

CAPRI/DNDC-EUROPE

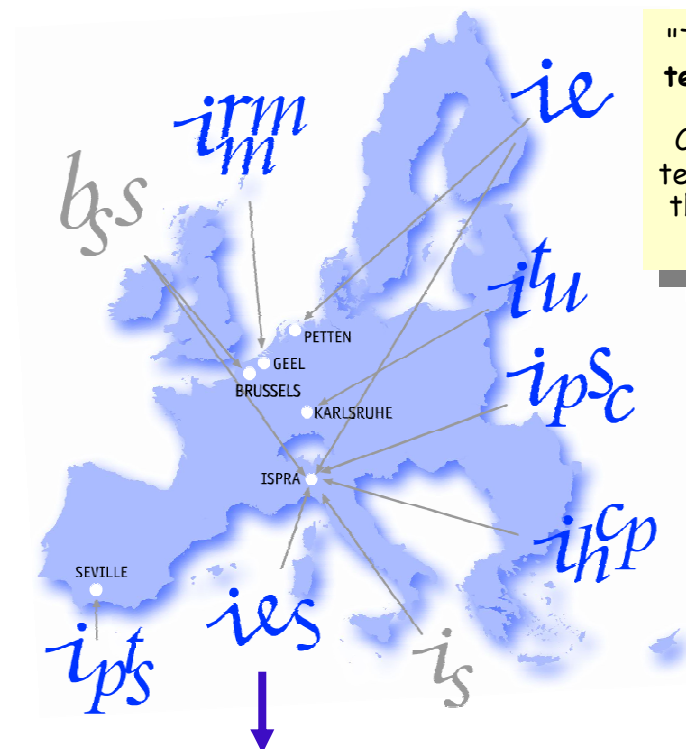
linking a process-based model with an
agro-economic framework

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The Climate Change Unit of the European Commission's Joint Research Centre

Joint Research Centre



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Global Air Pollution and Climate Change
Greenhouse Gases in Agriculture, Forestry and other Land Uses
Integrated Climate Policy Assessment: Emissions and Environmental Impacts

Institute for Environment and Sustainability
Climate Change Unit
Global Environment Monitoring Unit
Transport and Air Quality Unit
Rural, Water and Ecosystem Resources Unit
Spatial Data Infrastructures Unit
Land Management and Natural Hazards Unit

Activities related to agriculture

- Quality assessment of national GHG inventories
- Bottom-up modelling of GHG emissions from agricultural soils using biophysical models
- Scientific support on various topics related to emissions from agricultural soils (biofuels, livestock, cross-compliance, climate change/air pollution, nitrogen assessment, ...)

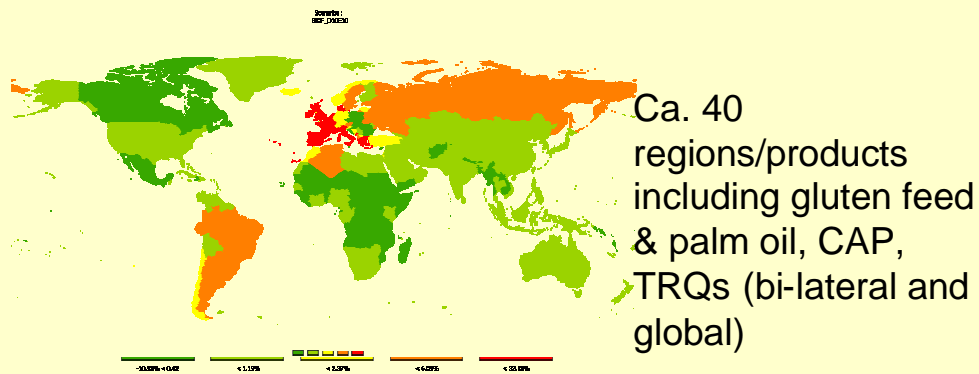
The CAPRI/DNDC-EUROPE framework: Motivation

- **Agricultural impact on the environment cannot be assessed without a socio-economic framework**
- **Many environmental effects are highly complex and non-linear with respect to anthropogenic drivers**
 - **Variability in time and space**
 - **Targeted measures at farm level require detailed assessment**
 - **Synergetic/antagonistic effects require integrated assessment**
- **Agricultural impact on the environment cannot be assessed without (some) mechanistic understanding**



CAPRI – Common Agricultural Policy Regional Impact Assessment

Global spatial (Armington) Multi-Commodity Model

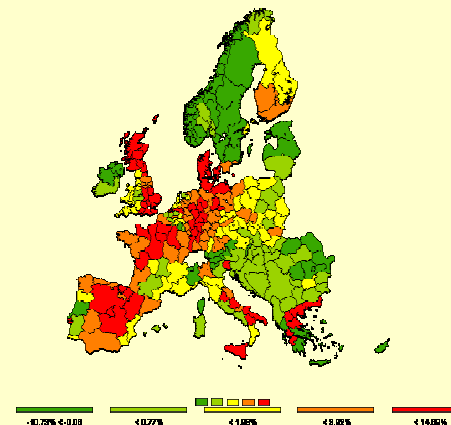


Economic model – production, demand, trade and prices are interacting and simulated simultaneously

Two interlinked modules:

- A globally closed model for production, demand and trade in primary and secondary agricultural products, including oils and cakes
- NUTS II simulation models for EU27 which capture in detail farming decisions (crop shares, animal herds, yields, fertilizer use ..)

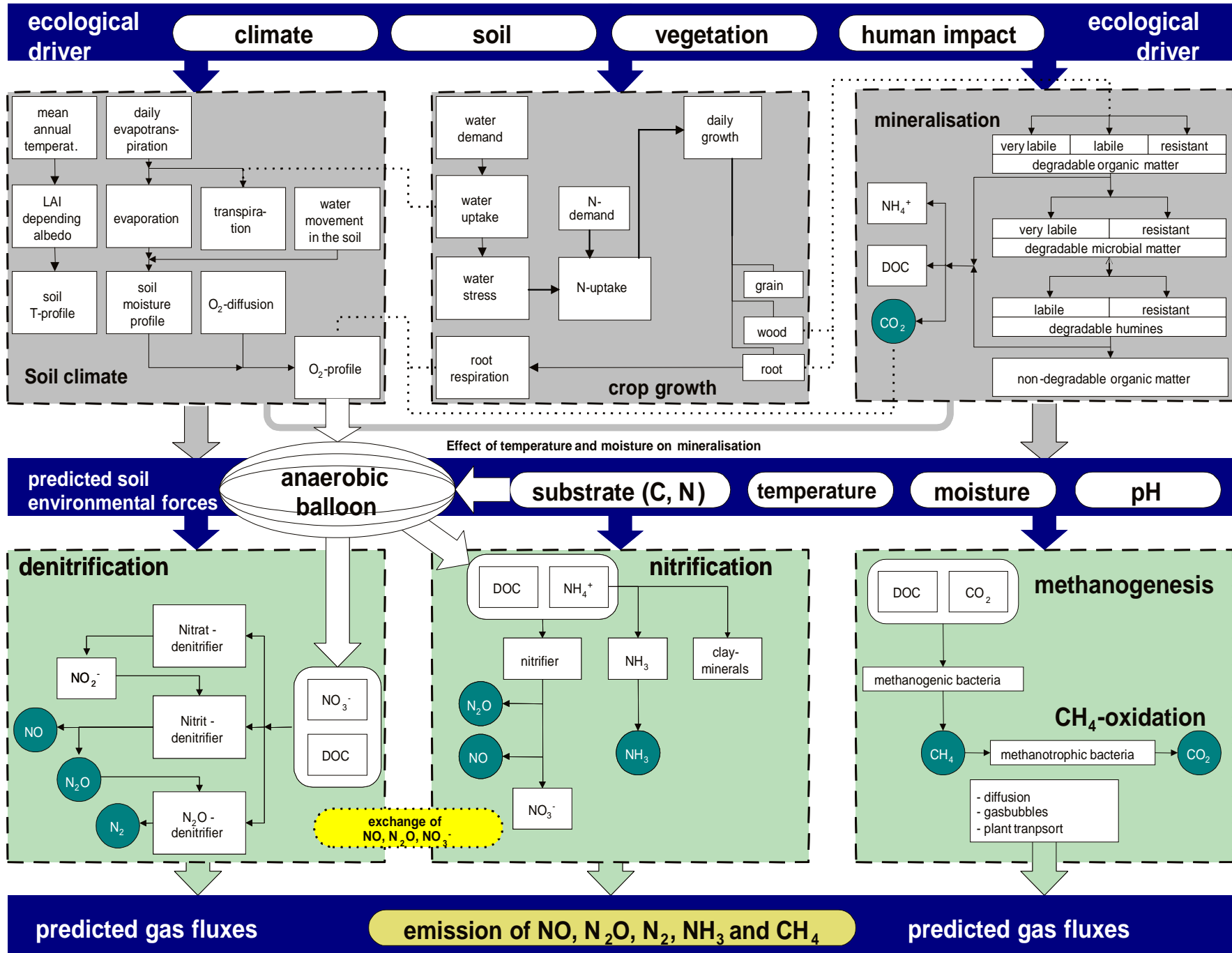
Regional aggregate programming models



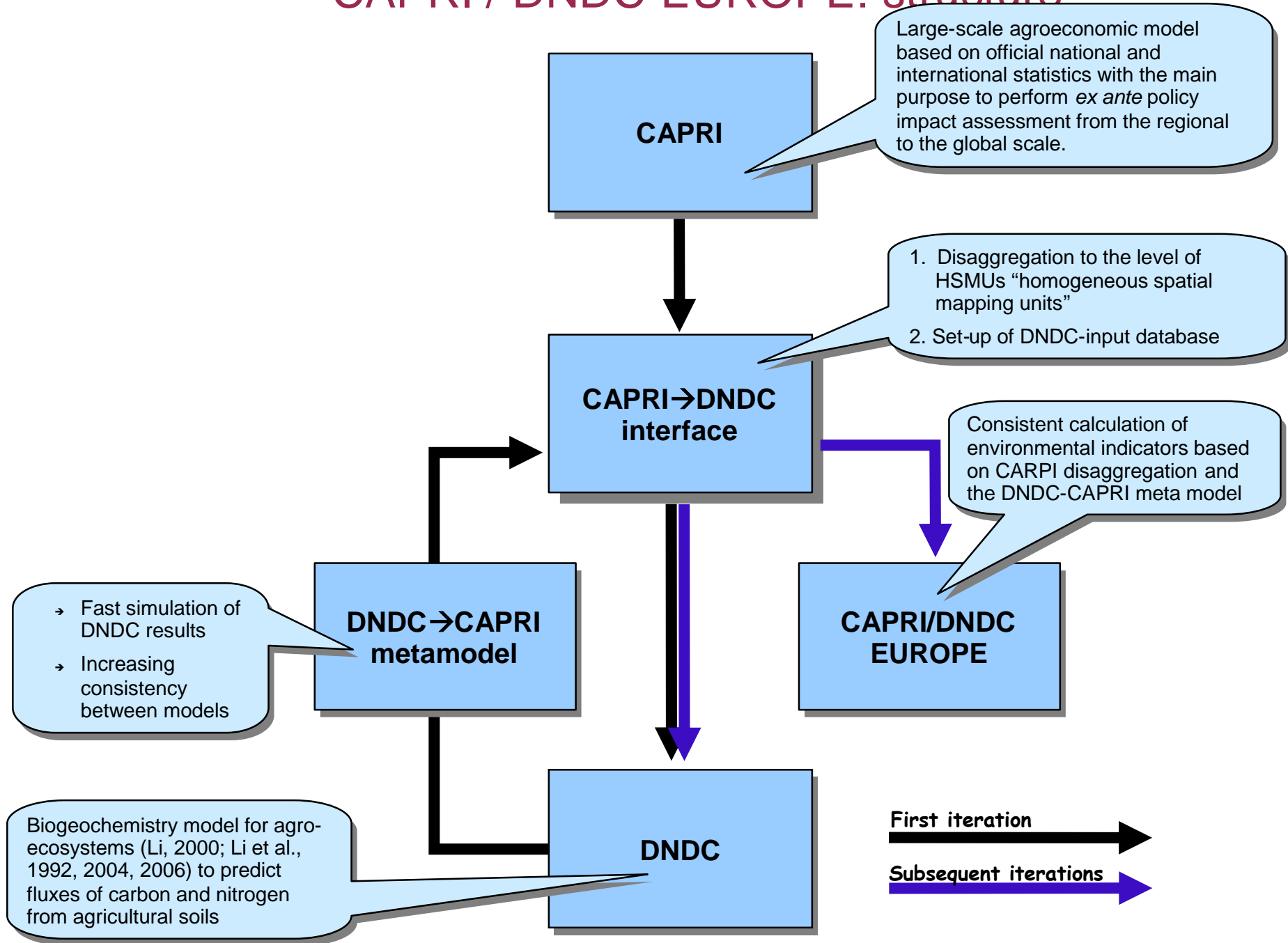
250 regions for EU27+Norway +Western Balkans, endogenous yields, detailed input coefficients, CAP policy

Indicators calculators

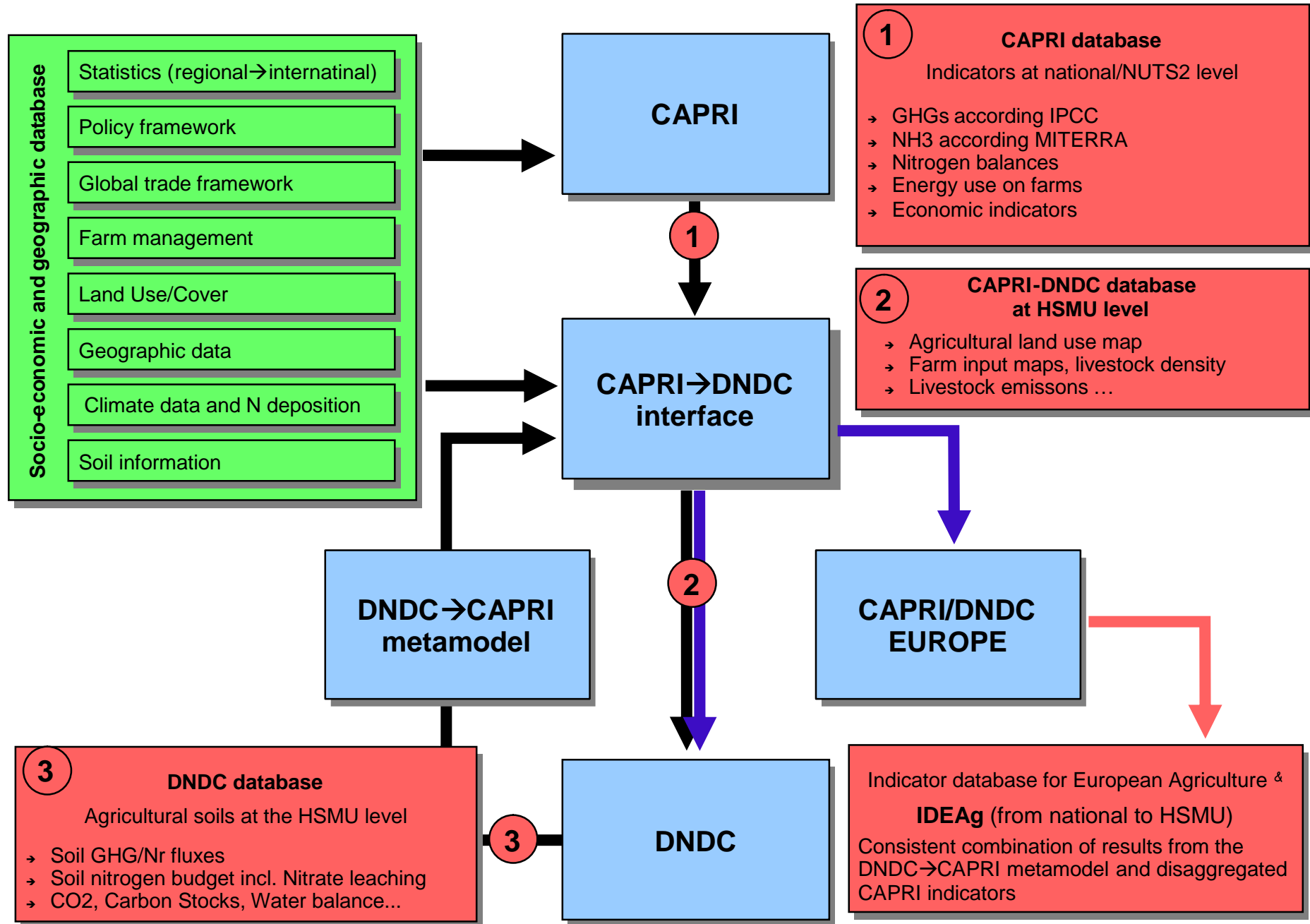
GHG budget according IPCC
Nitrogen balances from GAINS/MITERRA
LCA energy use in agriculture



CAPRI / DNDC-EUROPE: structure



CAPRI / DNDC-EUROPE: databases



& Name provisional

1. Methodological aspects - selection

2. Applications - selection

3. Conclusions ...

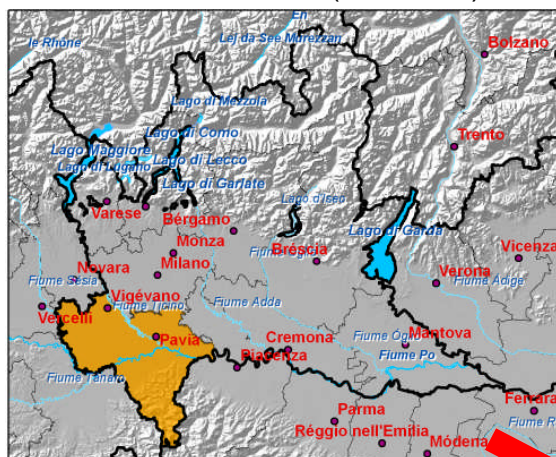
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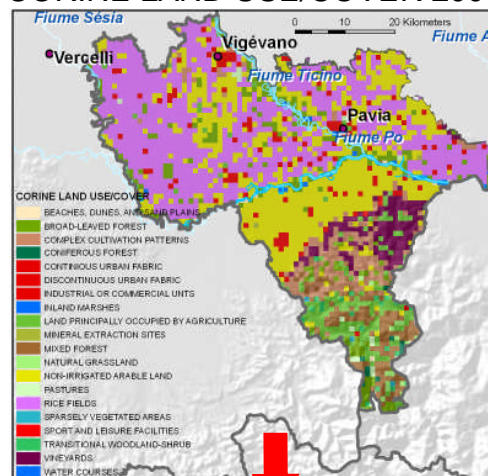
3. Conclusions ...

Calculation Units: HSMU's "Homogeneous Spatial Mapping Units"

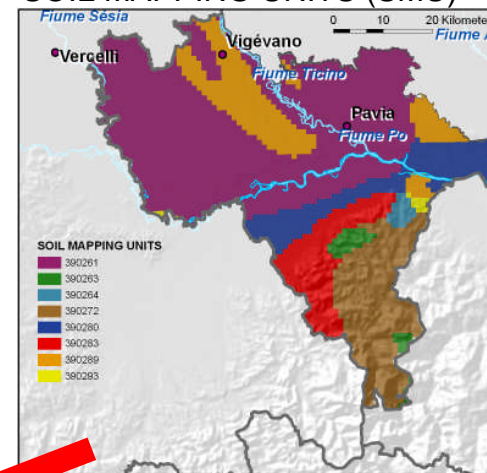
FSS NUTS REGIONS (NUTS2/3)



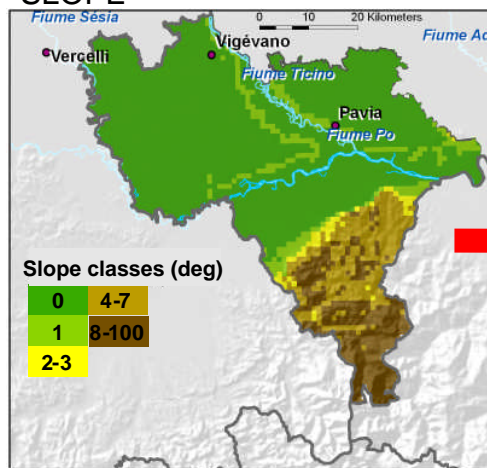
CORINE LAND USE/COVER 2000



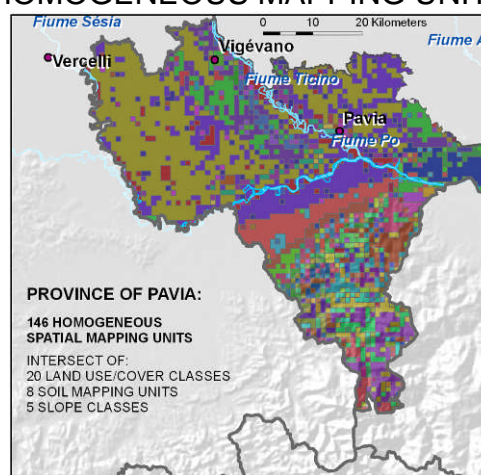
SOIL MAPPING UNITS (SMU)



SLOPE

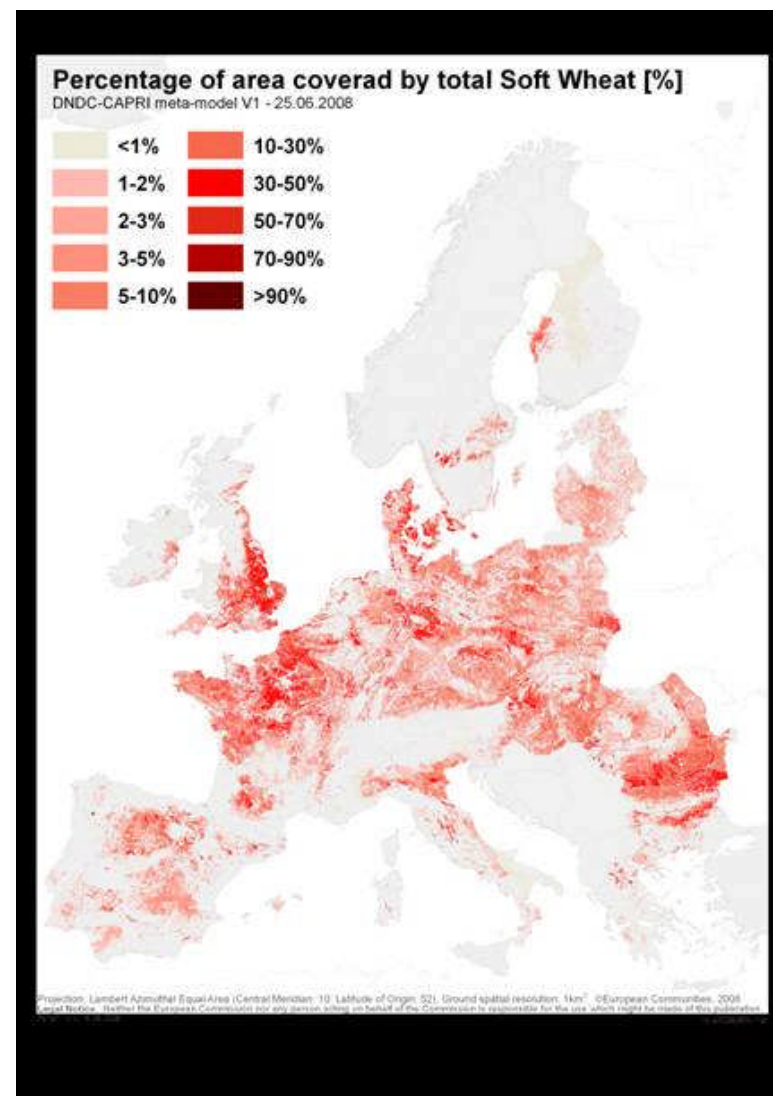
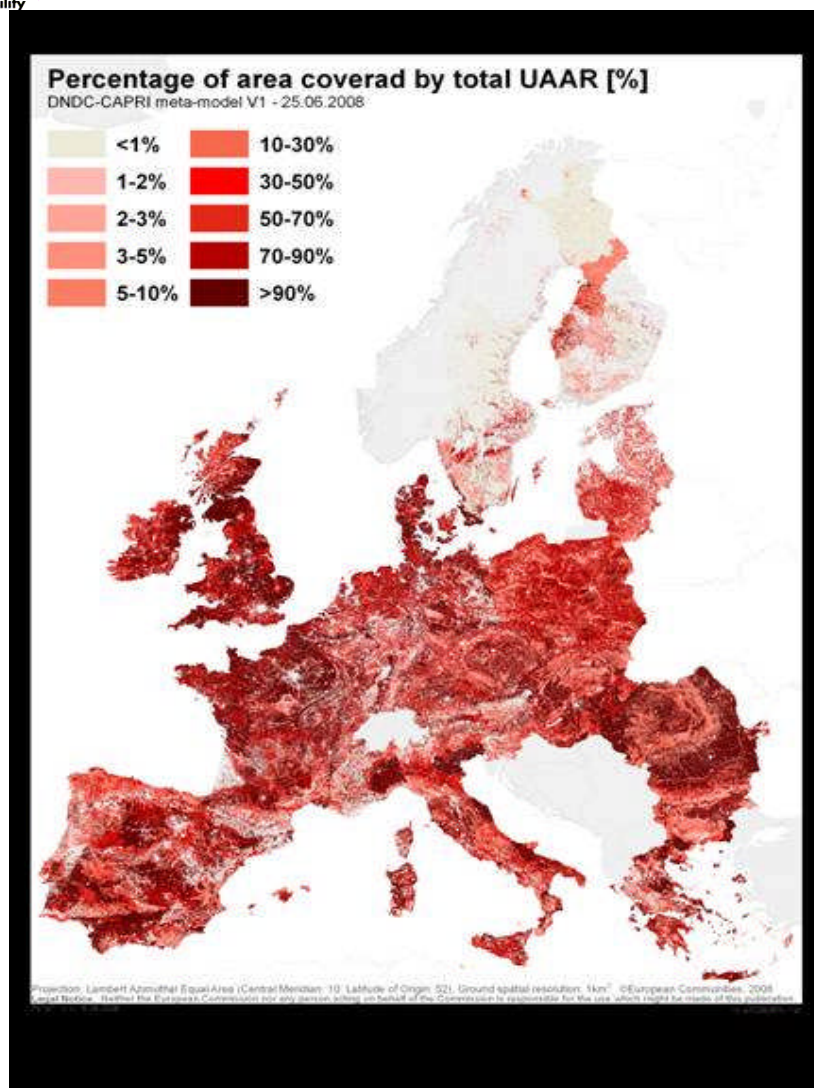


HOMOGENEOUS MAPPING UNITS

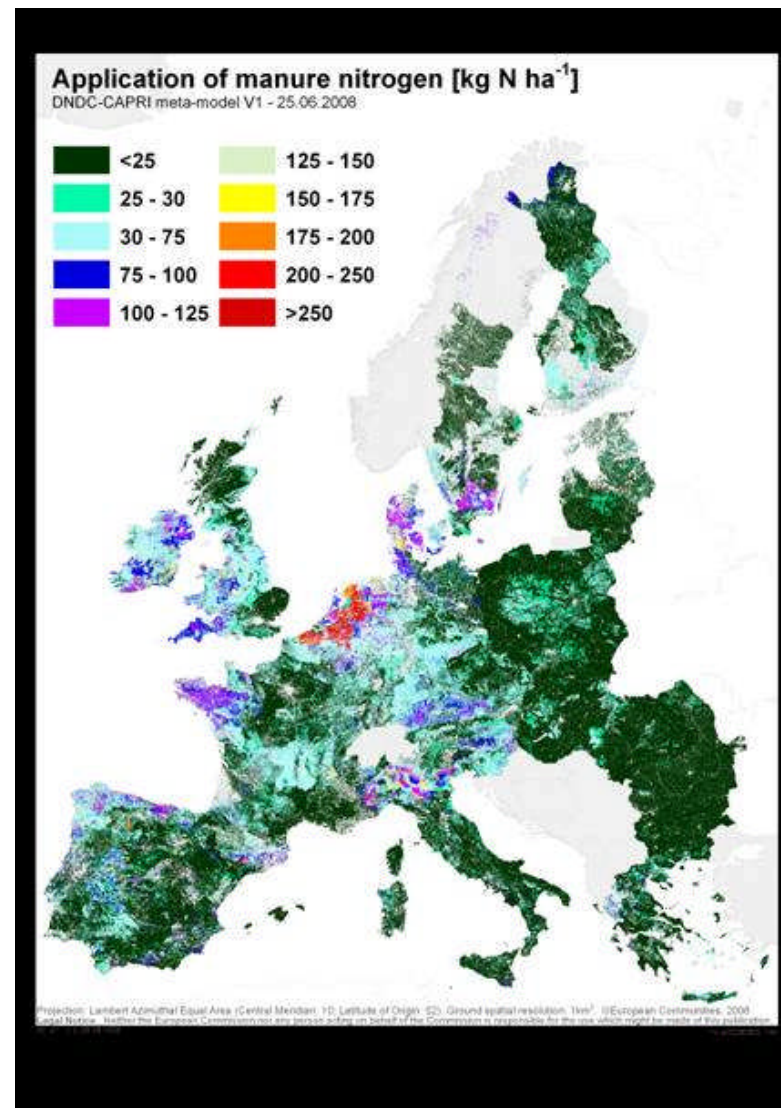
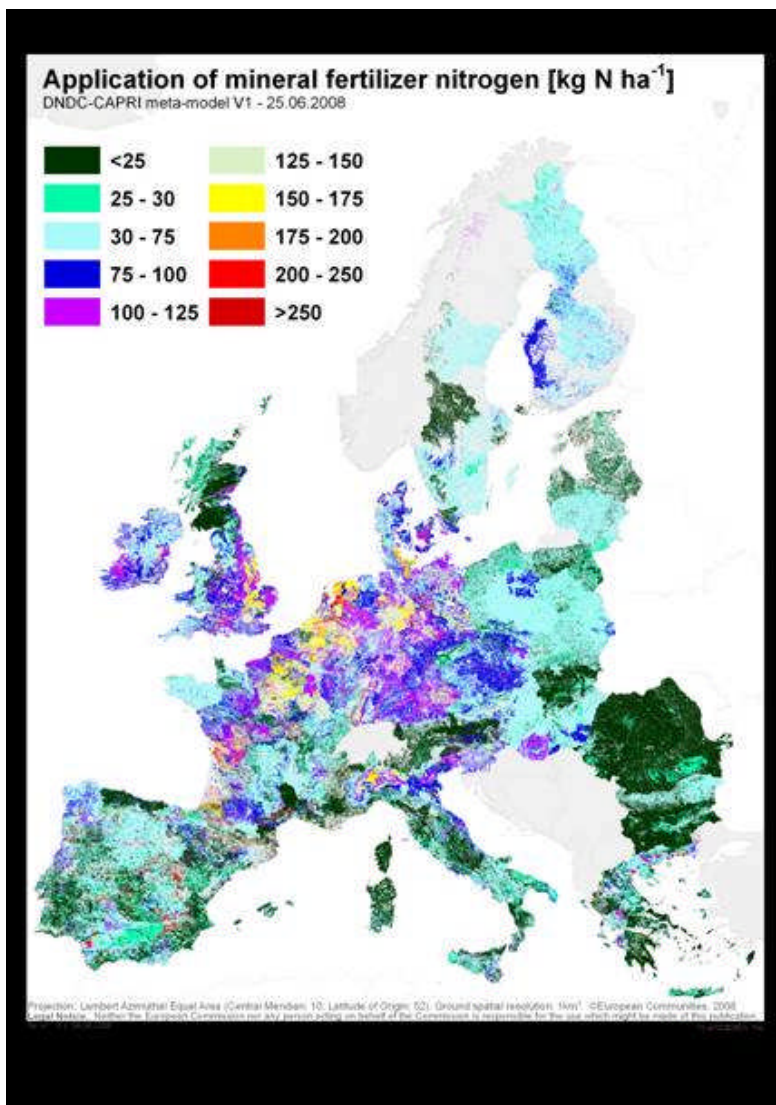


Pixel resolution: 1km by 1km
Spatial Extent: EU27
Total about 200 000 HMSUs

For each Spatial Unit: Agricultural Land Use Maps (29 crops) ...



... mineral fertilizer and manure N application by crop ...

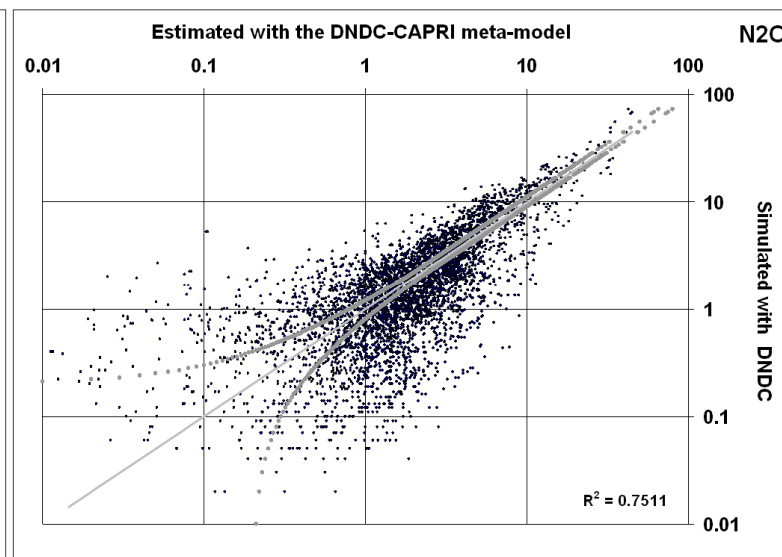
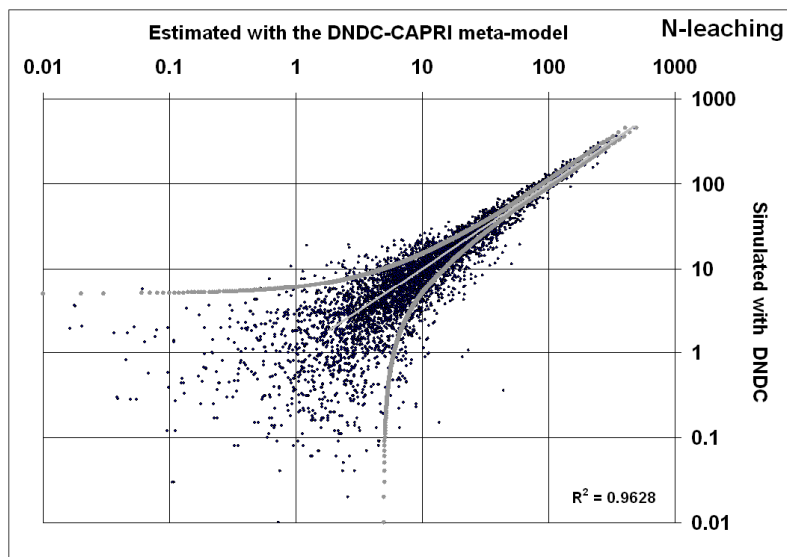


DNDC-CAPRI metamodel



rch Centre

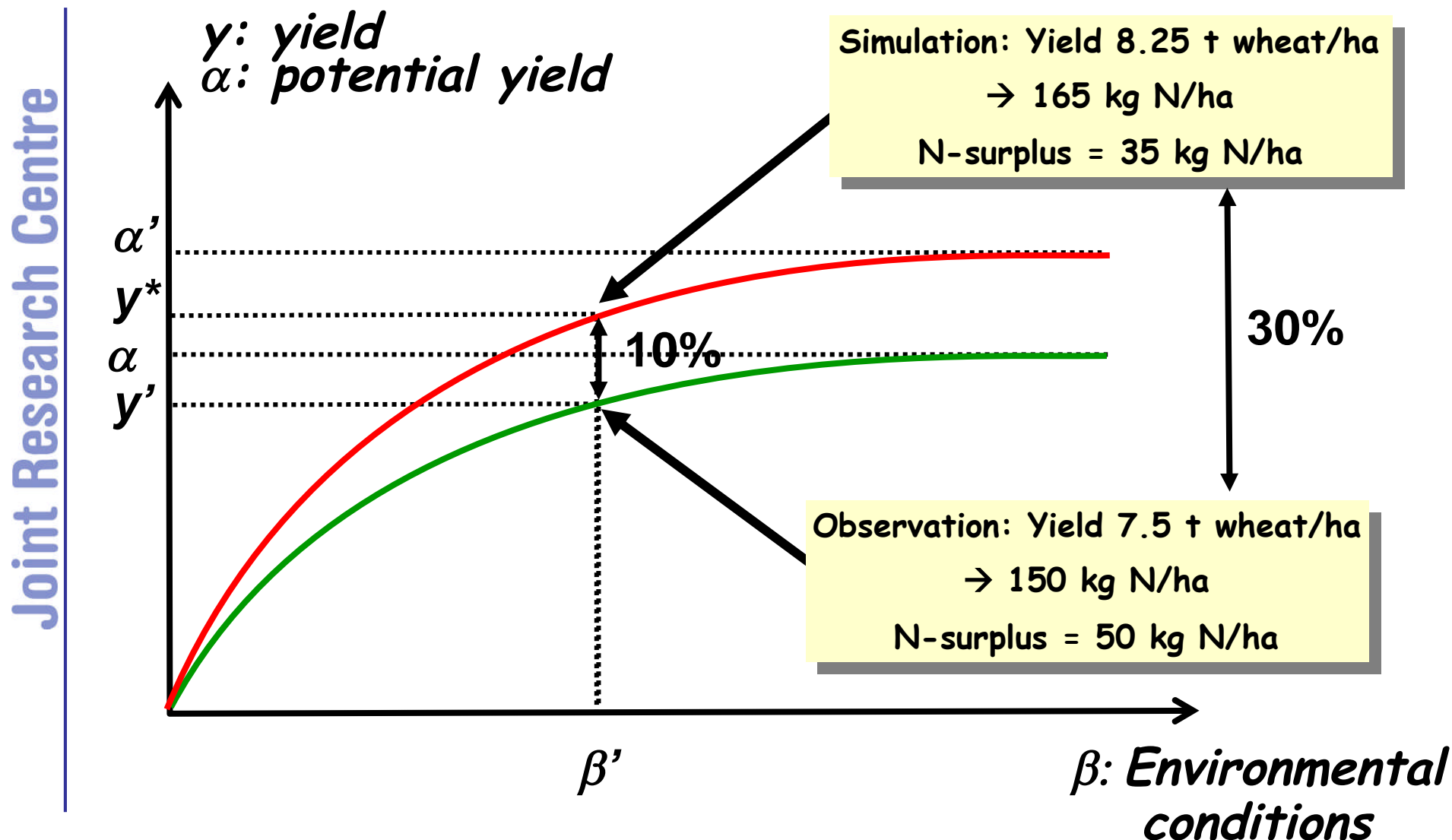
R²



		N- Leaching	N- Mineraliz.	N ₂	N ₂ O	NH ₃	NO	N- denitrific.	N surplus
BARL	noIrr	0.977	0.997	0.963	0.787	0.982	0.940	0.955	0.997
	Irr	0.964	0.999	0.972	0.882	0.991	0.969	0.957	0.999
MAIZ	noIrr	0.914	0.993	0.792	0.830	0.983	0.946	0.846	0.990
	Irr	0.877	0.997	0.772	0.888	0.983	0.961	0.884	0.990
POTA	noIrr	0.923	0.997	0.932	0.867	0.984	0.964	0.928	0.989
	Irr	0.911	0.998	0.937	0.915	0.984	0.969	0.941	0.989
SUGB	noIrr	0.929	0.992	0.932	0.932	0.988	0.967	0.944	0.991
	Irr	0.899	0.991	0.909	0.924	0.991	0.976	0.932	0.990

Nitrogen losses for the cultivation of wheat.

Metamodel: For nitrogen indicators it is important that nitrogen input matches (expected) nitrogen yield and nitrogen surplus **for each spatial unit and crop**



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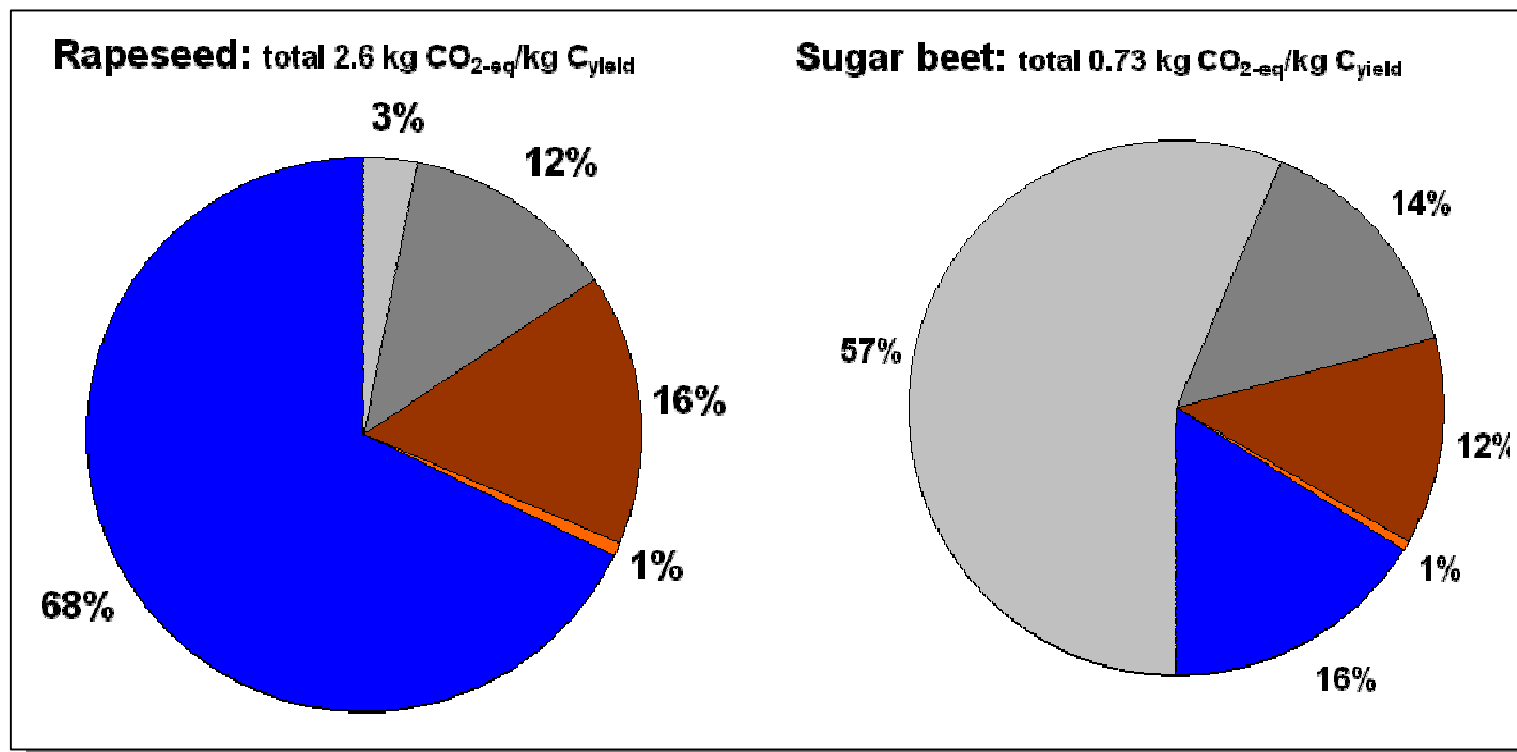
3. Conclusions ...

- **Assessment of European Carbon balance (CarboEurope IP) – www.carboeurope.org**
- **The nitrogen cycle and its influence on the European greenhouse gas balance (NitroEurope-IP) – www.nitroeuropa.eu**
- **Cross Compliance Assessment Tool (CCAT) www.ccat.wur.nl/UK/**
- **European Consortium for Modelling of Air Pollution and Climate Strategies (EC4MACS) - www.ec4macs.eu**
- **Climate Change – Terrestrial Adaptation & Mitigation in Europe (CC-TAME) - www.cctame.eu**
- **Evaluation of the livestock sector's contribution to the EUs GHG emissions, (GGLES)**
- **European Nitrogen Assessment <http://www.nine-esf.org/?q=node/206>**
- **Thematic Programme Biofuels**



Elements of GHG balance of biofuels

- + Avoided CO₂ emissions from fuel burning
- + Avoided CO₂ energy input fossil fuel
- Energy input processing
- + Credits from by-products
- N₂O emissions
- Fertiliser production - N₂O
- Fertiliser production - energy
- Energy input farming
- Carbon losses from arable fields
- + Enhanced Carbon sink



PRELIMINARY DATA

Marginal N-fluxes for rapeseed DNDC→CAPRI meta-model V1 ...

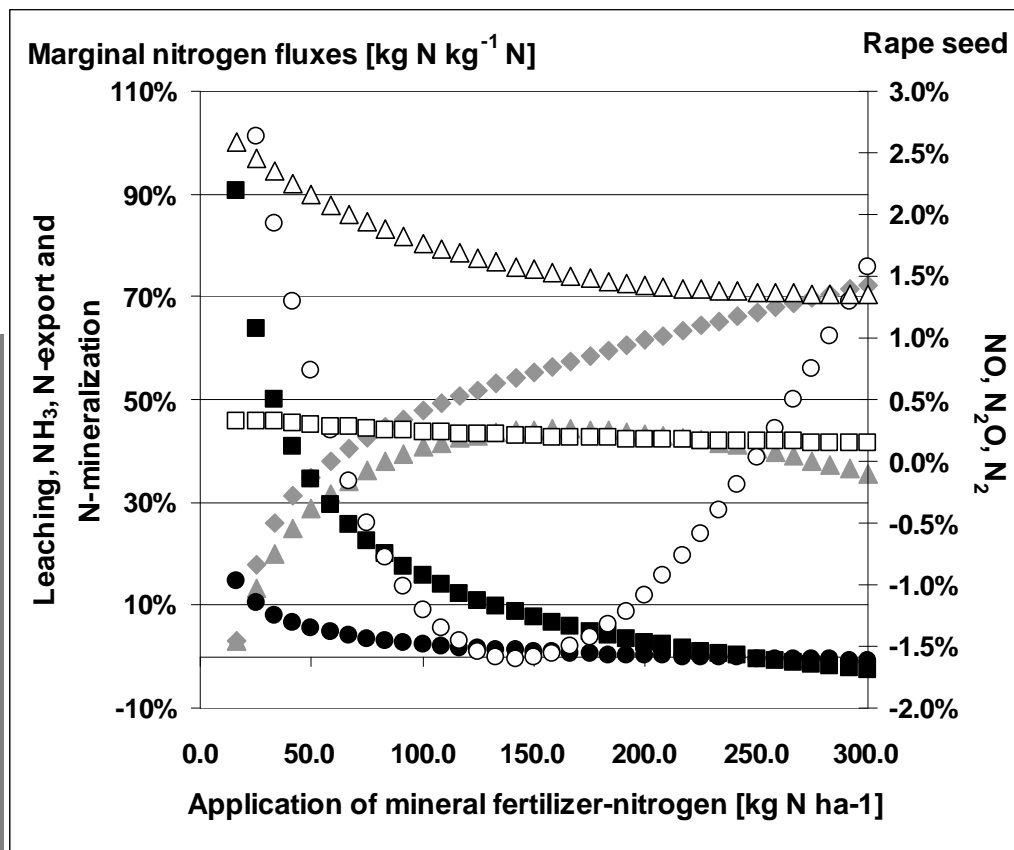
Marginal N-fluxes as a function of N-input at representative European conditions

Left axis

- Nitrogen in plant biomass
- ▲ N-leaching
- N-mineralization
- ◆ NH₃

Right axis

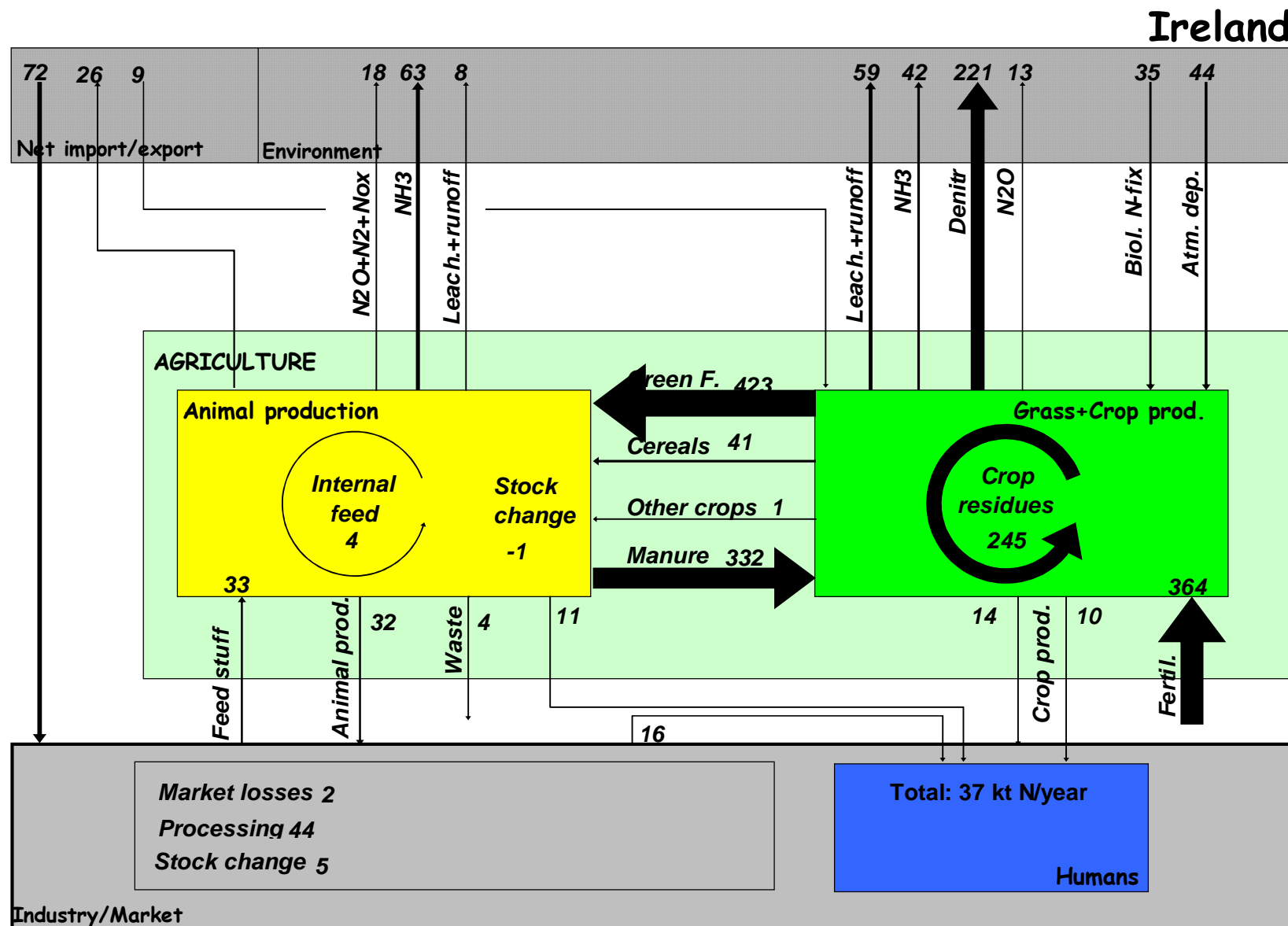
- N₂
- NO
- △ N₂O



Britz and Leip, subm.

**The environmental impact of the first liter of biofuel
produced is very different than the environmental impact
of the last litre!**

The N-budget for agriculture in Ireland

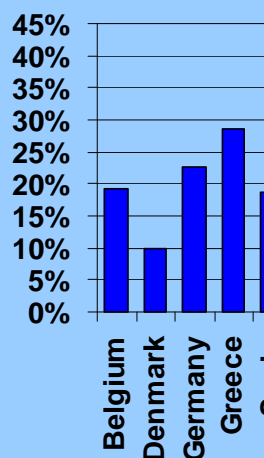


Source: CAPRI, rev. 2714; 03/2009

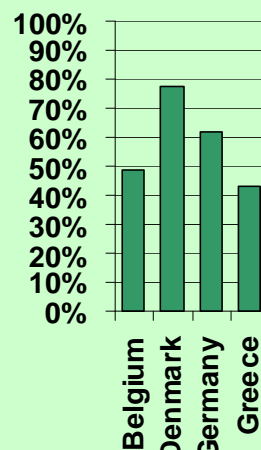
Values in kt N/year

Characterizing countries ...

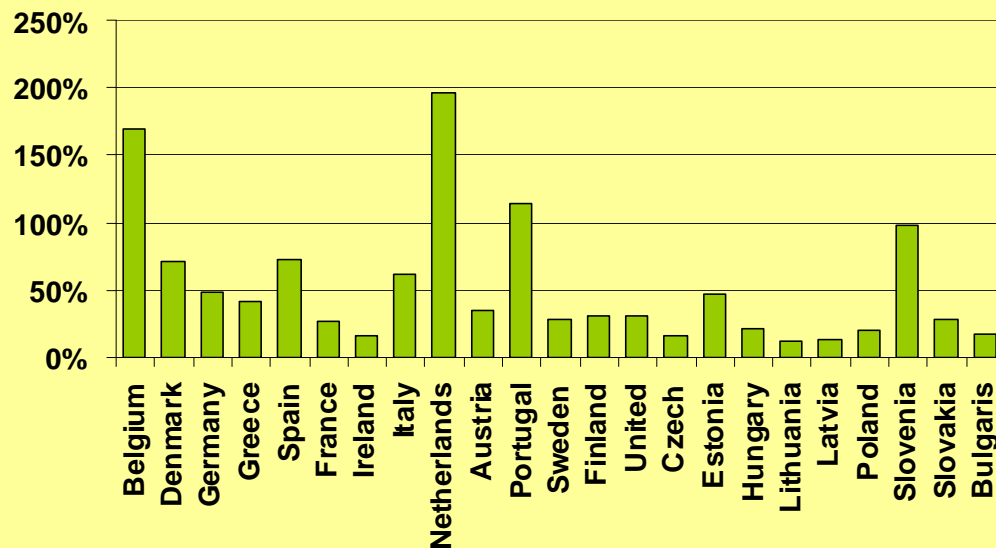
Human consumption to new N-input (mineral
fert.+biological fixation+net import)



Crop products for animal feed to total crop
products



Total import to total domestic production



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Methodology

- **CAPRI/DNDC-EUROPE delivers scale-consistent information combining state-of-the art models**
- **The quality of the (disaggregated) database is unique for Europe**
- **The indicator database can serve a wide range of applications for integrated policies**

Results

- **N2O emissions can offset a significant part of GHG saving from biofuels**
- **Impact of changes in land use/management (intensification/mitigation) should look at the marginal effect!**
- **Livestock production systems reduce the nitrogen efficiency of agricultural systems**