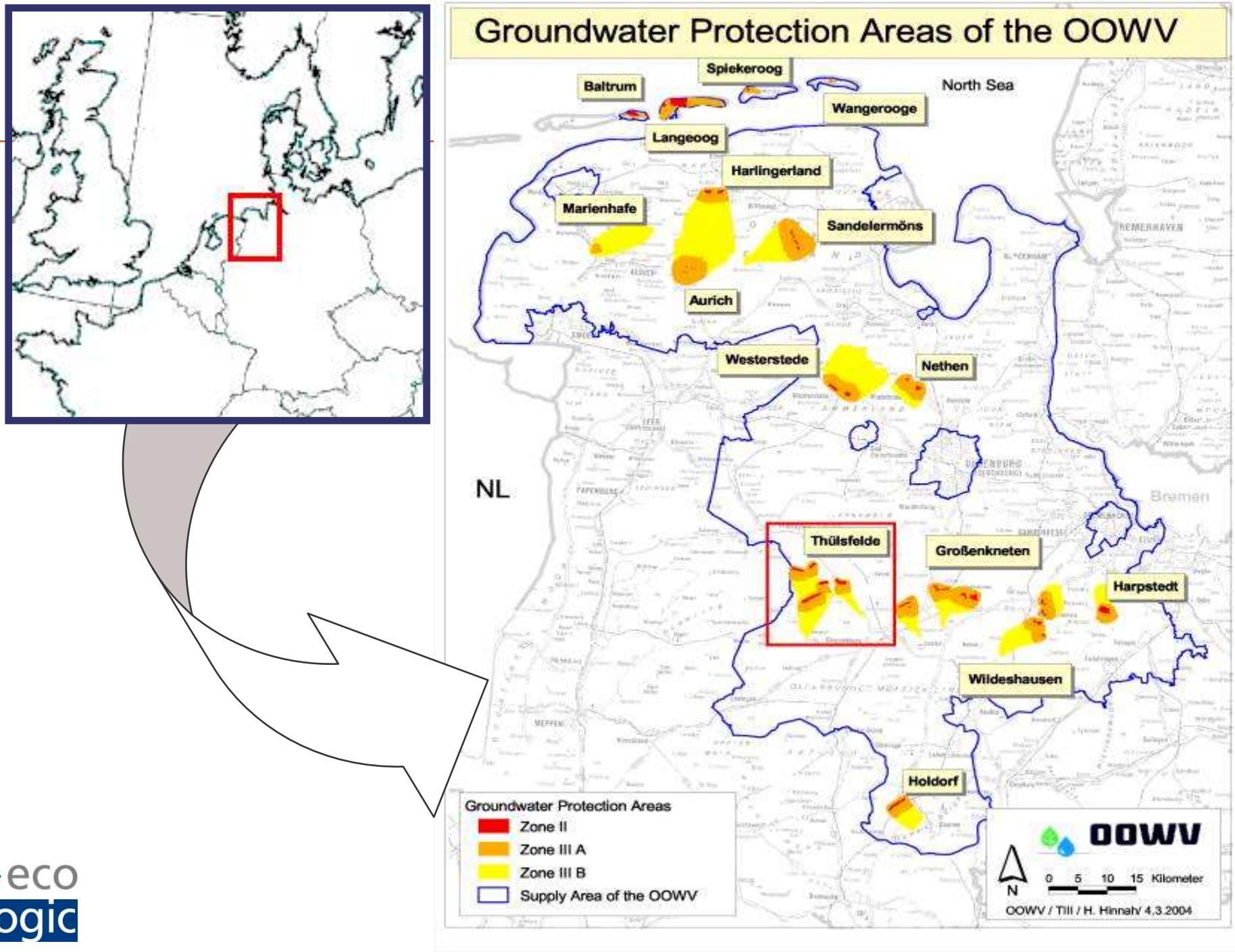
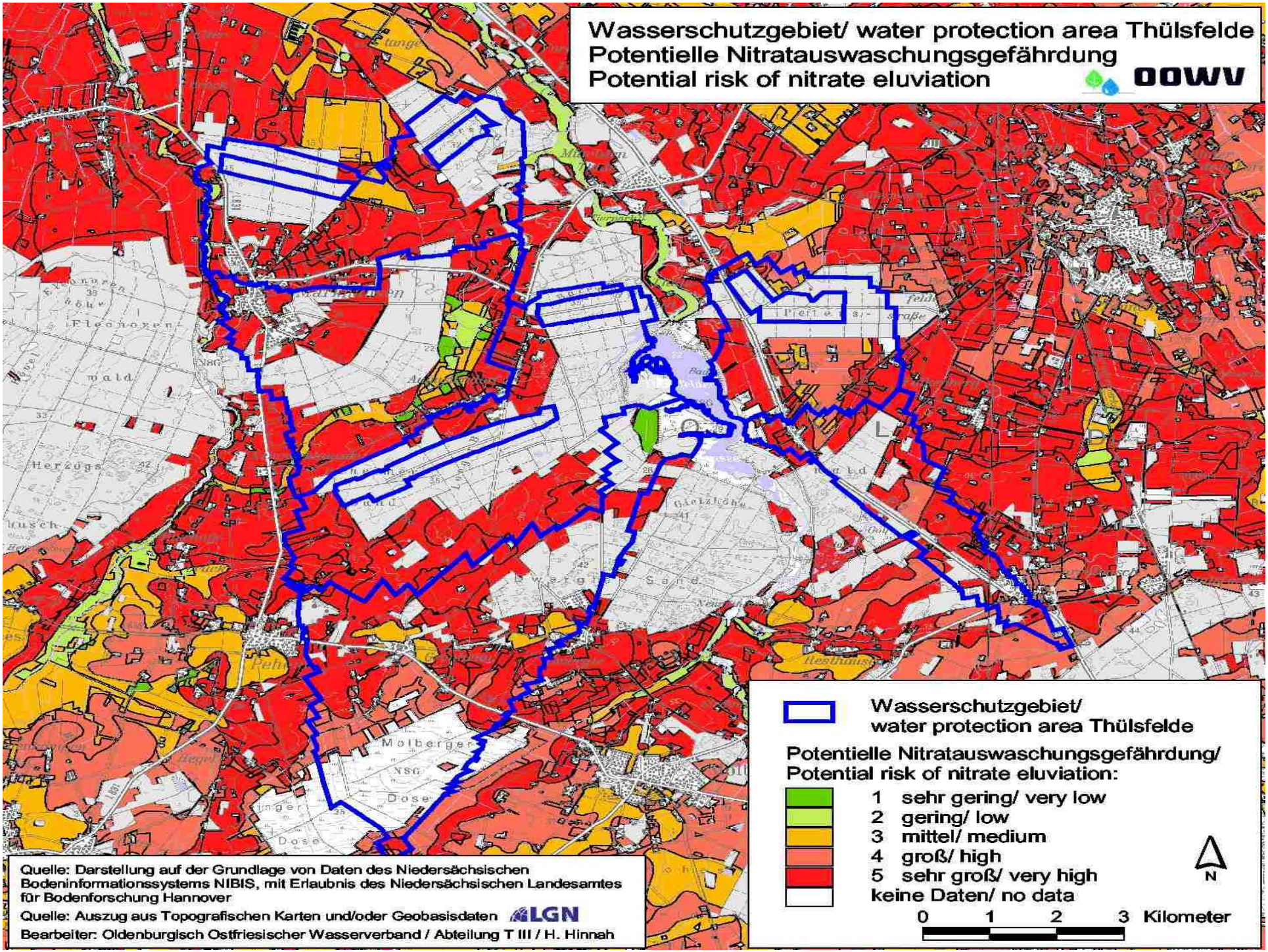

eco logic
Landwirtschaftskammer Niedersachsen
OOWV
Benjamin Görlach, Ecologic
Cost-effective groundwater protection: the Thülsfelde Water Protection Area
Interreg North Sea Region
Watercost


Groundwater Protection Areas of the OOWV
Spiekeroog
Baltrum
North Sea
Wangerooge
Langeoog
Harlingerland
Marienhafe
Sandelermöns
Aurich
Westerstede
Nethen
NL
Thülsfelde
Großenkneten
Harpstedt
Wildeshausen
Holdorf
Groundwater Protection Areas
Zone II
Zone III A
Zone III B
Supply Area of the OOWV
OOWV
N
0 5 10 15 Kilometer
OOWV / Till / H. Hinnah/ 4.3.2004

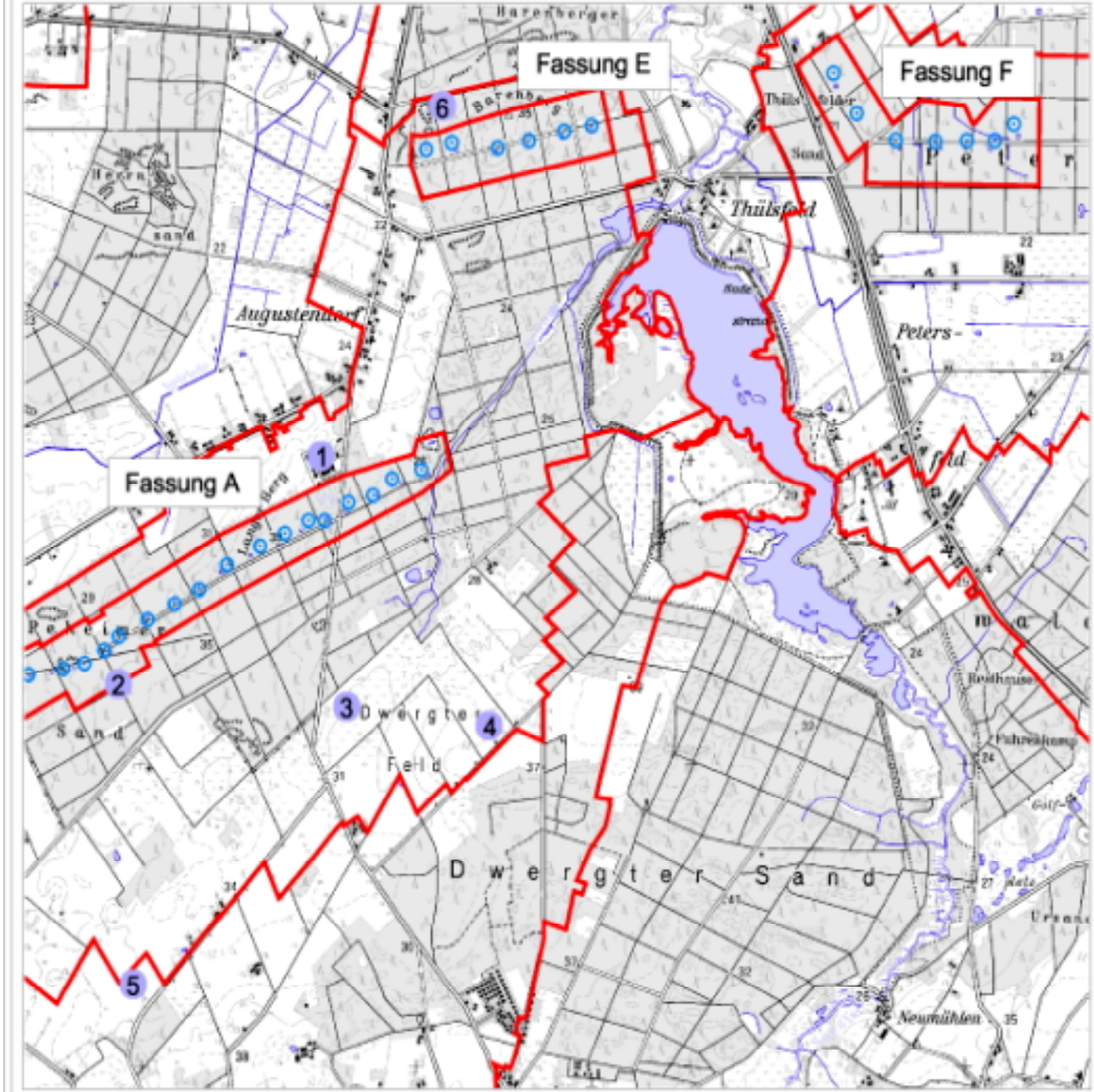
Characteristics: location / climate

level:	35 m a.s.l.
water table:	8 – 10 m below surface
geology:	glaciofluvial sand
rainfall:	819 mm/a
rainfall May - Sept:	350 mm/summer
evapotranspiration:	556 mm/a
climate water balance:	263 mm/a
percolating water (Sept-May):	314 mm/winter
percolating rate:	12,9 dm
leaching:	2,6 times per year


Wasserschutzgebiet/ water protection area Thülsfelde
Potentielle Nitratauswaschungsgefährdung
Potential risk of nitrate eluviation
OOWV
Wasserschutzgebiet/
water protection area Thülsfelde
Potentielle Nitratauswaschungsgefährdung/
Potential risk of nitrate eluviation:
1 sehr gering/ very low
2 gering/ low
3 mittel/ medium
4 groß/ high
5 sehr groß/ very high
keine Daten/ no data
N
0 1 2 3 Kilometer
Quelle: Darstellung auf der Grundlage von Daten des Niedersächsischen Bodeninformationssystems NIBIS, mit Erlaubnis des Niedersächsischen Landesamtes für Bodenforschung Hannover
Quelle: Auszug aus Topografischen Karten und/oder Geobasisdaten LGN
Bearbeiter: Oldenburgisch Ostfriesischer Wasserverband / Abteilung T III / H. Hinnah

Water abstraction in Thülsfelde

waterworks built in	1978 / 82
permitted water production	14,3 Mill. m^3/a
water production	around 12 Mill. m^3/a
number of wells	40
depth of filters	
water intake field A and E	30 – 80 m below ground
water intake field B and D	80 – 130 m below ground
water intake field F	100 – 160 m below ground
number of observation wells	80 (2/3 < 20 m below ground)



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Wasserwerk/ Waterworks Thülsfelde

1. Wasserwerk/ Waterworks
2. Nds. forstliche Versuchsanstalt/ Forest Research Institute of Lower Saxony
3. Aufforstungsversuch/ Experimental plot afforestation
4. Versuchsfläche LW-Kammer/ NLFB Experimental plot Chamber of Agriculture/ National Board of Soil Investigation
5. Versuchsläche "ökologischer Landbau"/ Experimental plot "organic farming"
6. Restaurant "Schöning"

weitere nicht dargestellte wissenschaftliche Untersuchungen/
further scientific investigations (not shown)

- Grünland - Untersuchungen/ Investigastions on grassland
- Dauerbeobachtungsfläche "Boden"/ Permanent plot of soil investigations
- LWK/ NLfB: Untersuchungen auf Forstböden/ LWK / NLfB: investigations on forest soils
- Förderbrunnen/ Abstraction wells
- Wasserschutzgebiet/ Water protection area

0 500 1000 1500 Meter

N

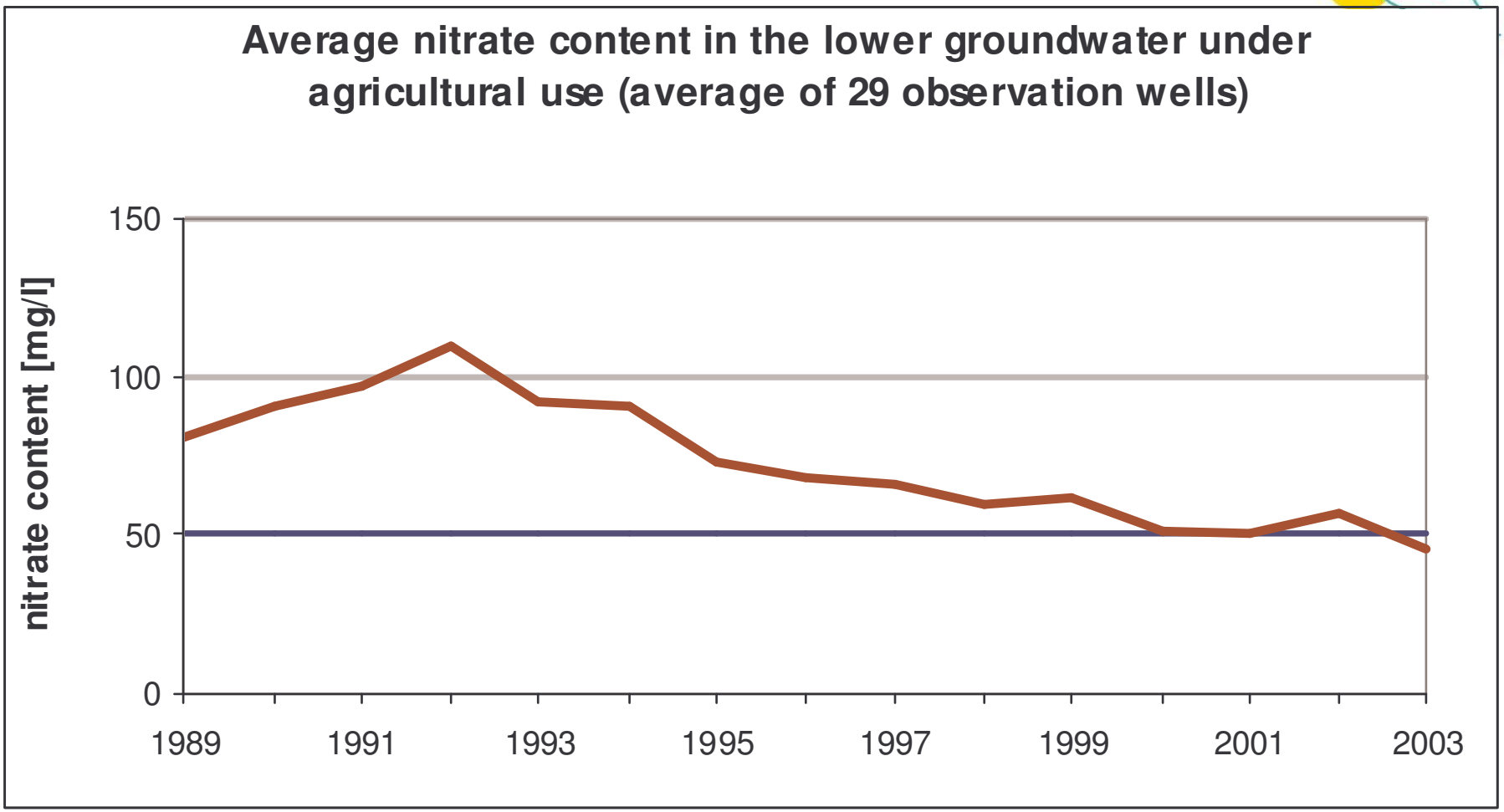
OOWV/ Abt. TIII / HH / März 2005
Quelle TK 50: Auszug aus Topografischen Karten und/oder Geobasisdaten

LGN

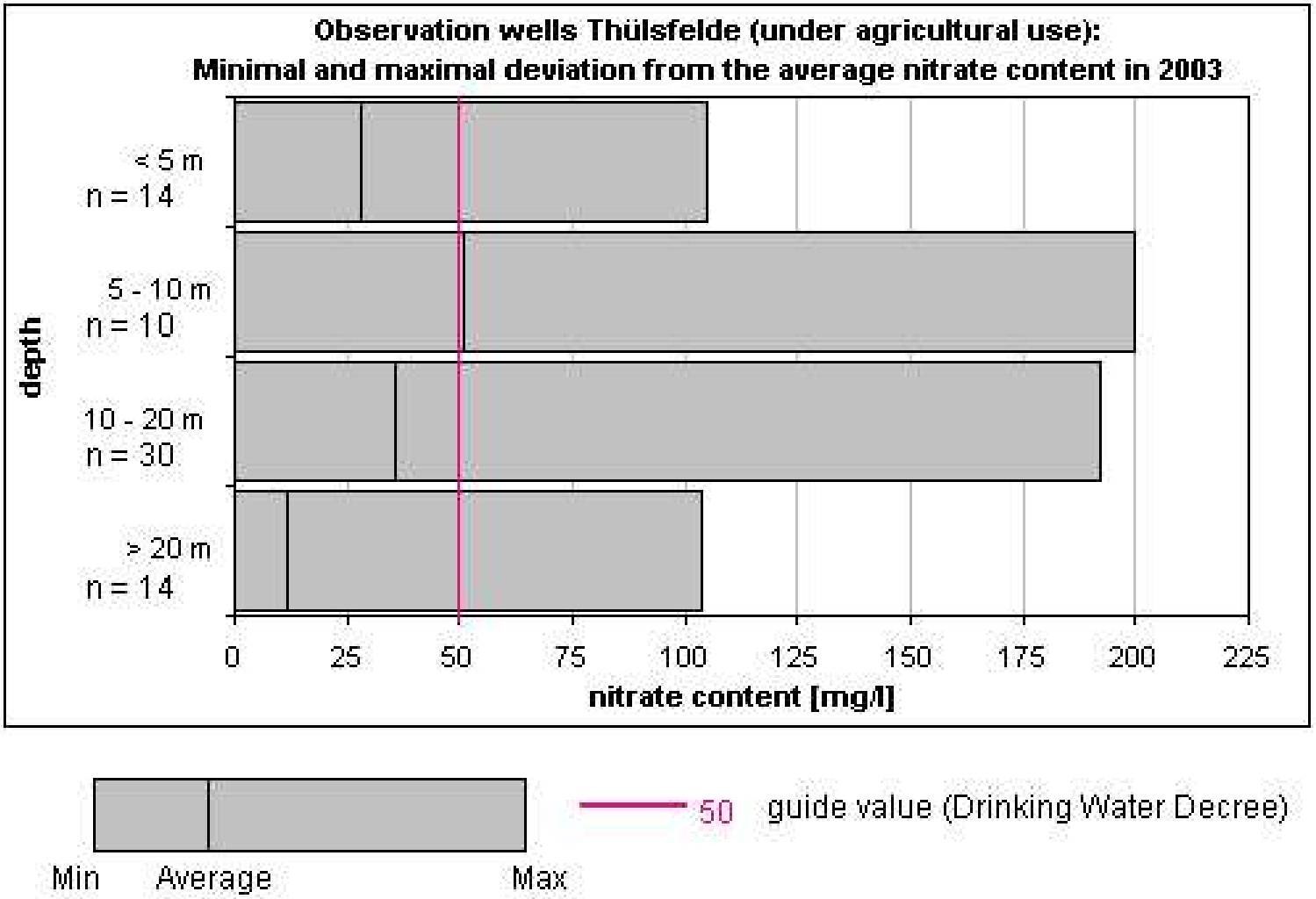
Water Protection Area (WPA) Thülsfelde

- statutory area for drinking water protection
- area: 7357 ha
- land use: 41,2 % arable land
  38,3 % forest
  7,0 % grassland
  4,5 % bog, swamp
  9,0 % settlement

Groundwater quality



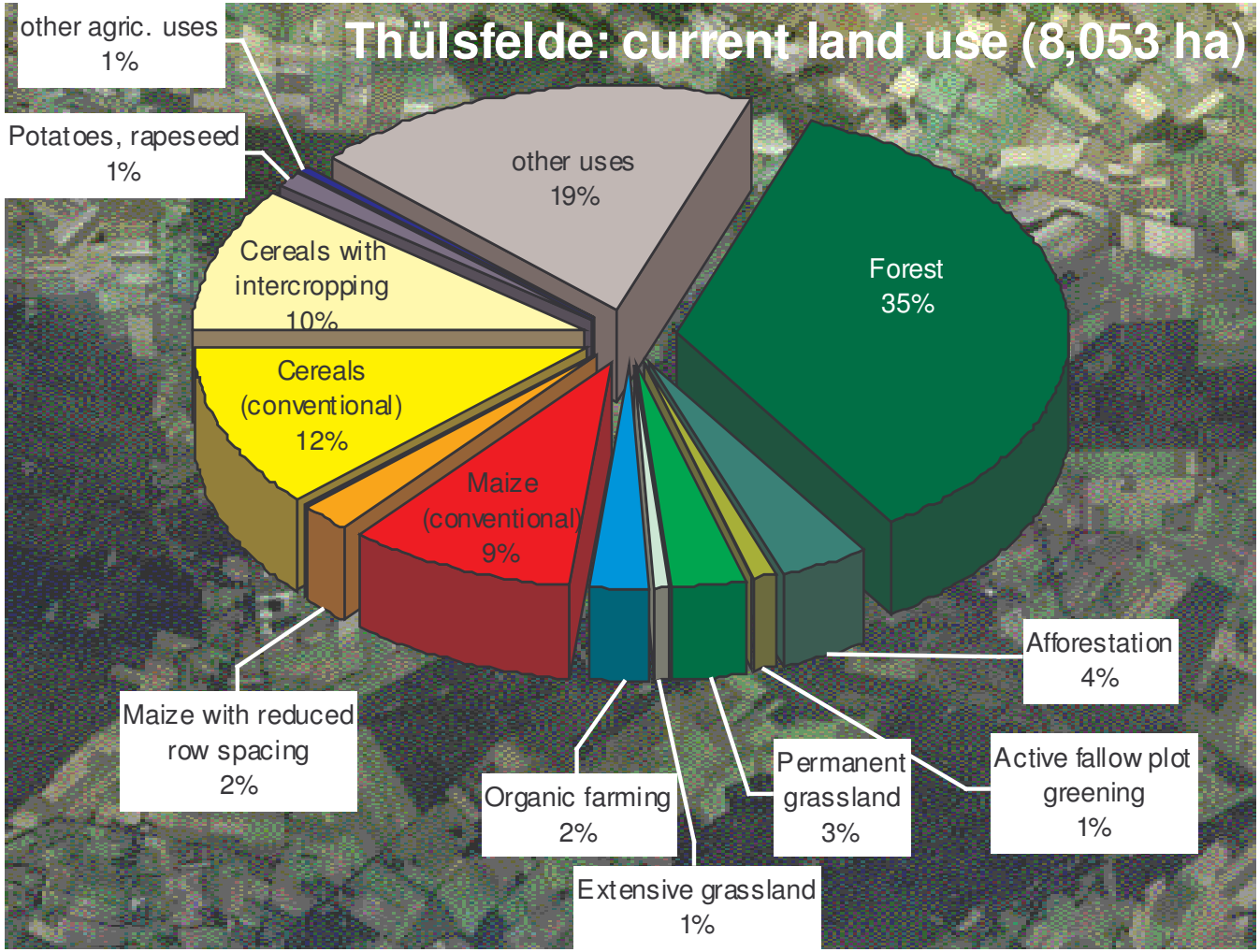
Groundwater quality



Existing / ongoing initiatives

- free advice for farmers (75% participation in advisory services
- contracts of „voluntary agreements“ (60% of farmers participating)
- special projects
- financed by the Water Abstraction Charge in Lower Saxony

Current land use in the area



Measures considered

- Afforestation
- Active fallow plot greening
- Permanent grassland
- Promotion of organic farming
- Maize with reduced row spacing
- Maize with limited fertiliser (100 kg N/ha)
- Cereals with intercropping
- Integrated fertiliser and manure application
- Temporal restrictions for manure spreading
- Towed umbilical hose / slit injection

Gap to be closed through measures

- Current total nitrate load: 1,640 t / 8,000 ha
- Av. nitrate concentration in leachate: 83 mg/l
- To reduce av. nitrate concentration to 50 mg/l, total nitrate load needs to be reduced by 656 t per year
- Measures defined in terms of area on which they are applied - not considered at which specific location they are applied

Modelling of measures

	A	B	C	D	E	F	G	H	I	J	K	L
1		Measure	Area	Potential N load	Leachate	Nitrate concentration in leachate	Amount of leachate	Nitrate load	Additional area	Nitrate load per ha	Nitrate reduction per ha	Saved total nitrate load of the area
2			ha	kg N / ha	mm	mg/l	l	kg	ha	kg NO3 / ha	kg NO3 / ha	kg NO3
3		Forest	2840	25	200	55	5.680.000	314.530		110,8		
4	A40	*Afforestation*	300	5	200	11	600.000	6.645	**20**	22,2	354,3	7.08
5	B3	*Active fallow plot greening*	89	19	300	28	267.000	7.491	**30**	84,2	292,3	8.76
6	A25	*Permanent grassland*	244	31	250	55	610.000	33.509	**40**	137,3	239,1	9.56
7		*Extensive grassland*	49	19	300	28	147.000	4.124	**10**	84,2	292,3	2.92
8	B4	*Organic farming*	197	51	300	75	591.000	44.508	**50**	225,9	150,5	7.52
9		Maize (conventional)	764	121	300	179	2.292.000	409.527		536,0		
10	B4	*Maize with reduced row sp*	168	111	300	164	504.000	82.611	**470**	491,7	44,3	20.82
11	A1	*Maize with limited fertilise*	1	33	300	49	3.000	146	**180**	146,2	389,8	70.17
12		Cereals (conventional)	950	96	300	142	2.850.000	404.016		425,3		
13	A22	*Cereals with intercropping*	818	43	250	76	2.045.000	155.821	**100**	190,5	234,8	23.47
14		Potatoes	19	85	300	126	57.000	7.154		376,6		
15		Ackergras	52	69	300	102	156.000	15.895		305,7		
16		Rapeseed	14	101	300	149	42.000	6.264		447,4		
17		other agric. uses	48	71	200	157	96.000	15.097		314,5		
18		other uses	1500	20	250	35	3.750.000	132.900		88,6		
19												
20		**Summe**	**8053**				**19.690.000**	**1.640.239**				**150.34**
21												
22	B7	*Integrated fertiliser and manure application*							**757,75**		60	45.46
23	A8	*Temporal restrictions for fertiliser/ manure/ slurry spreading*							**1**		60	6
24	A7	*Towed umbilical hose, trailing shoe or slit injection*							**200**		40	8.00
25												
26												
47												

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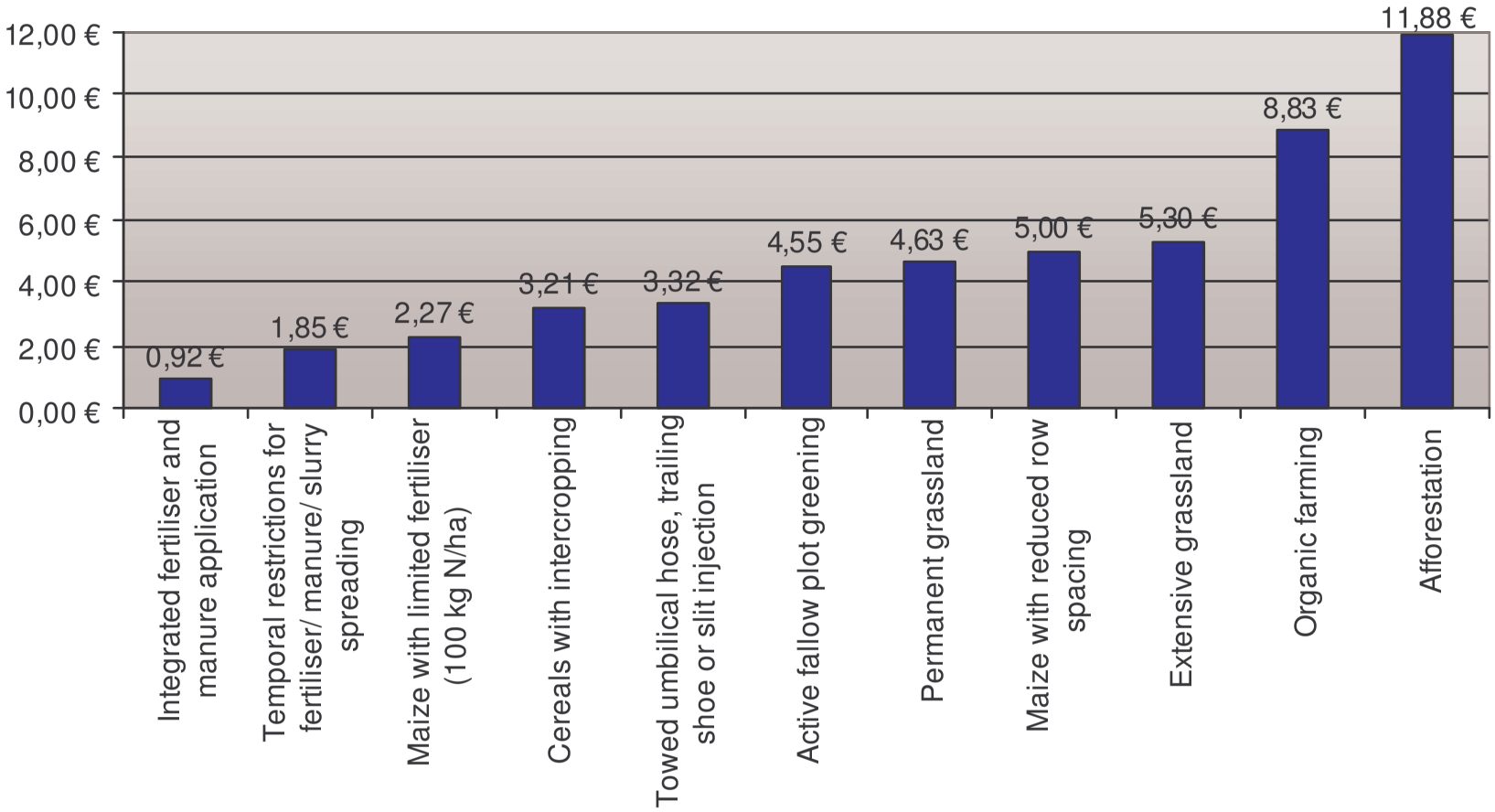
Cost-effectiveness of different measures



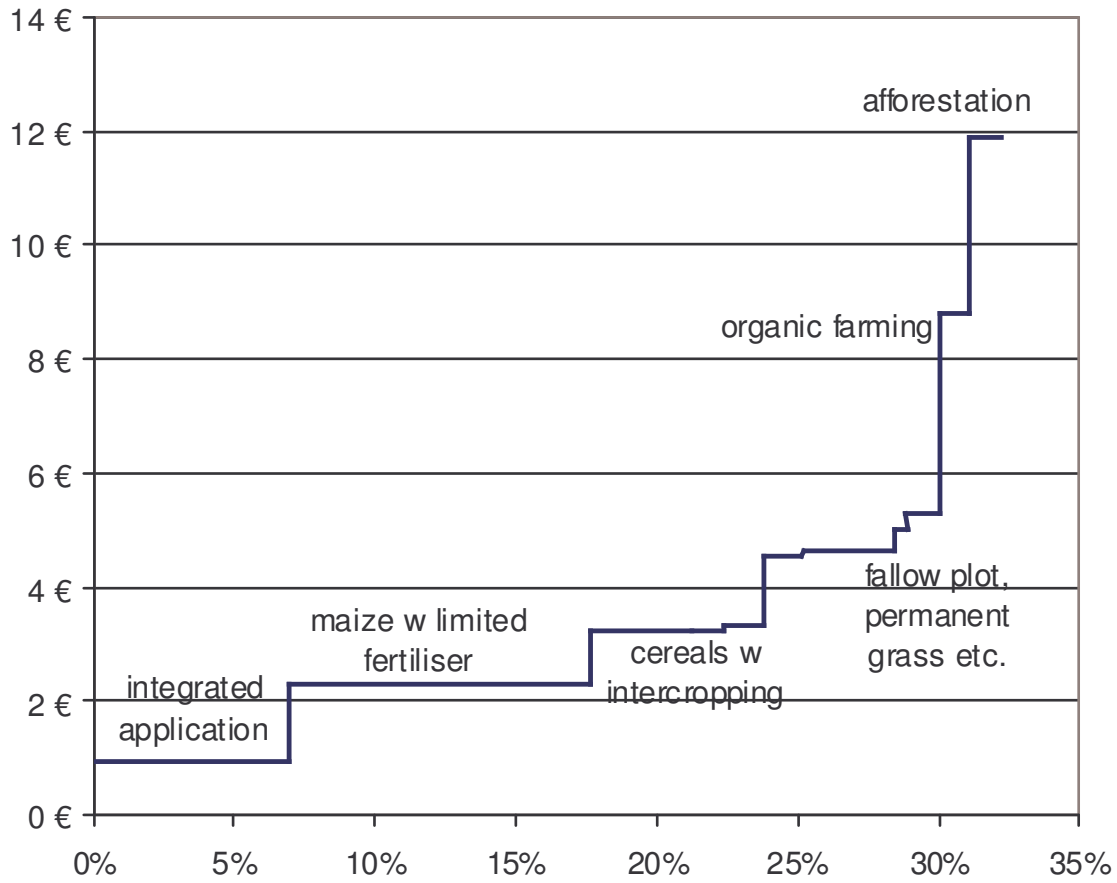
Combinations of measures

- Three scenarios developed:
  - Realistic: What can realistically be achieved by 2015 (business as usual)?
  - Optimistic: What could be achieved if considerations of political feasibility are viewed very optimistically?
  - Utopian / central planners optimum: ignoring all real-world constraints, what is the most cost-efficient way to 100% target achievemt?
- Starting from lowest-cost options, moving up

The realistic scenario

- What can realistically be achieved?
  - 20 ha afforestation (now 300 ha)
  - 30 ha fallow plot greening (now 89 ha)
  - 50 ha grassland (now 293 ha)
  - 50 ha organic farming (now 197 ha)
  - 470 ha maize w reduced row spacing (now 168)
  - 180 ha maize w 100 kg N /ha
  - 100 ha cereals w intercropping (now 818 ha)
  - Integrated application on 25 % of farmland, umbilical hose / slit injection on 200 ha

Realistic results

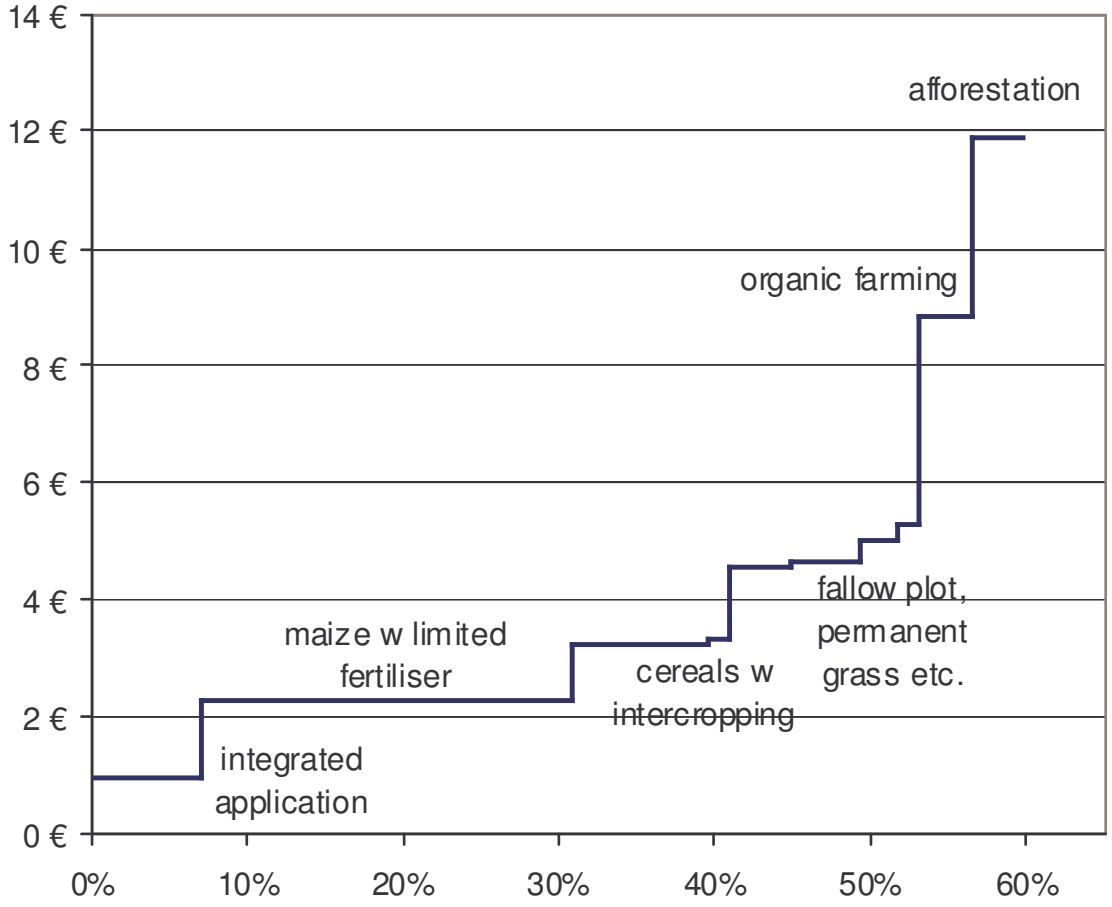


- gap closure: ~ $^1/_3$ only
- Total costs: 150,000 Euro
- 4,776 Euro / %pt gap closed
- av. cost: 3.13 Euro /kg N

The optimistic scenario

- If political & economic feasibility constraints are relaxed, what could be achieved in principle?
  - 60 ha afforestation (20 ha “realistic”)
  - 90 ha fallow plot greening (30 ha “realistic”)
  - 150 ha grassland (50 ha “realistic”)
  - 150 ha organic farming (50 ha “realistic”)
  - 400 ha maize w 100 kg N /ha (180 ha)
  - 364 ha maize w reduced row spacing (470 ha)
  - 250 ha cereals w intercropping (100 ha)
  - Integrated application etc: same as “realistic”

Optimistic results

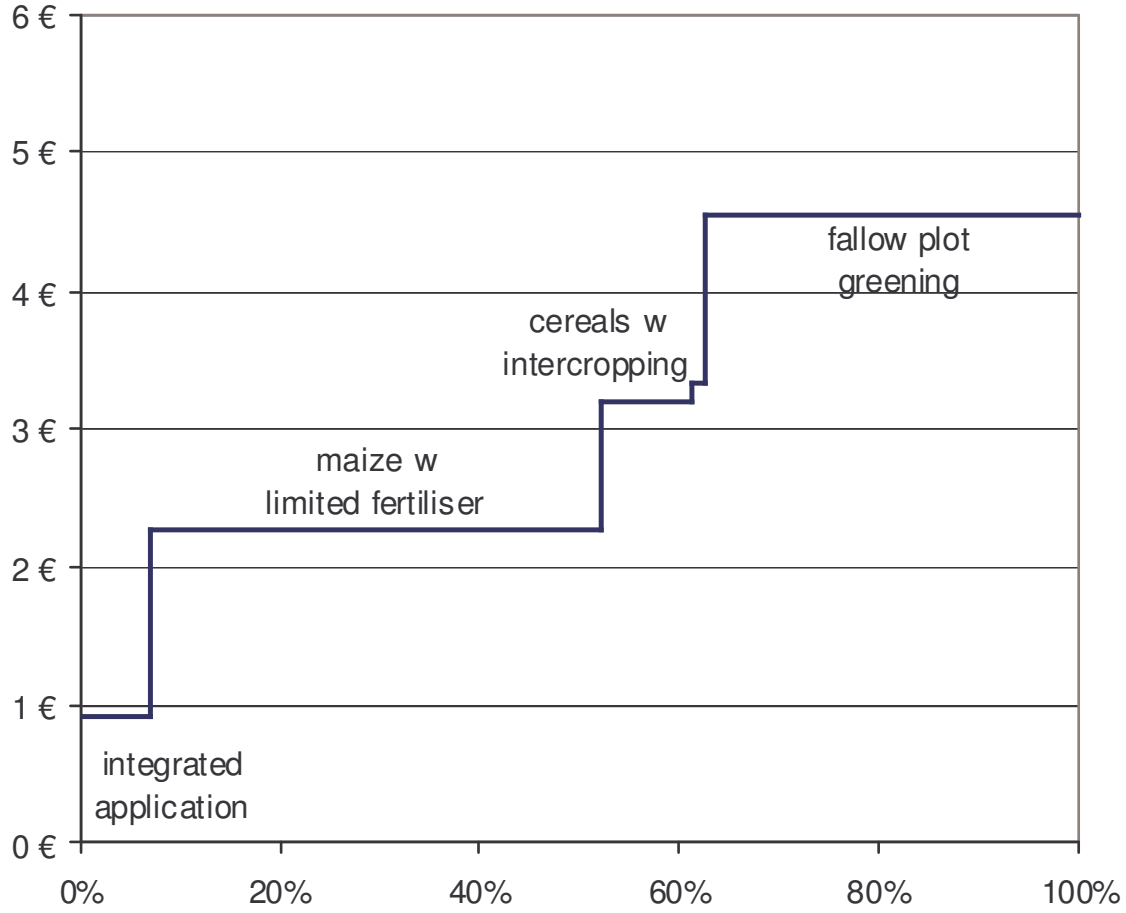


- gap closure: almost 60%
- total costs: 326,000 Euro
- 5,450 Euro / %pt gap closed
- av. cost of 3.68 Euro /kgN

The utopian scenario

- Ignoring all real-world constraints, what would a central planner's optimum be?
- 5 measures only:
  - Limited fertiliser application (100 kgN/ha) on all maize (764 ha)
  - Intercropping for all cereals (250 ha)
  - Integrated application, towed umbilical hose etc: same as "realistic"
  - Arable land converted to fallow plot until 100% is reached

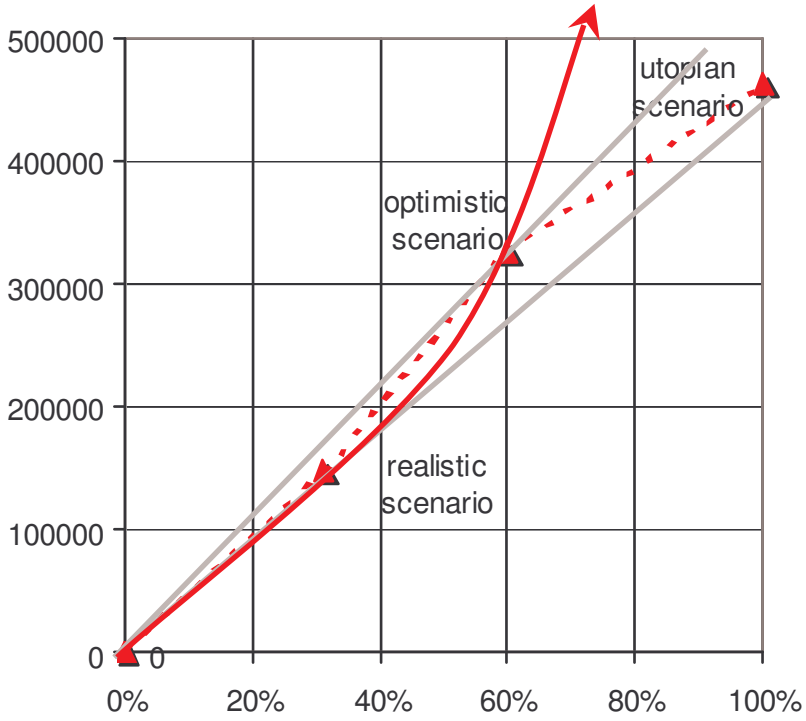
Utopian results: the planner's optimum



- 100% target achievement
- total costs: 463,000 Euro
- 4,630 Euro / %pt gap closed
- av. cost of 3.13 Euro /kgN

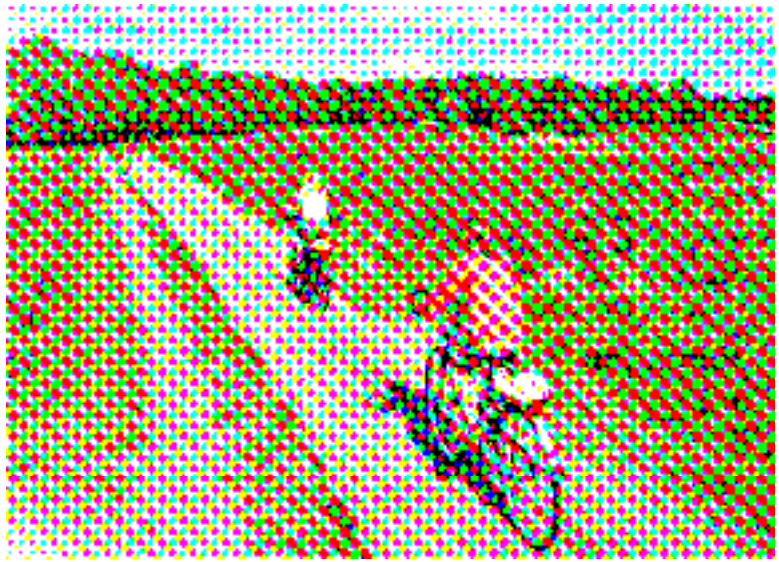
Comparison of scenarios

- Scenarios differ considerably in terms of cost, level of ambition (% of gap closed)
- Scenarios quite similar i.t.o. cost-effectiveness
- Strong assumptions for “utopian” scenario: cost more likely to go through the roof



External benefits

- Co-benefits of the different measures:
  - Water benefits other than nutrients (pesticides, water quantity)
  - Soil (erosion, compaction), biodiversity
  - Landscape, amenity (tourism in the area)
- Mostly relevant for
  - Afforestation
  - Fallow plot greening
  - Organic farming



Lessons learned

- Main results
  - Three measures achieve much of the reduction at low cost: integrated application of manure and fertiliser, 100 kg limit to N application, cereals with intercropping
  - 100% target may not be achieved - even two thirds would be a good result
- Confidence in the results
  - Cost and effectiveness estimates largely based on expert knowledge
  - Much experience with comparable measures

Lessons learned

- Surprises in the results
  - Little role for organic farming
  - Spatial dimension: different measures using the same area, partly excluding each other
- Experiences with the spreadsheet tool
  - Helpful to structure the analysis, less helpful for the combination of measures and the actual calculations
  - Measure database not used, since fairly good data on costs & effectiveness was available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Thank you for your attention !
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