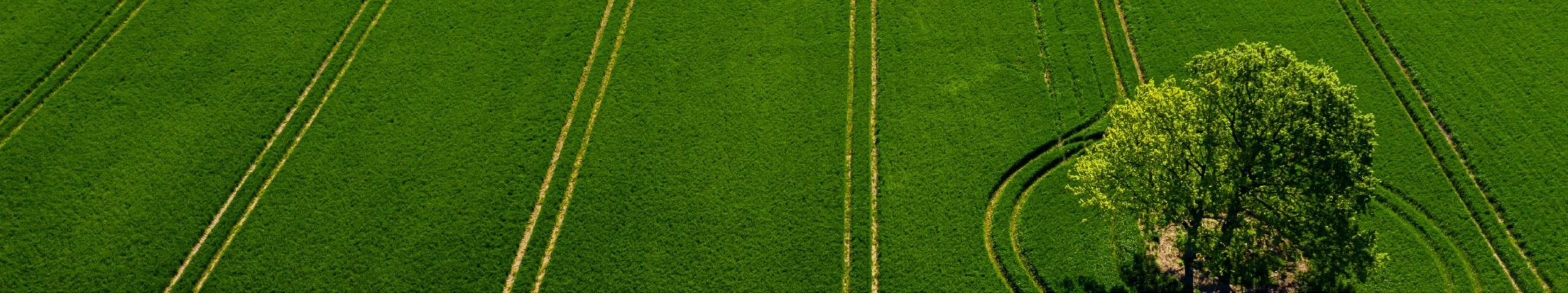

Modelling mitigation measures on nitrate in groundwater protection areas in the NL

Kevin Duan (kevin.duan@wur.nl)
Sustainable Soil Management,
Wageningen Environmental Research

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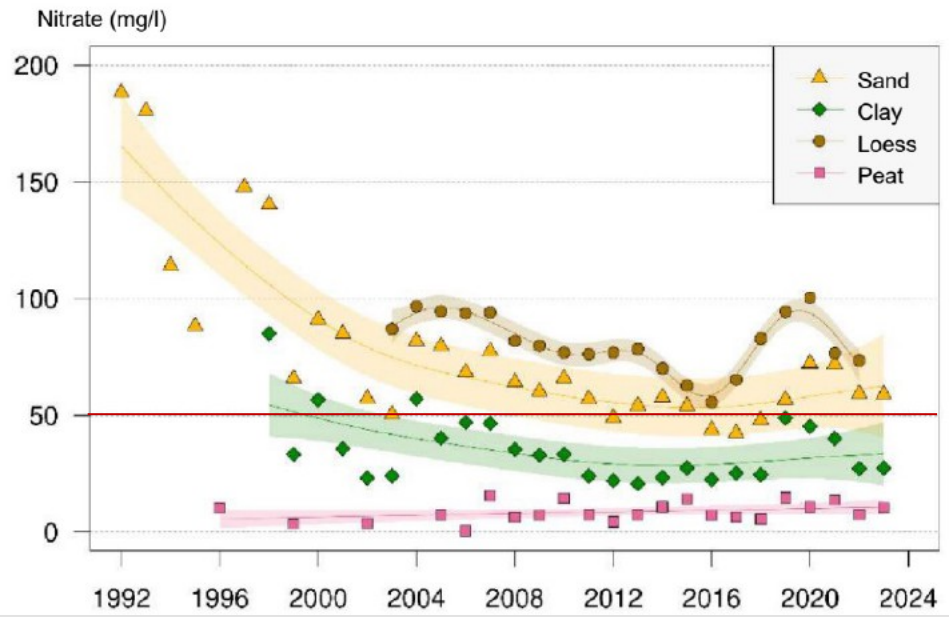
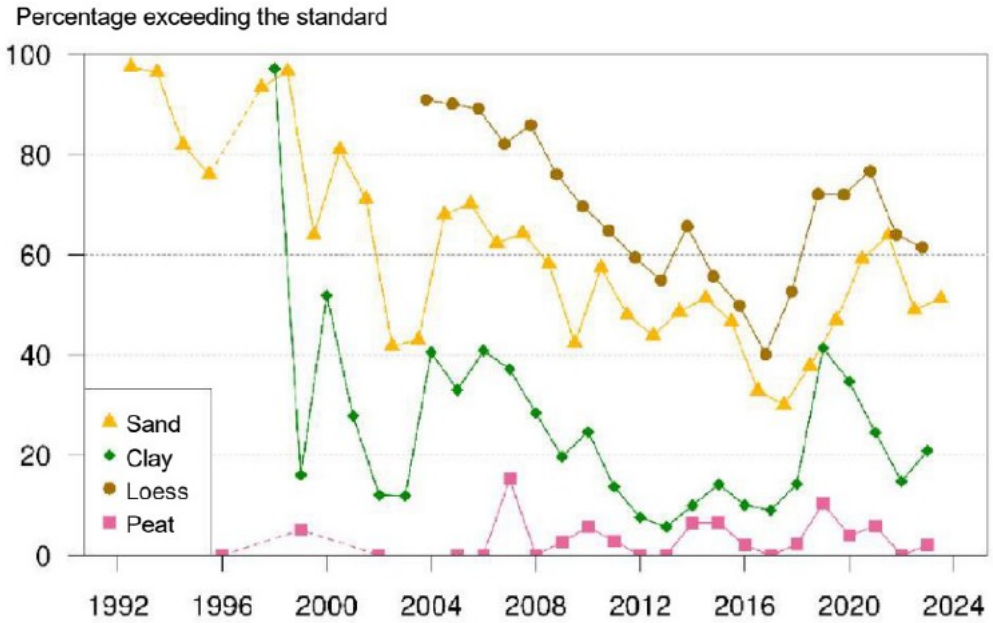
Background

High nitrate concentrations were found in groundwater under agricultural fields in NL.



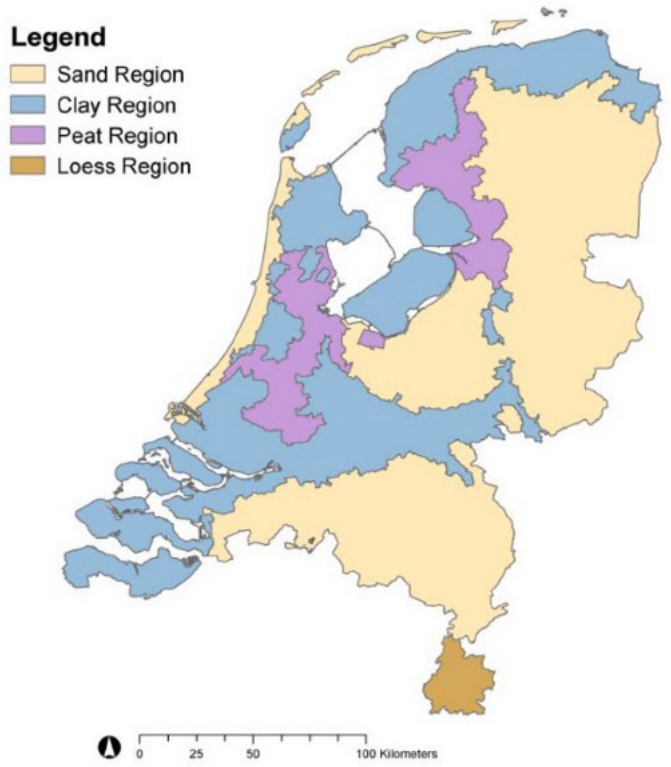
Recent monitoring found 50-100 mg/L GW nitrate in sand/loess soil regions.



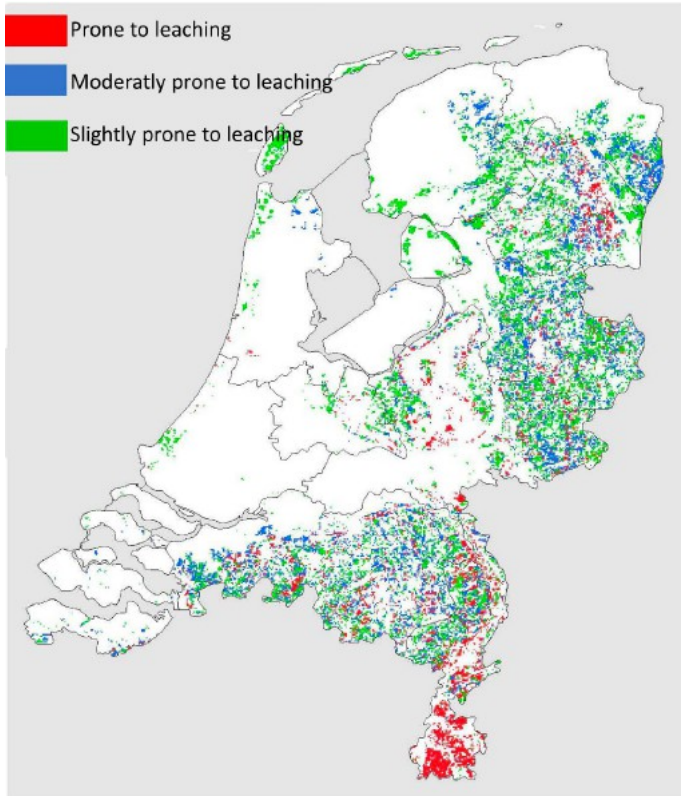
Nitrate leaching from > 50% farms in sand/loess soil regions exceed EU's 50 mg/L standard.

Source: Agricultural practices and water quality in the Netherlands: status and trends (1992-2023), RIVM

Background: Soil Types & Nitrate Leaching



Classification of main soil type regions



Areas prone to nitrate leaching

34 groundwater protection areas (GWP)

60% grassland & 40% arable land
Dry to very dry soils.

Source: RIVM

Approach: Model Chain

SWAP

Soil water fluxes

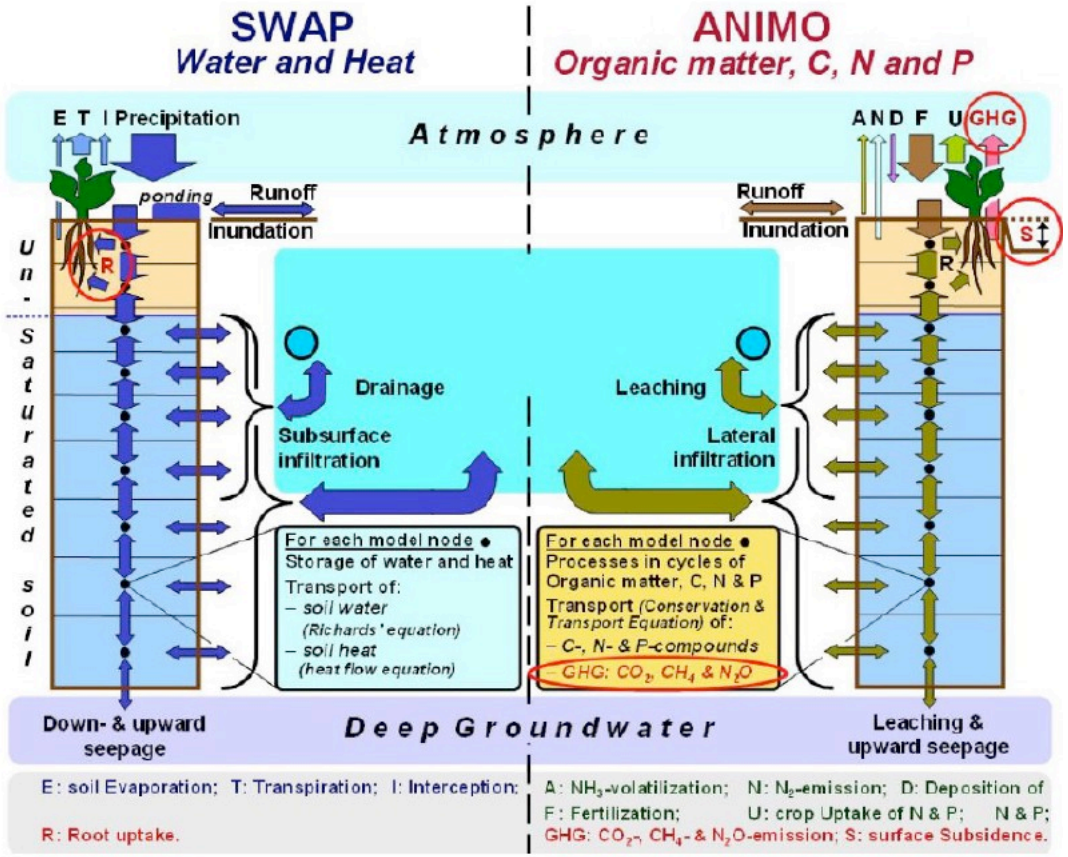
ANIMO

N flows in soil and leaching/runoff to water

QUAMOD/MEBOT

Crop N uptake and residue incorporation

A chained three-model approach



Coupling of SWAP and ANIMO models

Approach: Modelled Scenarios

	Baseline	Reference Scenarios		
	Fertilization according to standards, max 170 kg manure N; pasture grazing; catch crop after maize	**Reduce Fertilization × Climate (Precipitation)** • by 20% • by 33%	• Average (2006) • Dry (2003) • Moist, high production (2014)	
	Adjusting Crop Rotations	**Additional Farm Management**		**Organic Farming**
Dairy Farms	• Replace maize by grassland • Grassland rotation	• Grassland cutting • Reduced grazing		• Grass clover mixture for dairy farms
Arable Farms	• Potato to winter wheat • New potato varieties • Additional fiber crop • Potato to winter wheat + Fiber crop	• Row fertilization • Introducing catch crops • Recycle sugar beet residues.		• Crop rotation with alfalfa • Catch crop following all crops

Approach

34 GWP regions

218 plots

Sand & Loess Soils

Dairy & Arable Farms

32 Scenarios

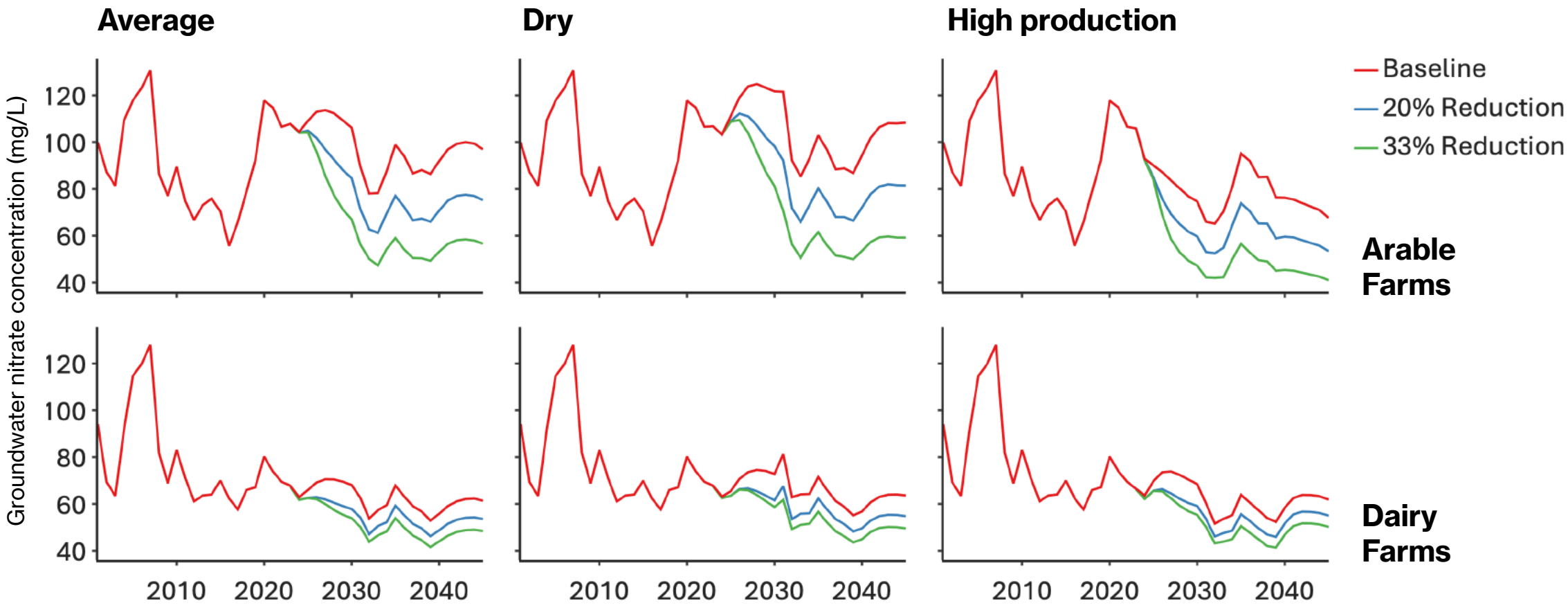
Assumptions for mitigation measures made based on expert judgement.

Temperate climate conditions.

Simulation period 30 years.

Calibration to a limited extent.

Results



Simulated groundwater nitrate concentration under different weather conditions for the reference scenarios

Groundwater Protection Area	Reduction Gap (mg/L)	Reducing Fertilization		Mitigation Measures to Dairy Farms				Mitigation Measures to Arable Farms								
		20% Reduction	33% Reduction	Grassland Rotation	Grassland Cutting	Reduced Grazing	Organic Farming	Potato to winter wheat	Additional fiber crop	Low fertilized fiber crop	Potato to WW + fiber crop	Potato to WW + low fertilize fiber crop	Catch crops	New potato variety	Recycle sugar beet residues	Organic Farming
Archemerberg	30	21-33	26-39	8	4	2		4	2	3	5	5	1	1	0	4
Beegden	140	75-88	87-97	3	6	3	8	18	1	10	13	24	7	7	11	24
Bergen	75	13-40	24-48	2	3	2		22	9	13	81	83	11	7	0	32
Bergen op Zoom	65	9-30	12-34	4	6	3	39									
Breehei	150	63-89	79-98	3	5	3	6	24	4	11	26	32	-2	8	8	44
Craubeek	30	18-36	24-40	6	1	1		15	2	5	18	20	22	4	3	16
De Dommel	20	17-30	22-33	6	2	1		12	2	3	14	15	10	3	2	10
De Tombe	10	14-26	18-30	5	1	1		11	4	5	16	17	13	3	2	15
Dinxperlo	75	33-51	40-55	2	7	4		15	10	11	17	18	2	3	0	16
Gasselte	55	20-33	37-43	2	4	2	18	17	6	10	18	21	8	5	8	5
Gilze	0	13-19	16-21	8	1	1	10	0	0	0	0	0	1	0	5	
Gilzerbaan	0	12-16	16-19	6	1	1	8	1	-1	0	2	3	0	1	2	5
Grubbenvorst	70	33-38	44-49	3	3	2	3	38	-8	4	35	43	-14	9	18	6
Haarlo	5	13-18	14-19	5	3	1	10	3	1	2	3	3	1	0	0	1
Havelterberg	65	3-19	21-34	4	8	4	38	18	12	14	22	24	14	2	2	8
Heel	105	63-82	71-88	3	5	2		35	14	22	37	43	9	8	0	28
Heer-Vroendaal	10	14-26	19-29	5	1	1		10	-1	0	15	16	11	3	3	15
Helvoirt	25	16-23	20-27	2	2	1	5	17	8	12	20	22	3	4	0	18
Herikerberg	50	21-34	26-38	7	10	5										
Hoge Hexel	55	22-34	27-36	6	6	3	24	8	3	4	8	9	2	2	0	6
Holten	50	21-34	25-36	9	7	4	12									
IJzeren Kuilen	20	17-29	22-33	4	1	1		13	3	5	16	17	17	4	3	16
't Klooster	10	17-25	20-27	7	4	2		2	0	1	2	3	0	0	0	2
Leggeloo	0	8-10	11-11	3	1	1	6	3	1	2	3	4	1	1	0	3
Manderveen	25	17-24	22-28	8	5	3	5	13	10	11	14	15	8	2	0	9
Mookerheide	40	16-22	22-27	1	6	3		4	1	2	4	4	2	1	1	1
Nuland	30	18-22	21-26	5	1	1	14	12	3	6	12	14	3	3	4	7
Olden Eibergen	0	9-13	11-16	7	2	1	8	2	1	1	2	2	1	0	0	1
Roodborn	30	19-34	25-38	4	3	1		16	3	5	19	21	13	4	3	15
Roosendaal	20	19-30	23-33	3	2	1	5	6	2	3	6	7	2	2	2	2
Valtherbos	25	12-23	19-28	2	2	1	7	15	5	9	15	18	4	4	7	6
Vessem	60	34-41	40-45	7	3	2	11	11	-1	2	10	13	4	3	5	
Waalwijk	10	10-19	10-19	1	4	2	10									
Waterval	100	37-63	47-70	4	4	2		26	5	8	31	33	21	6	5	23
Wierden	70	31-43	38-48	6	7	3	23	9	8	8	13	14	5	1	0	8

Average over Agricultural Lands vs Entire GWP Area

Results averaged over agricultural lands only
in line with the Nitrates Directive

31 GWP Areas that do not meet the standard

5-150 mg/L
required reduction to meet the standard

Results averaged over entire GWP area
in line with *Bestuursovereenkomst Nitraat*

16 GWP Areas that do not meet the standard

3-79 mg/L
required reduction to meet the standard

The decision is left for the policy makers.

Conclusion

- Reducing N fertilization is simple but effective.
- The effect of mitigation measures vary significantly depending on farm types and the region.
- By deploying the measure with the greatest effect, the target of 50 mg/L nitrate can be met in ca. 50% of the GWP areas.
- A combination of measures must be considered for a greater reduction.


Thank you.
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