

European Environment Agency



External costs of nitrogen for health and environment



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- ... through the provision of timely, targeted, relevant and reliable information to policy making agents and the public”
- EEA is an independent EU institution with 32 member countries incl. Turkey, Switzerland and Norway



■ Member countries
■ Collaborating countries

- 200 staff in Copenhagen headquarters - and 6 Topic Centres with wide network throughout Europe



Some findings (EXIOPOL, FP7)

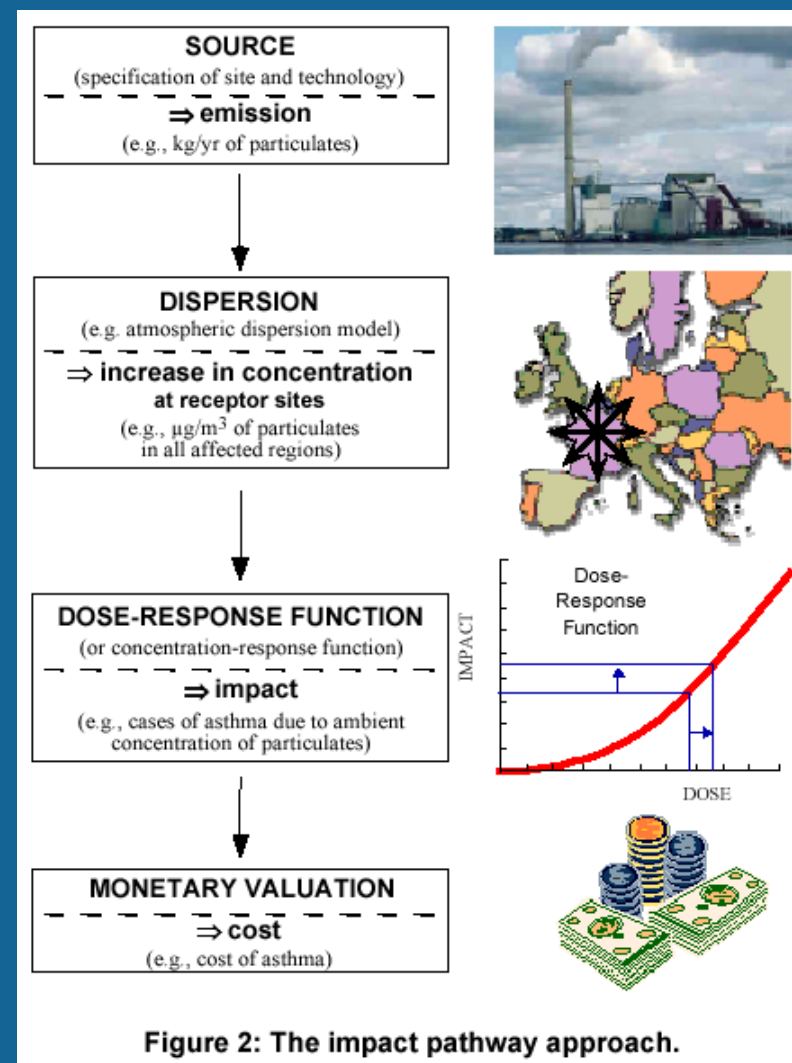
- External costs of nitrogen are site specific: hot spots and robust areas
- Precautionary approach required as scientific evidence base is incomplete
- External costs of nitrogen for EU27 with method consistent with approach used for air pollution (RAINS/GAINS etc.)



Impact pathway method (ExternE)

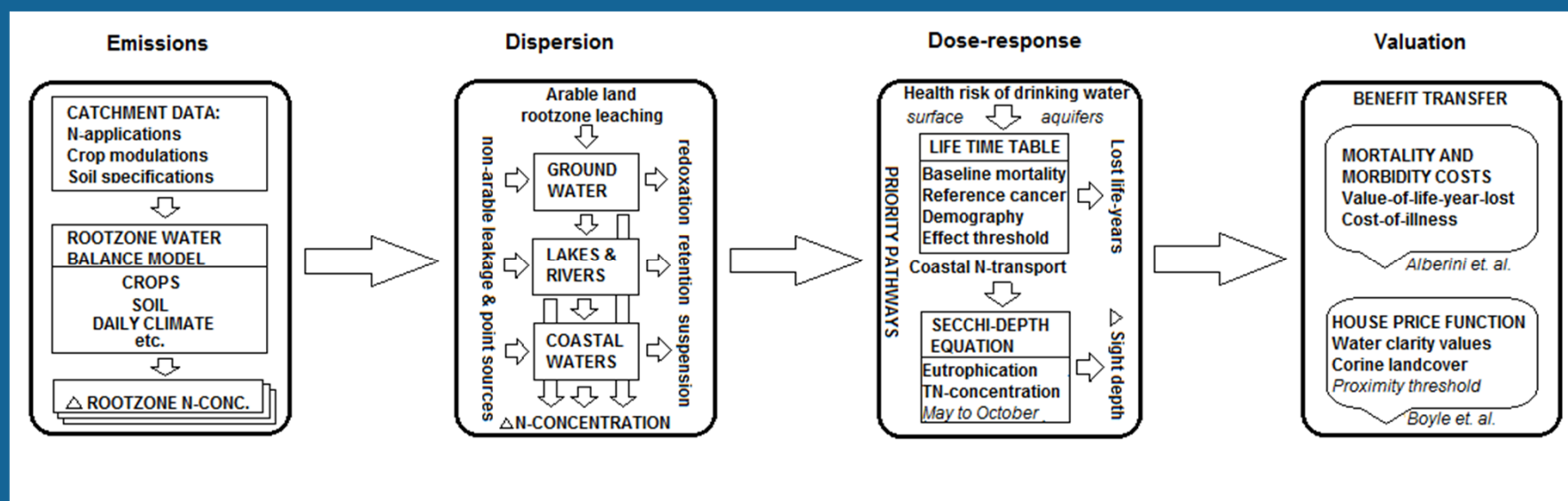
Four steps:

- Local and regional dispersion
- Change in exposure resulting from emissions
- Exposure-response functions for effects
- Valuation of effect end-points



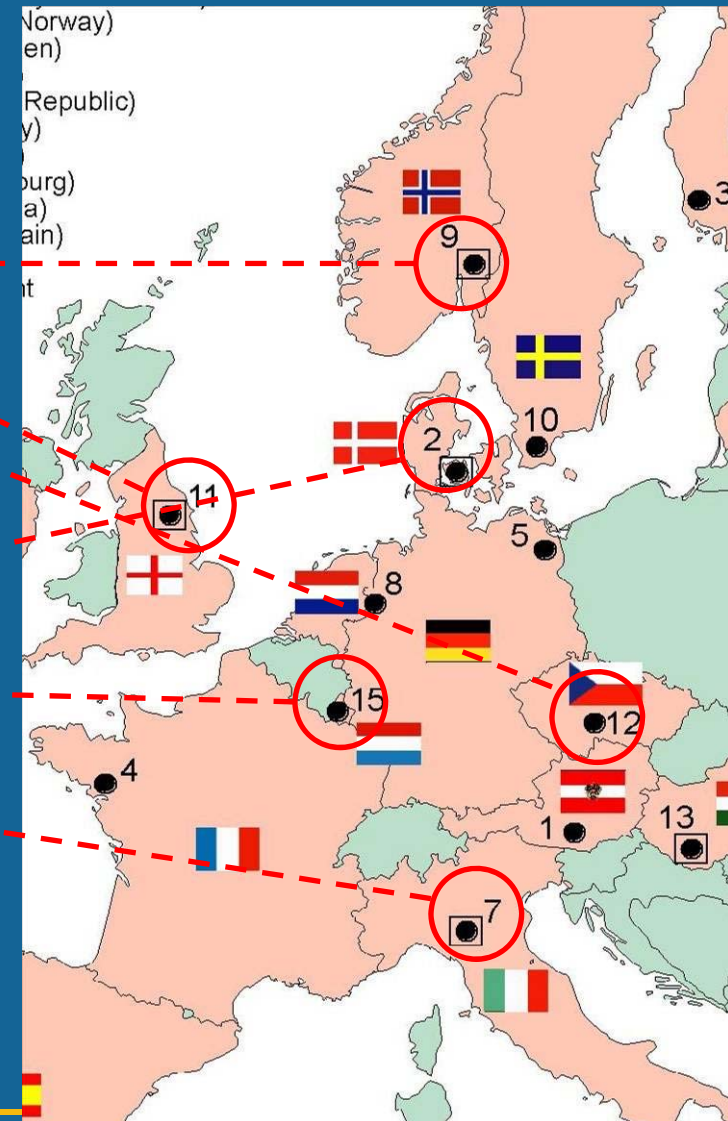


Aquatic environment: impact pathway of N

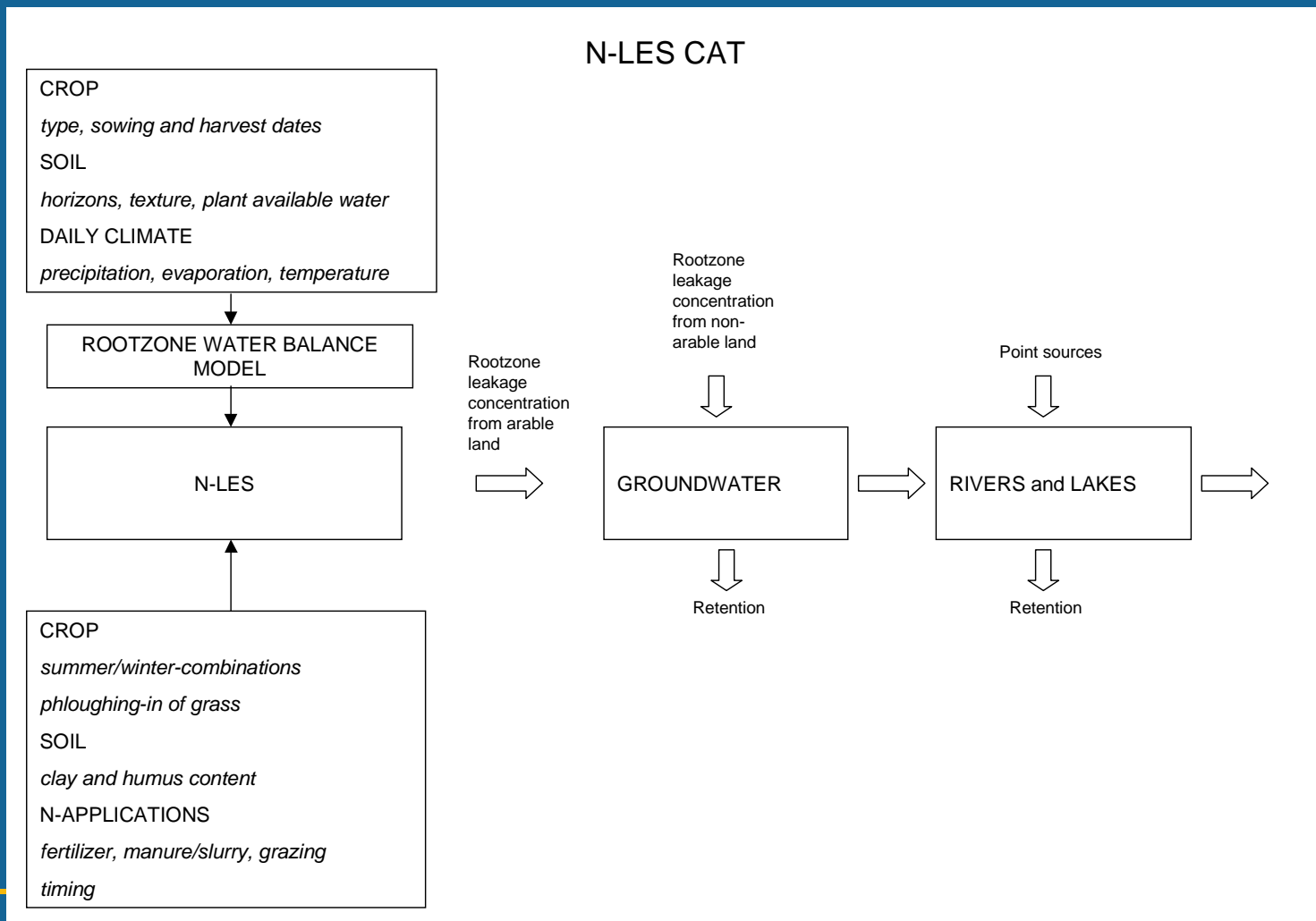


EUROHARP catchments & water supply

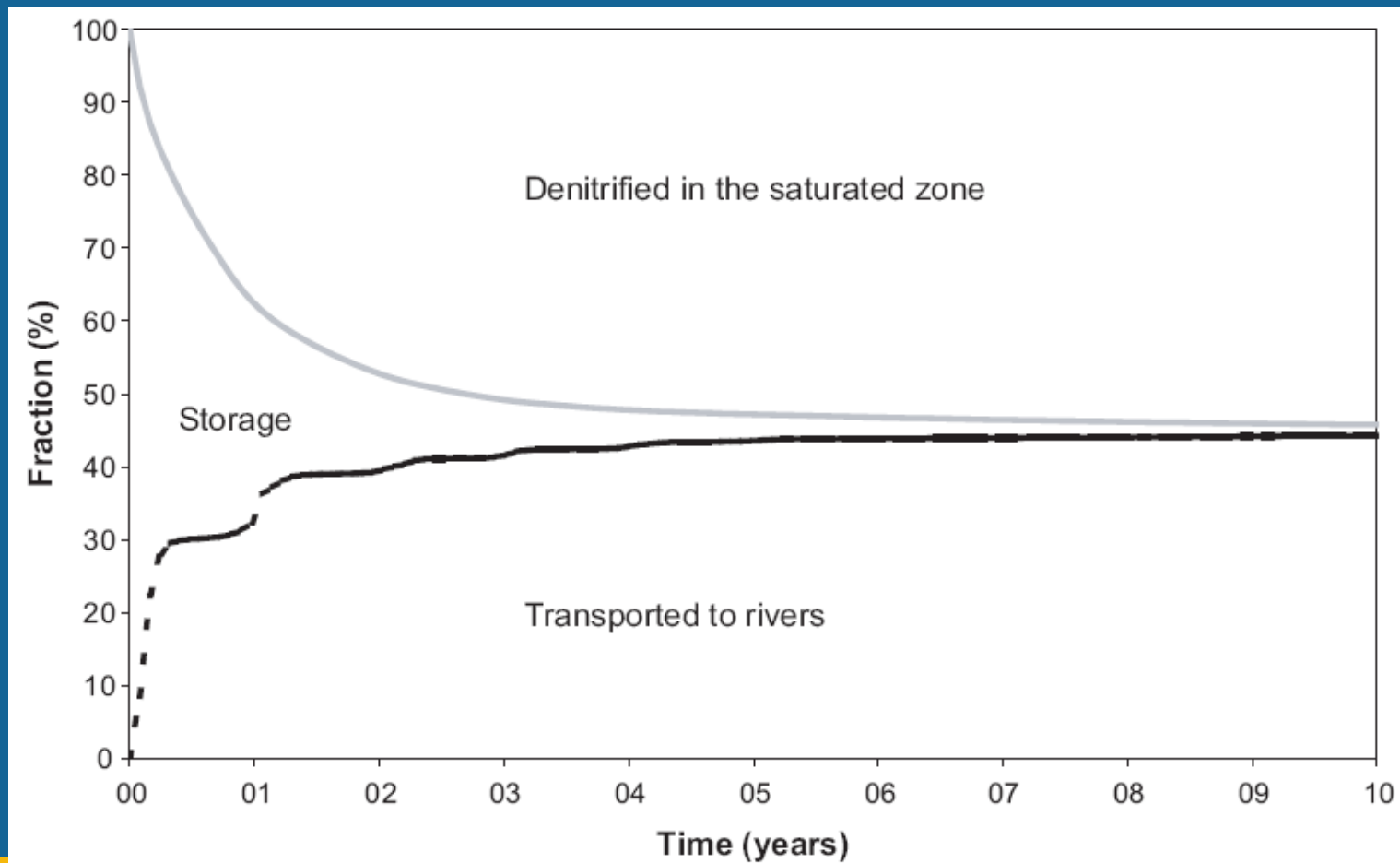
- Surface water
 - Vansjø-Hobøl, Norway
 - Ouse, UK
 - Zelivka, Czech republic
- Ground water
 - Odense, Denmark
 - Attert, Luxembourg
 - Enza, Italy



Dispersion and transport of N: model



Step 2: N-pulse in groundwater



Step 3: Dose-response - mortality and morbidity



- State of the art on Nitrate
 - may inhibit nitrosamines (NOC) that cause increased frequency of cancer in all animal species tested
 - biologically plausible mechanisms to suggest bladder cancer
 - 2/3 of consumed N is detected in bladder within 24 hours
 - according to IARC: 'probably' carcinogenic impact (group IIa)
- Risk quantification on basis of epidemiological literature
 - Iowa health study; large cohorte (Weyer, 2001)
 - Slovakian nitrate study (Gulis, 2002)
 - 🍷 Bladder cancer incidence (>55 years) 0.106 / mgNO₃/l
 - 🍷 Colorectal cancer inc. (>55 years) 0.01 - 0,02 / mgNO₃/l
 - 🍷 Non-Hodgkins leukemia (>55 years) 0.03 / mgNO₃/l
 - 🍷 Ovarian cancer (Females >55 years) 0.035 / mgNO₃/l

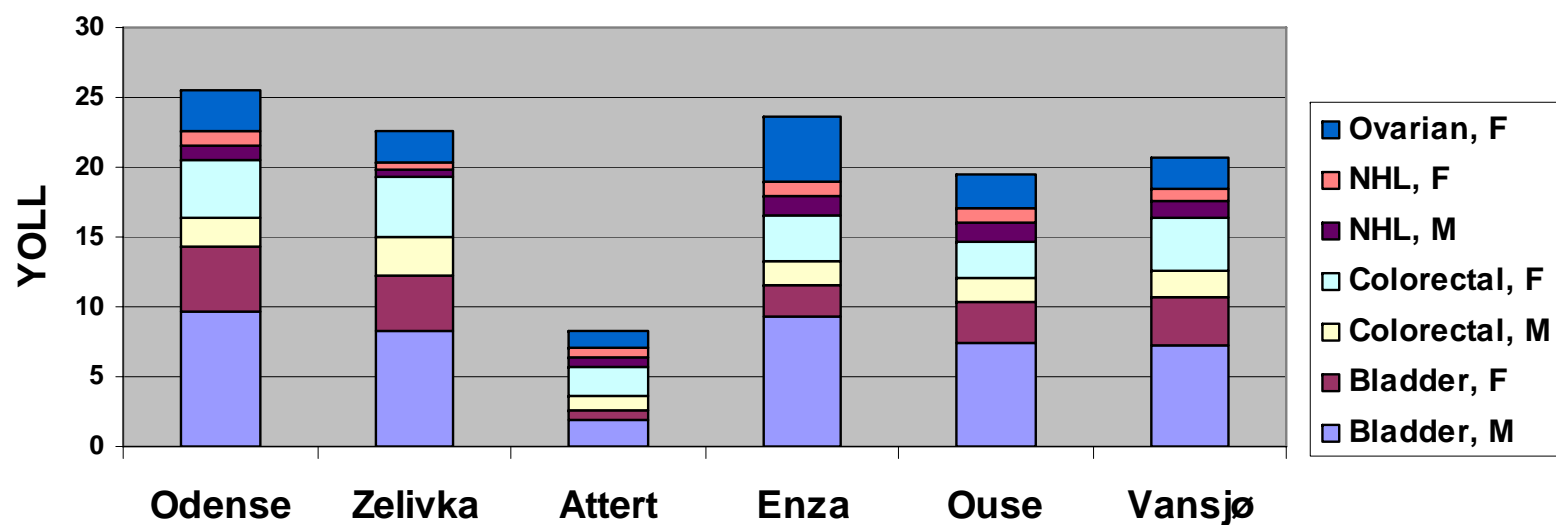


Lifetime table: years of lost life

Age Cohort	Death Risk	Population at time t from start									
		0	1	2	3	...	97	98	99	100	
55	0.0068	5511									
56	0.0073	5554	5460								
57	0.0074	5314	5500								
58	0.0082	5119	5261								
...											
97	0.4581	24	15								
98	0.5027	20	14								
99	0.5522	9	10								
100	0.6091	6	5								
Life years lived		100,000	96,670								
										Sum	
										1,588,907	

Years of Life Lost (YOLL)

per 100,000 persons, average demography, one-year increase in 1mg/l NO₃.





Monetary valuation approach

- Mortality
 - Chronic deaths: 40,000 € per life year
 - Similar approach as in EU's CAFE assessment
- Morbidity
 - Health end-points valued
 - Updated unit values based on cost-of-illness approach



Table 9. External health risk costs per unit of nitrogen applied to and emitted from arable land in six European catchments.

Nitrogen applied and emitted	Health risk costs (euro/mgNO ₃ /l per capita per year) cf. Figure 3	Dose-response (mgNO ₃ /l per tTN) cf. Table 5	External cost per capita per tTN (cents ₂₀₀₀)	Water consumers (number)	External cost per tonTN (>25 mg NO ₃ /l) ^b (euro ₂₀₀₀)
Mineral fertiliser-N applied to arable land					
Attert (LUX)	3.99	1.90E-3	0.76	12,600	96 ^b 0.1 €/kgN
Enza (IT)	11.10	1.10E-3	1.22	293,300	3586 ^b 3.6 €/kgN
Odense (DK)	11.47	1.30E-4	0.15	60,000	(89)
Ouse Yorkshire (UK) ^a	8.93	0.43E-3	0.38	200,000	762 ^b 0.7 €/kgN
Vansjø (NO) ^a	9.40	1.92E-3	1.81	60,000	(1085)
Zelivka (CR) ^a	10.06	3.46E-3	3.49	909,000	31,682 ^b 31.7 €/kgN
Organic fertiliser-N applied to arable land					
Attert (LUX)	3.99	1.57E-3	0.63	12,600	79
Enza (IT)	11.10	0.74E-3	0.82	293,300	2402 ^b
Odense (DK)	11.47	2.35E-4	0.27	60,000	(162)
Ouse Yorkshire (UK) ^a	8.93	0.55E-3	0.49	200,000	988 ^b
Vansjø (NO) ^a	9.40	1.46E-3	1.37	60,000	(825)
Zelivka (CR) ^a	10.06	3.98E-3	4.00	909,000	36,376 ^b
Emission (loss) of nitrogen from arable land (N-LES CAT)					
Attert (LUX)	3.99	5.42E-3	2.16	12,600	273 ^b
Enza (IT)	11.10	2.94E-3	3.27	293,300	9579 ^b
Odense (DK)	11.47	4.46E-4	0.51	60,000	(307)
Ouse Yorkshire (UK) ^a	8.93	1.47E-3	1.31	200,000	2619 ^b
Vansjø (NO) ^a	9.40	4.37E-3	4.11	60,000	(2467)
Zelivka (CR) ^a	10.06	2.58E-2	25.95	909,000	235,926 ^b

^aSurface water.

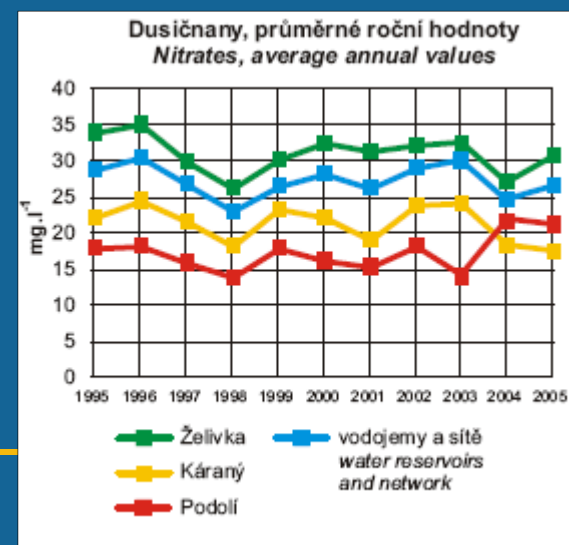
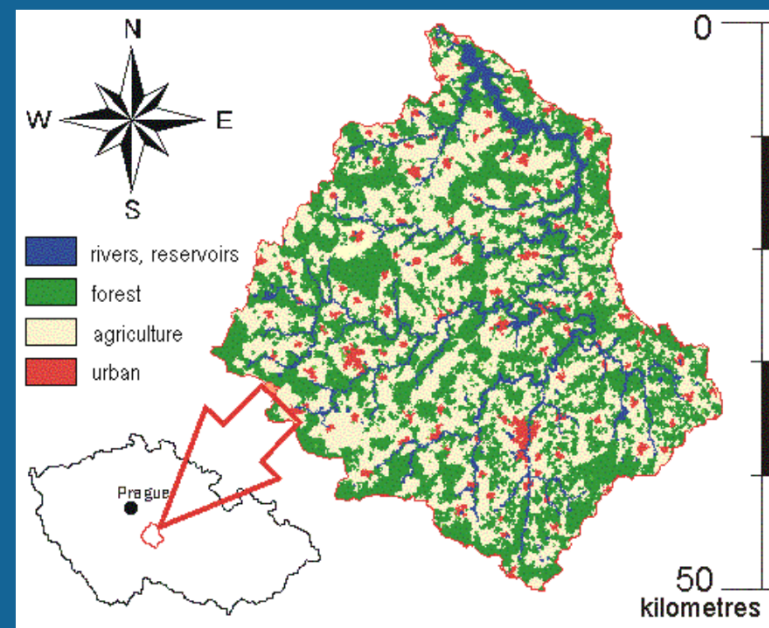
^bExceedance of 25 mgNO₃/l threshold in catchment.



Hot spot: Zelivka catchment



- Agricultural practice
 - 114 kg N/ha
 - Leaching to water reservoir
 - 75% of Prague's water supply
- External cost
 - 32-36 € per kg N applied
 - (3-4 eurocent per inh. per kgN)
 - population density is pivotal



EU27 unit costs of N (illustrative)



Table 13. Illustrative figures for average external costs (in 2000-prices) per kgN applied (mineral and organic fertiliser) related to potable water nitrate health risk costs in EU-27.

	kgN/ha (utilized arable land)	Potable water from surface (%)	Surface water above 25 mgNO ₃ /l (%)	If health threshold 25 mgNO ₃ /l (€2000/ kgN-applied)	If health threshold 10 mgNO ₃ /l (€2000/ kgN-applied)
AT	67	72	1	0.03	0.27
BE	215	35	30	1.29	2.48
BG	43	66	0	0.01	0.03
CY	96	42	8	0.07	0.53
CZ	78	53	18	0.30	1.25
DE	139	26	4	0.15	1.22
DK	139	0	12	0.15	0.22
EE	23	53	8	0.03	0.29
ES	57	85	4	0.08	0.32
FI	82	39	1	0.00	0.00
FR	105	40	19	0.23	0.74
GR	91	59	1	0.02	0.12
HU	51	5	5	0.02	0.05
IE	130	84	2	0.02	0.25
IT	77	13	2	0.05	0.16
LT	32	0	2	0.00	0.00
LU	172	25	40	0.48	1.17
LV	18	43	1	0.00	0.02
MT	171	0	86	0.39	0.39
NL	331	39	7	0.34	1.46
PL	57	38	4	0.05	0.32
PT	69	60	1	0.07	0.16
RO	45	60	2	0.03	0.11
SE	70	51	0	0.00	0.00
SI	79	19	1	0.03	0.07
SK	49	19	0	0.07	0.25
UK	113	65	34	1.34	2.48
EU27	85			0.29	0.85

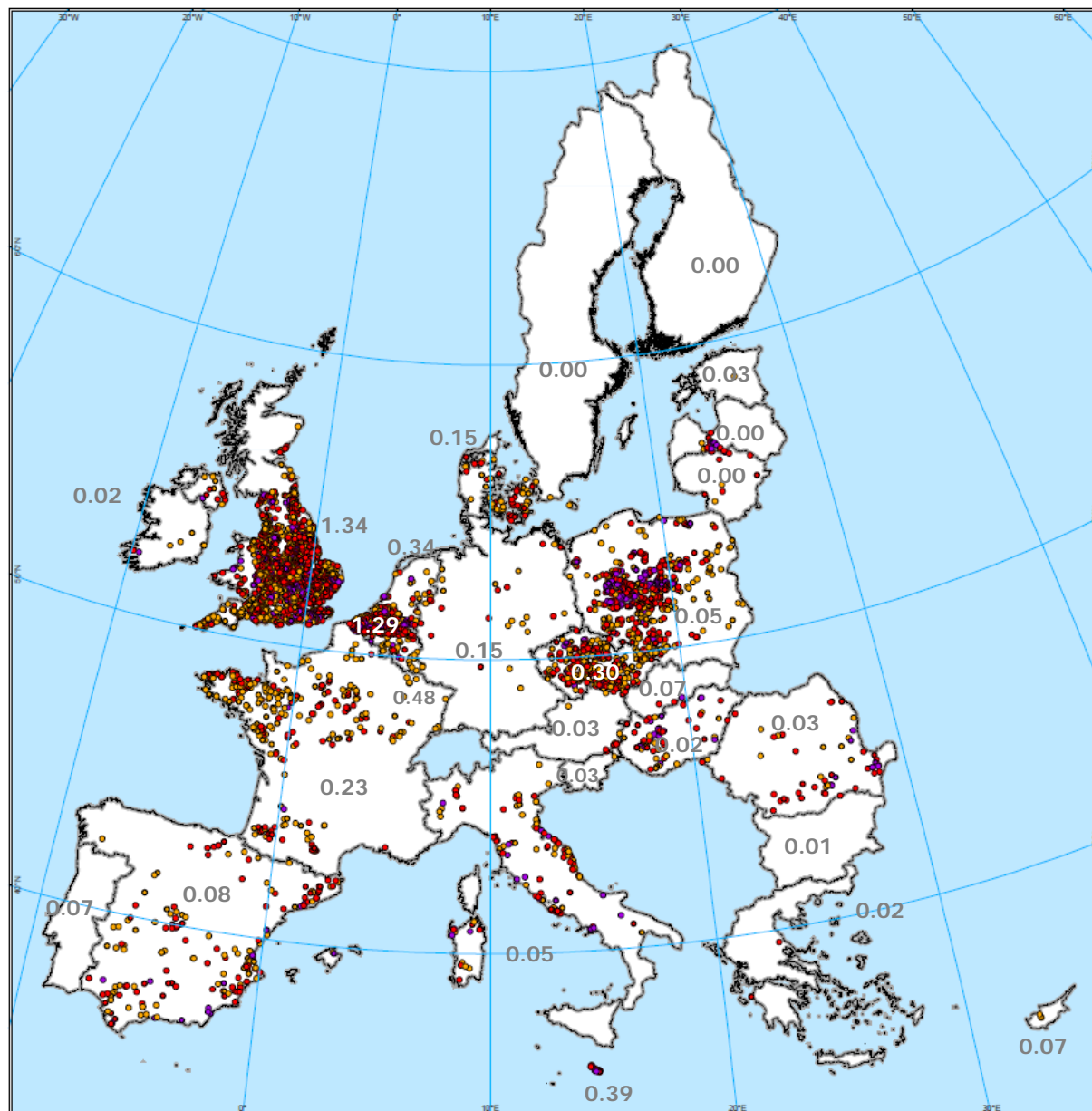
Source: EXIOPOL.



Figure 1. Maximum nitrate concentrations in surface water in EU-27 (European Commission, 2010).

best estimate for
EU nitrogen unit cost
~ 0.29 €/kgN





NITRATES DIRECTIVE EU-27

NITRATE VULNERABLE ZONES SURFACE WATER

Surface water maximum nitrate concentration
max NO₃ mg/l

- 40-50
- 50-100
- >100



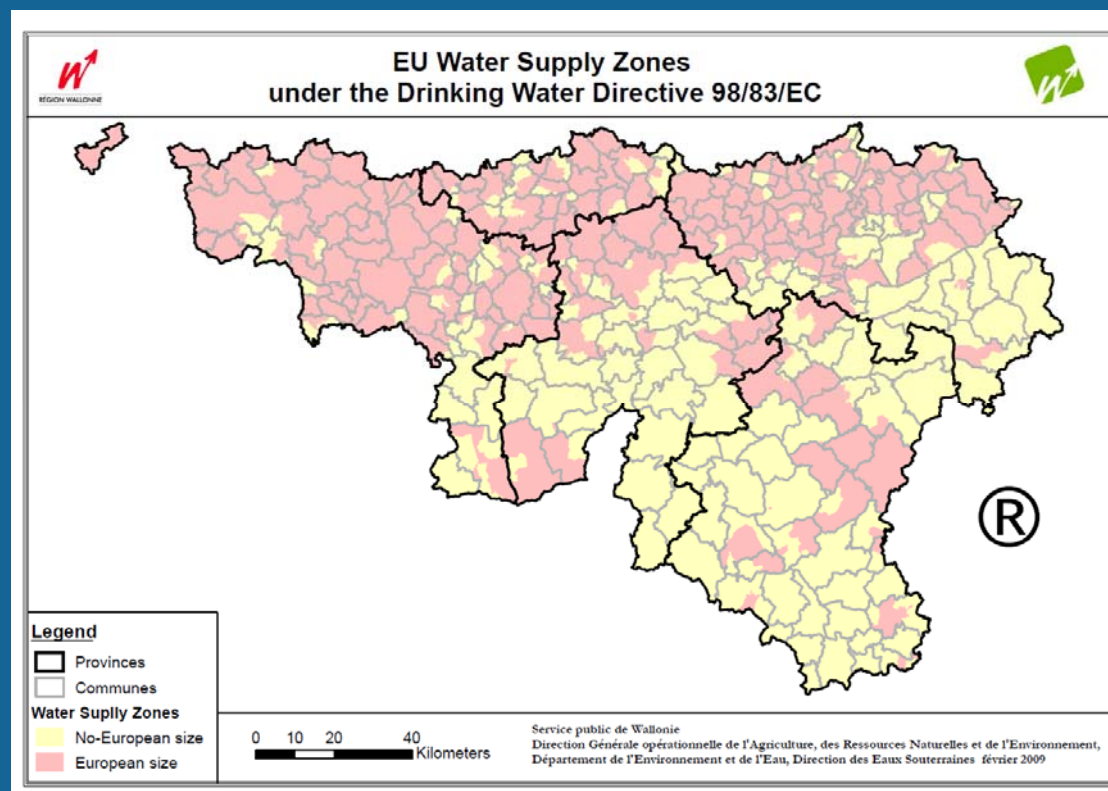
with illustrative
health-related
external costs

€/kgN_{applied}
(NUTS1)

Sources : DG ENV, Member States reports on Nitrates Directive Implementation
Coordinate Reference System: ETRS89 Lambert Azimuthal Equal Area
Cartography : JRC, 01/2008
© EuroGeographics for the administrative boundaries
© 2008 Copyright, JRC, European Commission
Extracted from ELISA (European Land Information System for Agriculture and Environment)
<http://elisa.jrc.it/webinfo/insitartv2.html>



Future effort: water supply zones and site-specific external costs of N





References

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- Gulis, G et. al. (2002): An ecologic study of nitrate in municipal drinking water and cancer incidence in Trnava district Slovakia, **Environmental Research**, 88: 182-187.
- Weyer, PJ et. al. (2001): Municipal drinking water nitrate level and cancer risk in older women: The Iowa women's health study, **Epidemiology**, 12:3, 327-338.



Thank you for your attention

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