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NitroEurope IP

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An integrated nitrogen budget for Europe

Adrian Leip

European Commission - Joint Research Centre - Institute for Environment and Sustainability

Wim de Vries

John van Aardenne, Gilles Billen, Lex Bouwman, Michel Prud'homme, David Simpson, Mark Sutton, Maren Voss,

5th International Nitrogen Conference, 3-7 December 2010, New Delhi, India

Integrated Nitrogen Budgets

"Quantification of all major nitrogen fluxes across all sectors and media within given boundaries, and fluxes across these boundaries, on an annual basis"

European Nitrogen Assessent (ENA), 2011

→ **Sectors: Industry/energy, transport, agriculture (crop- and livestock production), (semi)natural terrestrial ecosystems, consumers, waste management systems (waste water and solid)**

→ **Media: atmosphere, hydrosphere (freshwater, coastal water)**

→ **Boundaries: European Union (EU27) without Malta and Cyprus**

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The European Nitrogen Budget (ENB)

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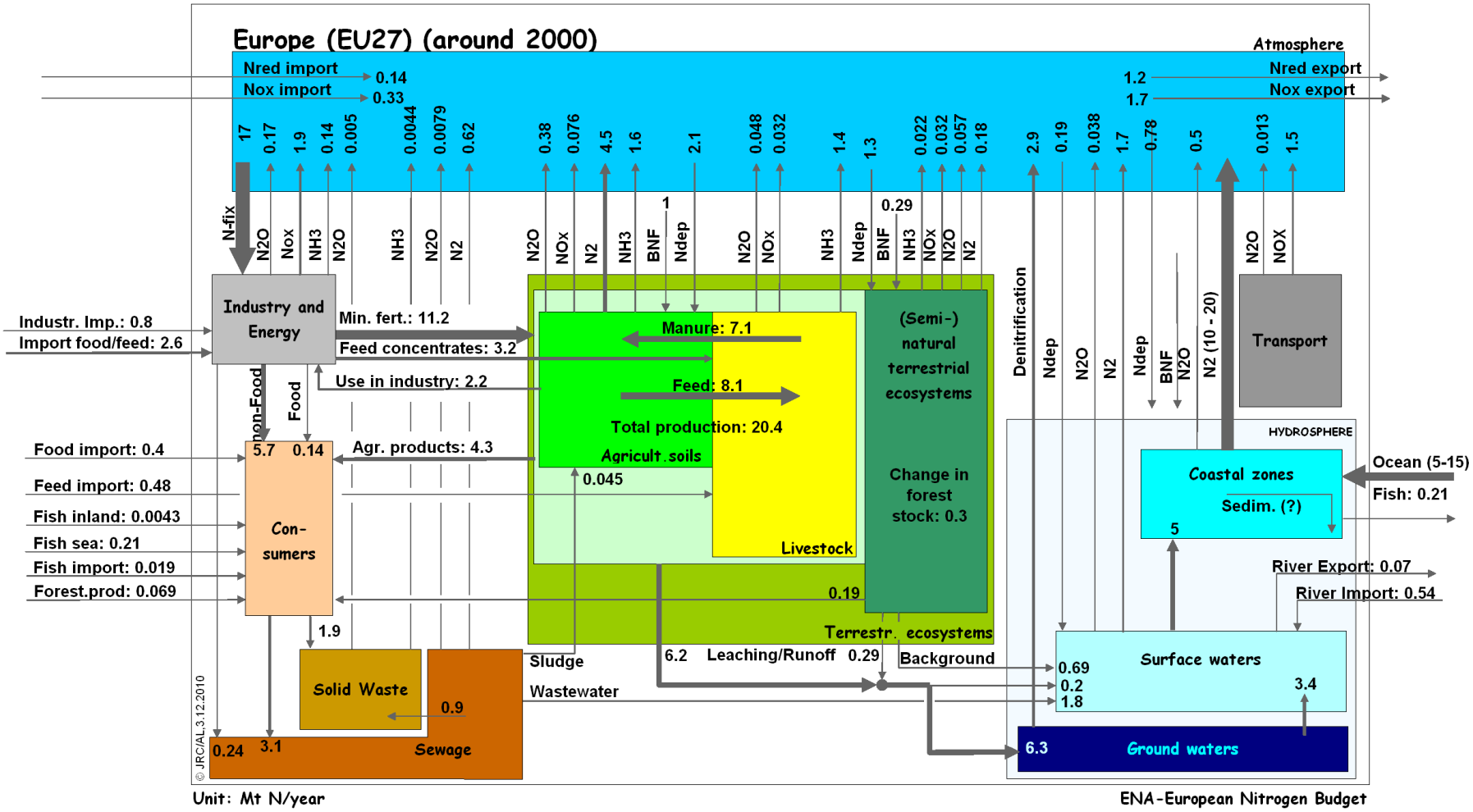

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Visualization & Quantification of the Nitrogen Cascade

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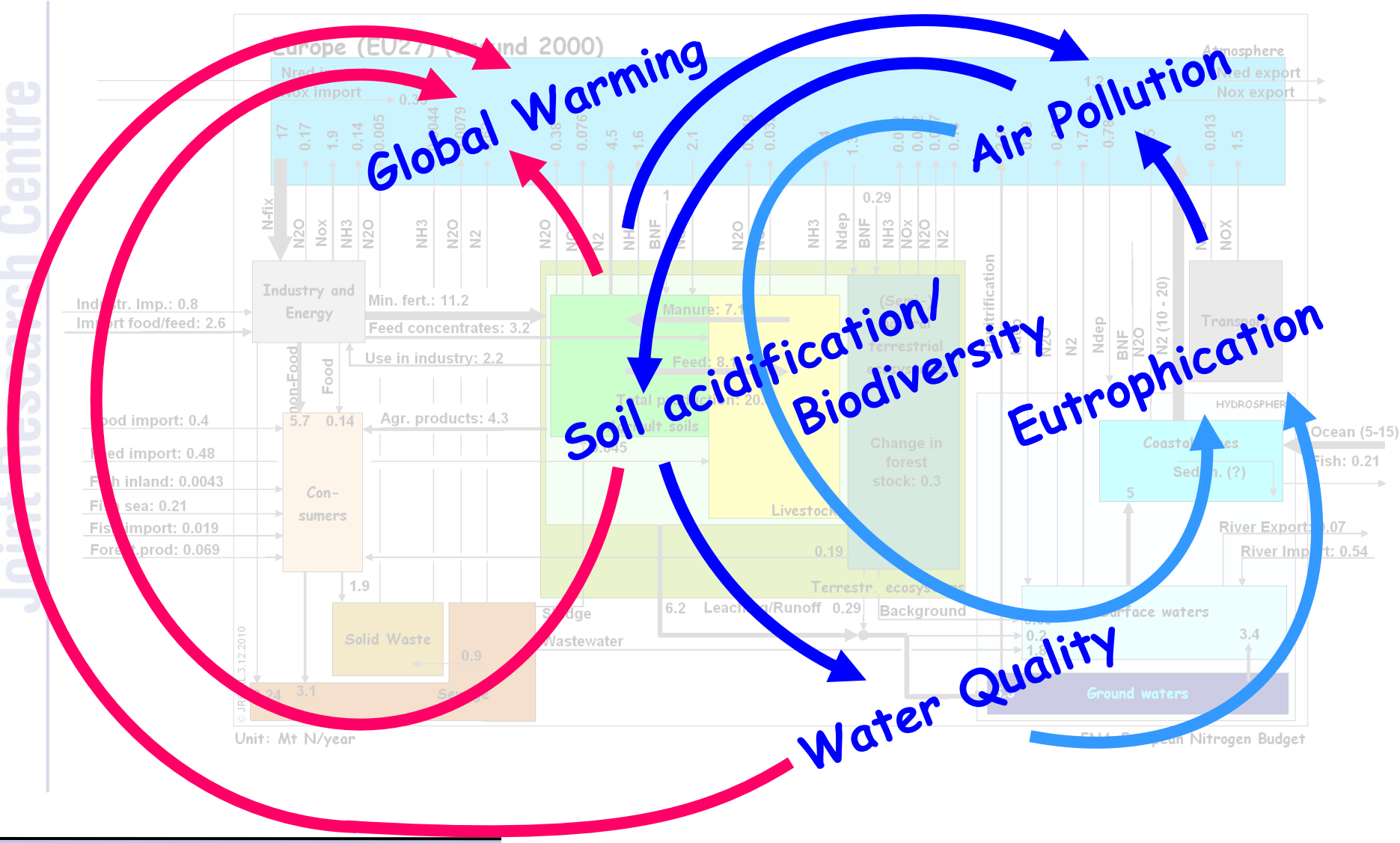

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Methods: mainly model-based estimates

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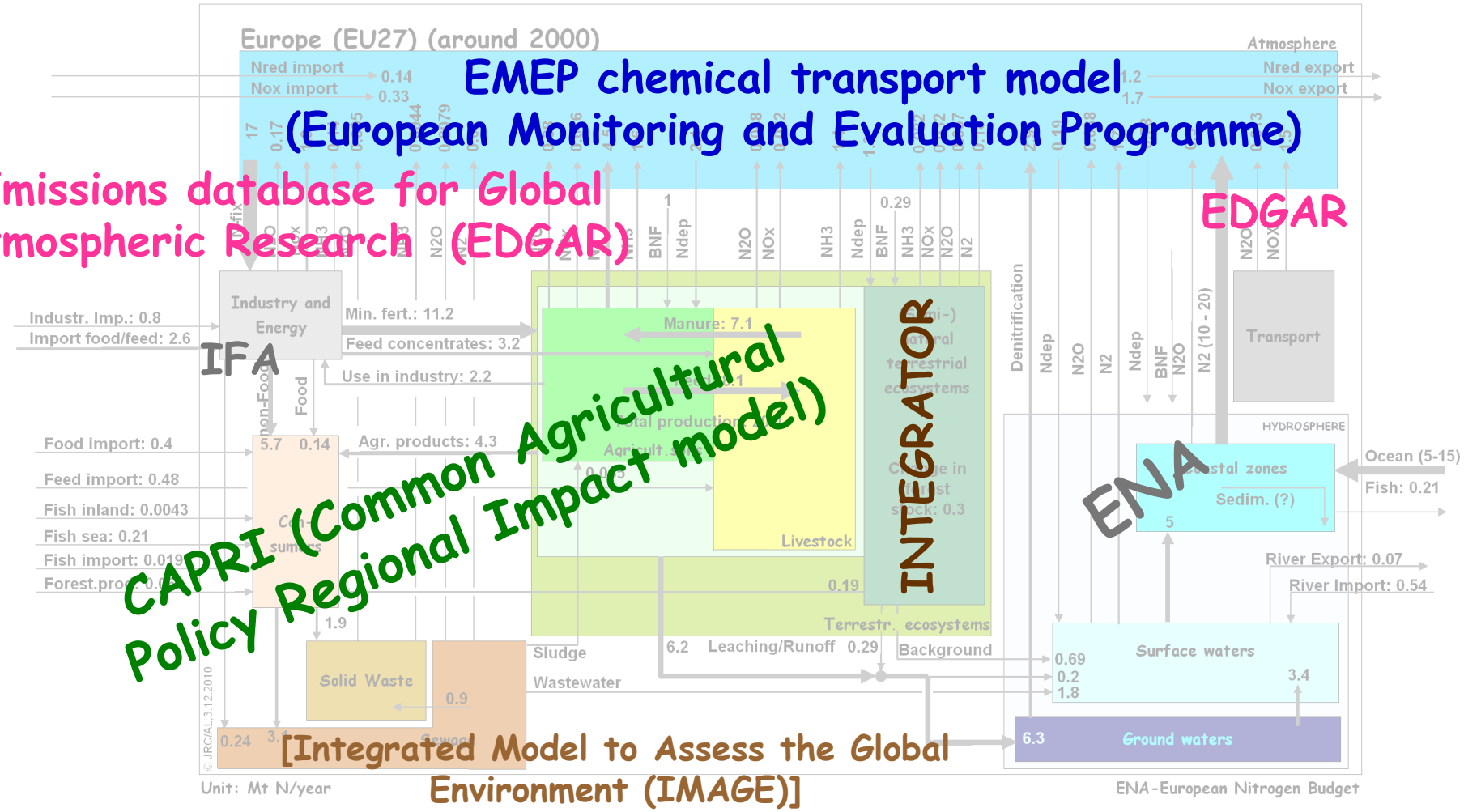

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Total human consumption

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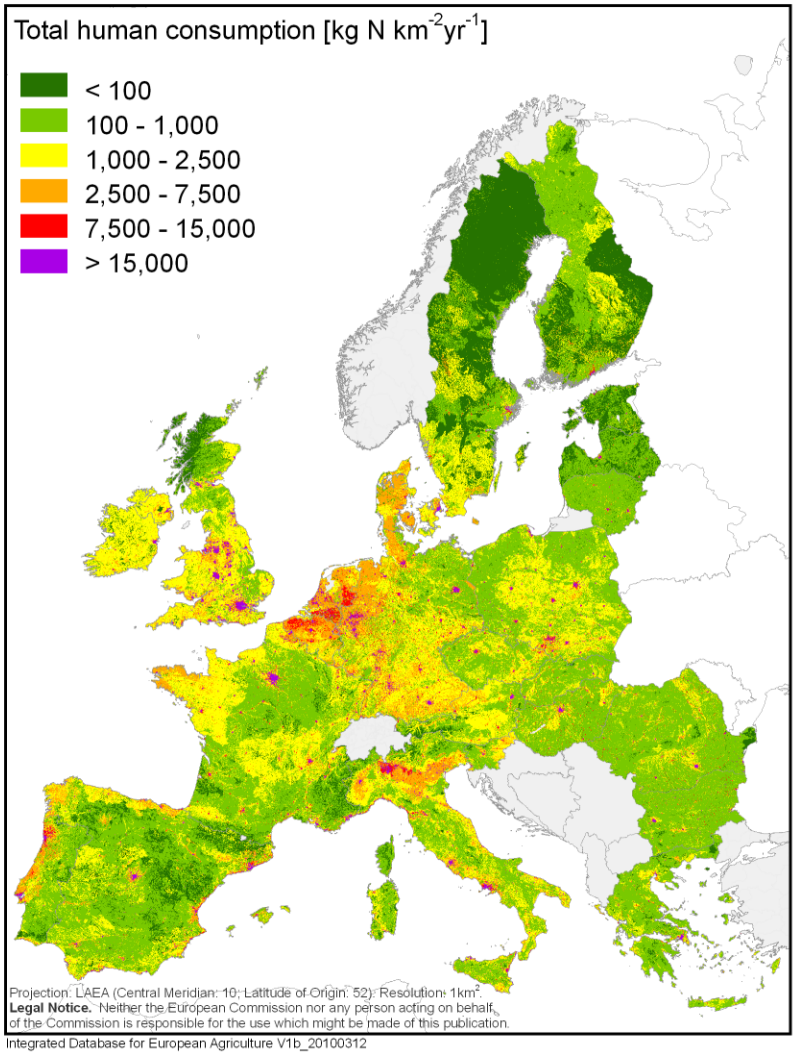
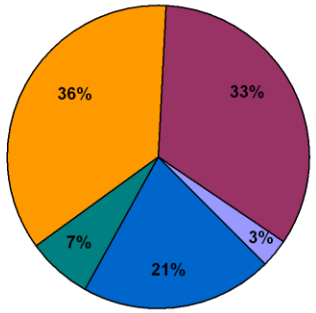


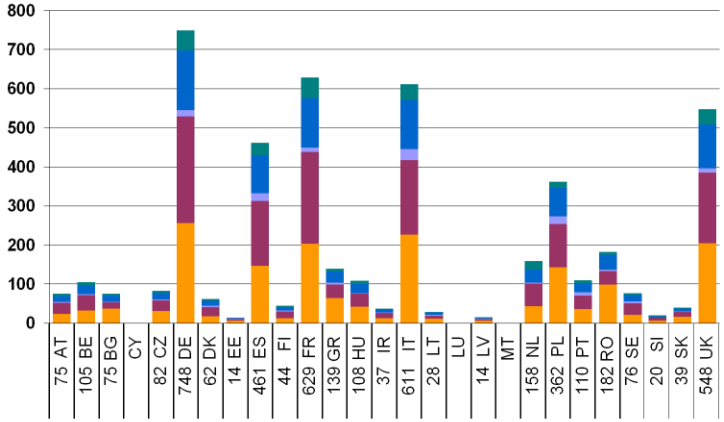
Integrated Database for European Agriculture V1b_20100312

Split of human N-consumption for EU27 [Gg N yr-1]

Crop products	1700
Animal products	1580
Fish products	150
Food waste	970
Non-edible	330
Total human	4730



Split of human N-consumption by country [Gg N yr-1]



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Total N2O emissions

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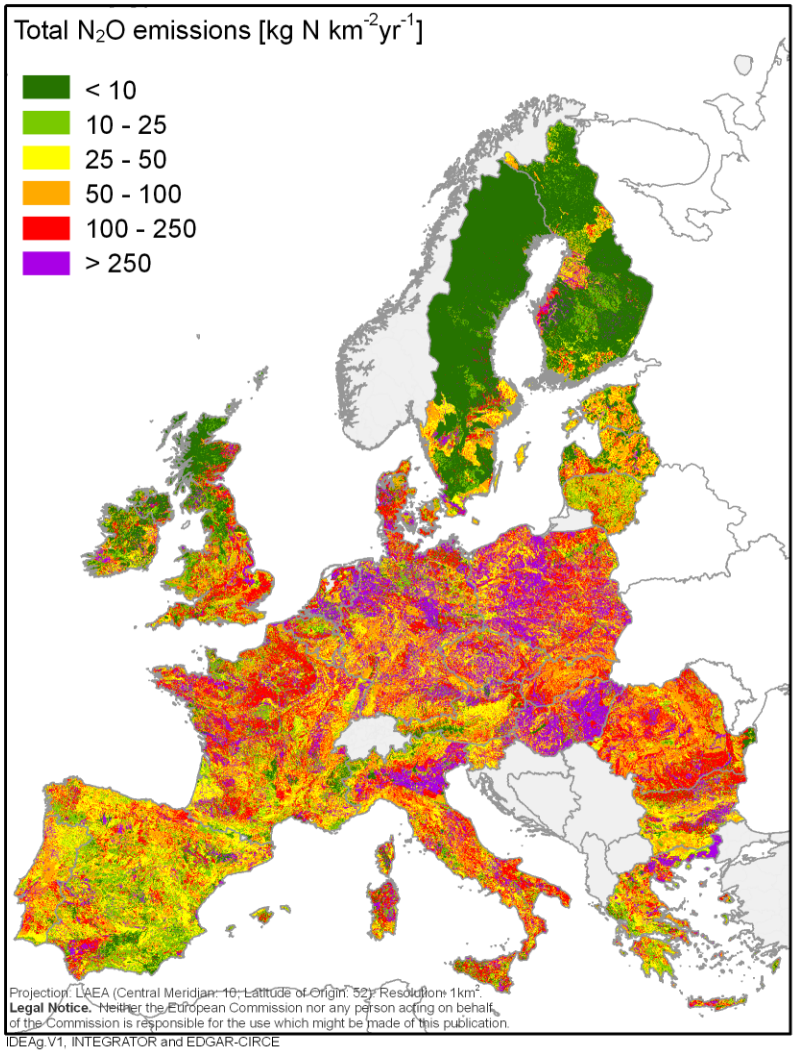
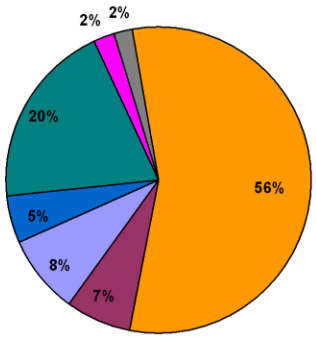
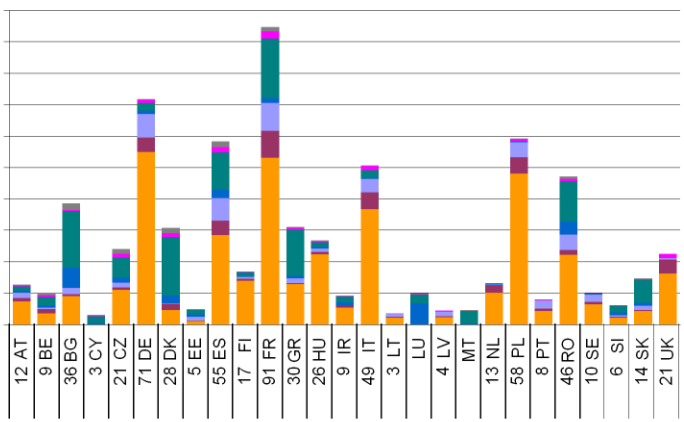


Split of total N_2O emissions for EU27 [Gg N yr^{-1}]

Agriculture - soils	380
Agriculture - manure	50
Forest soils	60
Energy	30
Industry	140
Waste	20
Transport	10
Total	690



Split of total N_2O emissions by country [Gg N yr^{-1}]



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Emission inventories

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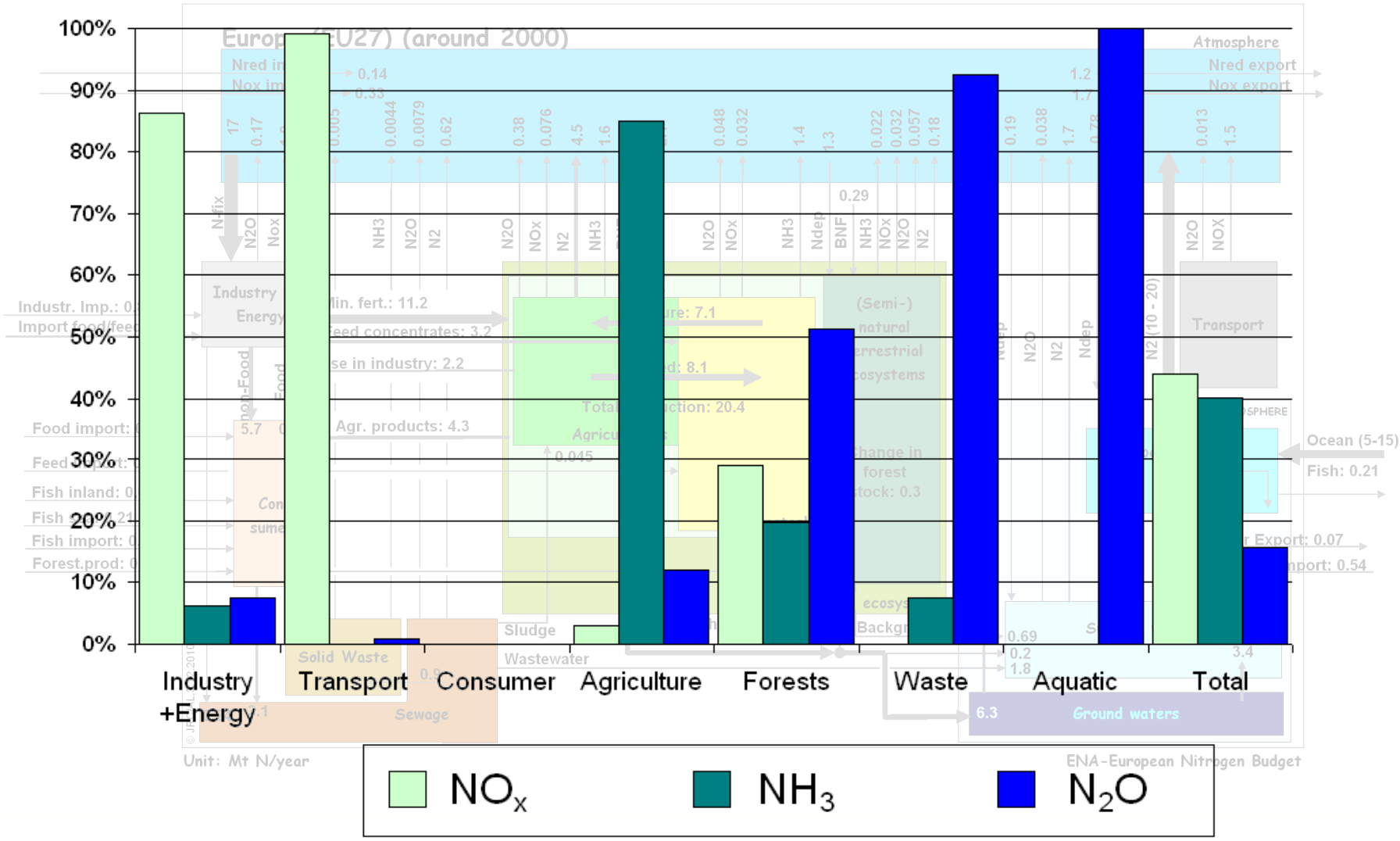

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Receiving medium of emissions

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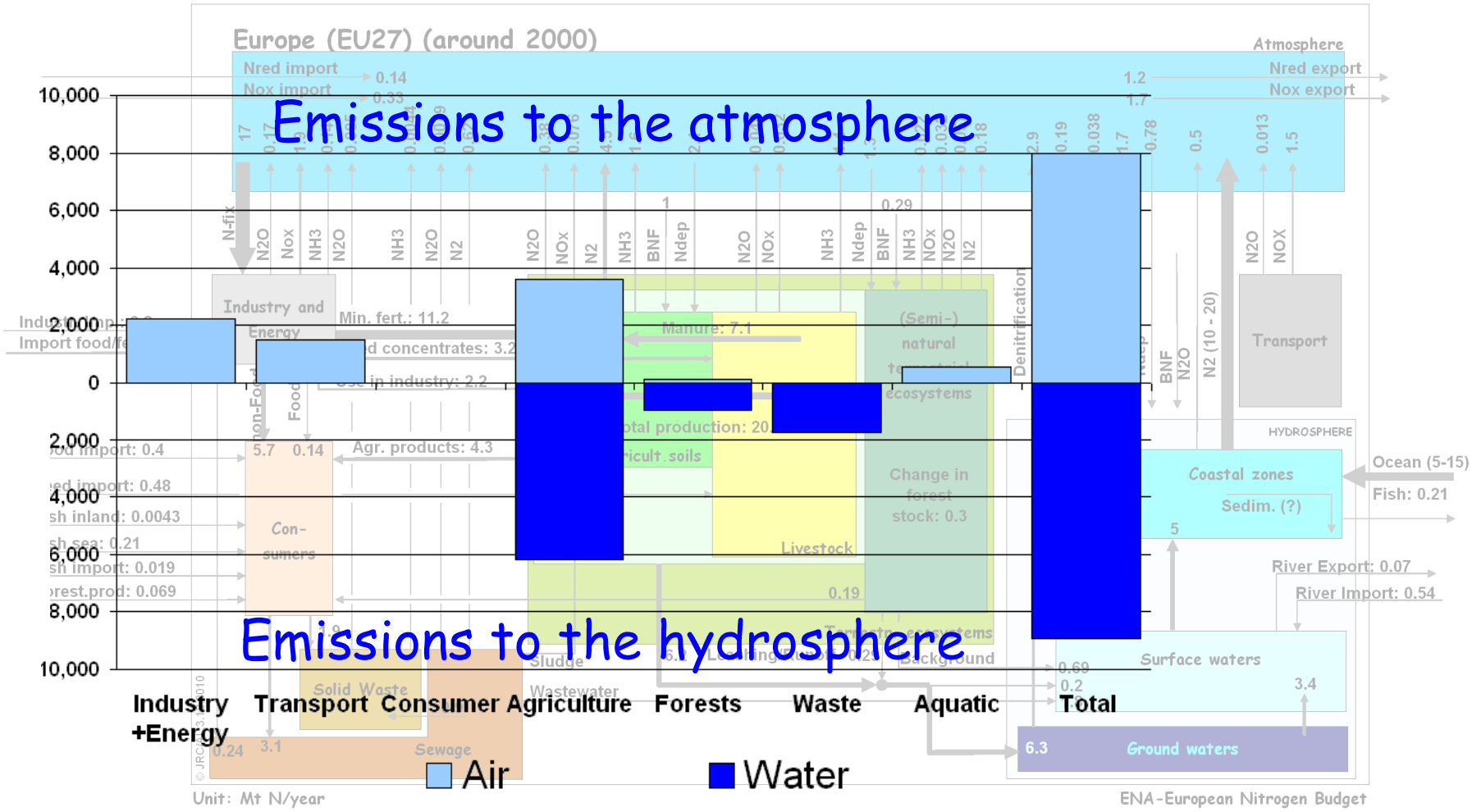
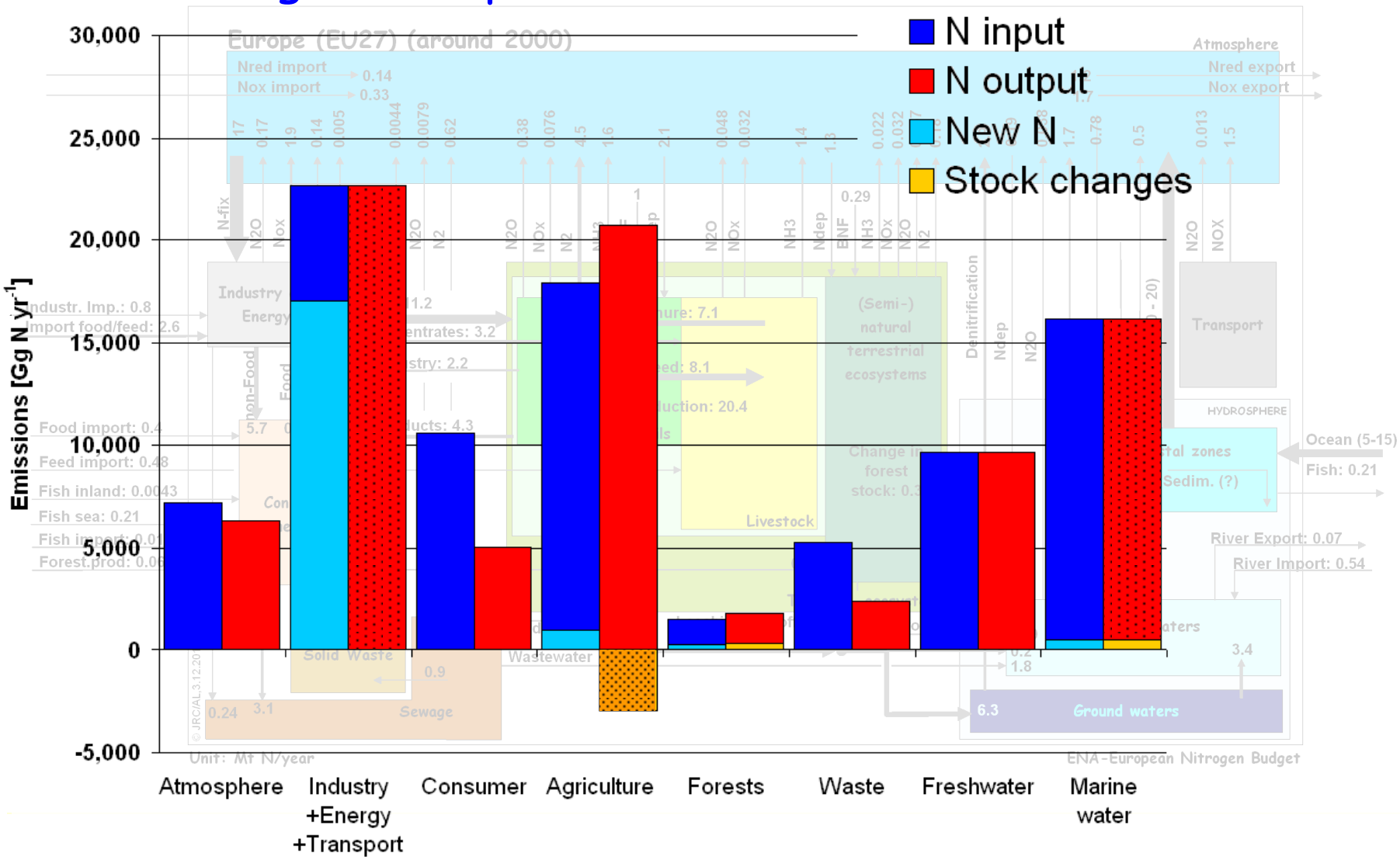


Data gaps

Sub-budgets for pools



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The ENB – highlighting important fluxes

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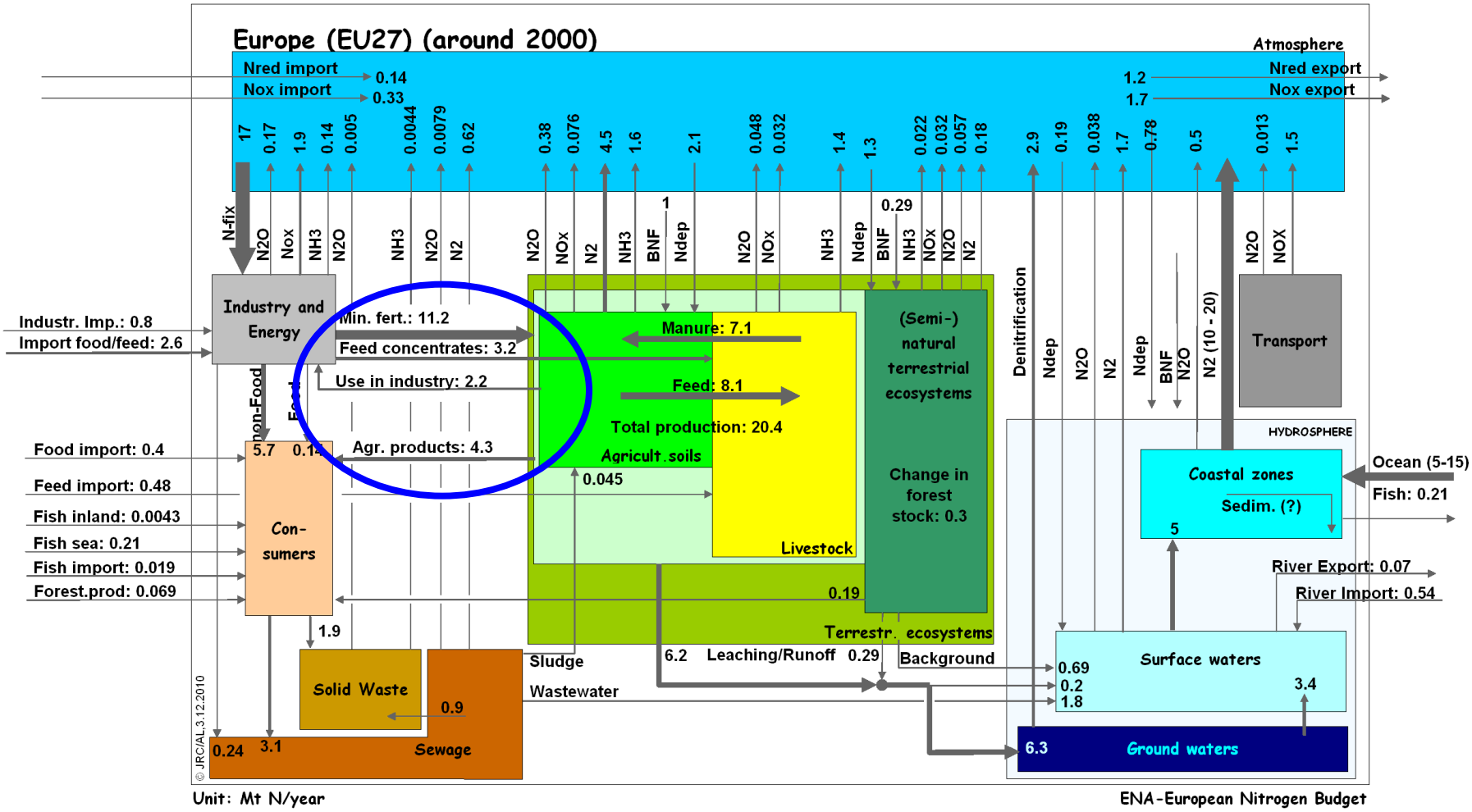

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Agriculture sector

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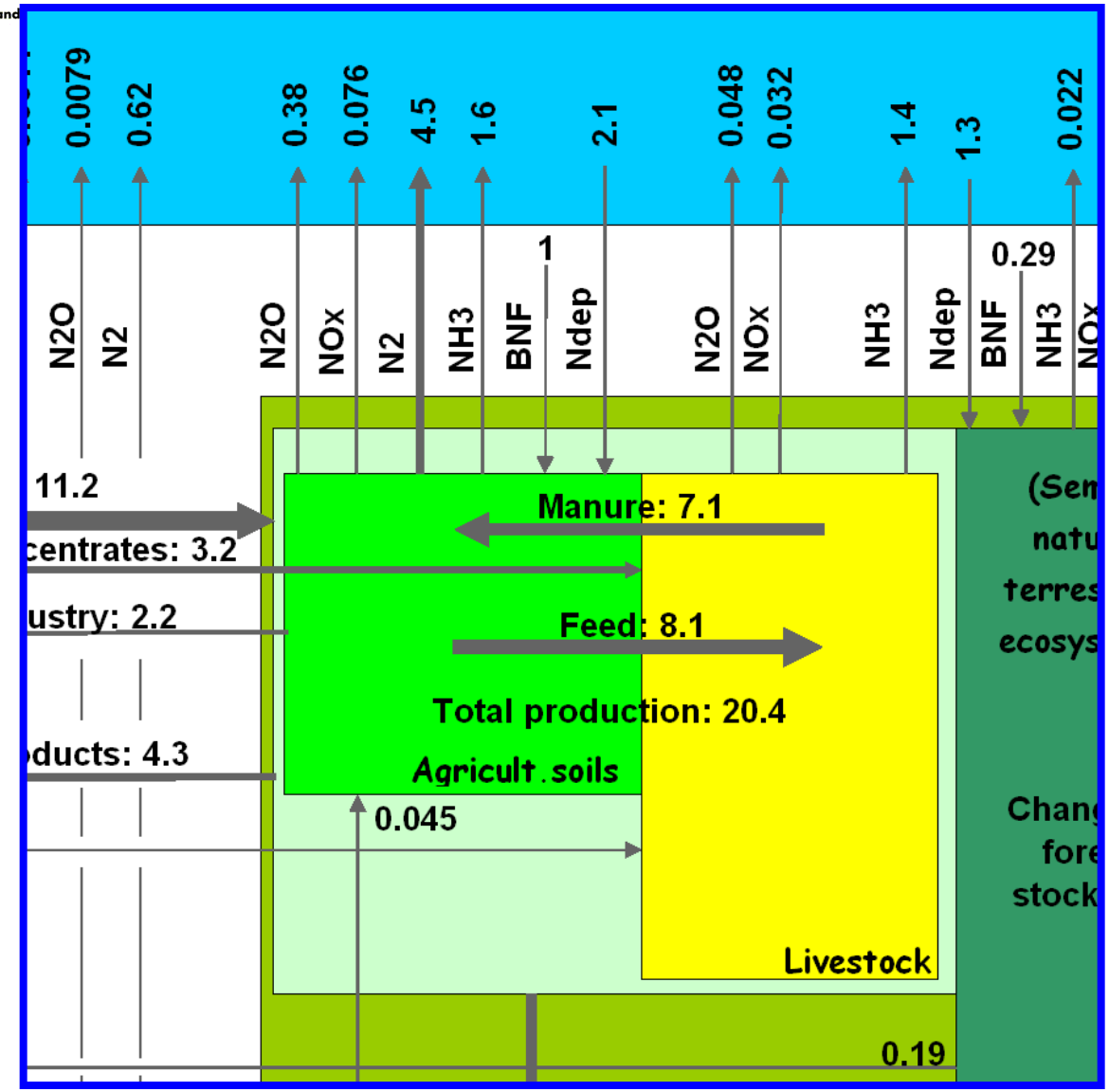

→ **Large fraction of nitrogen cycles between animal and crop-production systems**

→ **High losses**

→ **Driven by high rates of consumptions of animal products**

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Conclusion

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→ **Integrated Nitrogen Budgeting at large scale is very challenging and asssociated with high uncertainties**

→ **iNBs are useful vehicles to trigger debate across disciplines and identify problems in the interfaces**

→ **iNBs give a comprehensive overview of a country's or a region's nitrogen cascade …**

→ **… to raise awareness, to enable detailed assessments, to give decision support**

→ **"Expert Panel on Nitrogen Budgets" of the "Task Force on Reactive Nitrogen" will formulate precise recommendation for the construction of national integrated nitrogen budgets**

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National integrated Nitrogen Budgets (NiNBs)

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→ **Available so far by six countries**

→ **Compiled by national experts**

→ **see Poster 165**

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National integrated nitrogen budgets in Europe

Adrian Leip[1], Nevečeřal Rostislav[2], Pavel Čermák[3], Anne-Christine LeGall[4], Markus Geupel[5], Till Spranger[6], Albert Bleeker[7], Beat Achermann[8], Jürg Heldstab[9], Penny Johnes[10], Ulli Dragosits[11], Dave Fernall[12], Mark Sutton[11]

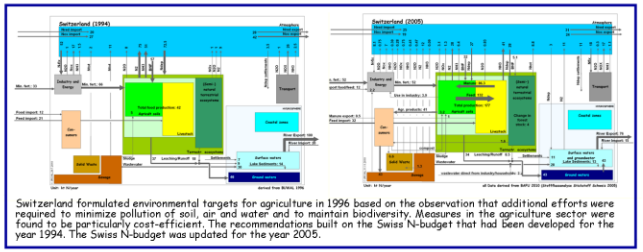
Abstract

Integrated nitrogen budgets are defined here as the quantification of all major nitrogen fluxes across sectors and media on an annual basis within given boundaries. In the case of National integrated Nitrogen Budgets (NiNBs), these boundaries are the borders of a country. Considered nitrogen fluxes include those that enter of leave the country. National integrated nitrogen budgets (NiNBs) are an efficient policy instrument. In particular, NiNBs can serve five objectives:

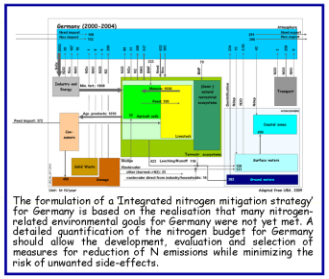
(i) NiNBs are an efficient instrument for visualizing the N cascade and its potential impact.
(ii) NiNBs provide policy makers with information for developing efficient emission reduction measures and instruments;
(iii) NiNBs constructed for different points in time can provide an efficient tool for monitoring the impact and environmental integrity of implemented policies. They can be used to check whether regulations are taking effect or should be reinforced.
(iv) NiNBs are useful for comparisons across countries and with modelling approaches.
(v) NiNBs can help pinpoint to knowledge gaps and thus contribute to improving our scientific understanding of the N cascade.

Methodology

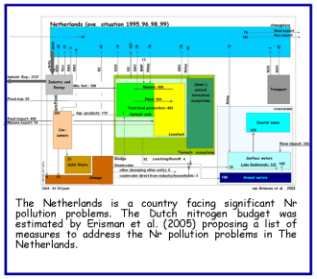
In the frame of the European Nitrogen Assessment we have compiled and compared the six available NiNBs for European countries. Each of these NiNBs focuses on the major N fluxes relevant for the specific conditions in the countries using best available data for each sector. Therefore, the N-balances are not necessarily closed. For three countries (Switzerland, the Netherland, and Germany), iNBs had already helped developing effective policy measures, while another three countries (United Kindom, the Czech Republic and France) constructed NiNBs recently.



Switzerland formulated environmental targets for agriculture in 1996 based on the observation that additional efforts were required to minimize pollution of soil, air and water and to maintain biodiversity. Measures in the agriculture sector were found to be particularly cost-efficient. The recommendations built on the Swiss N-budget that had been developed for the year 1994. The Swiss N-budget was updated for the year 2005.



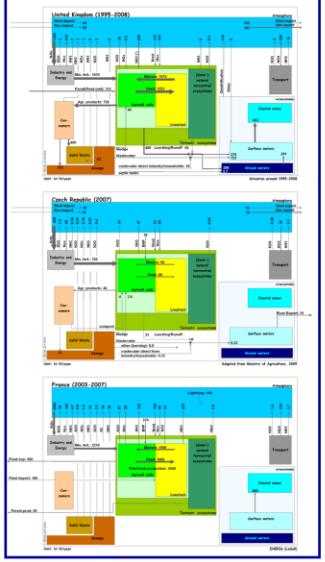
The formulation of a 'Integrated nitrogen mitigation strategy' for Germany is based on the realisation that many nitrogen-related environmental goals for Germany were not yet met. A detailed quantification of the nitrogen budget for Germany should allow the development, evaluation and selection of measures for reduction of N emissions while minimizing the risk of unwanted side-effects.



The Netherlands is a country facing significant Nr pollution problems. The Dutch nitrogen budget was estimated by Erisman et al. (2005) proposing a list of measures to address the Nr pollution problems in The Netherlands.

Previously, partial UK nitrogen budgets have been constructed separately for, e.g., atmospheric Nr (import, emission, deposition, export), surface waters, waste water, agricultural food and feed production import and export of materials. The NiNB brings together these elements for the first time, to create a complete nitrogen budget for the UK.

The Czech Republic and France have launched projects to estimate all N-fluxes following the German example with the aim of developing a global vision of the nitrogen cascade between economic sectors and environmental compartments. To that aim, pluridisciplinary group of experts on nitrogen questions from various research institutes and agencies and Ministries have been established.



Conclusions

- Agriculture is best-quantified, link to other sectors not yet established in all NiNBs
- Largest flux: N-fixation in the industry&energy sector
- Generally, agriculture is the main emitter of Nr to the atmosphere and to the hydrosphere; in the UK energy&industry emissions play the biggest role
- NH_3 in most country the dominating emissions to the atmosphere (ca. 50% of total Nr emissions) ; in UK and the Czech Republic NO_x about 60%
- Main gap between the sum of Nr emissions to and removals from the atmosphere is due to fluxes of molecular nitrogen (N2) through denitrification
- Emissions to hydrosphere 18-52% of total quantified Nr emissions

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