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European Perspective on Integrated Management of Reactive Nitrogen

Jan Willem Erisman, ECN, The Netherlands

Summary

- Negative environmental impacts have been observed
- Effects translated into effect parameters (indicators) and set long-term targets for sustainability
- Indicators used for risk assessment through Integrated Assessment Modelling, Best Available Techniques and cost-benefit analysis
- Aim: limit exceedance of limits against lowest cost through targeted policies and measures
- Losses to air and water decreased
- Up till now: focus on water and air separate
- Future: TFRN will aim for integrative approach

Outline of presentation

- N in Europe: the issues
- N policies and their success
- A proposal for integrated nitrogen approach
- Comparison between the US and Europe
- Conclusions





100 years (and 1 week) Haber Process

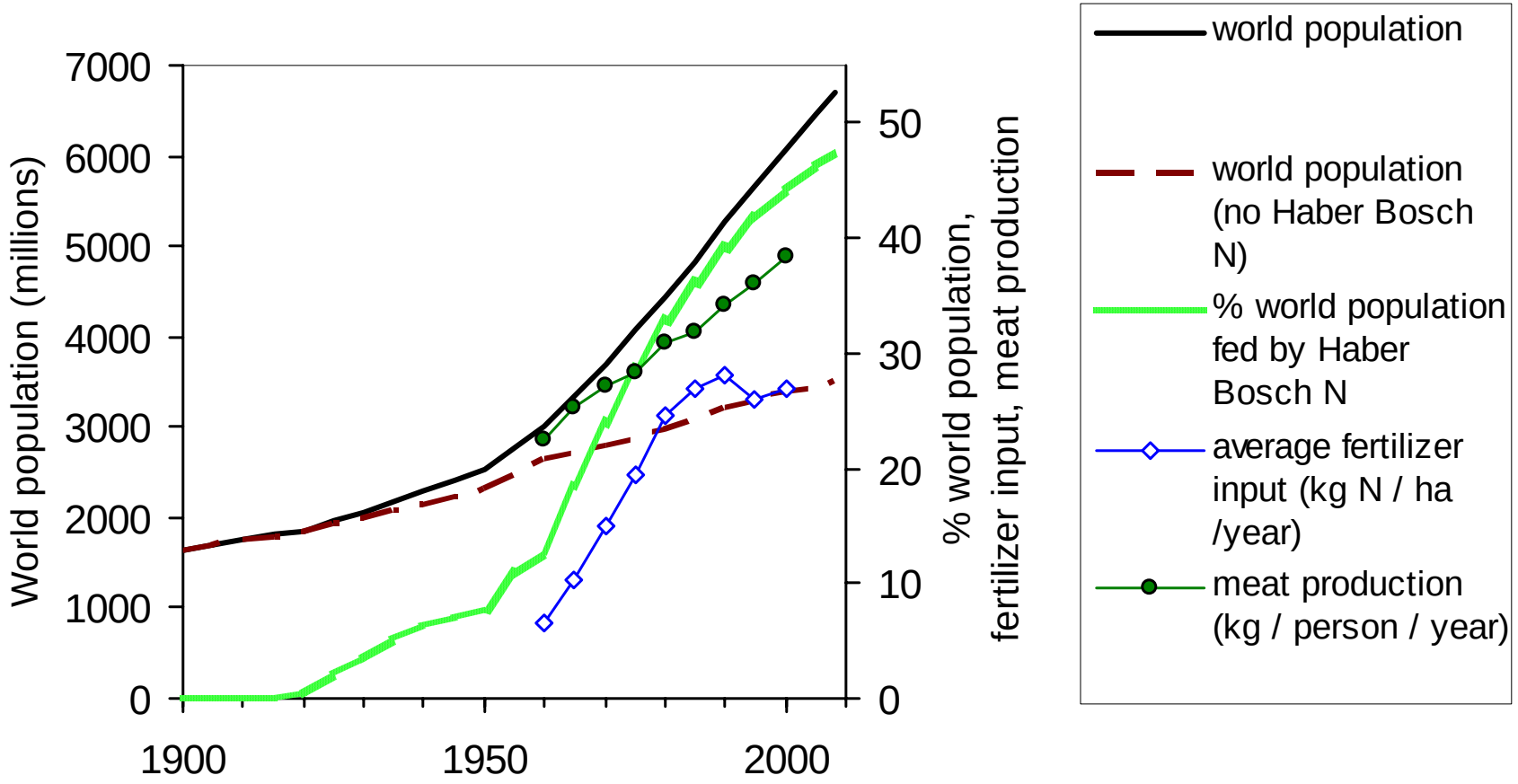
FEATURE

How a century of ammonia synthesis changed the world

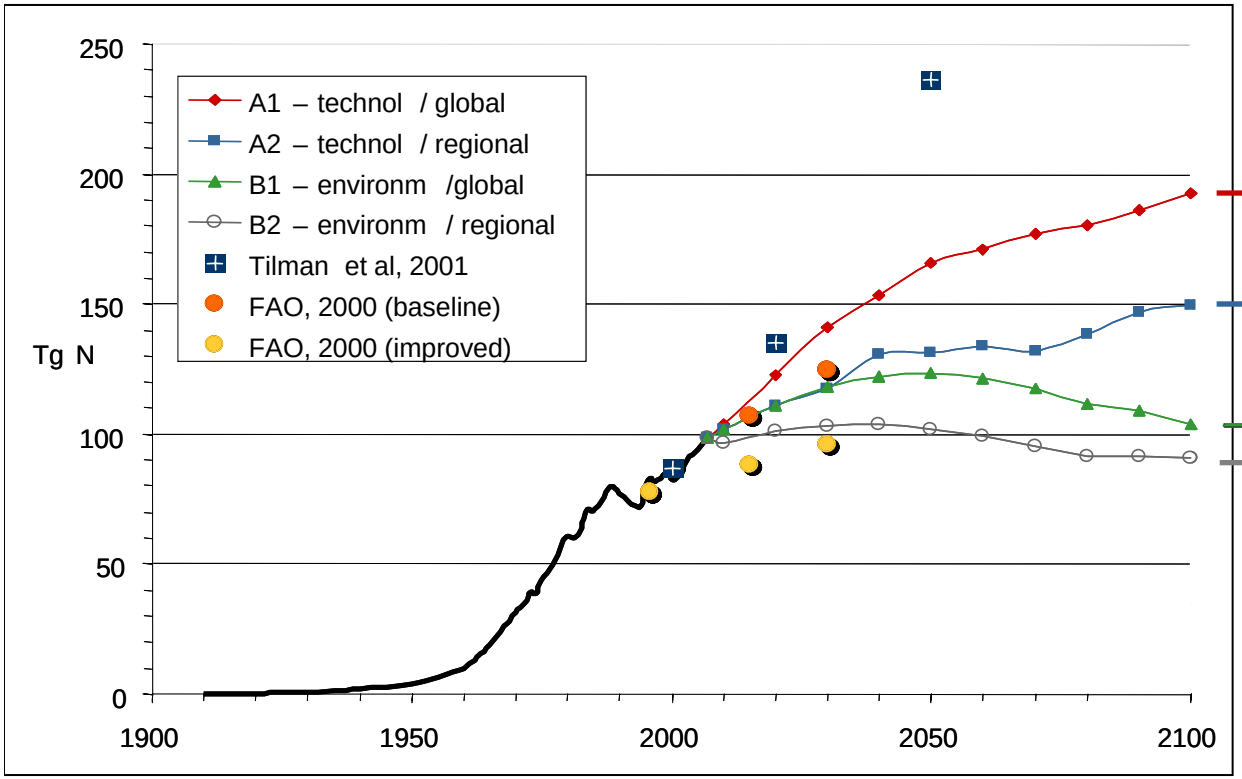
On 13 October 1908, Fritz Haber filed his patent cn the "synthesis of ammonia from its elements" for which he was later awarded the 1918 Nobel Prize in Chemistry. A hundred years on we live in a world transformed by and highly dependent upon Haber–Bosch nitrogen.

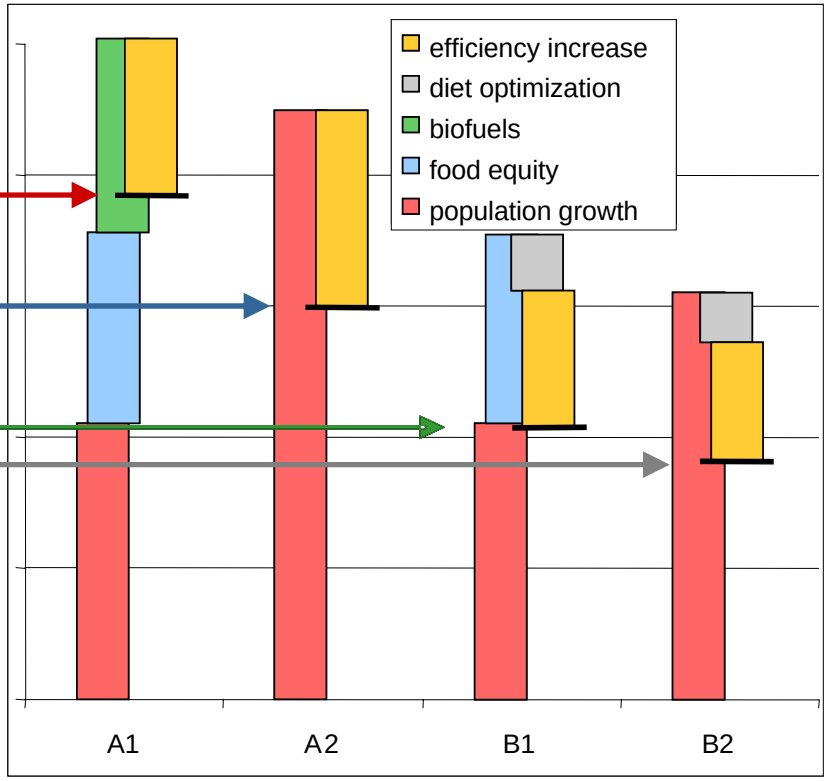
Erisman et al., 2008

Trends in human population and nitrogen use



Past and future global N fertilizer consumption 1900-2100



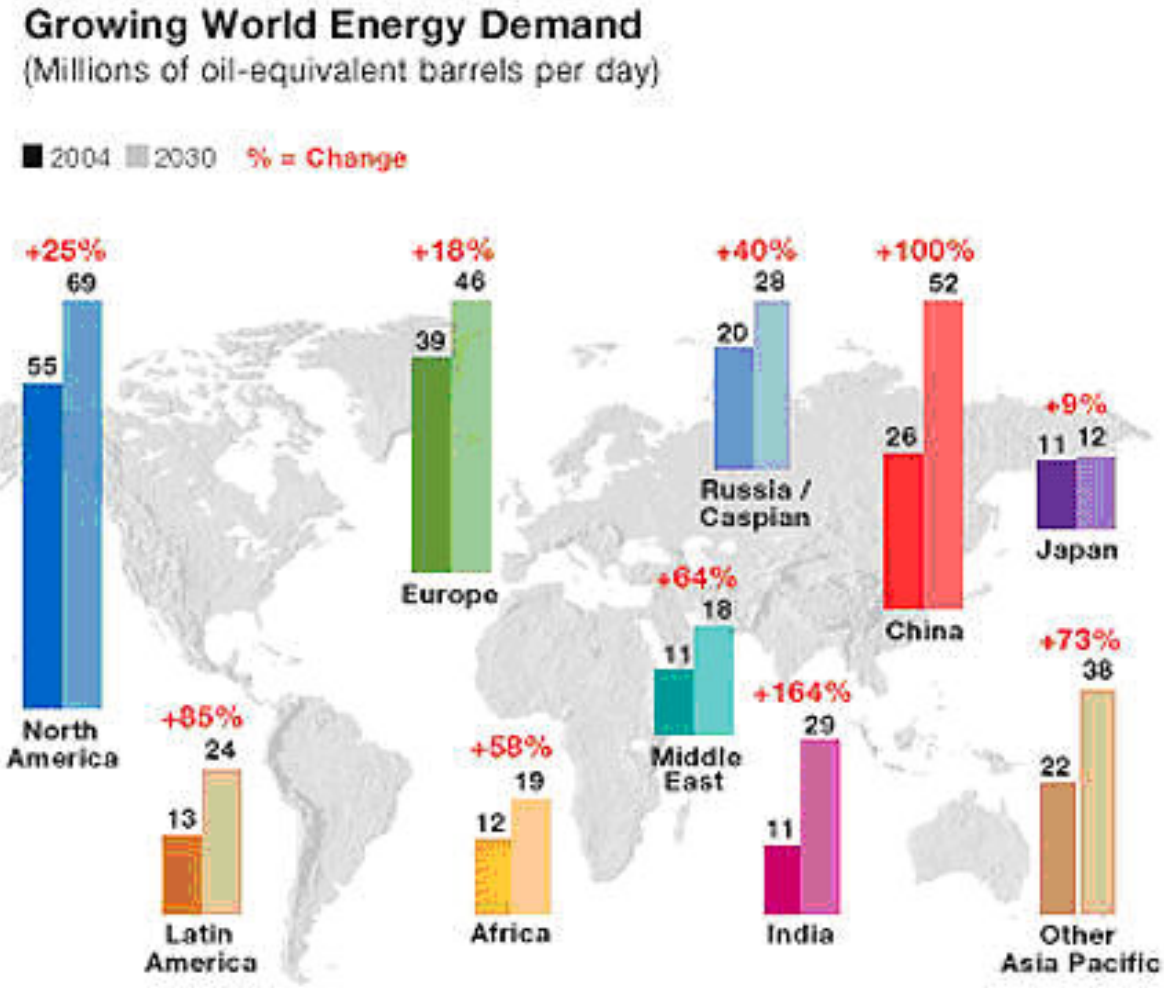


We need a new invention that will change the world the coming 100 years

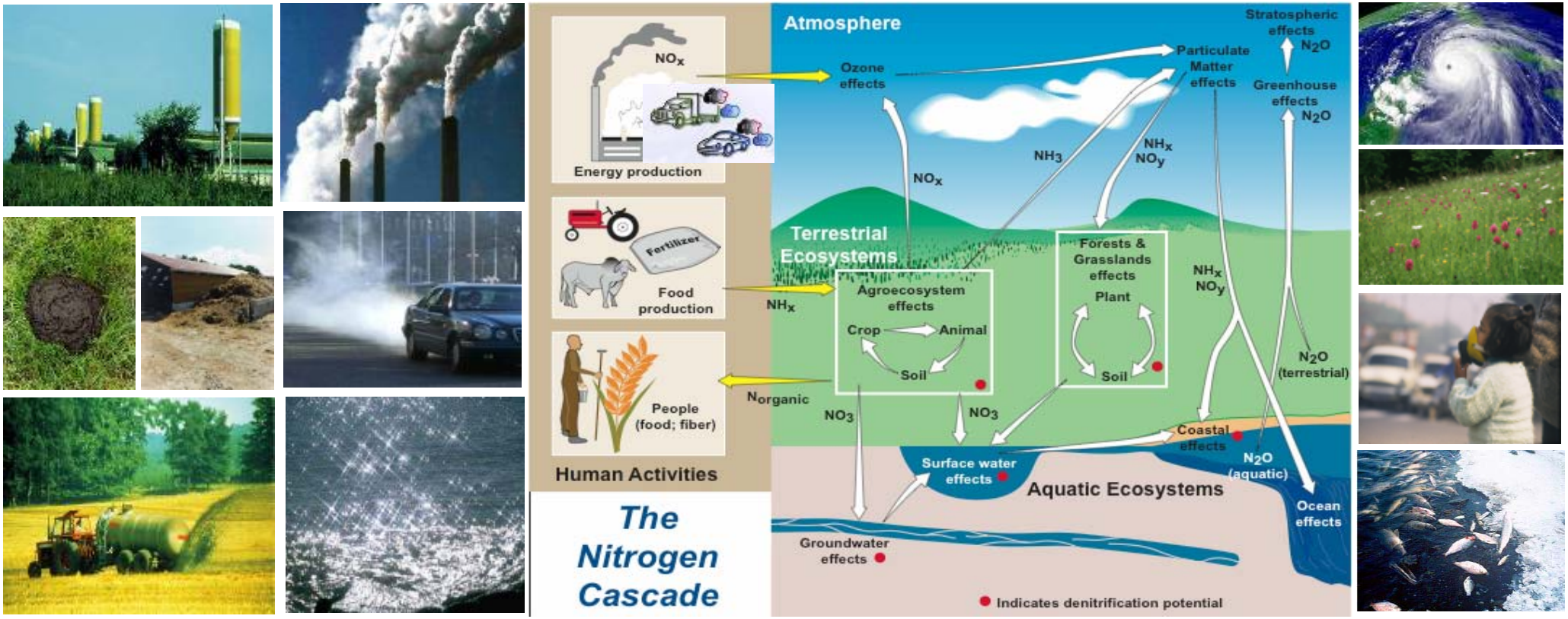
Erisman et al. 2008

Fossil fuels/energy and nitrogen

- NO_x emissions from combustion
- Fertilizer production
- Globalisation through transport
- Increased production through increased manpower
- Biofuels/bioenergy will require more fertilizer use



The reactive nitrogen formation and cascade



Sources

Cascade through the environment

Effects

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Nitrogen policies in Europe

Changing insights on role of N in water and air

- 1920s: N in water contribute to algal growth
- 1940s: NO_3 in drinking water has toxic effects on babies
- 1960s: N from sewage contribute to algal growth
- 1970s: N from agriculture contribute to algal growth
- 1980s: Managed pastures contribute to NO_3 leaching

- 1972: United Nations Conference on the Human Environment in Stockholm
- 1980s: ‘das Waldsterben’

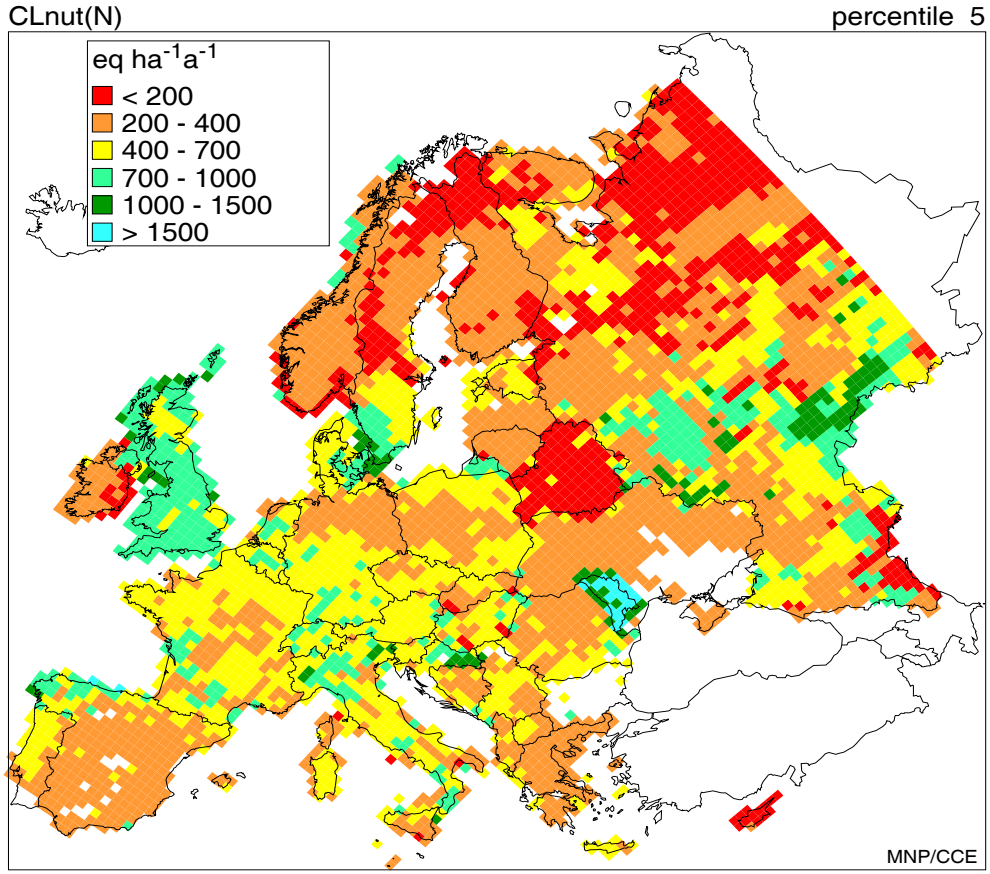
Policies on nitrogen in air Europe

- 1979: UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP)
- 1988: NO_X Protocol UNECE-CLRTAP
- 1999: Gothenburg Protocol

- 1984: EU Air Framework Directive (84/360/EEC),
- 1989: EU Large Combustion Plant Directive 88/609
- 1996: EU Integrated Pollution Prevention and Control Directive (96/61/EC
- 1999: EU Air Quality Directive (1999/30/EC)
- 2000: EU National Emission Ceilings Directive (2001/81/EC)
- 2005: EU Thematic Strategy on Air Pollution

- 1997: UNFCCC Kyoto Protocol

Effect based approach based on ecosystem critical loads

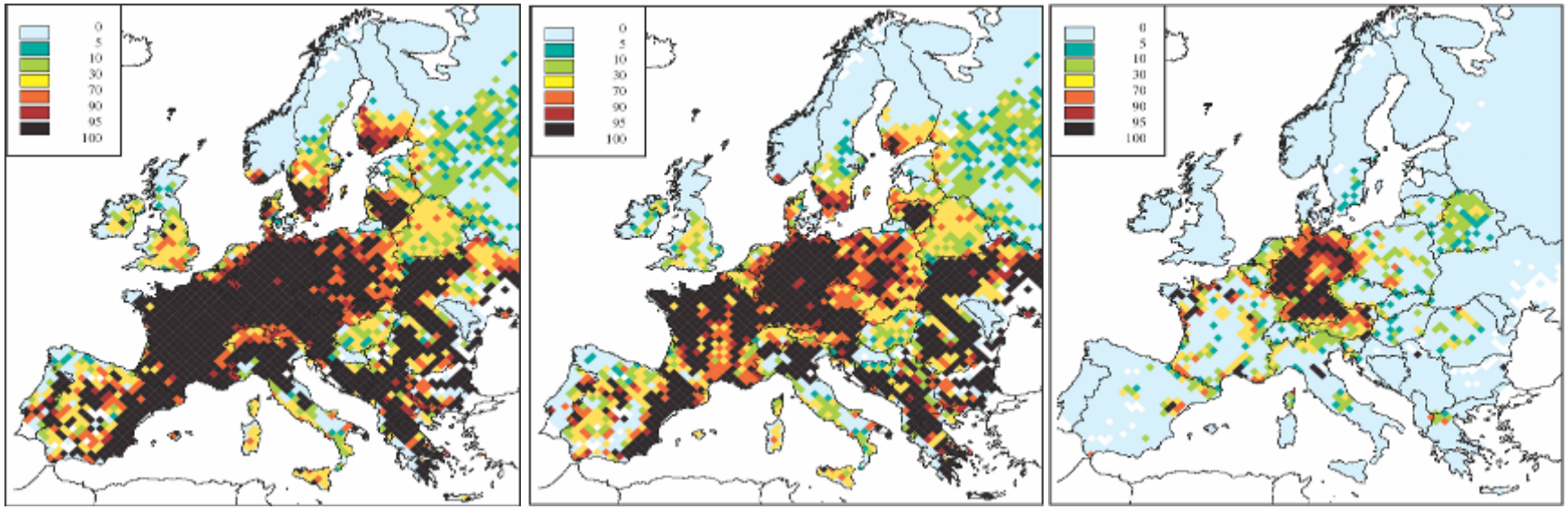


Critical load: “the highest deposition of (…) below which harmful effects in ecosystem structure and function do not occur according to present knowledge”

= long-term ecosystem capacity against eutrophication, acidification, heavy metal effects

used as **sustainability indicators** for policy guidance

Excess of critical loads for eutrophication



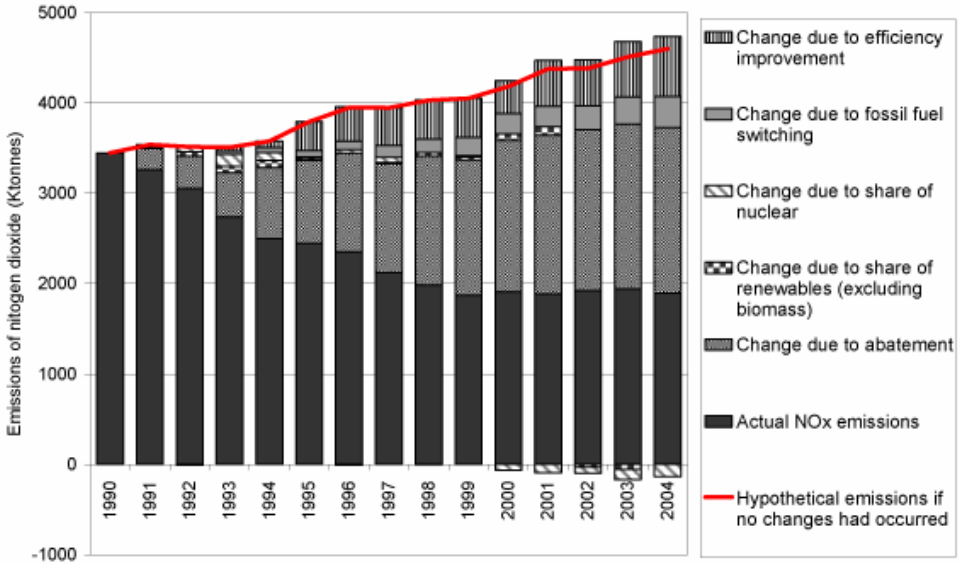
2000 | 2020 Current legislation | 2020 Max. feas. reductions

Percentage of ecosystems area with nitrogen deposition above critical loads using grid-average deposition. Calculation for 1997 meteorology

Policies on nitrogen in air in Europe:

Industry and traffic: decreasing NO_X emissions

- Instruments:
  - Regulatory limits and standards
  - Regulatory ceilings (from flat-rates to critical loads)
  - Economic instruments (charges, subsidies)
- Measures:
  - Best available techniques (BATs)
  - (Structural measures: changes in energy sources, transport)
- Effects:
  - In EU-25 in 2006 a decrease in NO_X emissions of ~34% relative 1980
  - A further decrease needed of ~27% to reach 2010 ceilings
  - Side effects: increases in energy use, NH_3, N_2O, CO_2 emissions

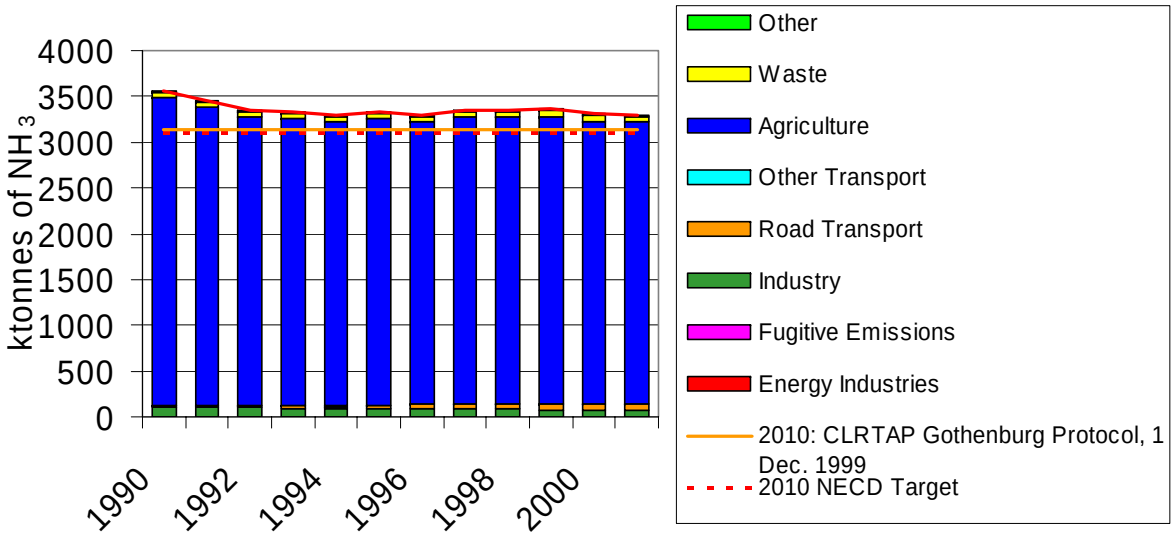


Source: EEA

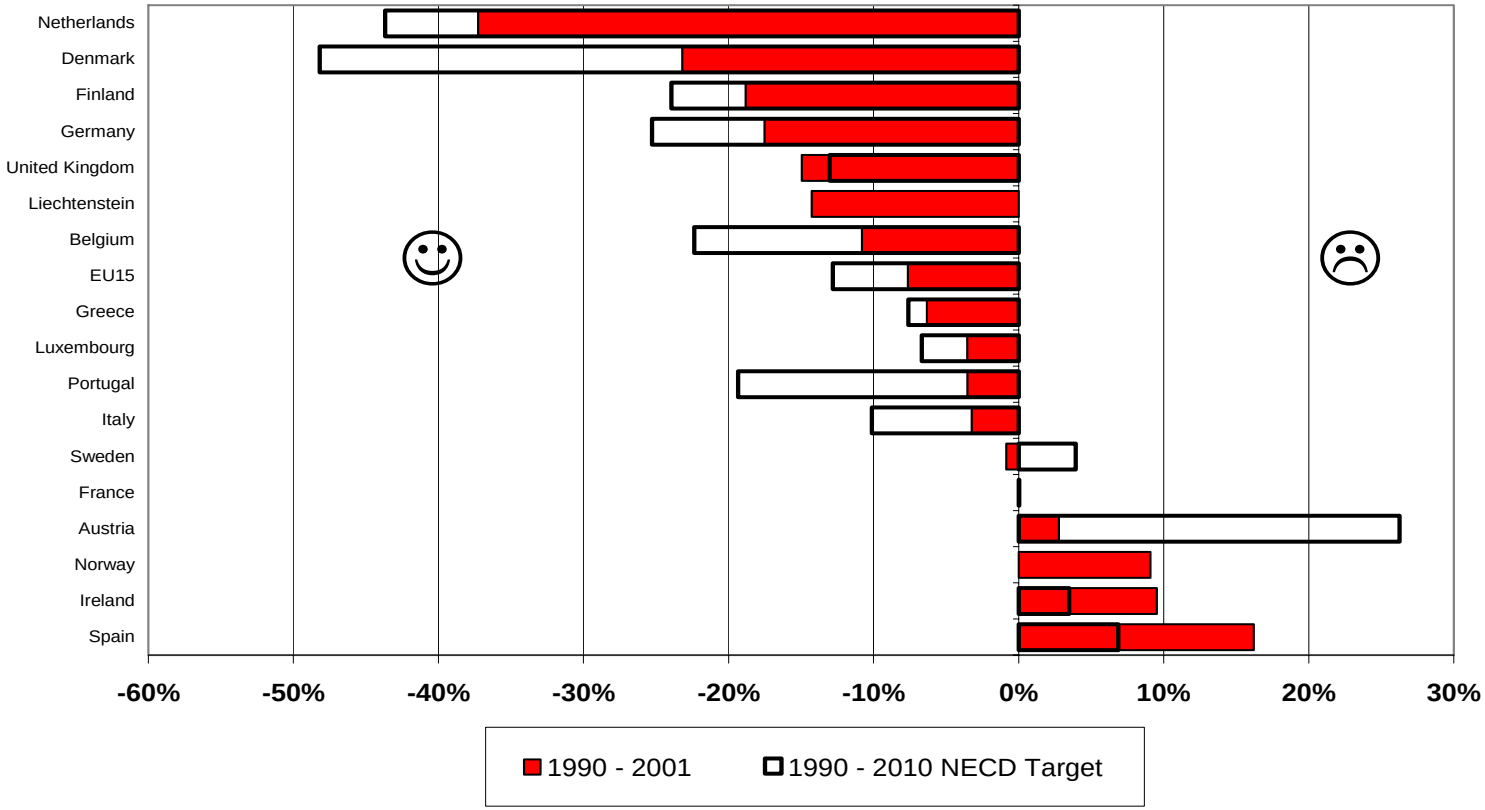
Policies on nitrogen in air in Europe:

Agriculture: decreasing NH_3 emissions

- Instruments:
  - Permits for large pig and poultry operations
  - Regulatory ceilings (based on critical loads)
- Measures:
  - Best available techniques (BATs)
  - (milk quota system, less fertilizer)
- Effects:
  - In EU-15 in 2006 a decrease in NH_3 emissions of ~19% relative 1980
  - A further decrease needed of ~2 - 30% to reach 2010/2020 ceilings
  - Side effects: increase in N_2O emissions and NO_3 leaching



Changes in NH_3 emissions



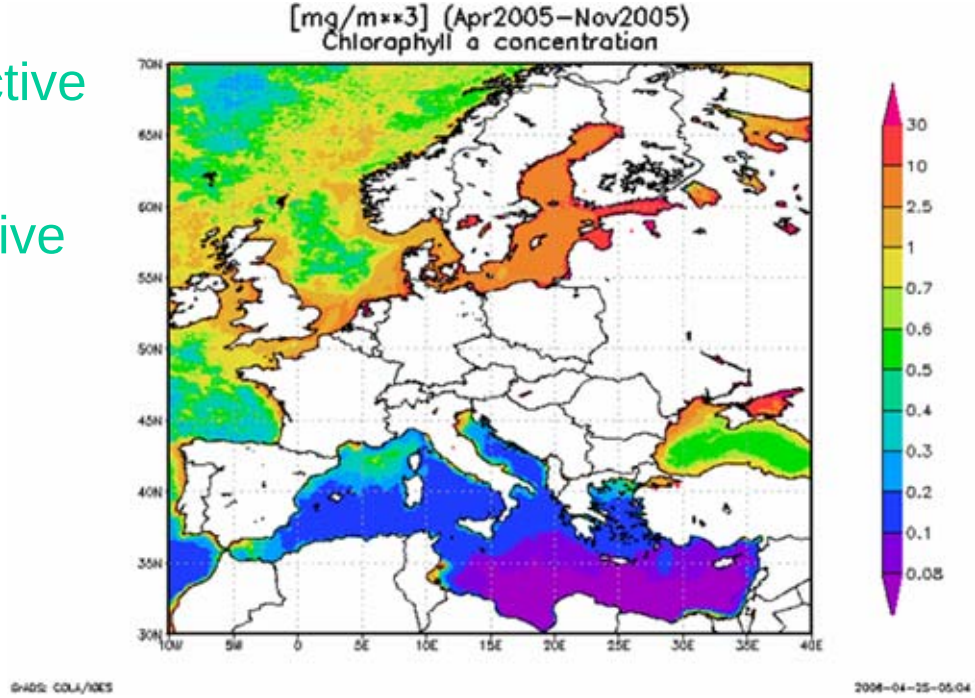
% change from 1990 to target (1999 & National Ceilings 2010)

Source: EEA

Policies on nitrogen in water Europe

- 1972: Helsinki Convention / OSCOM / PARCOM
- 1976: Mediterranean Action Plan
- 1992: HELCOM /OSPAR Conventions :50% decrease in N and P loads

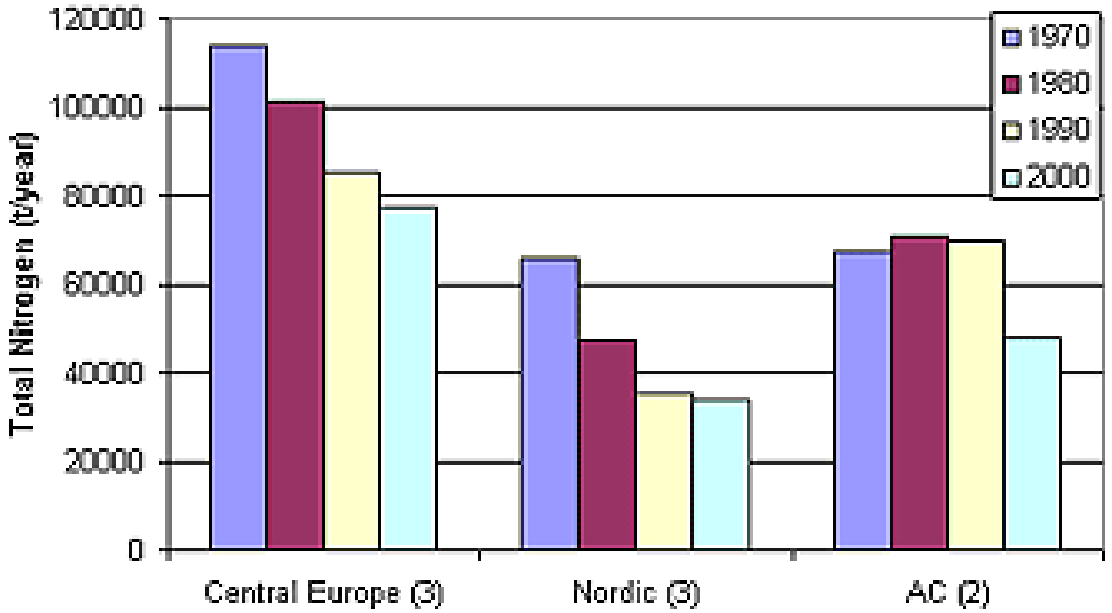
- 1991: EU Urban waste water Directive
- 1991: EU Nitrates Directive
- 2000: EU Water Framework Directive
- 2006: Groundwater Directive
- 2007: Marine Strategy



Policies on nitrogen in water in Europe:

Urban waste: Decreasing N loading to surface waters

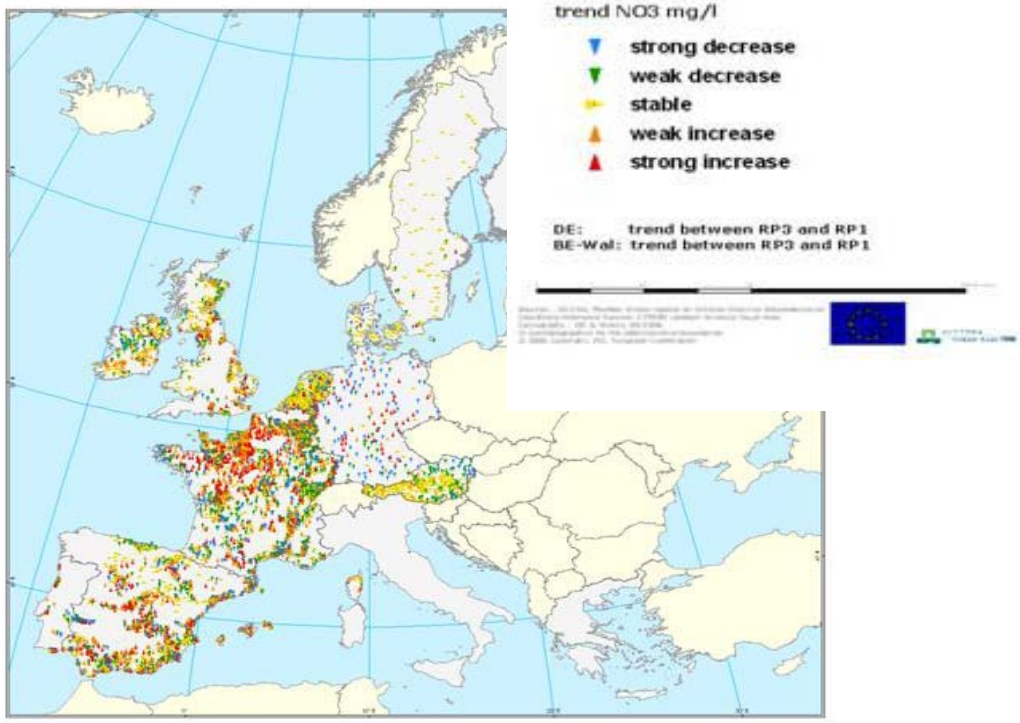
- Instruments:
  - Regulations for collecting & treatment
  - Regulatory limits for discharges
- Measures:
  - Collection of sewage
  - Treatment
- Effects:
  - Decrease in N loading of surface waters by ~40%
  - Regional diverse



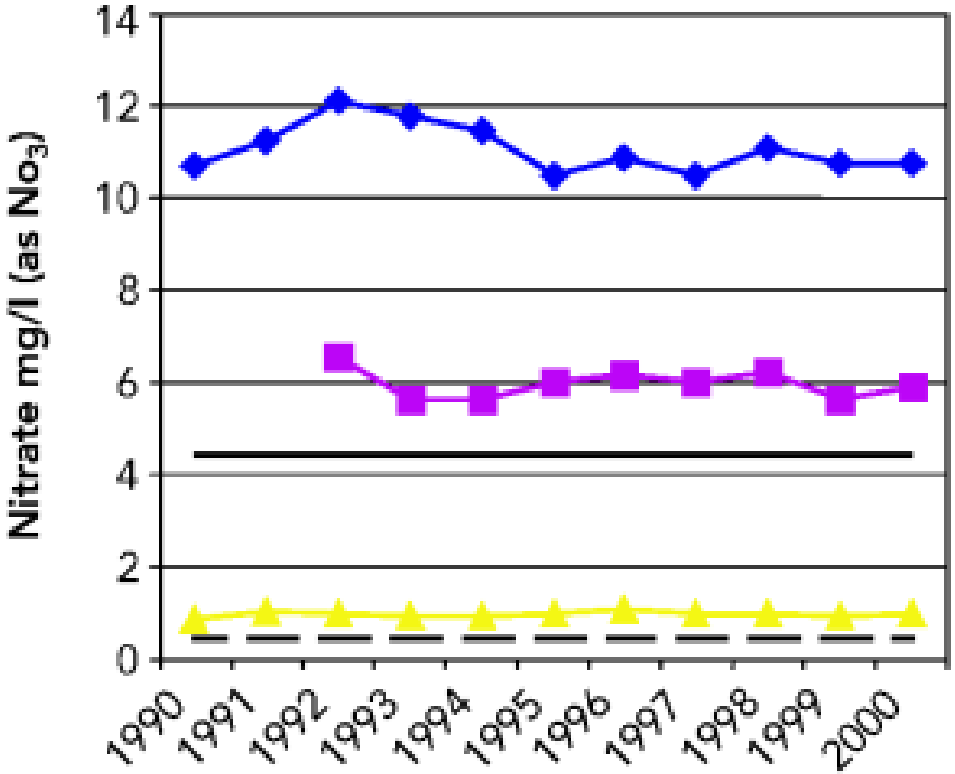
Policies on nitrogen in water in Europe:

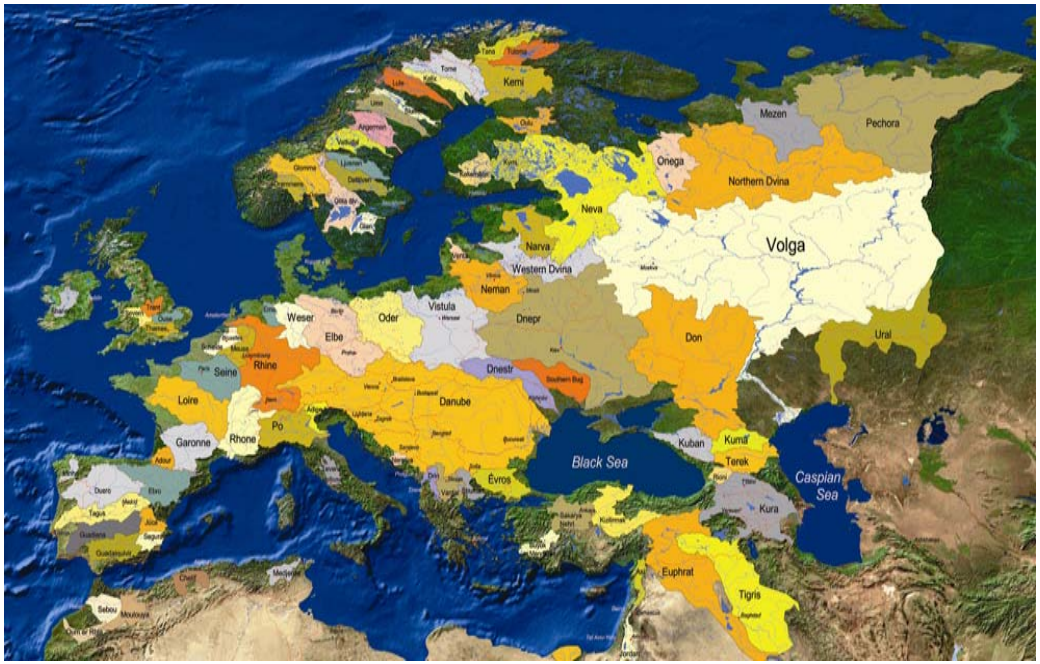
Agriculture: Decreasing NO_3 leaching losses

- Instruments:
  - Regulatory limits on the use of fertilizers and animal manure
  - Communicative instruments
  - Economic (through Cross compliance regulations)
- Measures:
  - Codes of Good Agricultural Practices
  - Zoning, Nitrate Vulnerable Zones
  - Action Programs
- Effects:
  - Decrease in fertilizer N use of ~5%
  - Changes in agricultural practices
  - Not much change in NO_3 concentrations yet



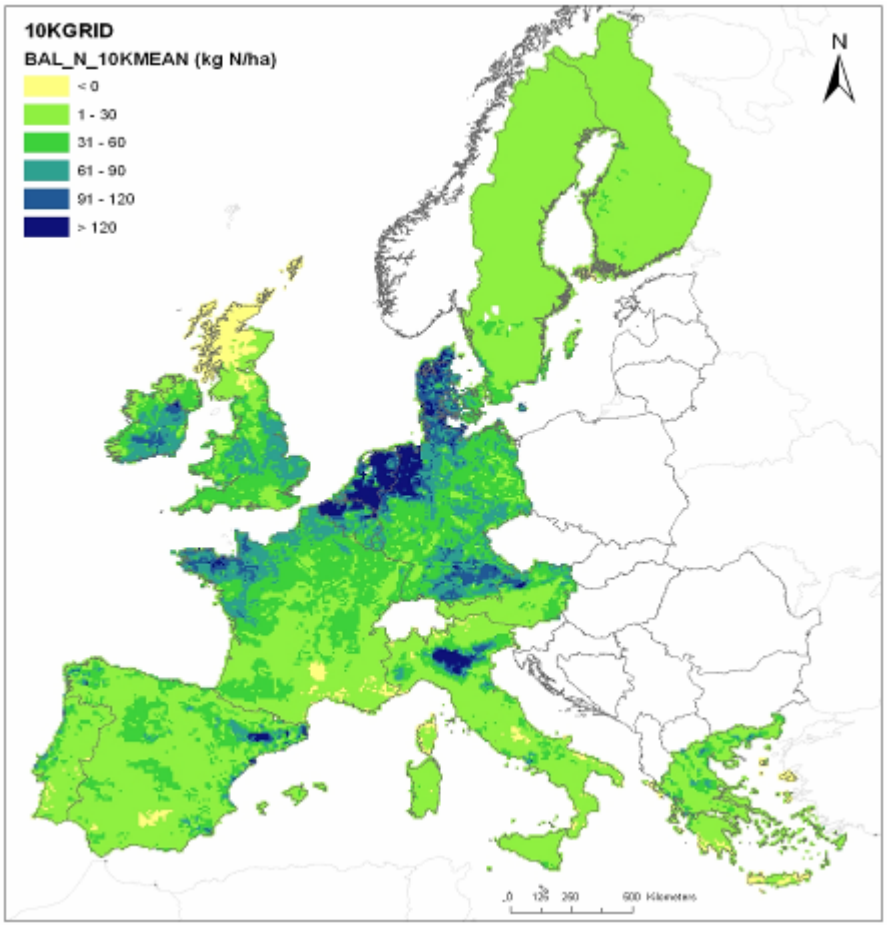
Nitrate concentrations in some rivers

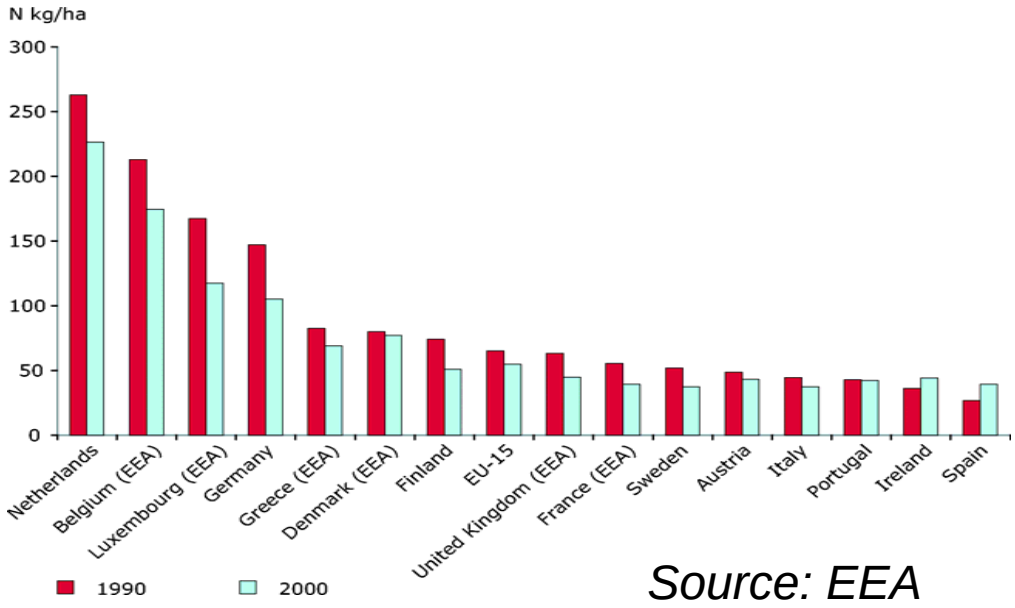




Source: EEA

Spatialised Gross Nitrogen Balance indicator



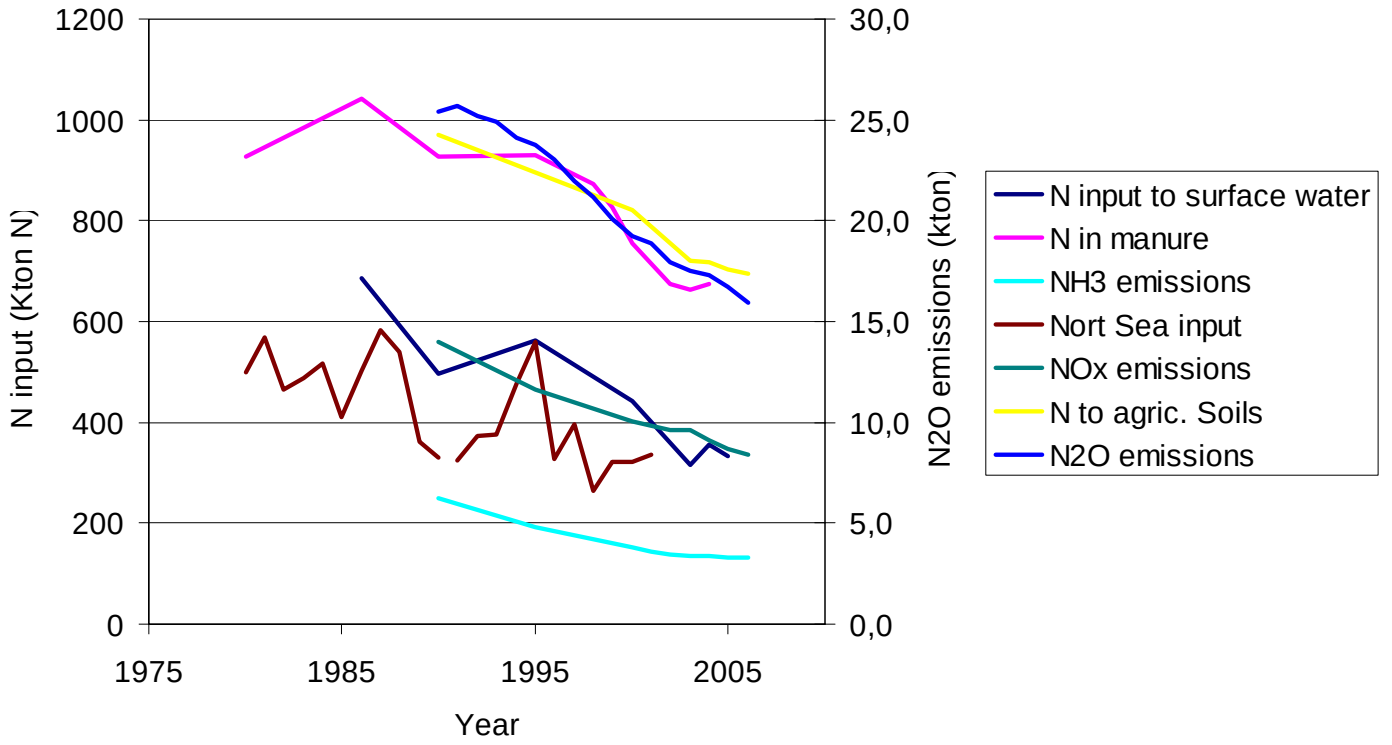


Source: EEA

Spatialised gross nitrogen balance (average on 10 km grid), JRC

Successful national examples: the Netherlands

- Mineral accounting system
- Emission poor housing
- Slurry injection
- Coverage of manure storage
- Maximum manure application per land use
- Decrease of N in concentrates: lowering urea concentration in milk
- Manure processing
- Housing cattle at night
- No slurry application in winter
- Good agricultural practice
- SCR industry and transport
- Fuel switch



Why are some policies effective?

	Combustion	Agriculture		Urban
	NO_x	NH_3	NO_3	N_{tot}
Few stakeholders	x			x
Technology driven	x	x		x
Low costs			(x)	
Cost to consumers	x			x
Knowledge extensive		(x)		(x)
No yield loss	x	x		x

Reasons for being effective

- Regulatory pressure (catalytic converter, MINAS)
- No choice and builds good image (catalytic converter)
- Cost effectiveness caused by optimization (MINAS) and emission trading (SCR) and monetizing external costs (fines or taxing)
- Actor is given clear insight in his own actions in relations to the environmental consequences (MINAS)
- Ecological targets for an environmental compartment: effect based approach

Reasons for being less effective

- Ambiguous and complex policies, uniform for all systems and conditions
- Complexity: many small diffuse sources with different owners; complex interactions (scale, components)
- Juridical emphasis of the problem; no education, training and persuasion
- Actors do not support/understand the reasoning behind measures (slurry injector less effective than it could be)
- Measures not profitable (low prices, cheap energy/transport); economic optimum is at 50% efficiency or loss
- Lack of integration and no links with economic and structural developments

➡ More integrated approach

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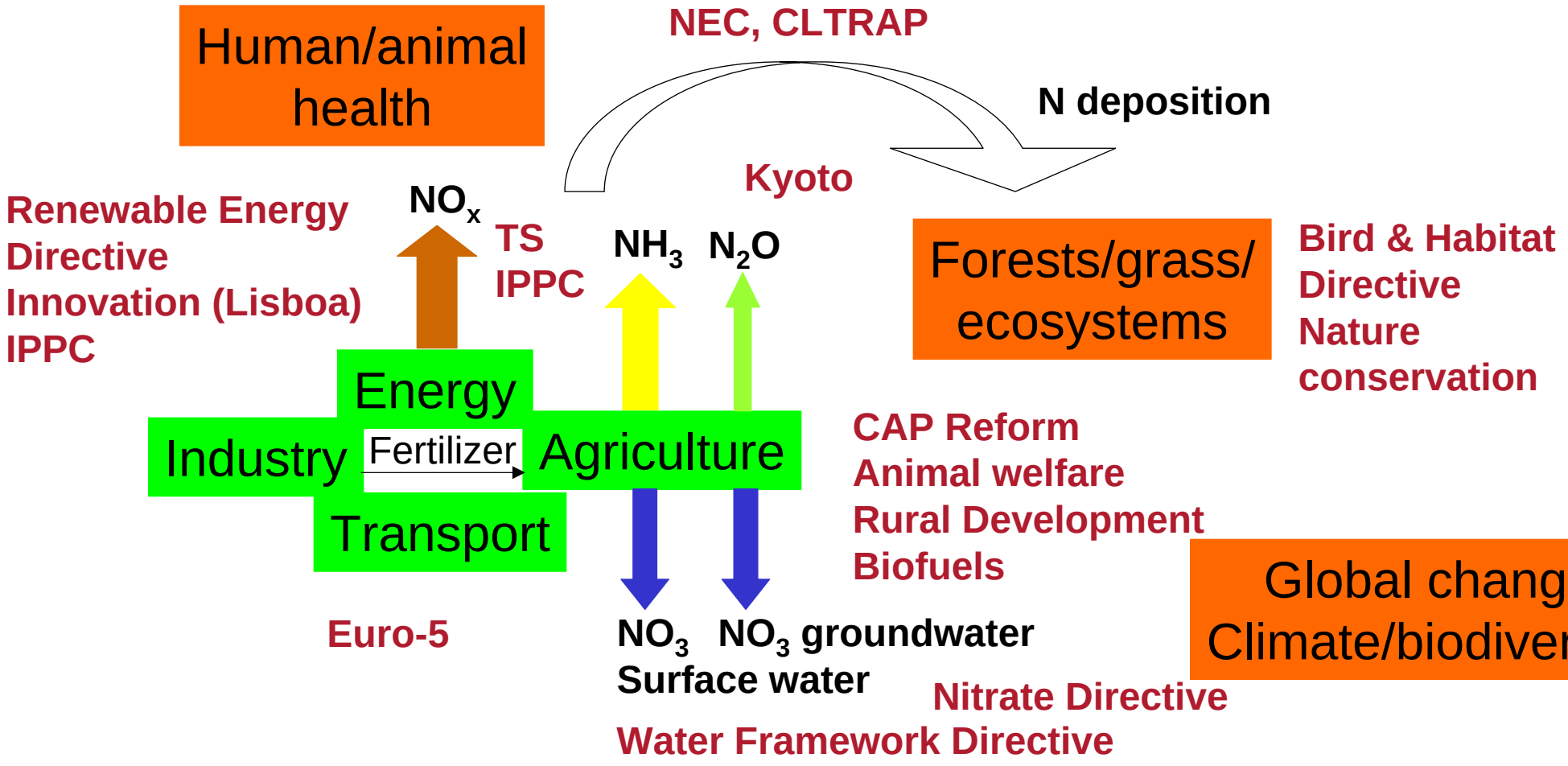
Towards an integrated Nitrogen approach

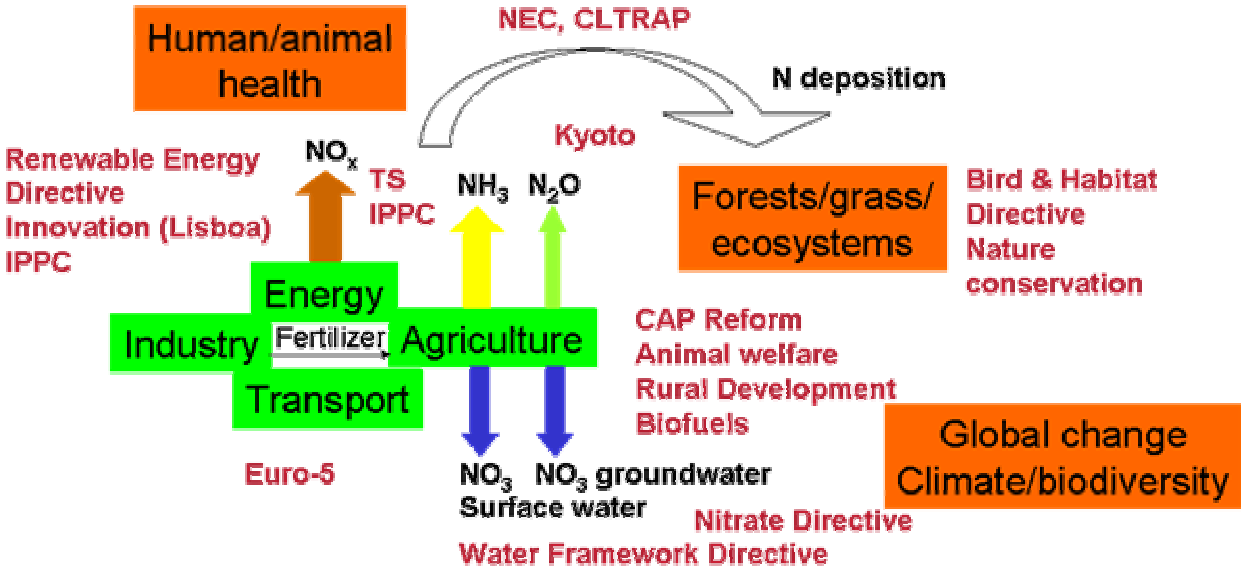
Multiple EU policies affect nitrogen in different sectors



Strategy towards a successful integrated approach

What is needed?

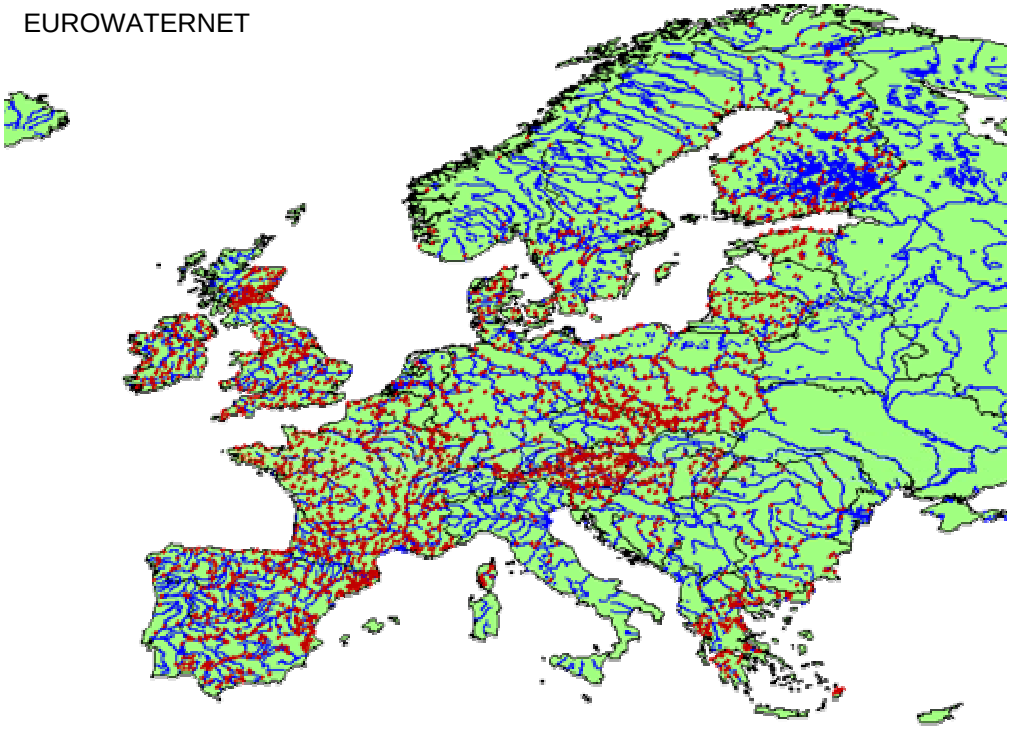
- Evidence of effects
- Develop a concept
- Assessment of benefits of an integral approach
- Tools: models; toolboxes
- Organization
- Communication/education
- Policy forum/outlet



Water quality monitoring

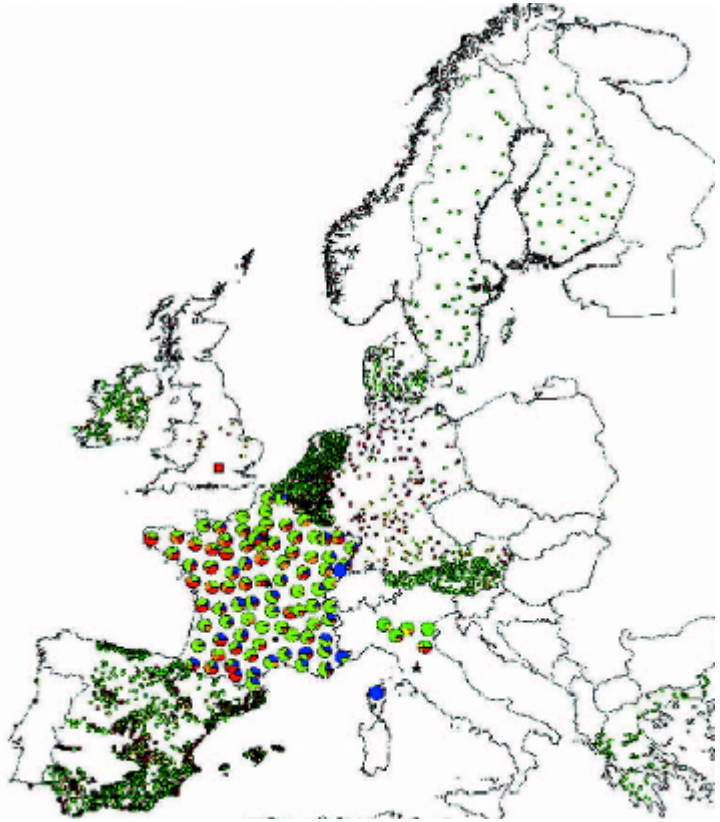
River stations – EIONET Water

EUROWATERNET



More than 3000 river stations from more than 30 countries – timeseries for many stations from 1992-2002

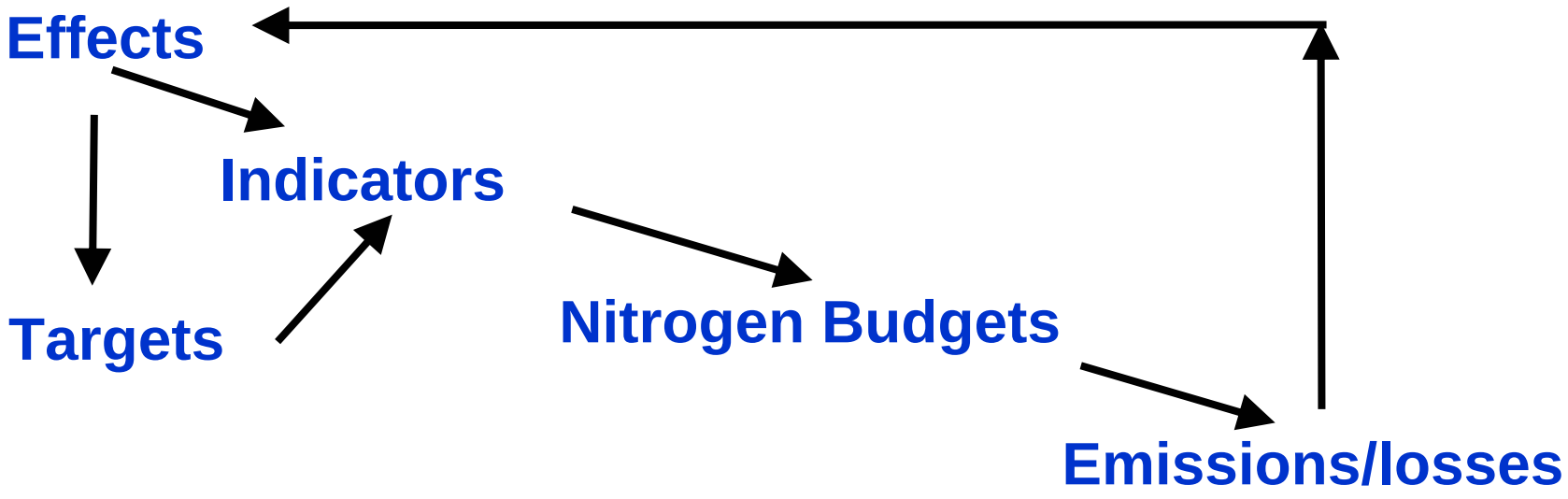
Nitrate in groundwater



Source: CEC 2002 Implementation of Nitrate Directive

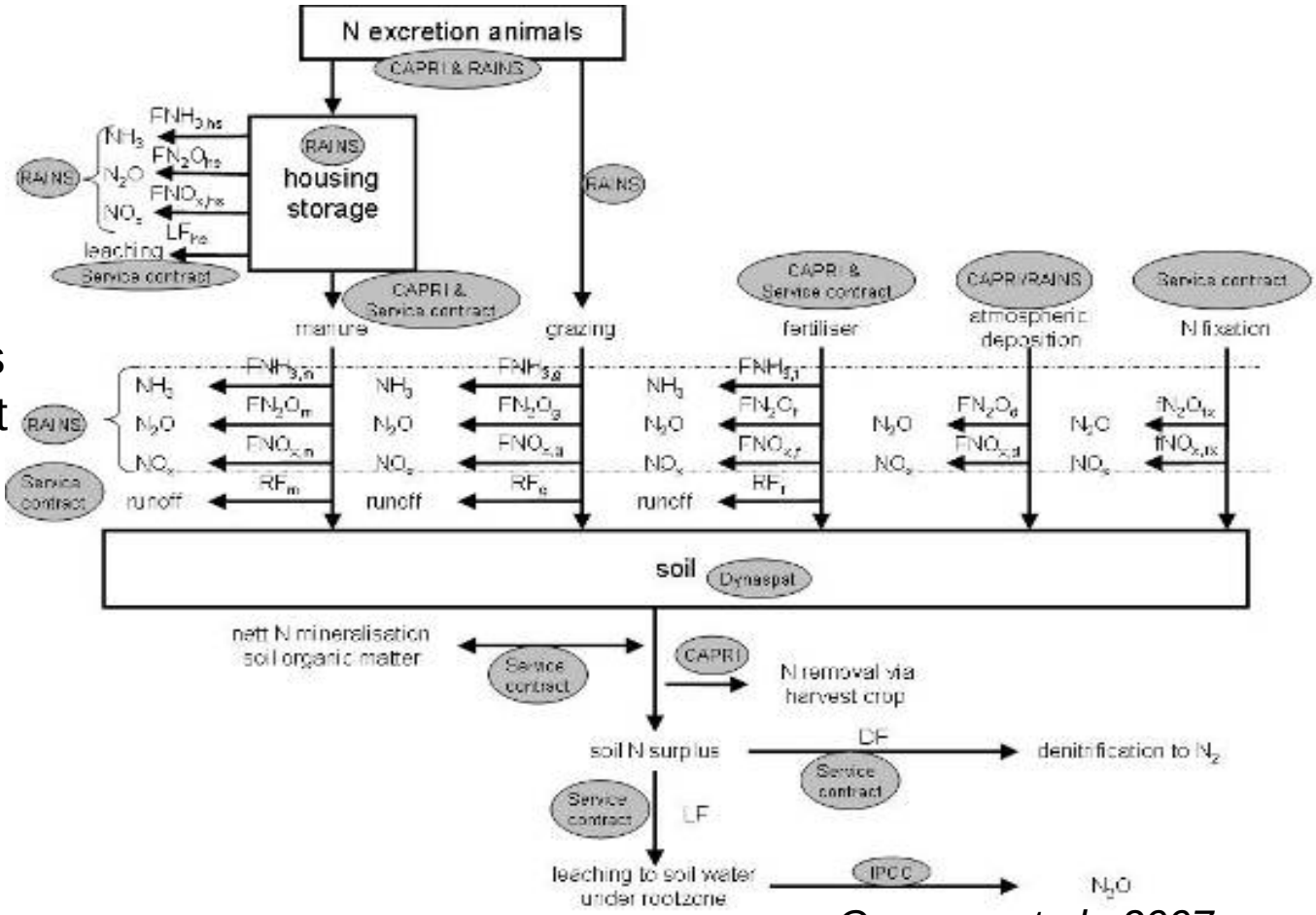
Build on the effect based approach for N

- Reduce emissions by increasing nitrogen efficiency
- Solve the ‘local problems’ through e.g. the IPPC directive
- Established a effect based framework to deal with N in an integrated manner (Nitrogen ceilings):



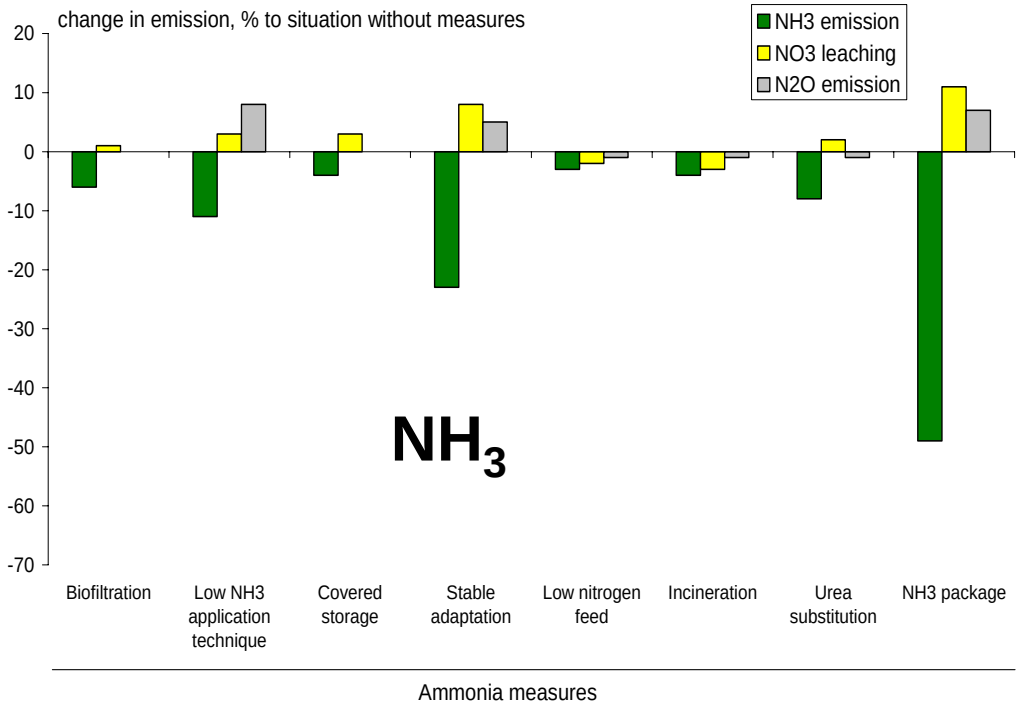
Integrated modeling system Miterra-Europe

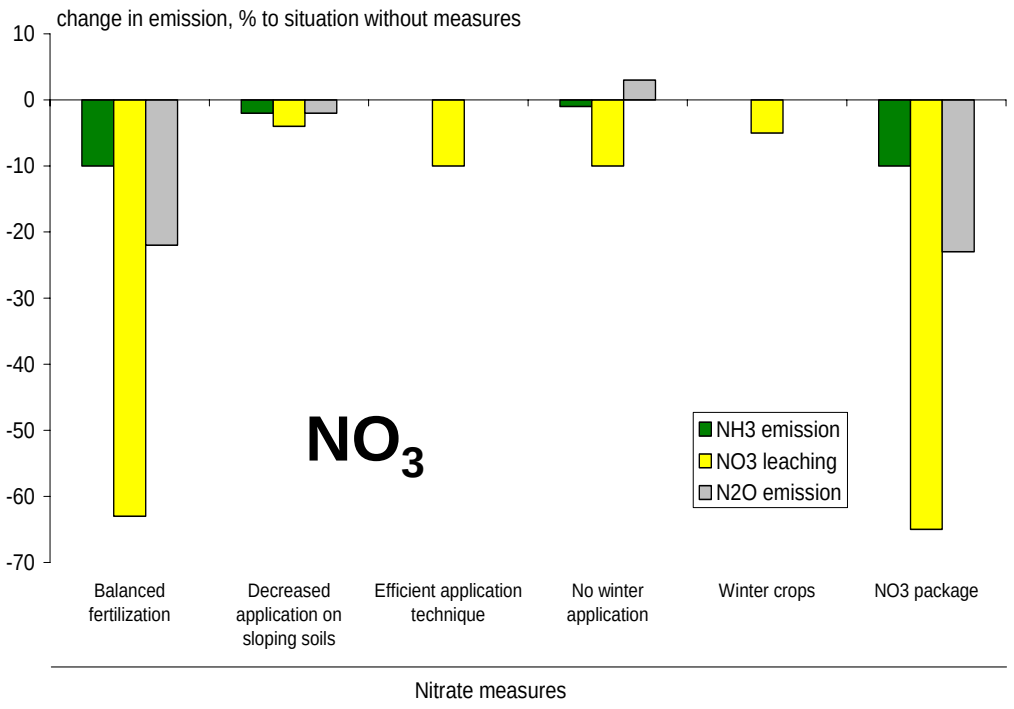
- Ammonia, nitrous oxide and methane emissions from housing, storage and soils
- Nitrate leaching
- Interactions between N flows housing and soils (consistent N budget)
- Measures to mitigate ammonia and nitrate emissions



Oenema et al., 2007

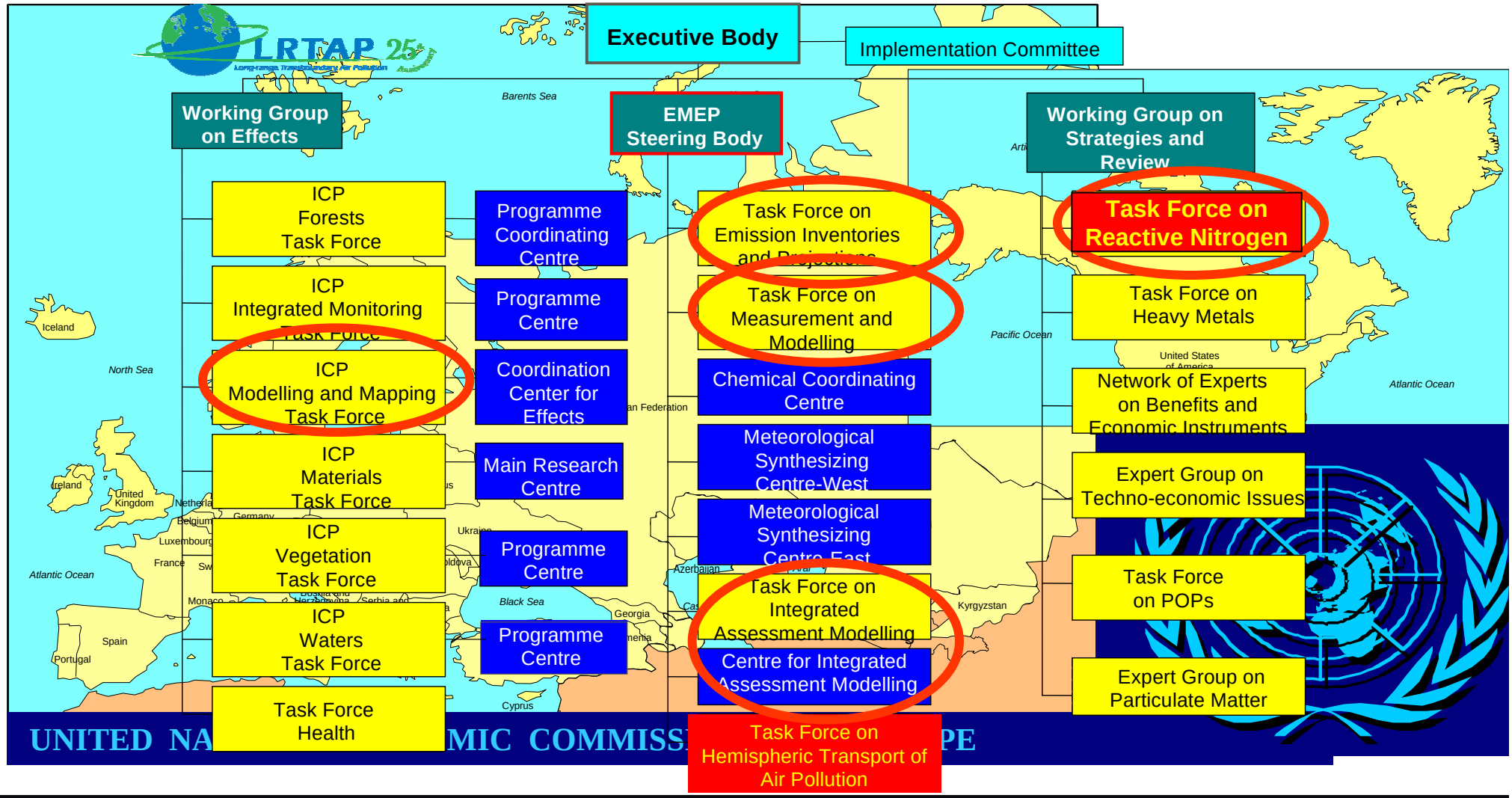
Result of integrated model Miterra: pollutant swapping





Oennema et al., 2008

Nitrogen and the Convention on LRTAP



Task Force on Reactive Nitrogen: TFRN

co-chairs: Mark Sutton (UK) and Oene Oenema (NL)

Long-term:

- To provide technical information to be able
  - to develop an integrated vision and approach to abatement of Nr emissions and effects;
  - to improve coordination on the development of integrated Nr policies;
  - to search for synergies between policies on air pollution and other policies;

Short-term activities:

- Expert Panel on N balances and budgets
- Expert Panel on mitigation of agricultural nitrogen
- European Nitrogen Assessment (ENA)
- Analyse the linkages across Convention,
  plus Convention Biological Diversity and Marine Conventions
- Develop Nr related options for revision of the Gothenburg Protocol

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http://www.clrtap-tfrn.org

LRTAP Long-range Transboundary Air Pollution

Task Force on Reactive Nitrogen

Home | Mission | Meetings & Events | Documents | TF Members | Login

Welcome to the TFRN website

This is the website of theTask Force on Reactive Nitrogen (TFRN) under the *Working Group on Strategies and Review*
of the UNECE Convention on Long-range Transboundary Air Pollution

TFRN is co-led by the **United Kingdom** and the **Netherlands**.

The Co-Chairs are **Mark Sutton** (United Kingdom) and **Oene Oenema** (Netherlands).

1st Task Force meeting
The first meeting of TFRN has taken place on **21-23 May 2008** at the Wageningen International Conference Centre (WICC), the Netherlands.

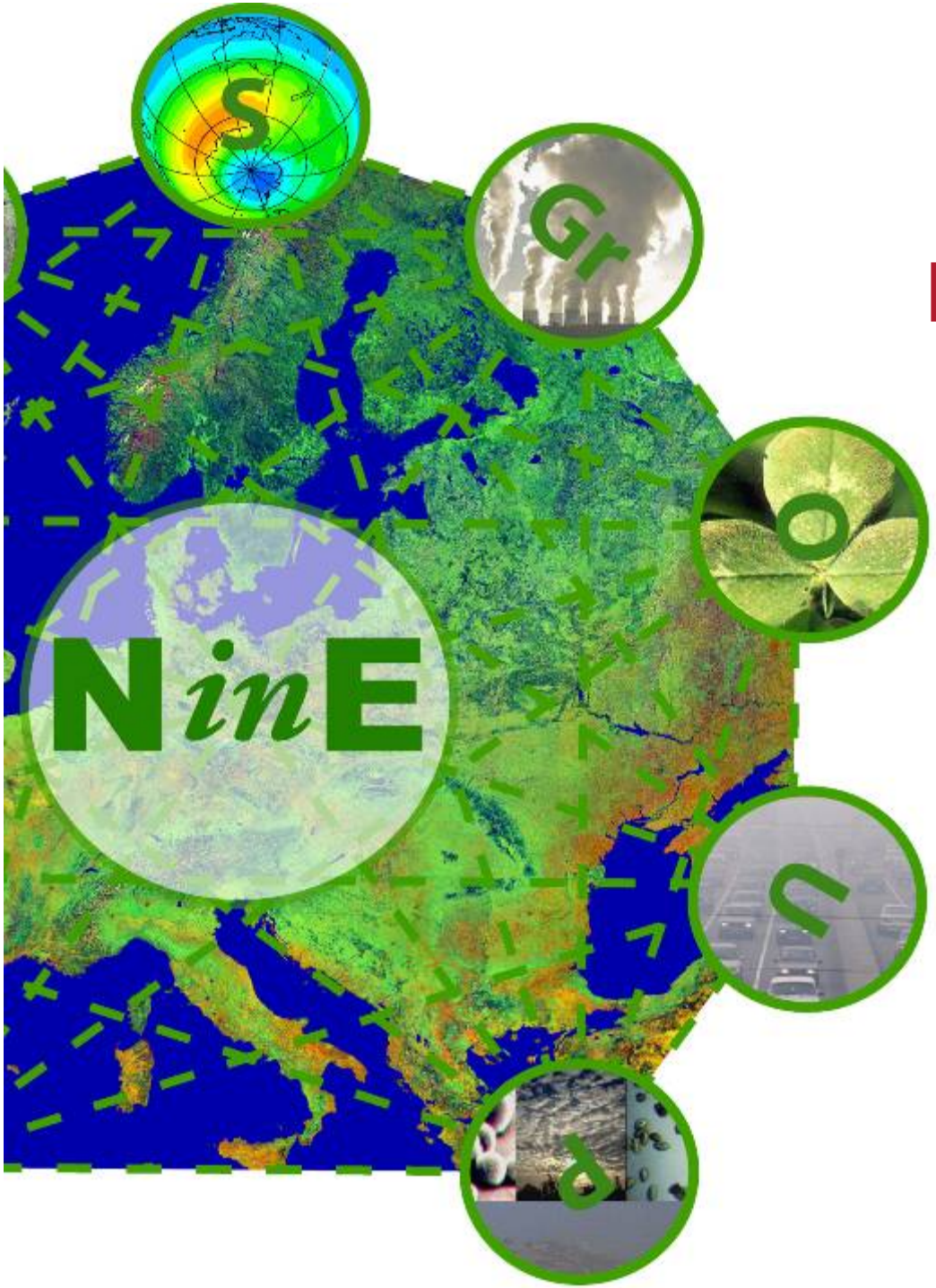
Documents

- Decision ECE/EB.AIR/91/Add.1: Establishment of the Task Force on Reactive Nitrogen
- Note of the chairs on the 1999 Gothenburg protocol, to be discussed during the late

Upcoming events

- 3rd Workshop of the European Nitrogen Assessment (ENA-3) (64 days)
- Workshop on costs of excess nitrogen (ENA5a) (92 days)
- NitroEurope IP Annual Meeting (147 days)
- TFRN 2nd Meeting (pending confirmation (240 days)

more



European Nitrogen Assessment

1. Nitrogen in Europe
2. Nitrogen processing in the atmosphere, aquatic and biosphere system
3. Dispersion and fate of nitrogen on different scales
4. Managing nitrogen in relation to key social threats
5. EU nitrogen policies and future challenges

www.nine-esf.org

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Communication and visualisation

NitroGenius

Visualisation tool:

Policy starts to work .....

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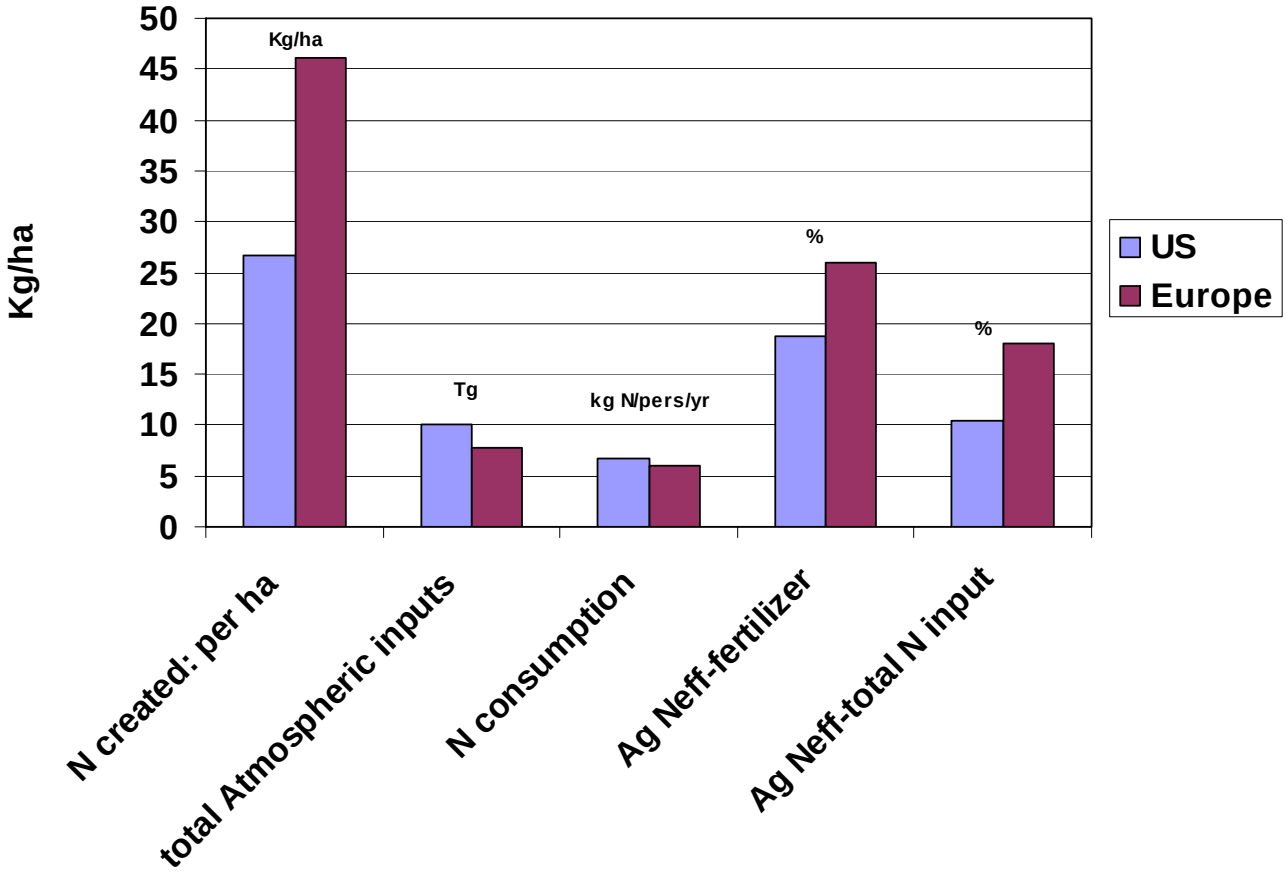
Comparison between Europe and the US

N efficiency in EU27 and the US

In the US:

- Population less than half
- Surface twice as high
- N creation a little higher
- Less intensive
- Atm. emissions 25% higher
- N consumption similar
- Agricultural N efficiency 8% lower

than in Europe



A view from Europe

- Good science, quantification of the major national N fluxes and the cascade! Coastal/watershed areas well covered. Good focus on ‘control points’. There is still large uncertainty (50%): ammonia; deposition; regionalisation needed
- Starting point should be the effects and sustainable levels of protection (end points); effect based approach through indicators (metrics) and risk assessment (exceedance of long-term targets)
- Integrated models and assessments to determine optima cot-effective policies (and co-policy e.g. climate change: less meat; manure processing; renewables; CO_2 sequestration, ..)
- Focus on N balances/budgets and improvement of efficiency
- Visualisation, communication
- “struggle with agriculture”

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Thank you for your attention!

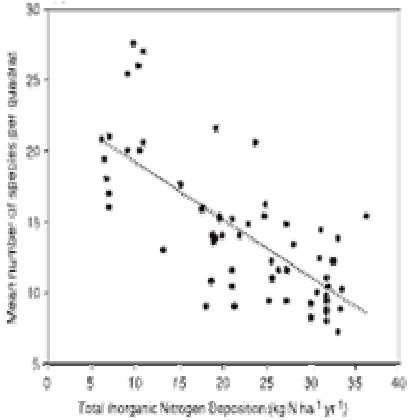
erisman@ecn.nl

www.nine-esf.org

Conclusions

- Negative environmental impacts have been observed
- Effects translated into effect parameters
- Indicators for risk assessment have been identified (incl. Nitrogen balances/budgets; Neff)
- Risk reduction through Integrated Assessment Modelling, Best Available Techniques and cost-benefit analysis
- Aim: limit exceedance of limits against lowest cost through targeted policies and measures
- Up till now: too much focus on water and air separate
- TFRN will aim for integrative approach

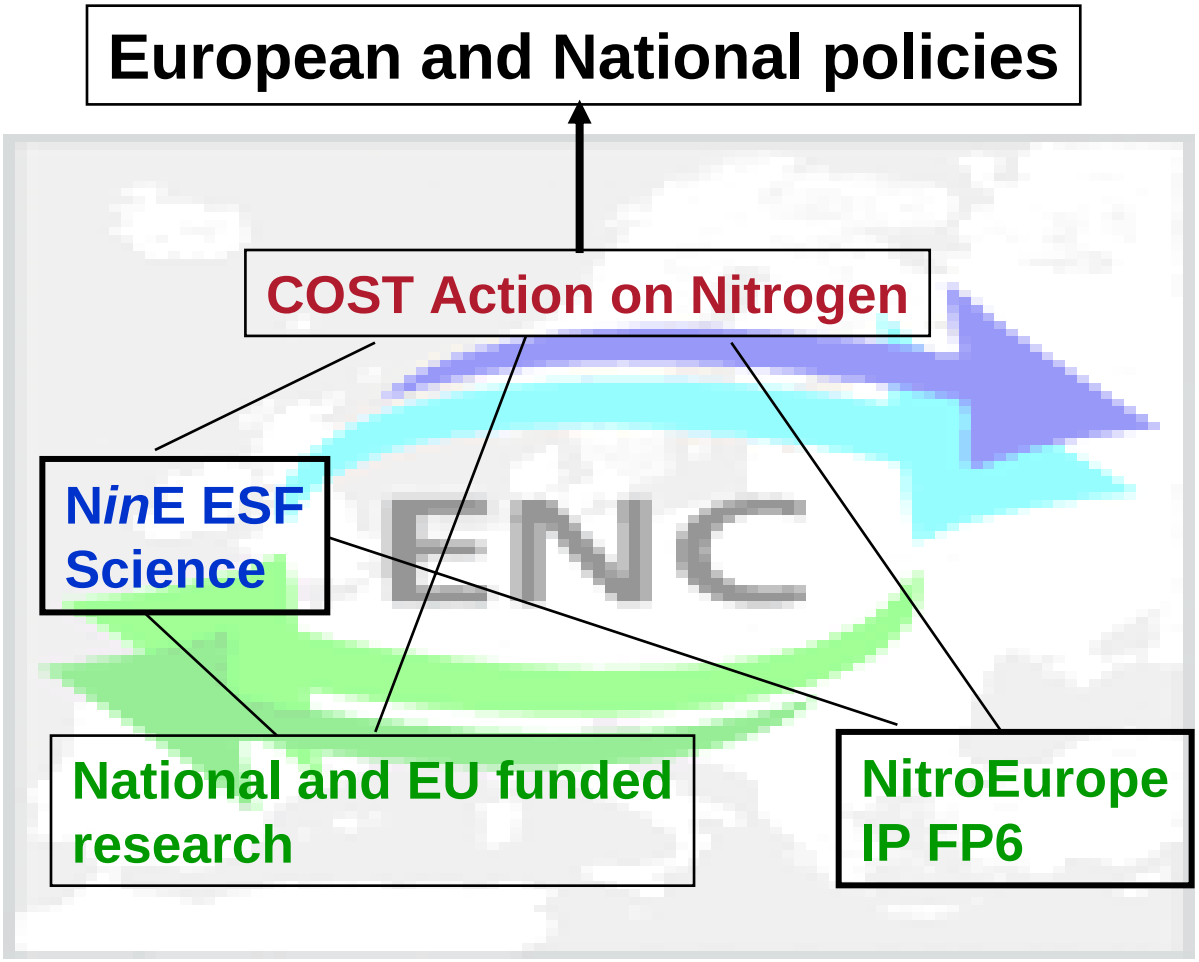
Effects of reactive nitrogen in the environment



Policies on nitrogen in Europe

- Policy responses: Sectoral & species approaches
  - Industry/traffic: NO_X (NH_3, N_2O), Norg, NO_3
  - Agriculture: NH_3, NO_3, N_2O, (NH_4, Norg)
  - Urban: Norg, NO_3, NH_4
- Focus on command and control measures:
  - Ambient targets
  - Emission targets
  - Technology targets
  - Penalties if limits / targets / standards are not met
- Other factors and processes affecting N
  - Food production (Common Agricultural Policy)
  - Rural development and demographic effects
  - Industrial changes
  - Changes in traffic, transport, shipping
  - Energy consumption
  - Nature and agricultural policies
  - Climate, etc.

European Nitrogen research and policy



UNEP, EU, VROM, LNV, TFRN

Integrated Assessment, Policy support

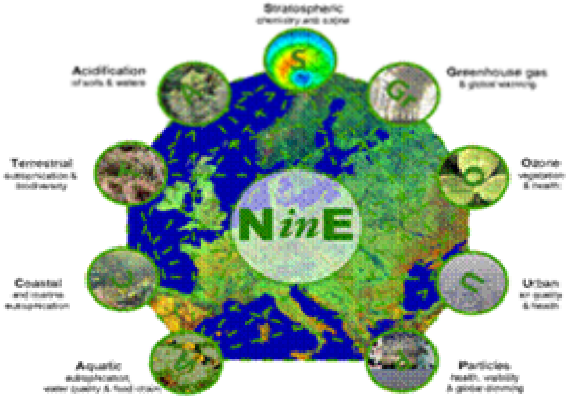
European Nitrogen Assessment Scientific coordination

Science Knowledge basis

More information on nitrogen:

www.cost729.org

www.initrogen.org



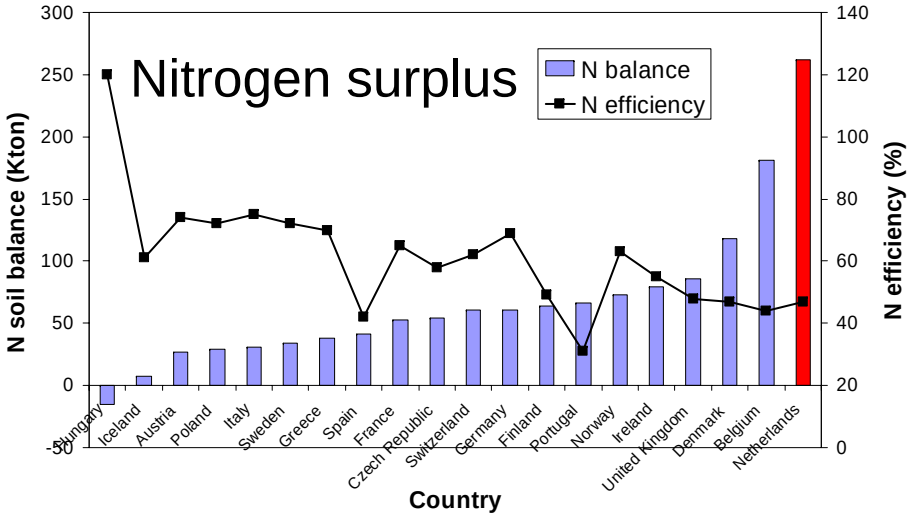
www.nine-esf.org

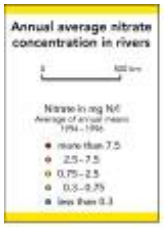
www.nitrogencentre.org

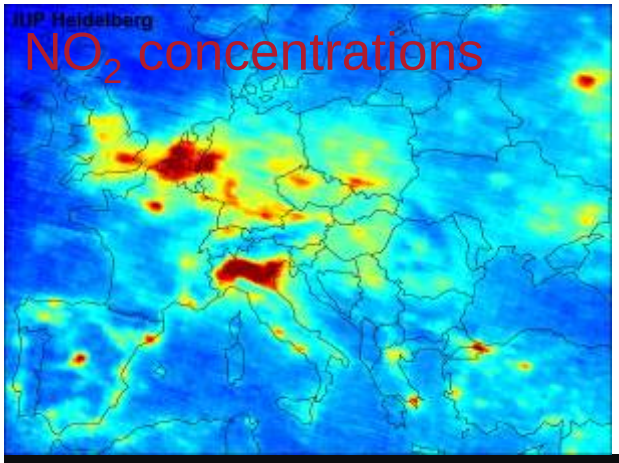
NitroEurope IP

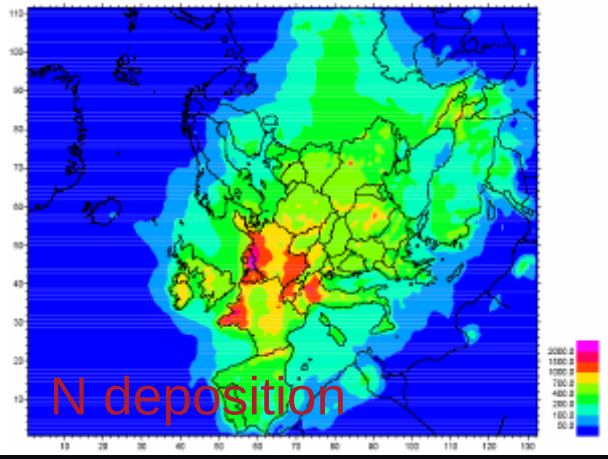
http://www.nitroeurope.eu/

The Netherlands is the ‘Nitrogen Hot spot’ of Europe

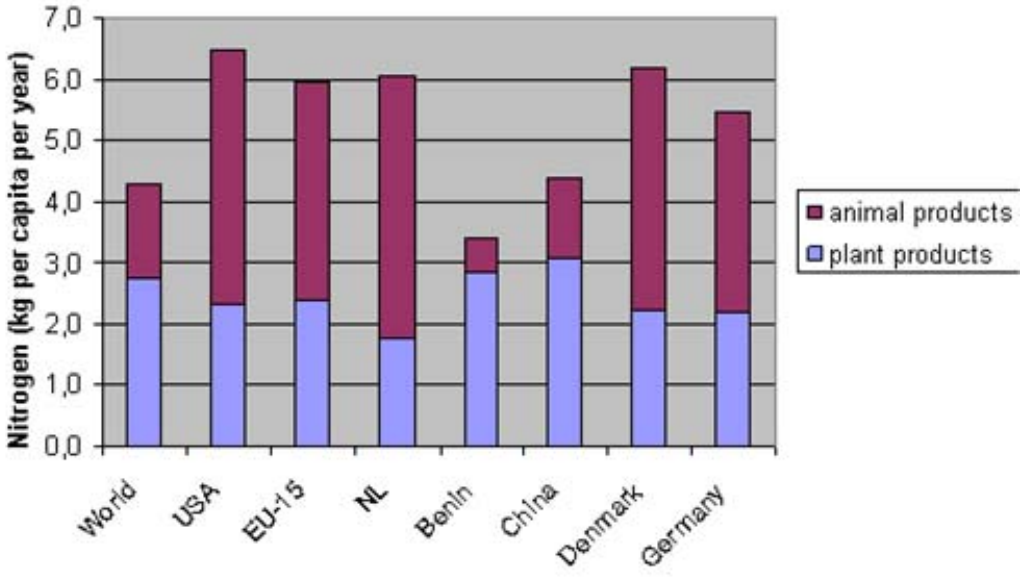




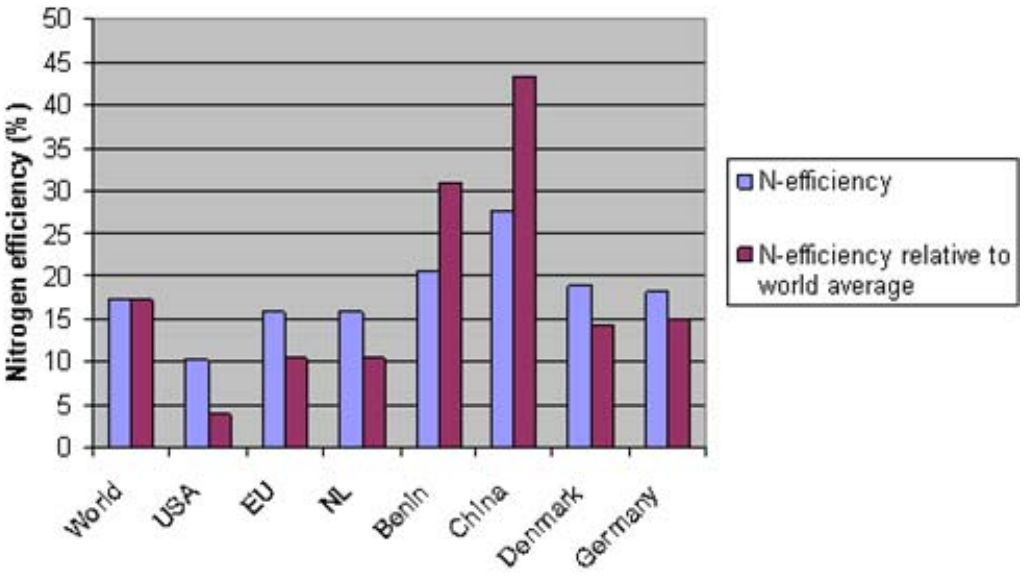




N-efficiency of protein consumption for different regions in the world



Nitrogen consumption (kg/cap/year)



Nitrogen efficiency (%) in 1995

Lessons to be learned from EU

- Effect based approach
- Integrated assessment for most optimal (cost-effective) measures
- One size does not fit all
- Emphasis on technological innovations as well as emphasis on management, structural, institutional innovations, and integration with economic policies
- There is need for more effective and efficient environmental policy measures in EU:
  - Integration of environmental policies needed
  - Integration of agricultural and environmental policies needed
  - More emphasis on increasing resource use efficiency needed through input control
  - Proper mix of policy instruments needed, targeted to the specific conditions
    - Communicative instruments
    - Economic instruments
    - Regulatory instruments

Tool box of policy instruments

- **Regulatory measures**
  - Limits, pollution standards
  - prohibition of specific methods, tools, techniques
  - public land use planning (zoning/spatial planning)
  - Fertilizer application limits
- **Economic instruments**
  - taxes & subsidies, fines
  - price support
  - import/export tarifs
  - tradable rights and quotas
- **Communicative instruments**
  - education, demonstration and persuasion
  - co-operative approaches
  - extension services