PBL Netherlands Environmental Assessment Agency

Het prijskaartje van de stikstofvervuiling

Ervaringen uit de European Nitrogen Assessment

NECOV | April 26, 2016 | Hans van Grinsven

What is PBL?

- National institute for strategic policy analysis in the field of environment and spatial planning
- Solicited and unsolicited outlook studies, analyses and evaluations in which an integrated approach is paramount
- Dutch government, EU, OECD, UNEP, IPCC
- Policy relevance, independency and scientific rigor

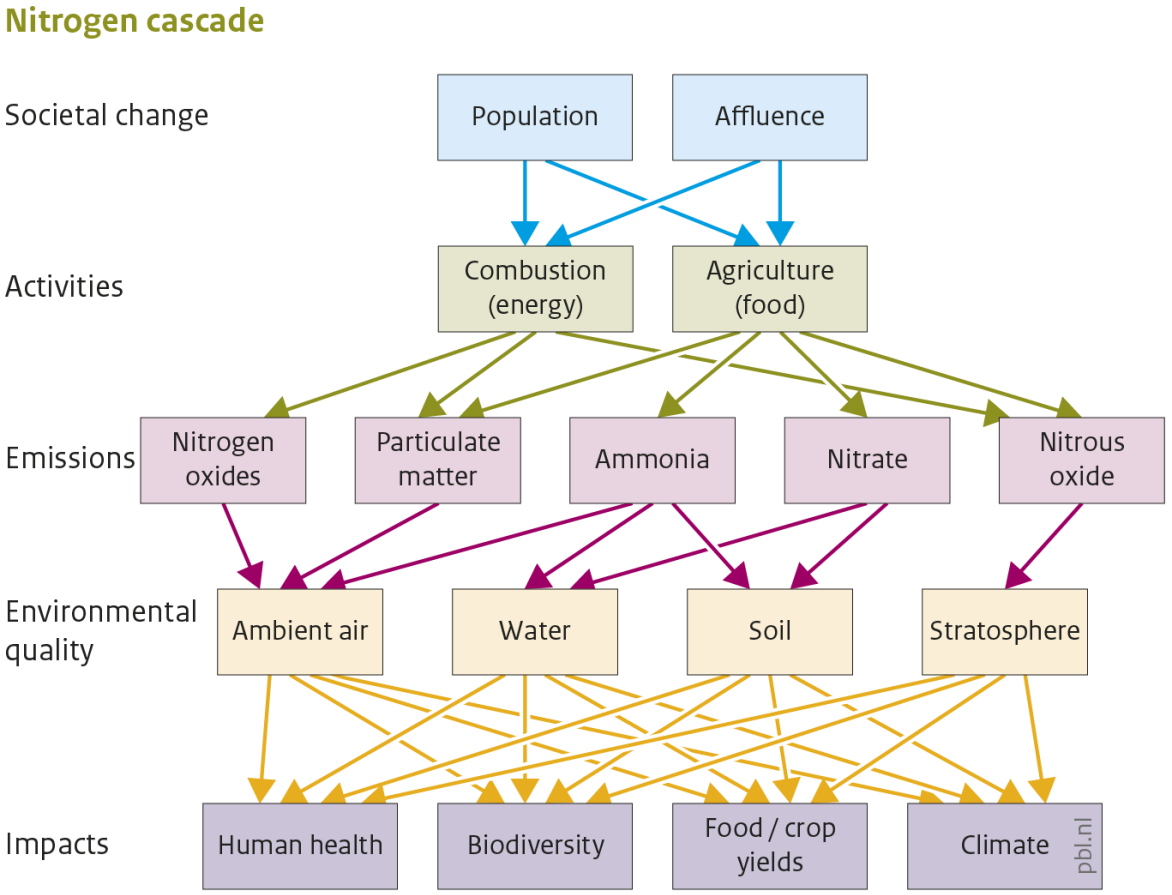
The Hague

Bilthoven

Nitrogen Cascade

(DPSIR)

Multiple:
- Sources
- Forms
- Routes
- Impacts



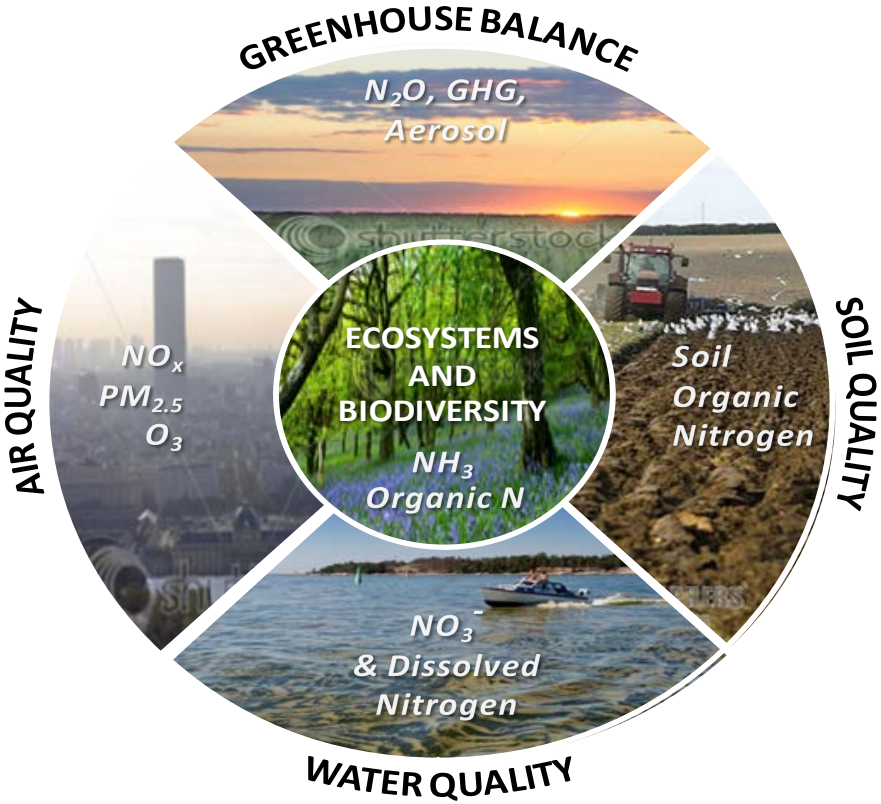
Source: I&M 2011

www.pbl.nl

Nitrogen Cascade

(DPSIR)

Multiple:
- Sources
- Forms
- Routes
- **Impacts**

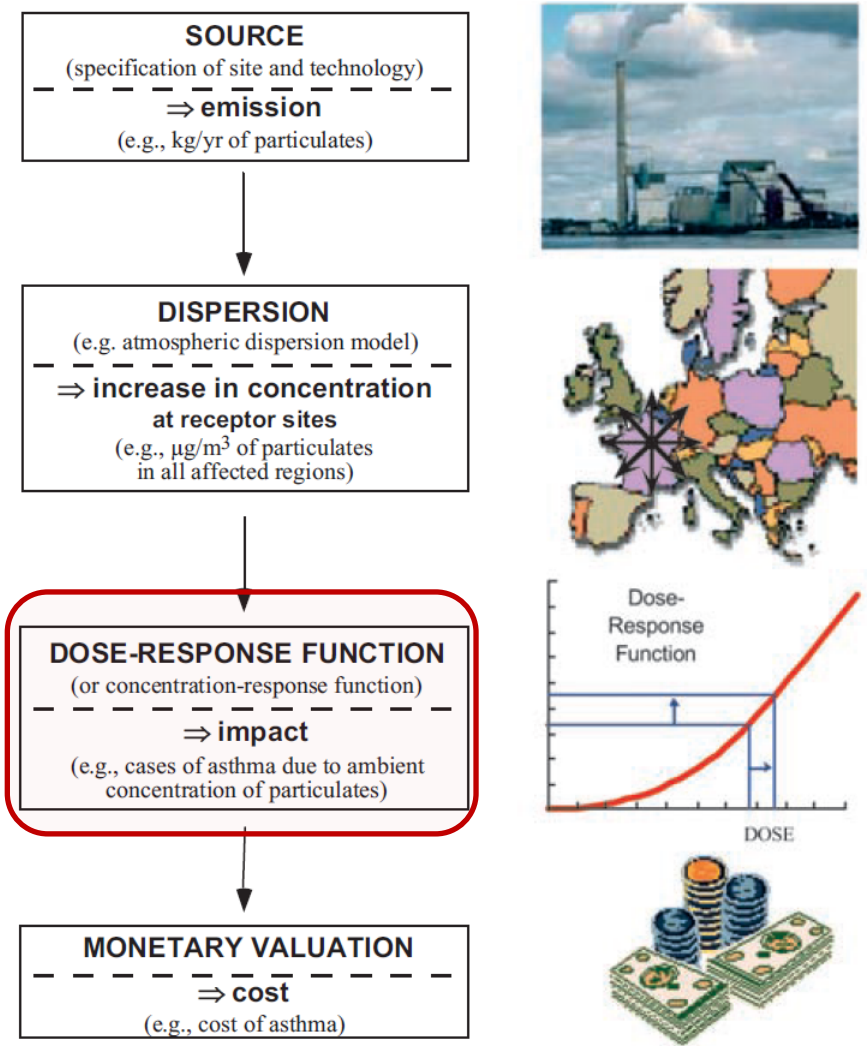


Environmental impacts of nitrogen

	Human health	**Ecosystems**	**Climate**
NOx-air	Cara, Cancers *mainly via ozone*	Eutrophication Acidification	*?Carbon-sequestration?* *?cooling particles?*
NH_3-air	Cara, Cancers *?weak causality?*	Eutrophication Acidification	*?Carbon-sequestration?* *?cooling particles?*
N (NO_3)-water	Cancer (colon) *?weak epidemiology?*	Aquatic Eutrophication	*?Carbon-sequestration?*
N_2O-air	Skin cancer, cataract		GHG-balance

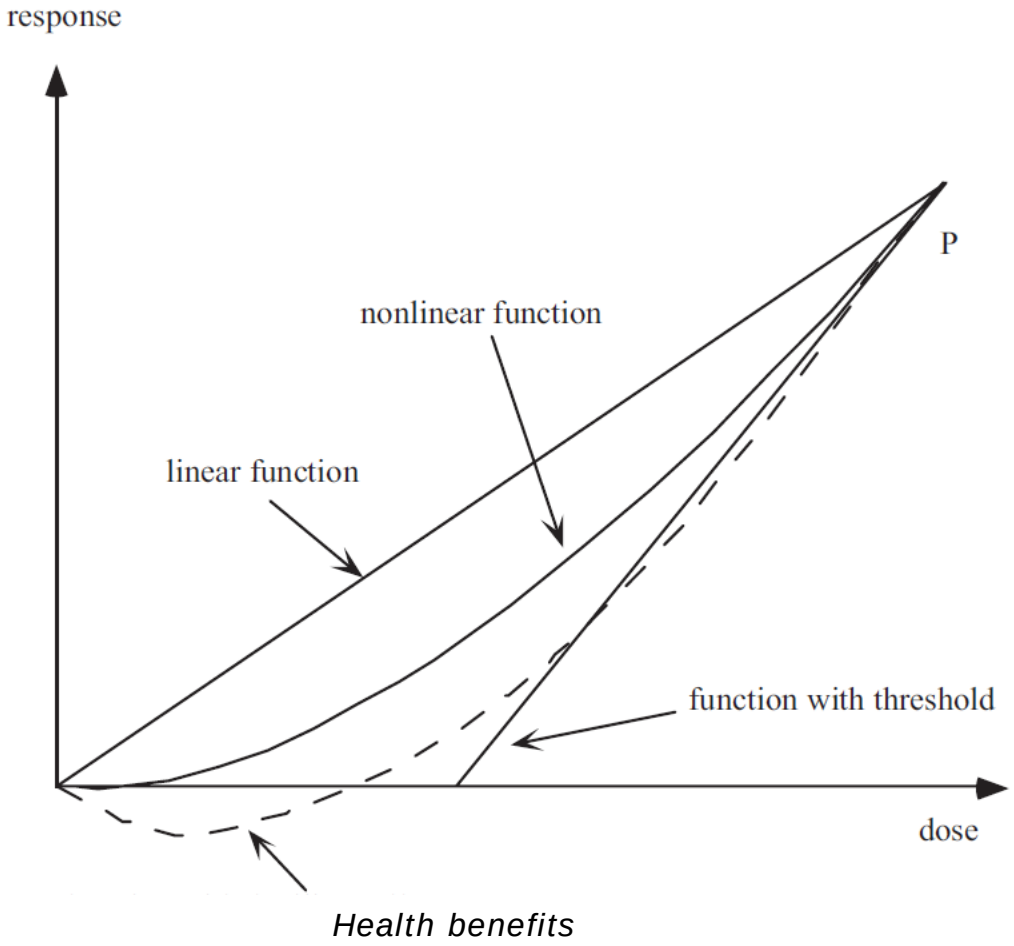
one "molecule" of N-emission can have multiple impacts – "cascade"

Principal steps of an impact - pathway - cost analysis



EXTERNE (2005)

Example: air pollution impacts on human health

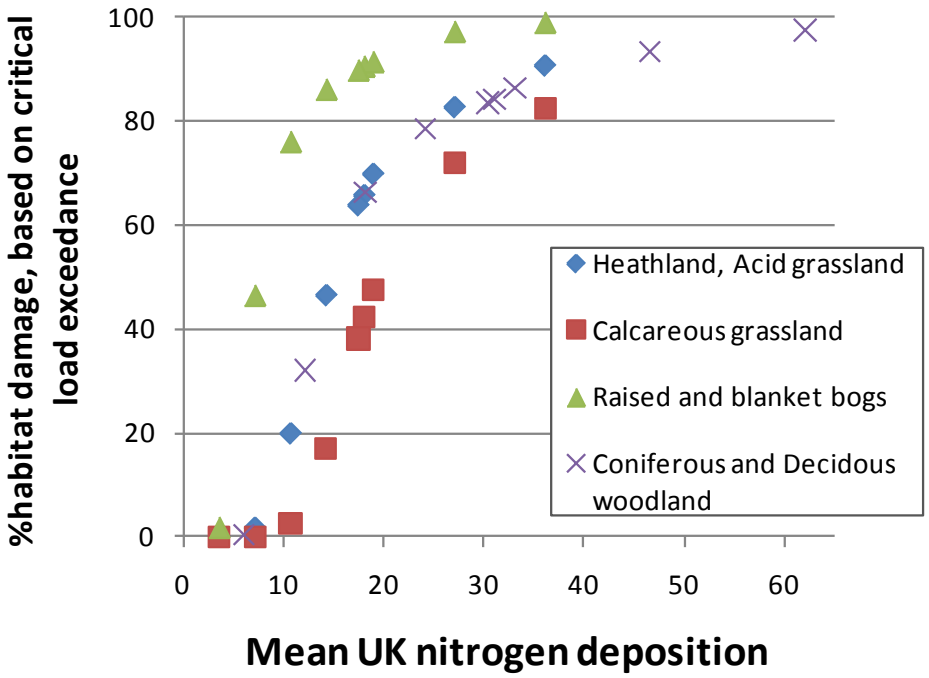


ExternE used Dose-response functions for NO_x, SO_2, Particulate Matter (PM) and O_3 that are **linear without threshold**

(PM: includes secondary – like ammonia aerosols)

EXTERNE (2005)

Example: N response curve ecosystem damage



Non linear with threshold (Critical N load ≈10 kg N ha^{-1} yr^{-1})
External cost based on critical load exceedance

Jones et al (2013)

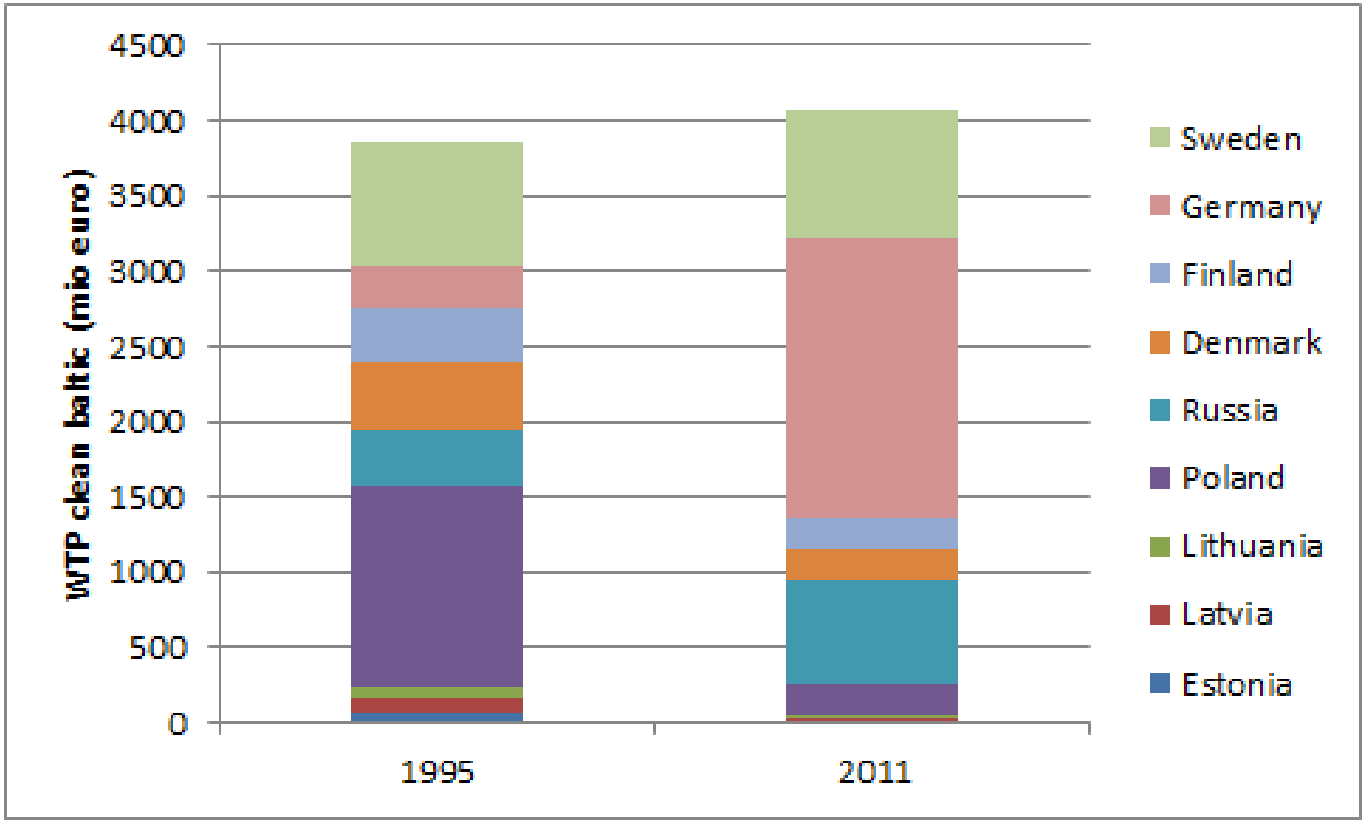
The economic value of N damage in ENA (2011)

Standard economic concepts and methods for valuation

Key is **willingness to pay approach** (WTP)

- Health impacts
  - Costs of medical treatment
  - Lost labor productivity
  - Reduction of risk of premature death (WTP for additional DALY)
  - Reduction pain and suffering (WTP additional QALY)
- Ecosystems impacts
  - WTP to prevent or restore damage
- Climate impacts
  - WTP to reduce greenhouse gas emissions.

WTP survey clean Baltic: results change over time



(Athiainen et al., 2014)

Calculation of cost of N pollution

1. Determine the societal cost of N related impact (WTP)

2. Determine the contribution of N to impact

3. Determine cost per unit of N emission for impact (UC)

   – UC = [Result 1] x [Result 2] / [N emission]

4. Extrapolate to determine N costs, eg.
   – Change of N emissions
   – For other regions

N-Cost = Price x Emission

	Health	Ecosystem	Climate	Total
	euro / kg N_r	euro / kg N_r	euro / kg Nr	euro / kg N_r
NO_x -N to air	10-30	2-10	-9 - 2	3-42
NH_3-N to air	~~2~~8–20*	2-10	-3 - 0	1-30
N_r to water	0-4	5-20		5-24
N_2O-N to air	1-3		4-17	5-20

X

	Emission EU27
Year 2008	Mton (Tg)
NO_x -N to air	3.2
NH_3-N to air	3.1
N_r to water	4.6
N_2O-N to air	0.8

Climate benefits of N

* *NH_3 health risk via sec. PM:*

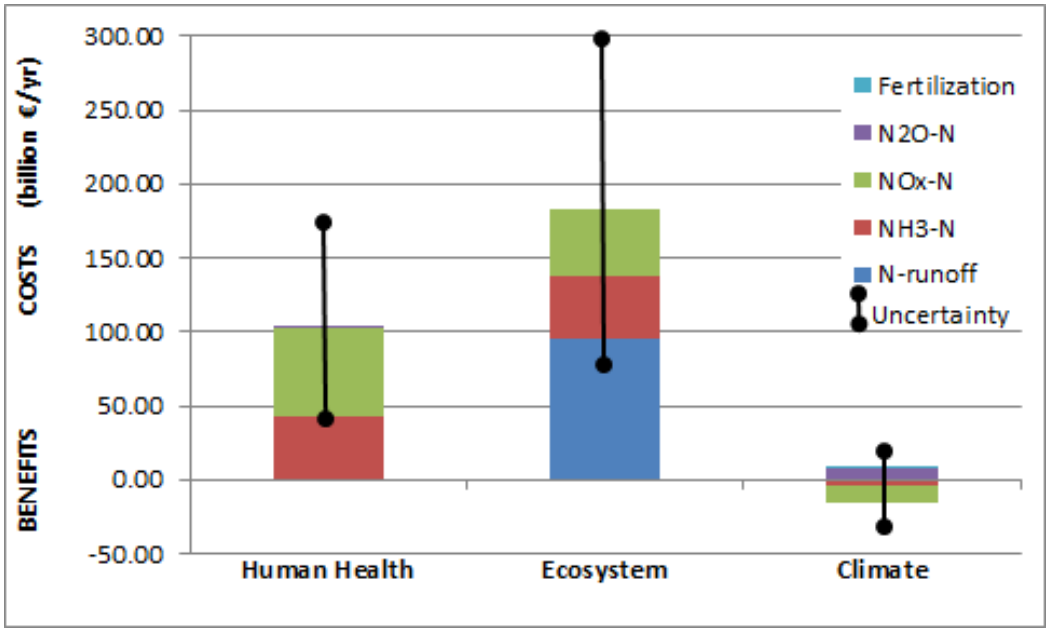
- *European Commission 2013,*
- *Brunekreef et al., Lancet 2016*

Costs and benefits of N EU27 in 2008

All sources

N pollution cost:
75-485 billion euro/yr
150-1150 euro/capita
1-4% GDP loss

Large uncertainties
50 - 70% air pollution
35 - 55% human health
60 - 100% ecosystems
-50 - 20% climate change



(Sutton et al, Our Nutrient World, 2013)

Agricultural activities and emissions

Internal - external costs and benefits agriculture

External: no markets, not or partly on price tag; "true cost" of food

	Internal	External
Benefits	• Food • Fibers • Fuels • …..	• Water management • Rural landscapes • Soil conservation • …..

Costs	• Labour
	• Capital
	• Inputs
	  • Fertilizer
	  • Feed
	  • Pesticides
	  • ….
		• Environmental pollution (N, P, ….)
		• Biodiversity loss
		• Antibiotic resistance
		• Soil degradation
		• ……

Compare to N costs to N – benefits farm & food

- Crop production (food production and security)

N benefits cereal production

	Emission EU27
Year 2008	Mton (Tg)
N-fertilization	14.1
	euro / kg Nr
Unit benefit	1.5-5

- Food economy (multiplier 2-3 on benefits farm economy)

Costs and benefits of N EU27 in 2008

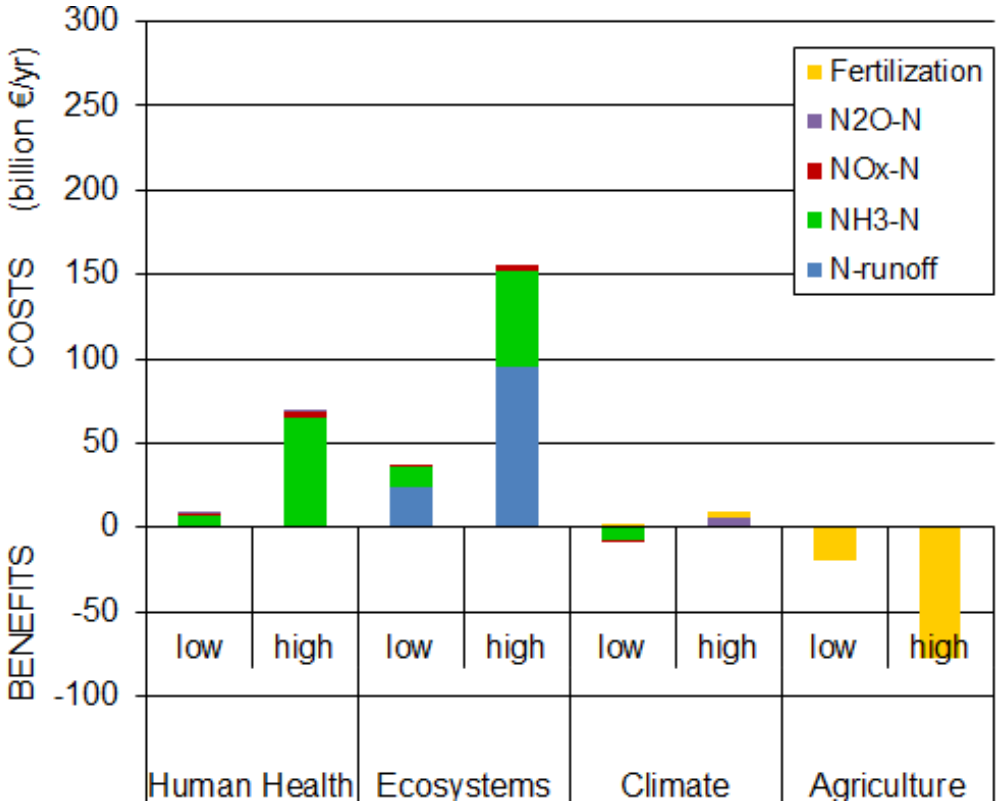
Agricultural sources

N pollution cost:
35-230 billion euro/yr

N crop benefits farm:
20-80 billion euro/yr

46% due to NH_3
48% due to N runoff

N cost > N benefits??



(Grinsven et al., ES&T 2013)

Costs & benefits agri-N policies Netherlands 2005

Annual costs (2010 – Meuro)

Farms

Manure transport	130-250
Manure administration	90-170
Manure storage	70
Manure LE application	40-80
Housing NH_3 reduction	15-80
Total cost	*(345-650)* ***505***

Society

Control costs	**30**
Total	*(400-700)* ***530***

Annual savings/benefits

Farms (since 1990)

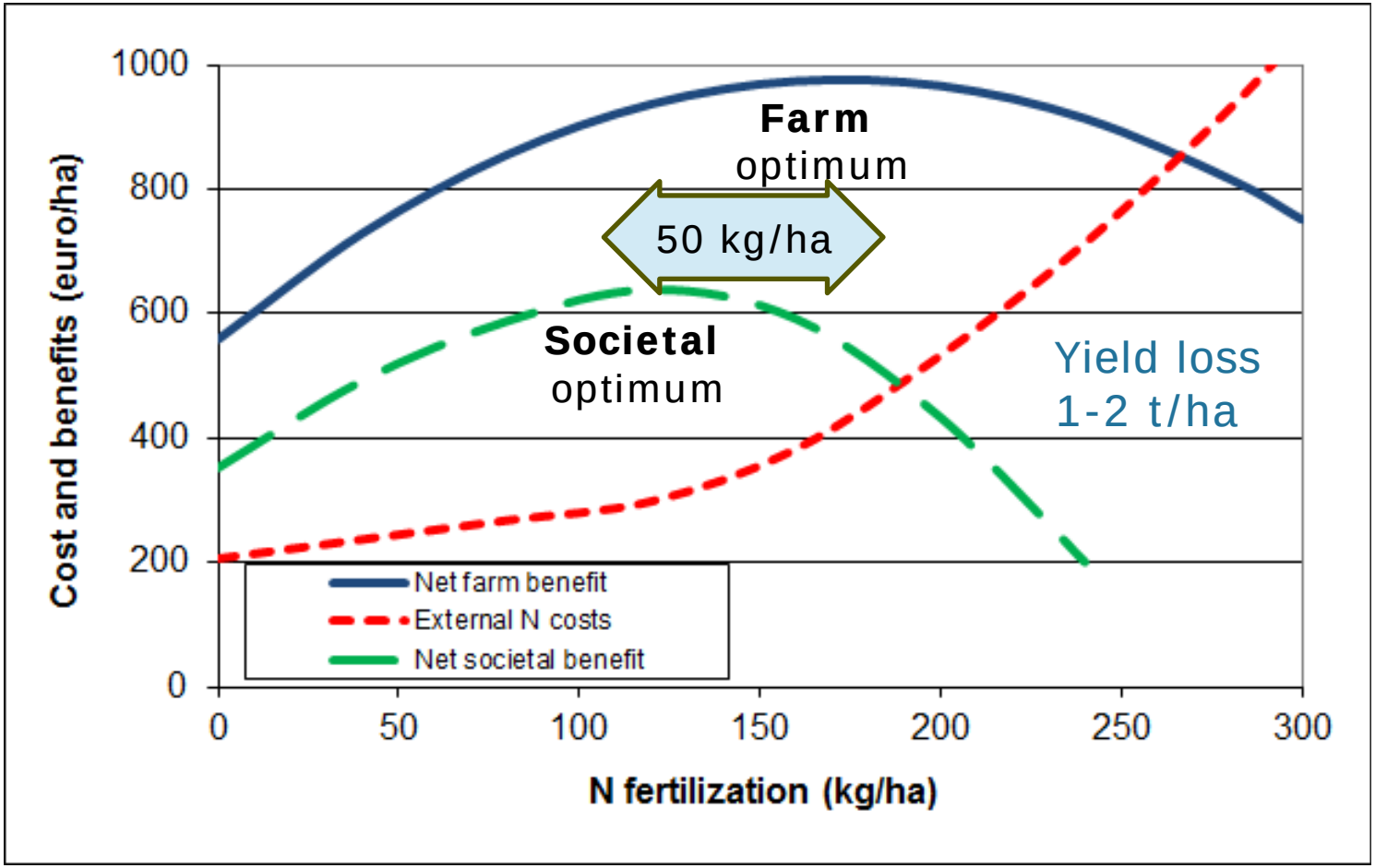
Fertilizer savings	150
– *ammonia share*	*100*
Yield reduction	0
Total NUE savings	***150***

Society

Reduced NO_3 pollution	**250-2000**
Reduced NH_3 pollution	**450-1500**
Total	*(900-3700)* ***2400***

(Grinsven et al., 2016)

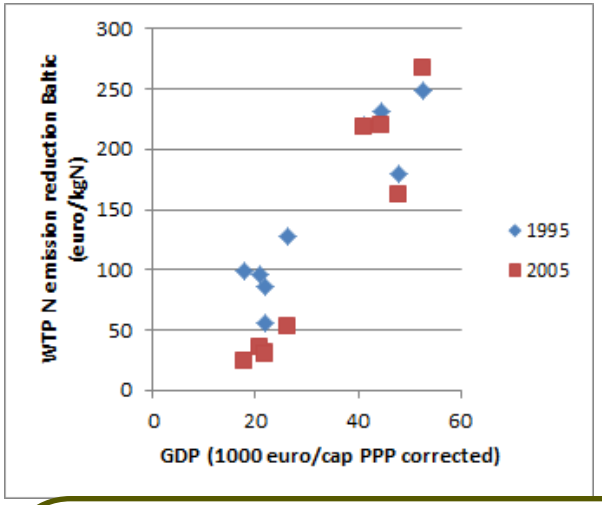
Optimum level N fertilization

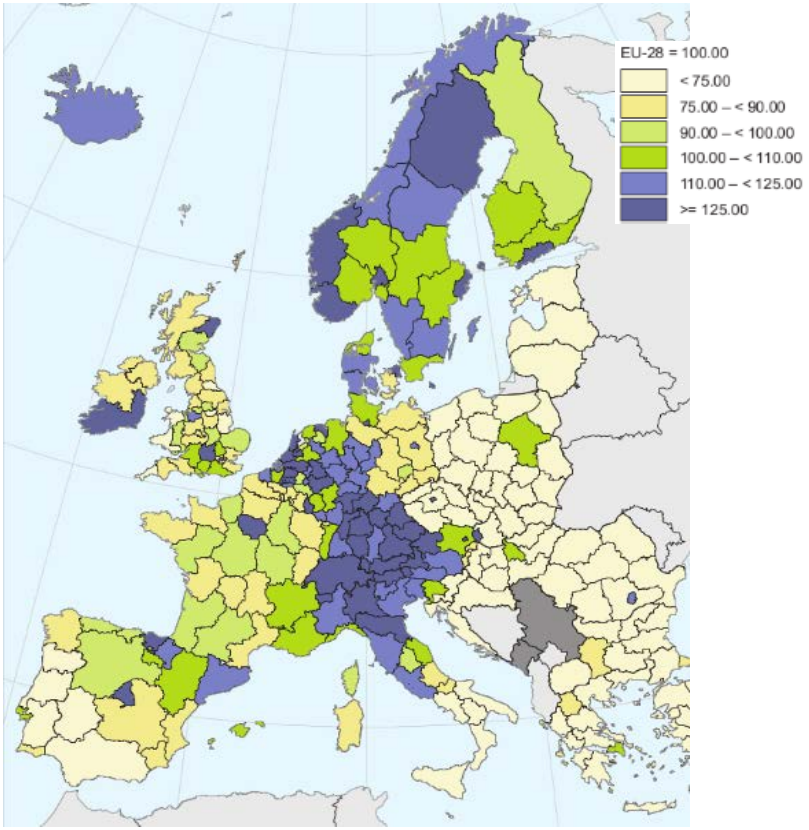


Wheat
Northwest Europe

Willingness to Pay is a controversial concept

WTP results per country



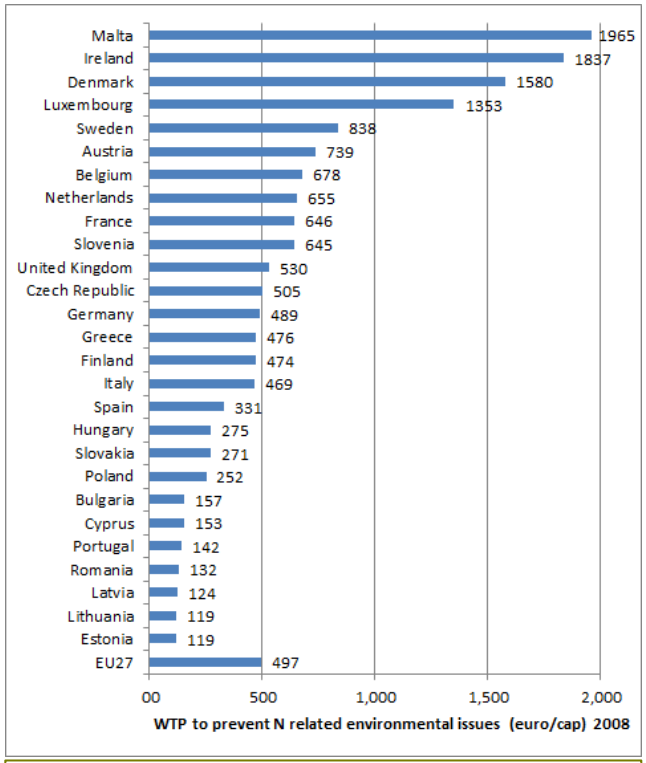


Depends on
- Citizen awareness
- Problem framing
- Gross Domestic Product

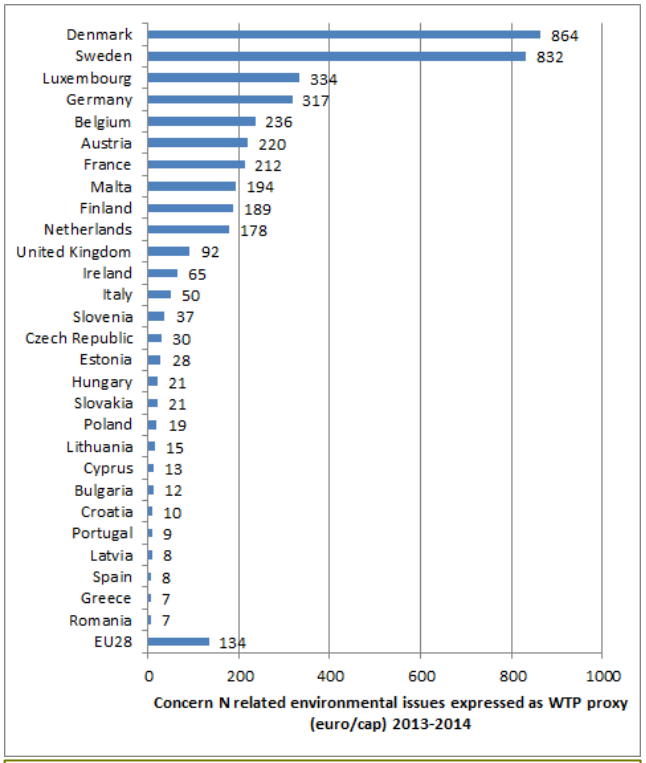
Is there a maximum WTP to prevent **all** environmental problems (≈1% EU, US)?

Test and improve estimates of cost of N pollution

Using the Eurobarometer surveys



WTP 2008 per country (ENA, 2011)



Collective WTP 2013 and 2014 based on the Eurobarometer (Grinsven et al., in prep)

Alternative estimate

- Cap is tax receipt
- 3-4 times lower ENA
- More contrast MS

Summarizing

1. CBA "*trick*" for policy analysis to weigh/add up Nr emissions
   - *Complementary tool to other weighting approaches like "Distance To Target", "Revealed policy priorities*"

2. Impacts of agricultural emissions
   - *ammonia and nitrate are most important*
   - *cost for society in same range as benefits of N fertilizer use*

3. Cost of N pollution is information to support e.g.
   - *Communication relevance of N pollution – price tag*
   - *Optimize level of mitigation (incl. pollution swapping)*
   - *Optimize level of N-fertilization*

THANK YOU