EUROPEAN WIDE PREDICTIONS OF NITROGEN FLUXES IN RESPONSE TO CHANGES IN LAND COVER AND LAND MANAGEMENT

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Aim of model study

- Predictions of N and GHG fluxes are made at a European scale (MITERRA and IMAGE) and a national scale (INITIATOR2 and MITERRA) for the year 2000 (base year) and 2030 based on IMAGE predictions regarding changes in
  - animal numbers
  - land cover/crop shares
  - crop yields
  - N fertilizer gifts

- Aim is to quantify impacts of data aggregation on national and European estimates of N and GHG fluxes

Models for use at different scales

Models for use at different scales with its geographic resolution

Scale of application	Geographic resolution		
	INITIATOR2	MITERRA	IMAGE
	STONE plots	NUTS2	Subcontinental/ country
Netherlands	x	(x)	(-)
Europe		x	(x)
World			x

In brackets implies that the models is not developed for that scale

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The models IMAGE, MITERRA and INITIATOR2

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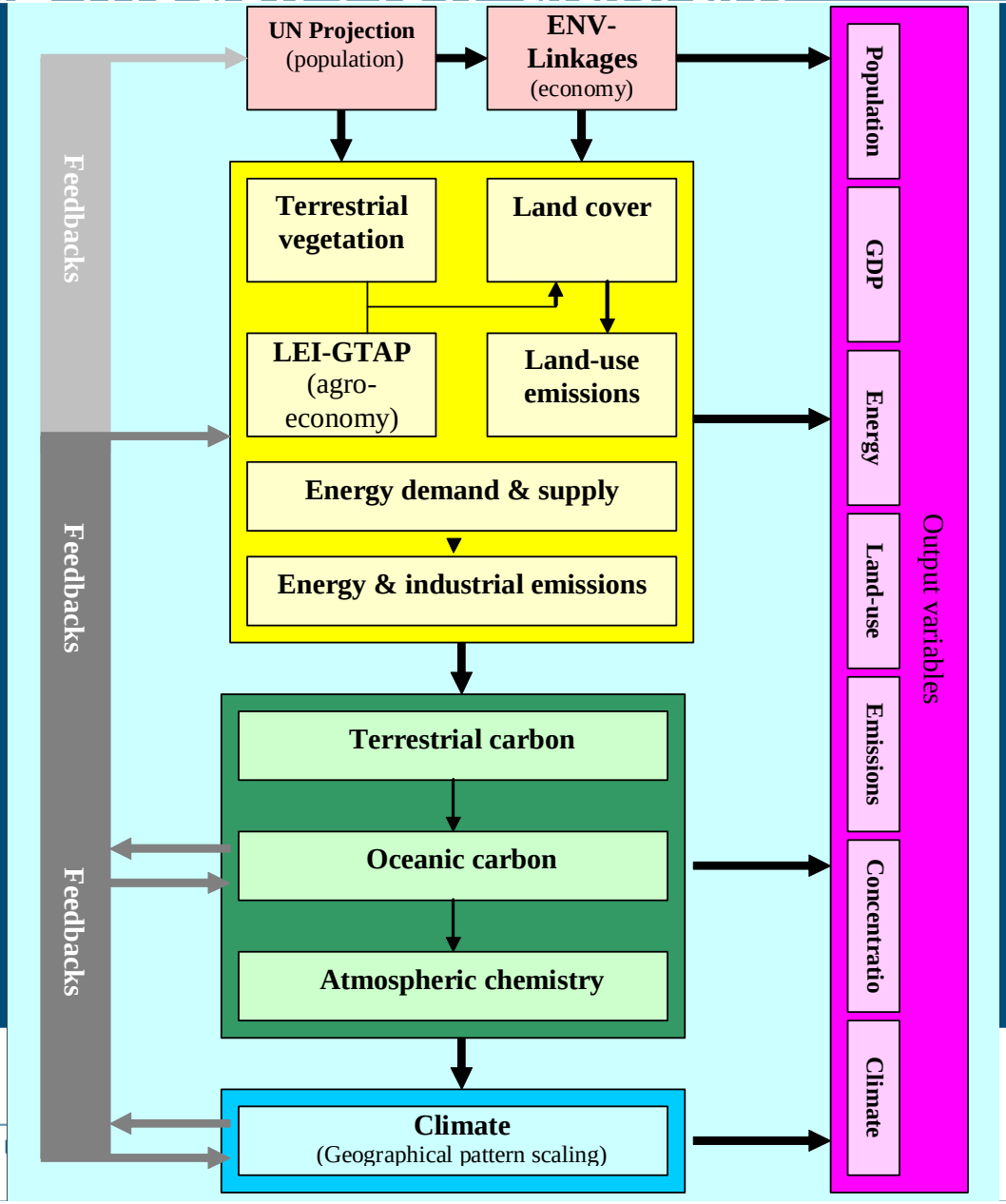
IMAGE model

- IMAGE aims to provide
  - a dynamic and long-term assessment of consequences of global change (climate, land use/management) up to 2100
  - at global scale at sub-continental level (For N in Europe: country level).

- The various models in the IMAGE framework are:
  - TIMER model: calculates energy emissions of greenhouse gases (GHG), ozone precursors and acidifying compounds.
  - Terrestrial Environment System (TES) model: calculates land-use changes and related emissions.
  - Atmospheric Ocean System (AOS): calculates changes in atmospheric composition using emissions from TIMER and TES.

The IMAGE model: Flow diagram



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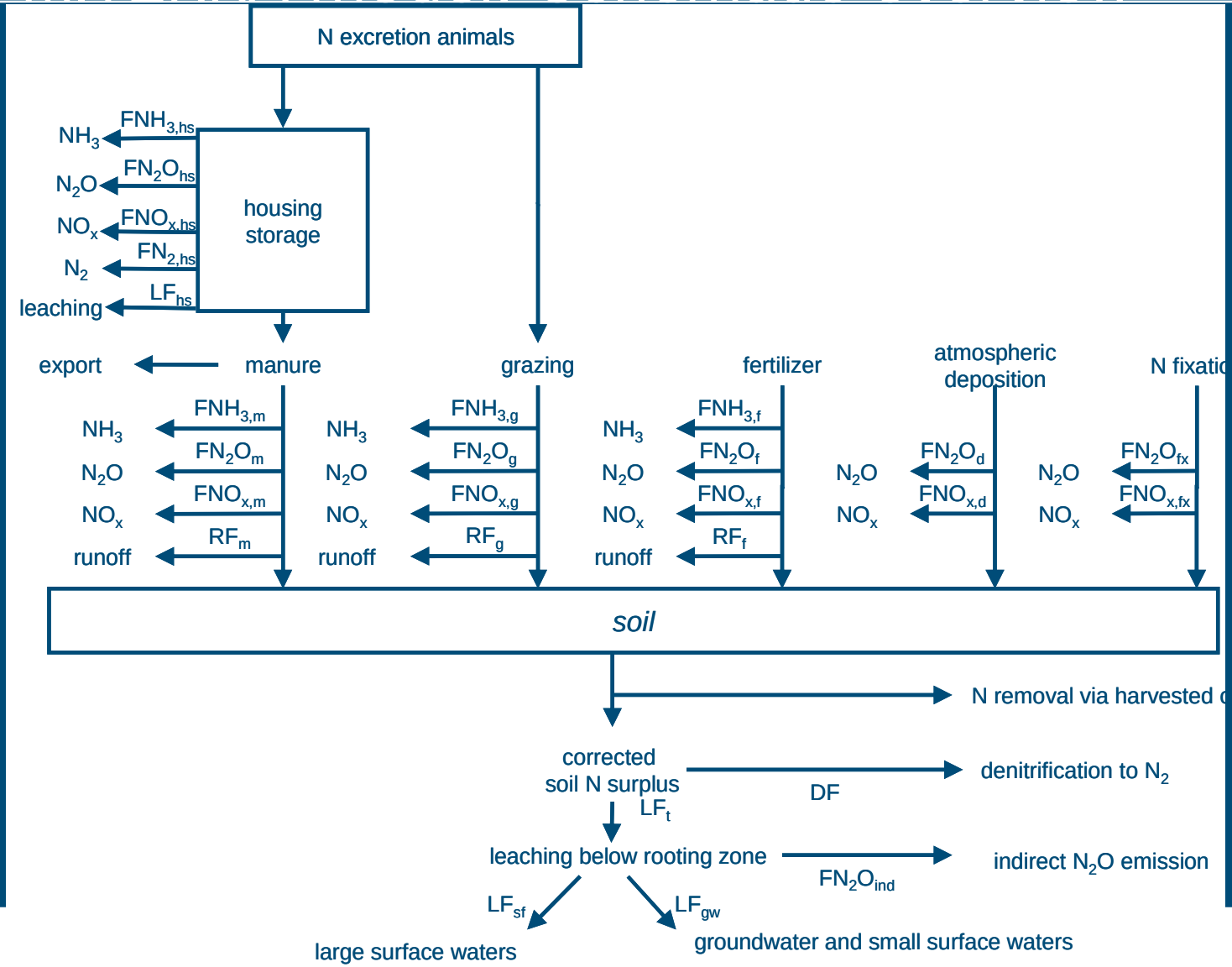
MITERRA model

- MITERRA aims to
  - Quantify effects of mitigation measures/policy options on N fluxes to atmosphere, ground water and surface water
  - For agriculture in EU 27 countries at NUTS2 level.

- Relevant fluxes include:
  - Ammonia, nitrous oxide and methane emissions, nitrate leaching and N runoff
  - from housing and manure storage systems and agricultural soils

The MITERRA model: Schematic overview



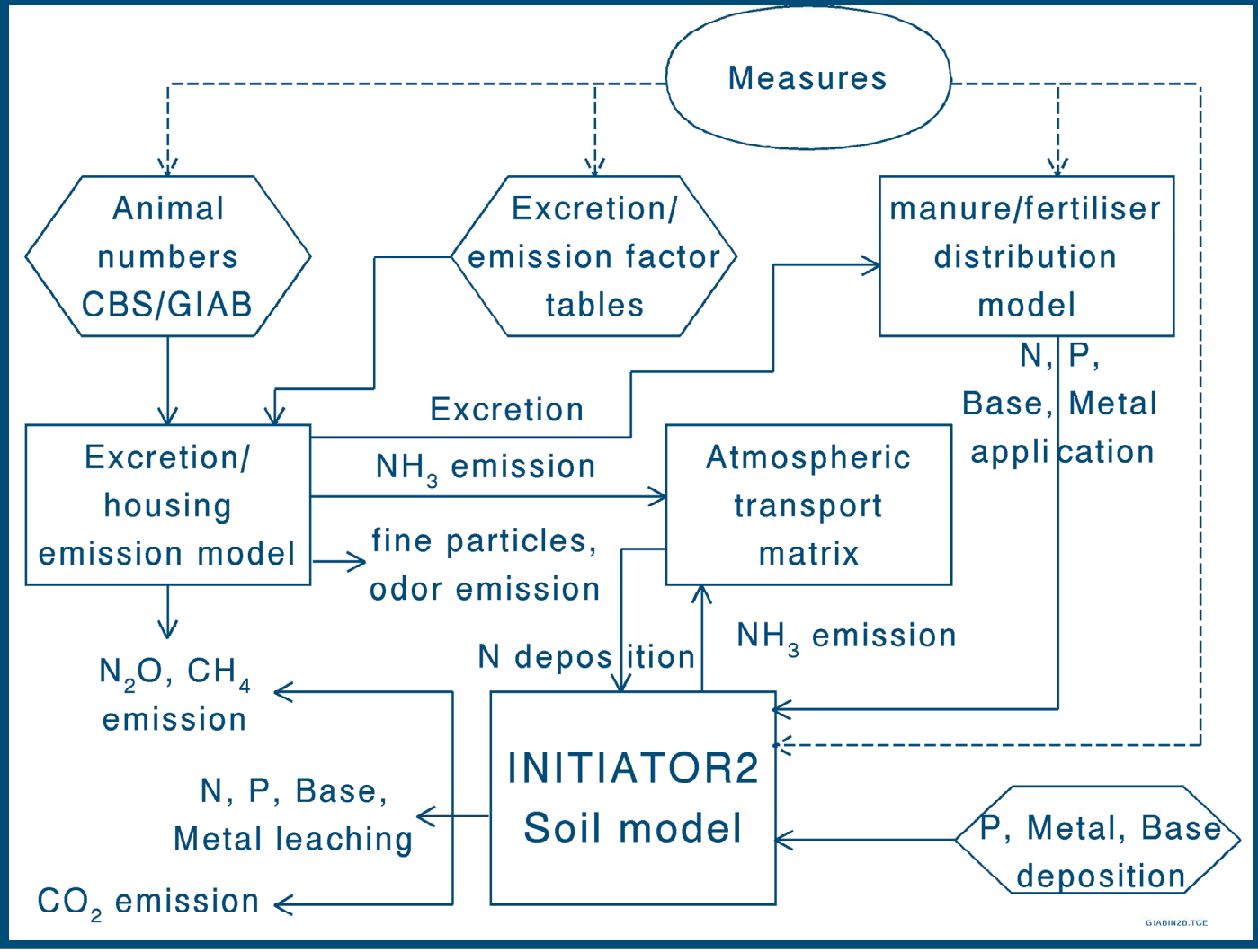
F emission fraction, L leaching fraction, D denitrification fraction, R runoff fraction.

INITIATOR2 Model

- INITIATOR2 aims to:
  - Quantify effects of of mitigation measures/policy options on fluxes of nutrients, GHG and contaminants to atmosphere, ground water and surface water.
  - For the Netherlands at STONE plot level

- Relevant fluxes include:
  - Atmospheric emission of **NH_3** and greenhouse gases (CO_2, CH_4, **N_2O**) from housing systems and terrestrial ecosystems.
  - Soil accumulation/release, leaching and runoff of C, **N**, P, base cations (Ca, Mg, K) and metals to ground water and surface water

Modelling approach: flowchart of INITIATOR2



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Assessment of trends in livestock, crop area, crop yield and N fertilizer inputs

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Assessment of trends by IMAGE

- Changes are calculated in response to IPCC-SRES Regional Communities (B2) scenario, with agricultural policies.
  - Demand, trade and production of animal products and crops is provided by the GTAP model.
  - Changes in animal numbers and crop yields and crop area are calculated in IMAGE based on GTAP outputs.
  - Changes in N fertilizer use are derived In IMAGE as a function of crop production and fertilizer use efficiency

Linkage of IMAGE trends to MITERRA and INITIATOR2

- The principle of the linkage of the IMAGE results of trends to MITERRA and INITIATOR2 is to
  - superimpose the IMAGE predictions on animal numbers, crop area,crop yield and N fertilizer use per country for the period 2000-2030, in terms of relative changes compared to 2000, on the more detailed data used by MITERRA and INITIATOR2 in the year 2000.
  - use tables that allocate the various animal and crop categories in IMAGE to those used by MITERRA and INITIATOR2.

Results for Europe

Comparison of IMAGE and MITERRA

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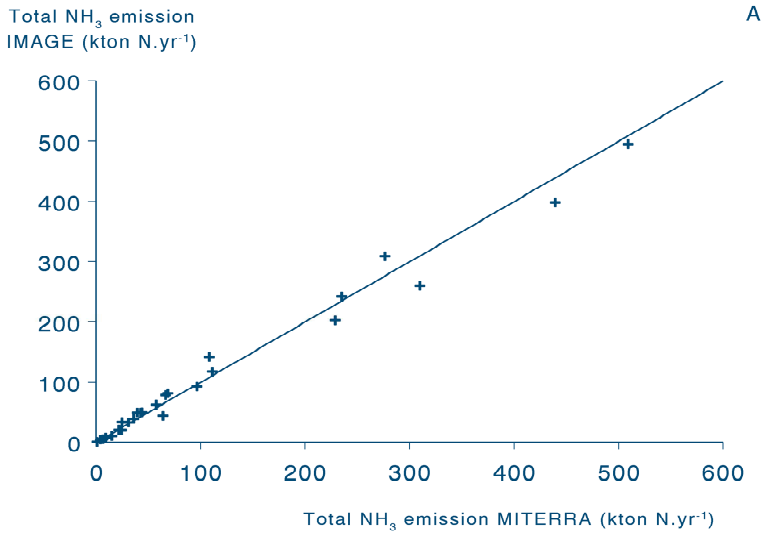
Comparison of IMAGE and MITERRA at European scale

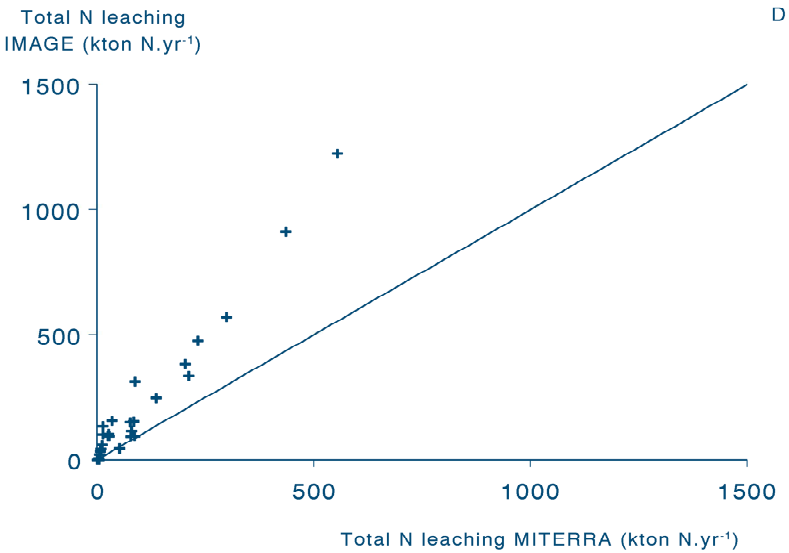
N budgets at EU 27 level for the years 2000 and 2030

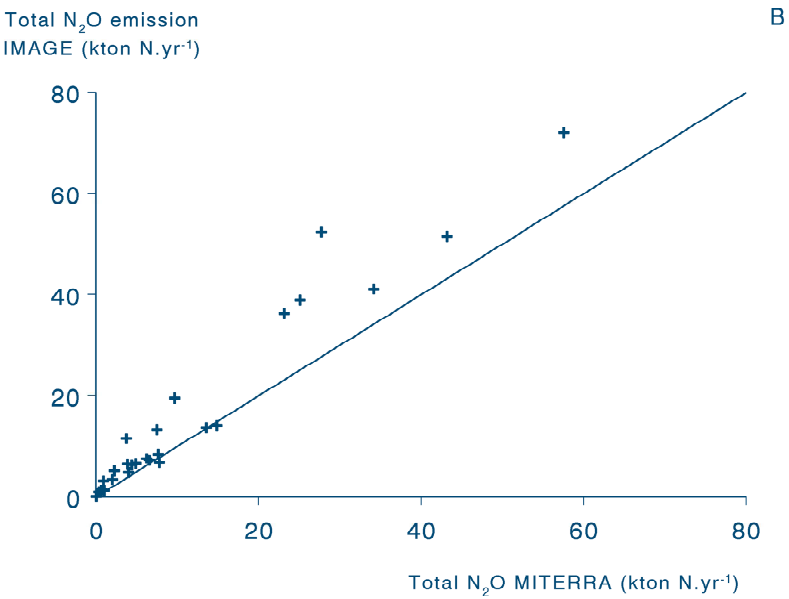
N budget term	N flux (kton/yr)			
	2000		2030	
	IMAGE	MITERRA	IMAGE	MITERRA
Fertilizer application	11223	11302	10312	11558
Manure application	4191	4785	3679	4162
Grazing	4609	3560	3141	2632
Deposition	2789	2015	1949	1812
Fixation	1385	832	1285	785
Total input	24179	22494	20366	20949
Crop removal	13500	10635	12270	11118
Surplus	10679	11860	9016	9832
NH_3-N emissions	2848	2873	2456	2584
N_2O-N emissions	434	318 (374)[1]	367	288 (343)[1]
NO_x-N emissions	219	93	184	85
N leaching and runoff	5945	2811	4443	2398

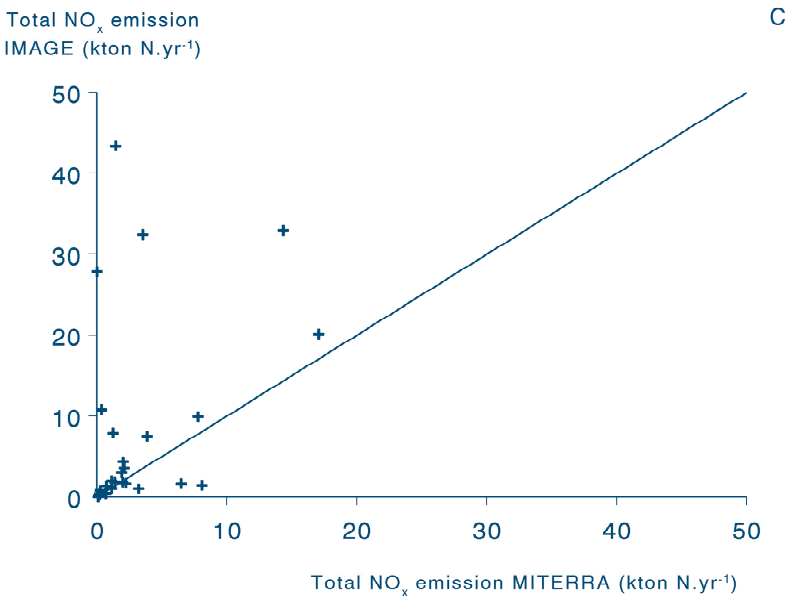
[1)] The value in brackets is the total N_2O emission calculated by MITERRA including indirect N_2O emissions

N emissions and N leaching at national scale for 2000

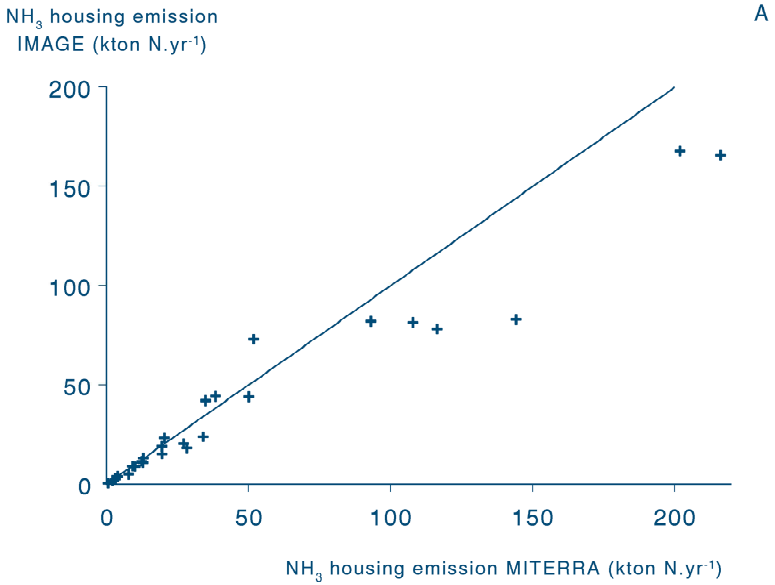


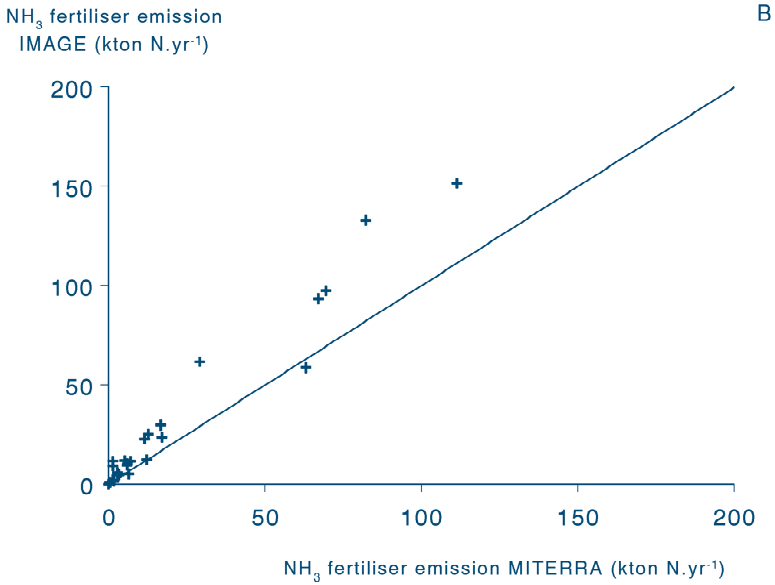


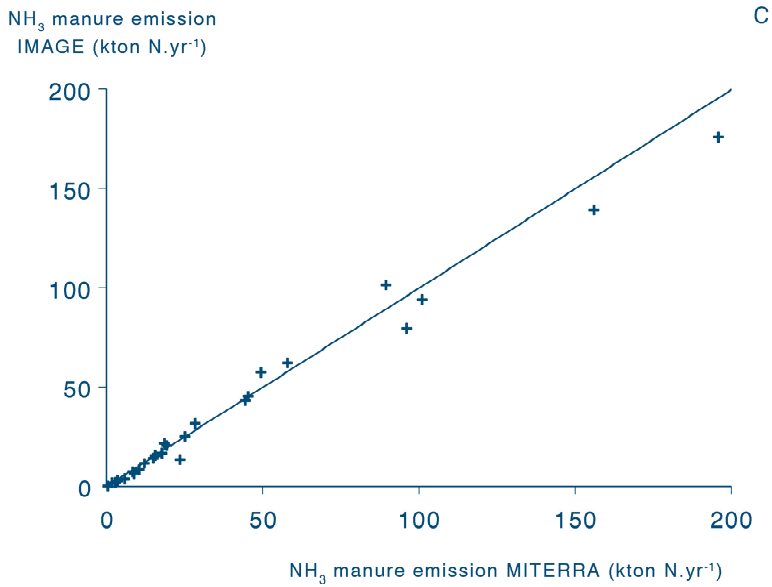


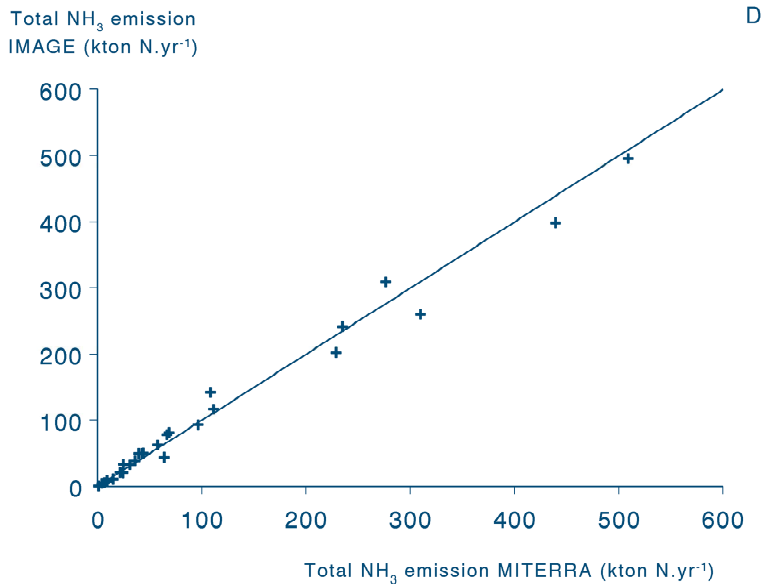


Sources of NH_3 emissions at national scale for the year 2000

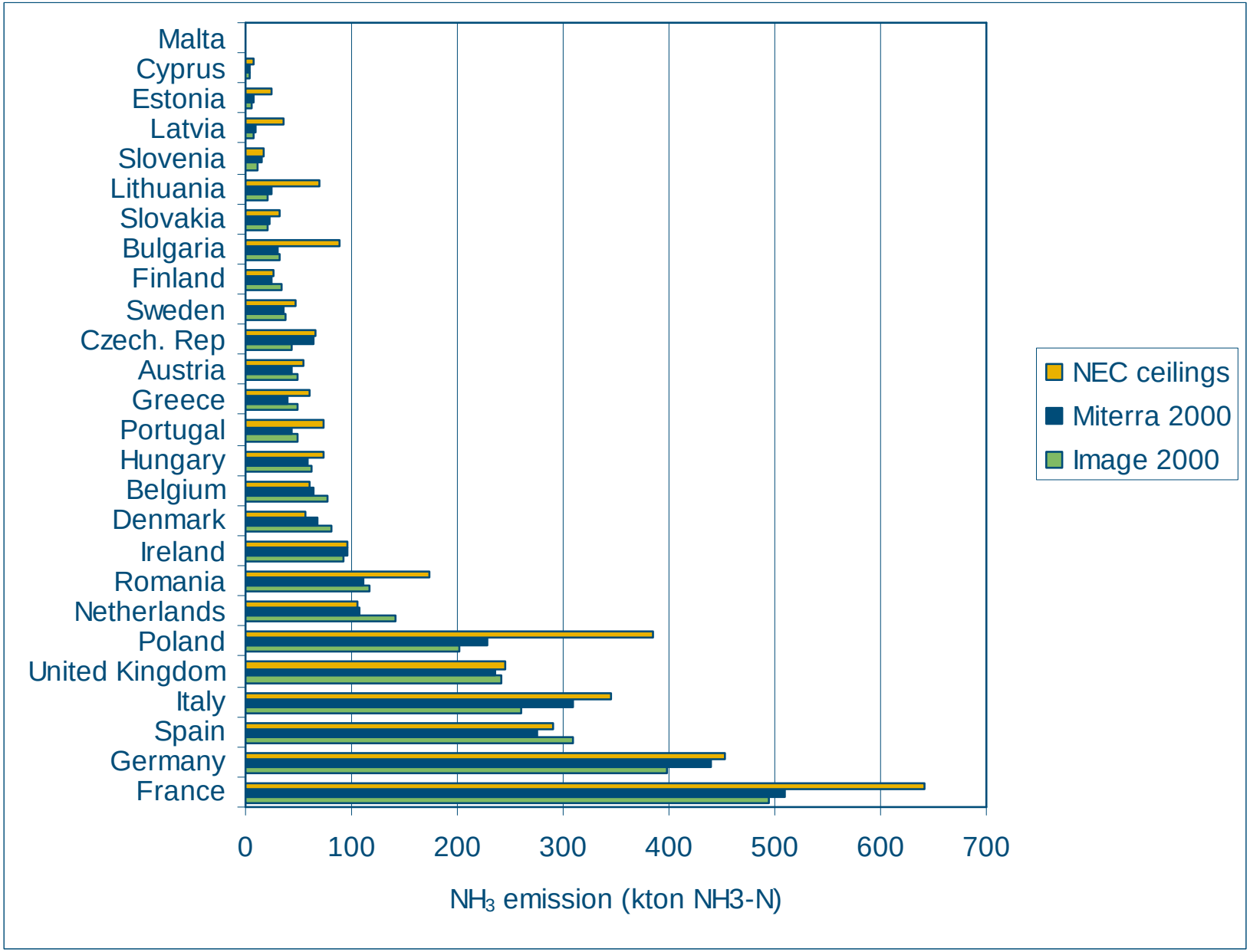








NH_3 emissions by MITERRA and by IMAGE in 2000 vs NECs



Results for the Netherlands

Comparison of MITERRA and INITIATOR

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Comparison MITERRA and INITIATOR2 at national scale

N budgets for the Netherlands for the years 2000 and 2030

N budget term	N flux (ktonN/yr)			
	2000		2030	
	INITIATOR	MITERRA	INITIATOR	MITERRA
Fertilizer	305	300	208	180
Manure application	314	308	235	272
Organic products	11	0	9.4	0
Grazing	108	122	87	97
Deposition	65	66	52	54
Fixation	16	7.8	15	7.0
Total input	820	803	606	610
N mineralization	69	0	63	0
Crop removal	425	337	385	343
Surplus	464	466	284	267
NH_3-N emissions	125	108	90	93
N_2O-N emissions	20.0	15.0	12.7	12.2
NO_x-N emissions	15.2	11.7	9.4	9.3
N leaching	88	108	53	53
N runoff	44	19.5	26	14.3

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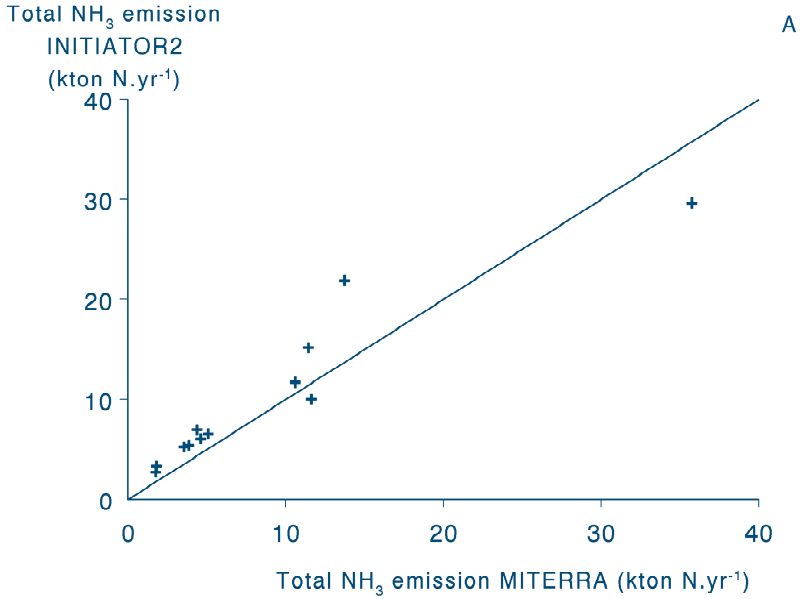
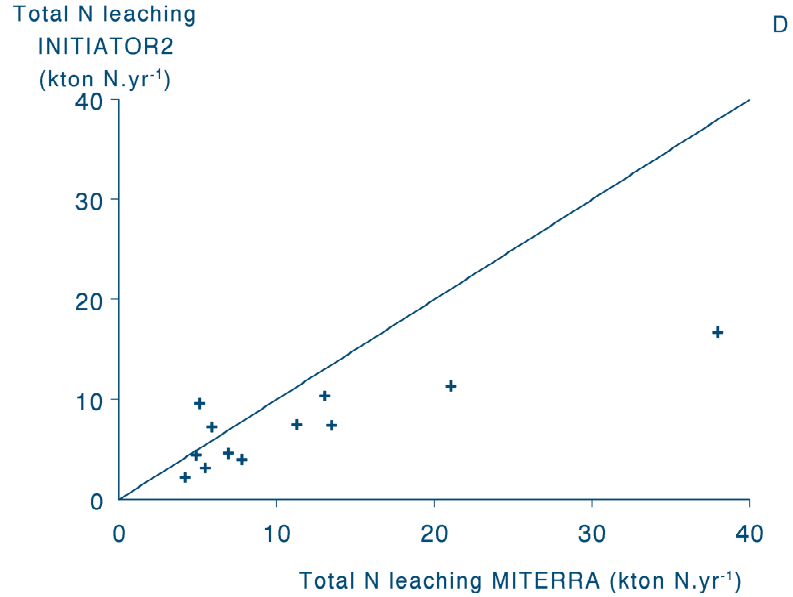
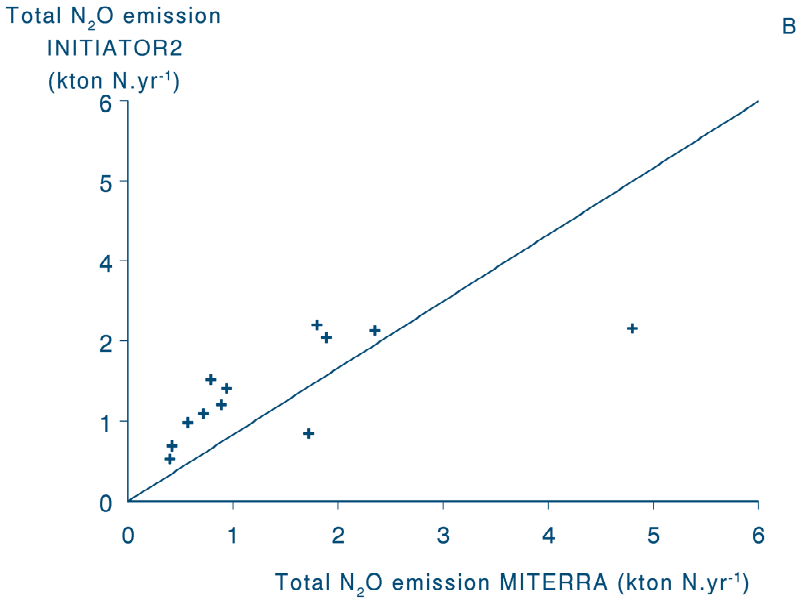
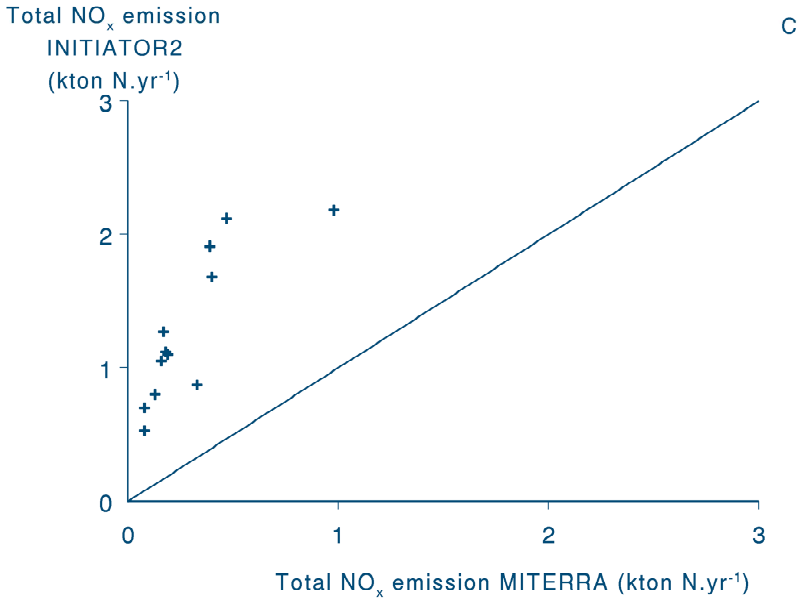
N emissions and N leaching at regional scale in 2000

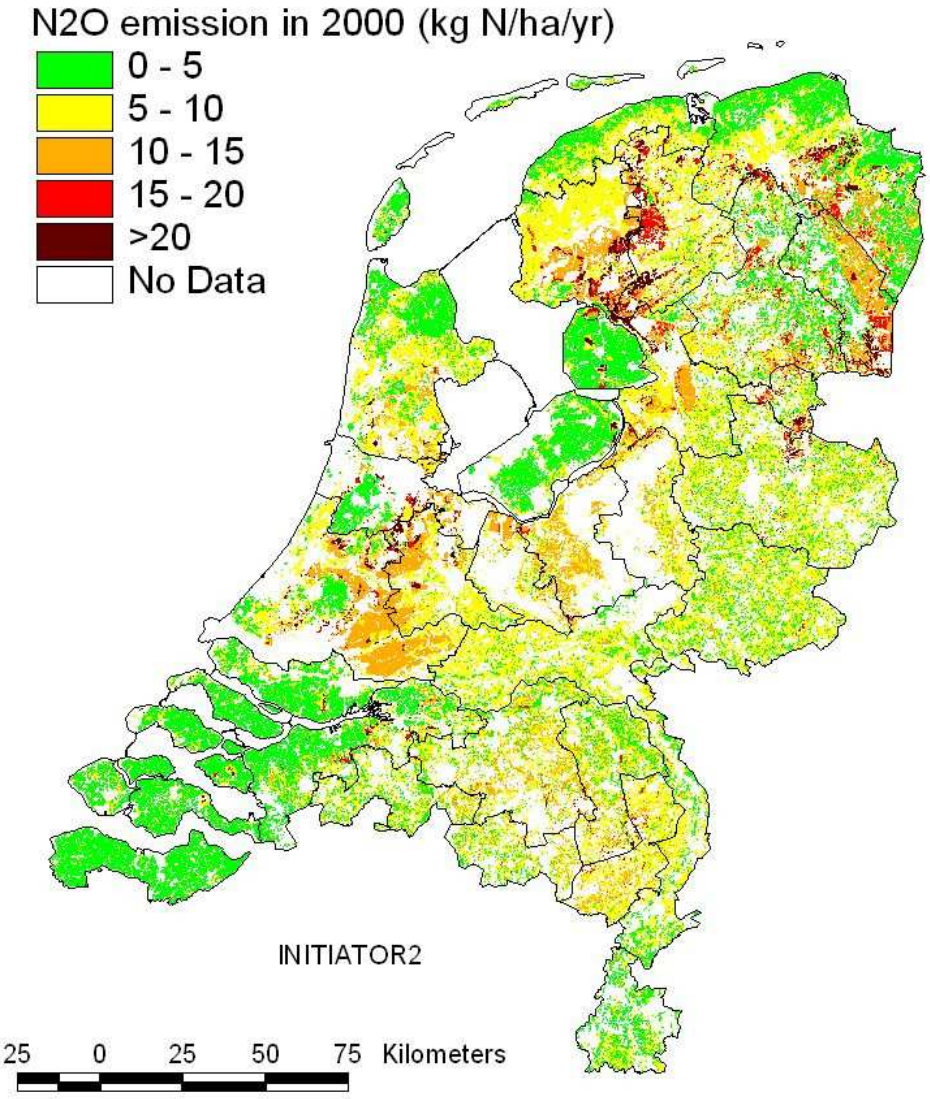


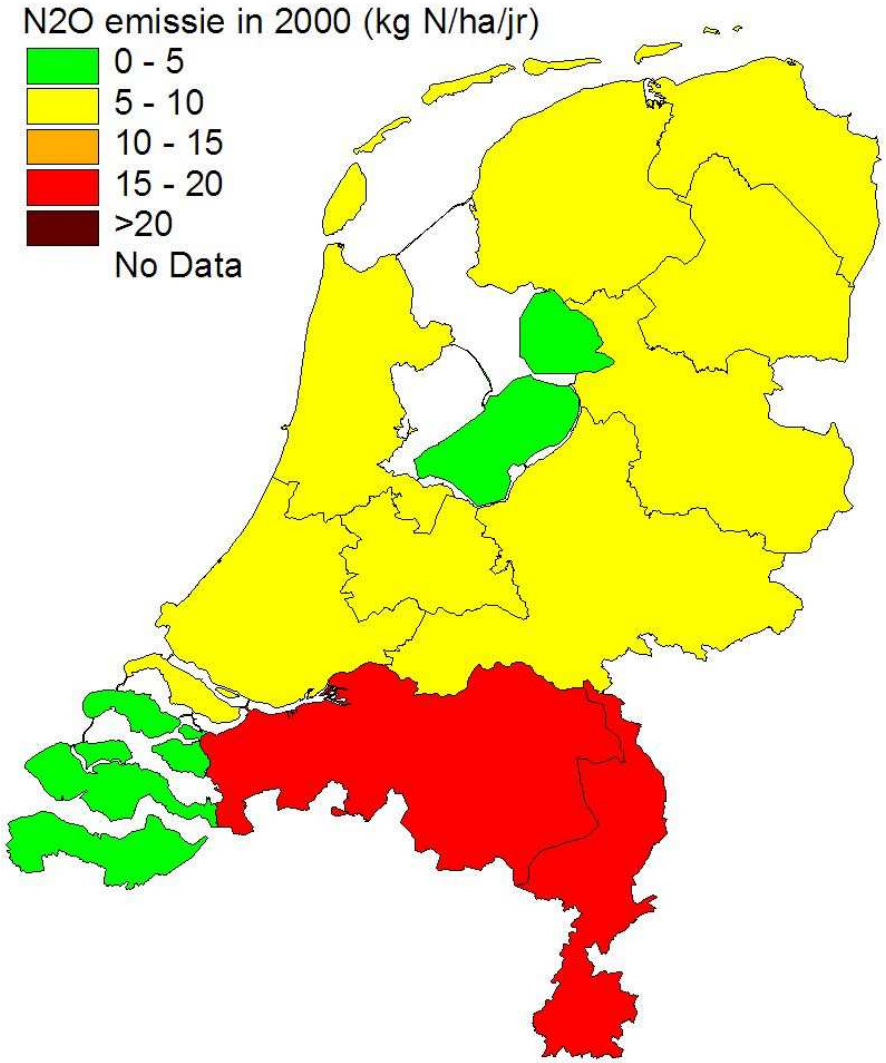




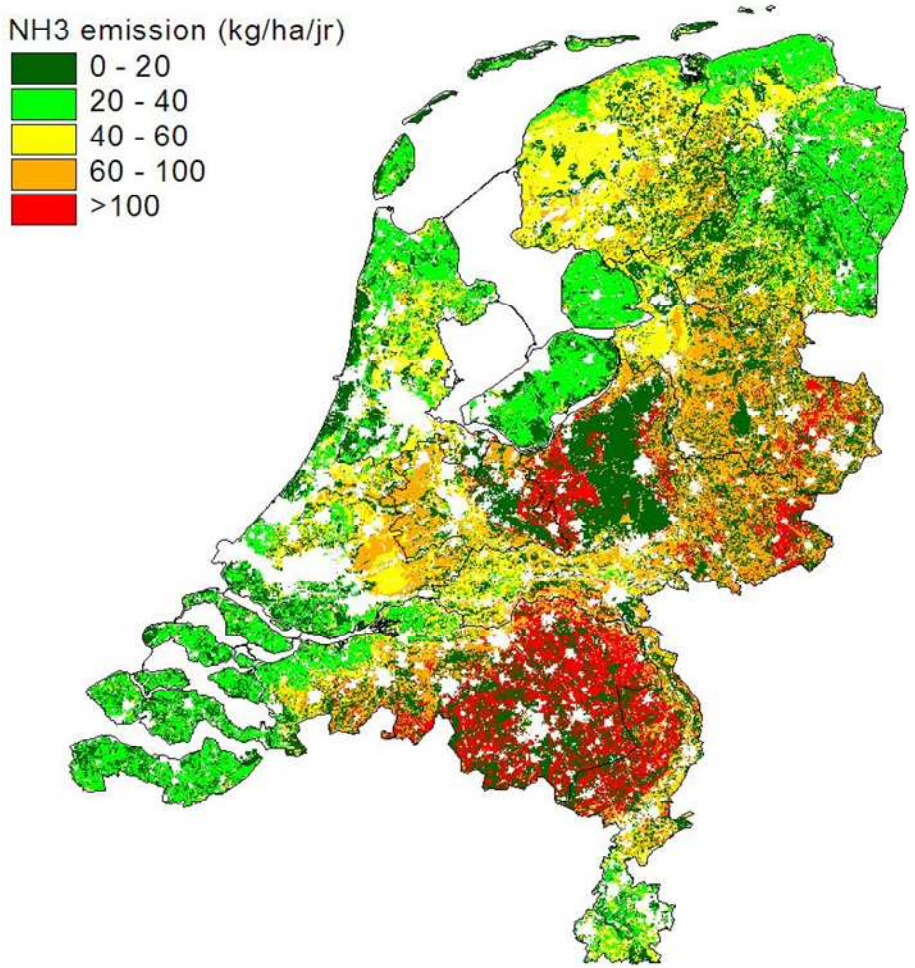


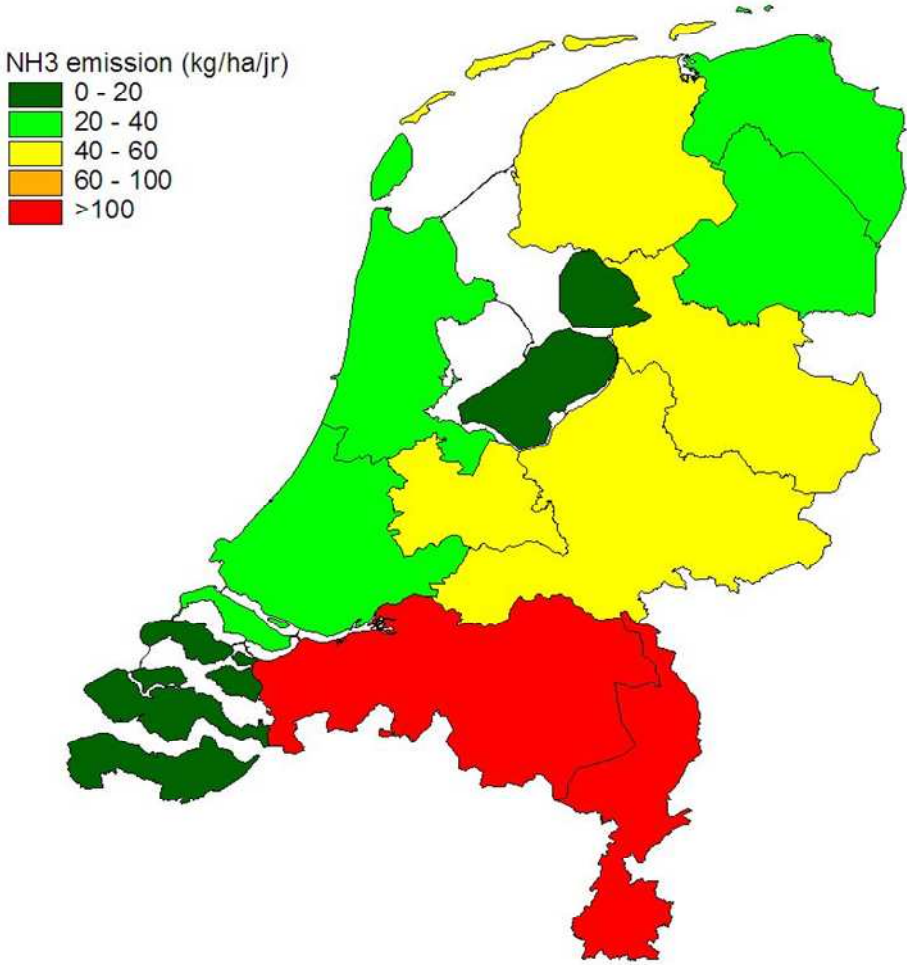
N_2O emissions at regional scale in 2000





NH_3 emissions at regional scale in 2000





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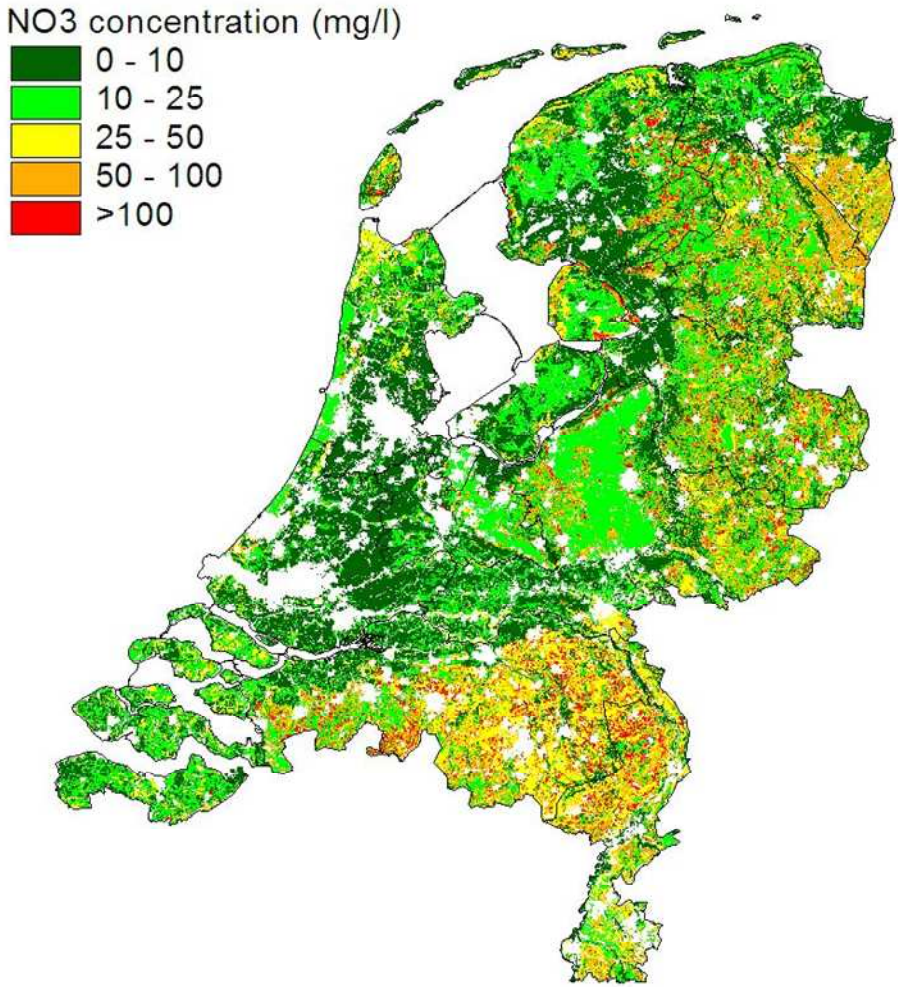
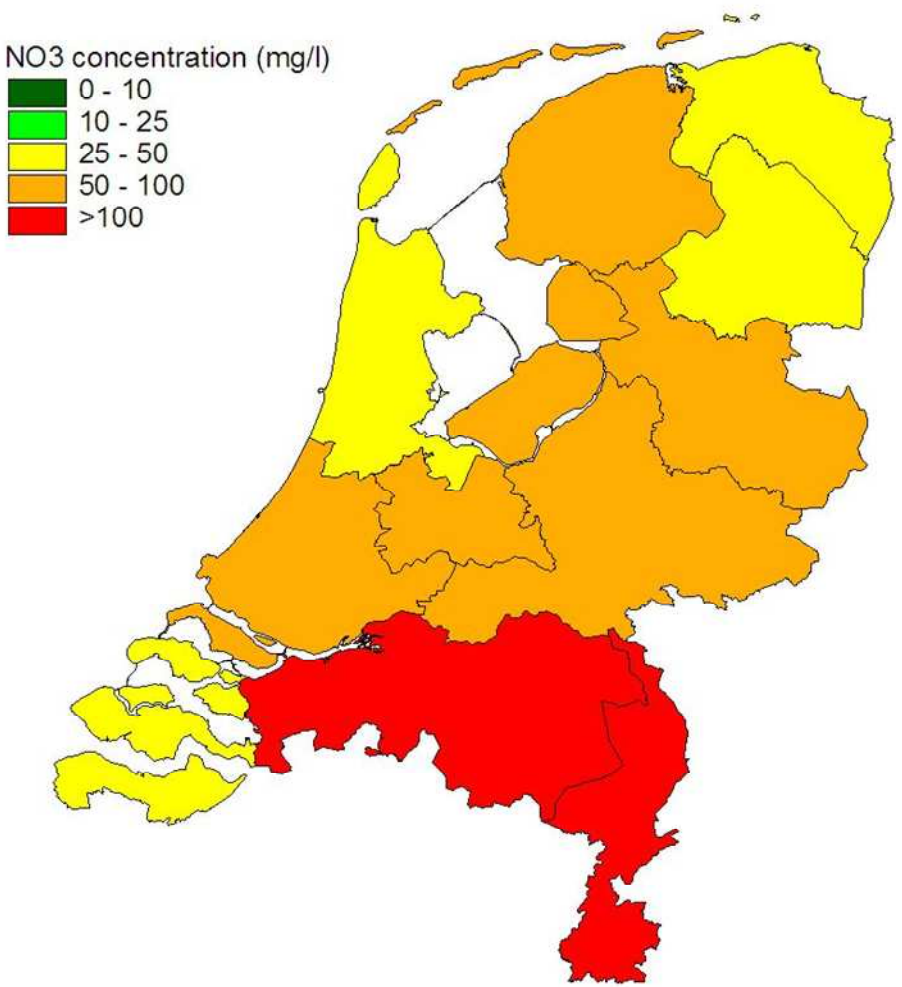
NO_3 concentrations in leachate at regional scale in 2000





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Impacts of data aggregation

Calculated exceedances of critical N loads in the Netherlands in view of impacts on biodiversity (N deposition) and ground water quality (N leaching) by INITIATOR and MITERRA in the year 2000

Type of exceedance	Model	Exceedance		
		Area (%)	Accumulated (ton/yr)	Average (kg/ha/yr)
Deposition	INITIATOR2	86	5174	8.5
	MITERRA	87	4294	6.4
Leaching	INITIATOR2	27	11	20
	MITERRA	70	51	37

Conclusions

- Spatial aggregation has a limited effect on national and continental scale emission estimates but a large effect on regional scale emissions.
- At the national or continental level the comparison of total estimates of NH3 emissions and N leaching is quite good, reasonable for N2O emissions and weak for NOx emissions.
- Exceedances of critical loads for nitrogen in view of impacts on biodiversity and ground water quality differ considerably due to spatial aggregation of the data

Questions??

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