Disaggregated nitrogen budgets for Danish agriculture

Adaption and application of the INTEGRATOR model to Denmark

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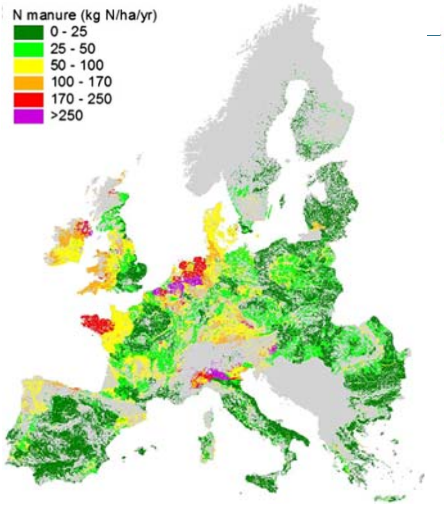
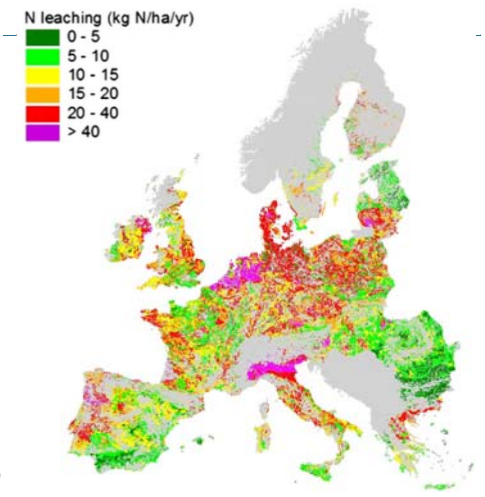
Contents

- Introduction and objectives
- Generating detailed spatially explicit agricultural N budgets
- Results
  - Comparison INTEGRATOR-EU – INTEGRATOR-DK for 2000
  - Detailed spatially explicit agricultural N budgets for 2000 and 2010
  - Trend N budget 2000-2010
- Conclusions

INTEGRATOR: a model for spatial explicit N budgets across Europe



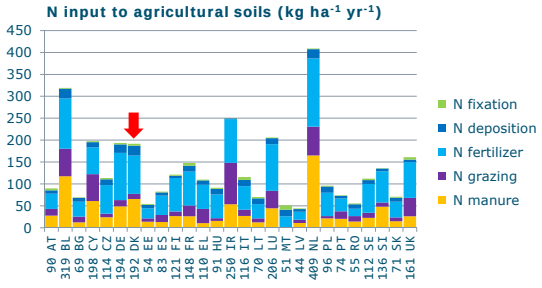
N input in 2000

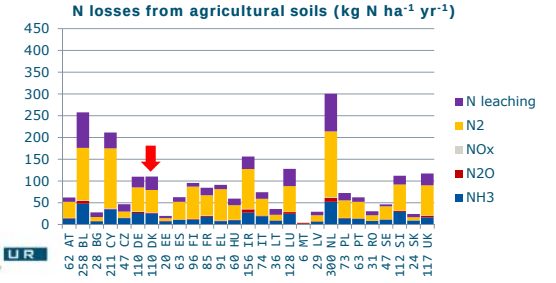


N leaching in 2000

De Vries et al. (2011)
http://www.nine-esf.org/ENA-Book

National N budgets across the EU in 2008





Kros et al. (2011): http://ec.europa.eu/environment/water/water-nitrates/pdf/Final__report_impact_Nitrates_Directive_annex.pdf

Objectives

- Inter-comparison of disaggregated agricultural N budgets for Denmark for the year 2000 based on (the new) INTEGRATOR with 1 × 1 km livestock data and manure distribution, using:
  - Generic data
  - Detailed Danish data
- N budgets for DK for the years 1990-2010 with detailed Danish data
- Evaluation of solution scenarios (RC6)

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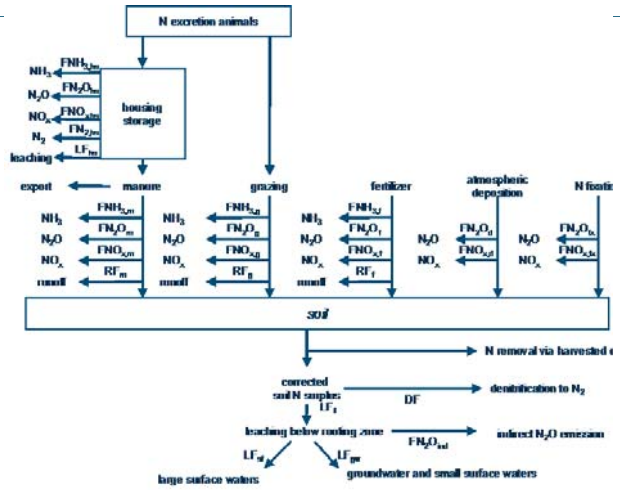
INTEGRATOR/MITERRA model: Schematic overview



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

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Spatial scale - NitroEurope Classification Units (NCUs)

- Polygons of clusters of 1 km x 1 km pixels. NCU is unique combination of :
  - administrative unit (Nomenclature of Territorial Units NUTS2 and NUTS3)
  - soil mapping units (SMU; Soil Geographic Database SGDB classification)
  - slope class (Catchment Characterisation and Modelling Digital Elevation Model, CCM 250 DEM)
- 142 NCUs for Denmark (~50000 for Europe)

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Geographic data on land use and soil properties

- Land cover:
  - CLUE model outcome, based on CORINE 2000
  - Includes arable, grass, rough grazing, forests, wetlands
- Land use
  - Crops: CAPRI-DNDC data for arable land.
  - Tree species: EFISCEN database for forest land
- Soil properties
  - Based on upscaled SPADE/WISE database
  - Includes texture class, C content and C/N ratio
- Animal numbers:
  - Based on NUTS2 values downscaled to NCU level

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INTEGRATOR versus INTEGRATOR-DK

INTEGRATOR-DK

- INTEGRATOR data structure but using Danish agricultural data on crop areas, livestock numbers, manure and fertilizer application of 95 municipalities
- Land use, animal numbers, crop types, N fertilizer rates, excretion and emission fractions and the fraction of implementation and their temporal evolution using detailed Danish data

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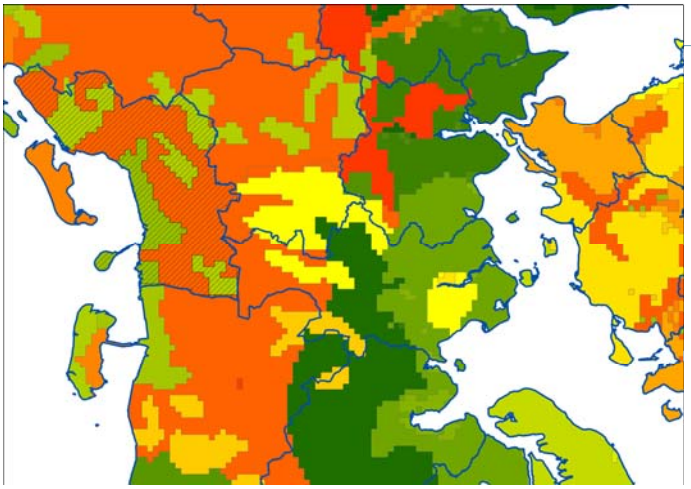
Adaptation of NCU boundaries DK version



Municipality boundaries are used to:

- Be filled with NCUs
- Split NCUs by municipality borders

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Manure and fertilizer distribution at NCU level; DK version

- Apply the given manure per NCU until reaching the maximum permissible application rate (230 kg for grass and 170 kg for arable)
  - 140 kg limit for pig manure/organic farms: not yet included
- All manure uniformly distributed between grass and arable
- N fertilizer distribution based on balanced fertilisation per crop, scaled with given N fertilizer use per NCU

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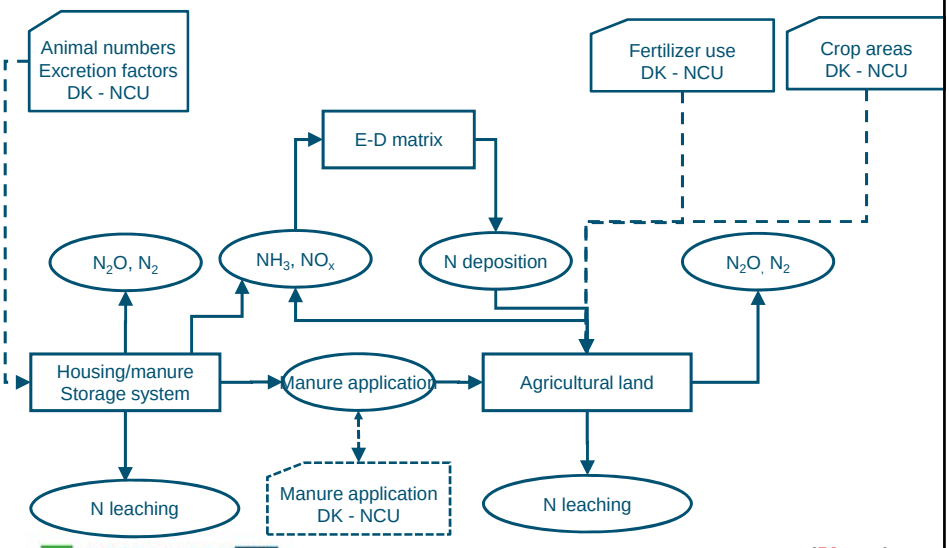
INTEGRATOR linked with DK data



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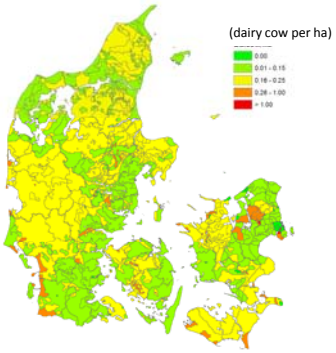
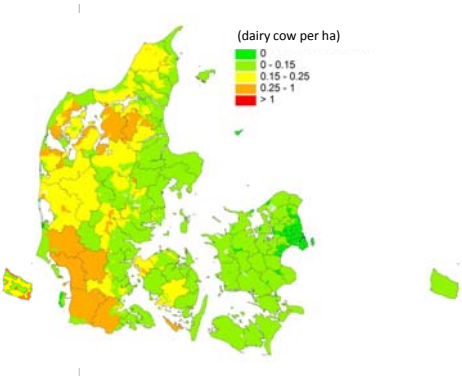
Disaggregated agricultural N budget for Denmark for 2000 using generic and detailed data

Results presented

- Comparison of INTEGRATOR-EU and INTEGRATOR-DK for total agricultural land with respect to:
  - Stocking density, manure application and nitrate leaching
- Separate INTEGRATOR DK results for:
  - Manure application (grassland and arable land)
  - Ammonia emission (housing and application)
  - Nitrate leaching (grassland and arable land)
- Comparison of:
  - Observed and INTEGRATOR-DK N leaching
  - National DK budgets

Stocking density cattle 2000

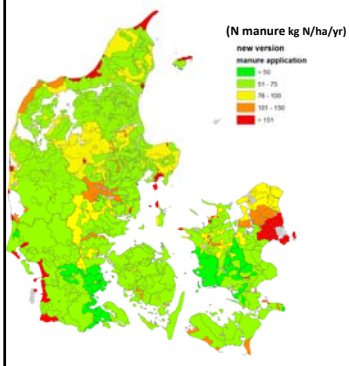


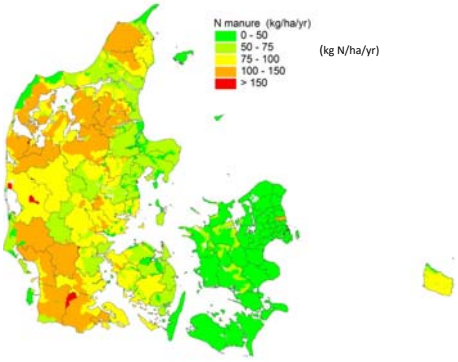


INTEGRATOR-EU

INTEGRATOR-DK

Manure application agricultural land 2000

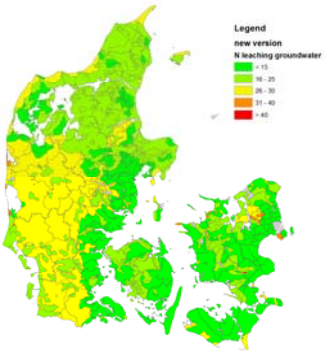




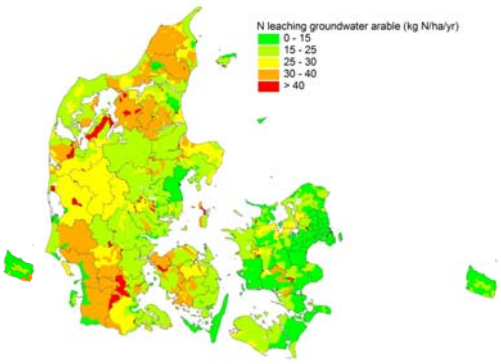
INTEGRATOR-EU

INTEGRATOR-DK

Nitrate leaching flux to groundwater for total agricultural land 2000



INTEGRATOR-EU



INTEGRATOR-DK

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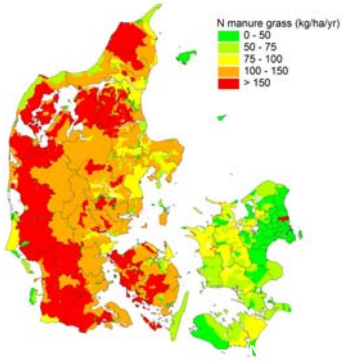
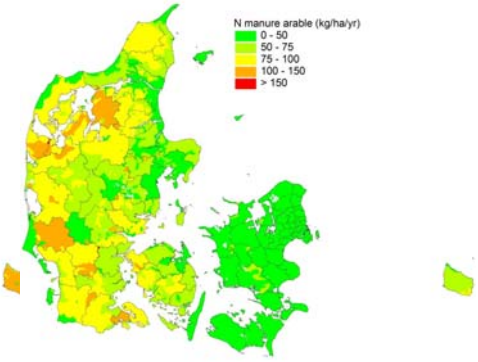
Manure application for arable and grass 2000



INTEGRATOR-DK Grass



INTEGRATOR-DK Arable

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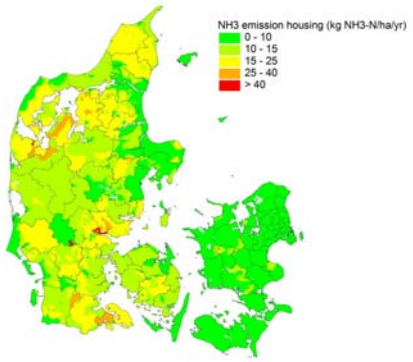
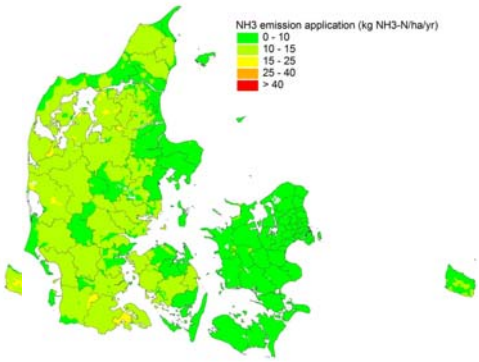
Ammonia emission from housing and application 2000



INTEGRATOR-DK Housing
(all livestock houses)



INTEGRATOR-DK Application
(agricultural land)

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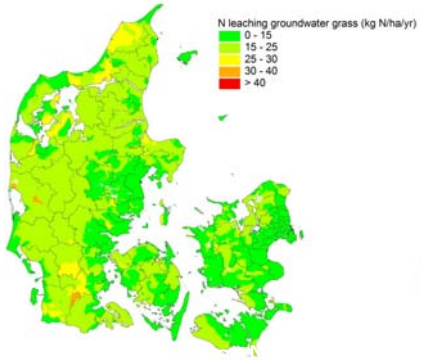
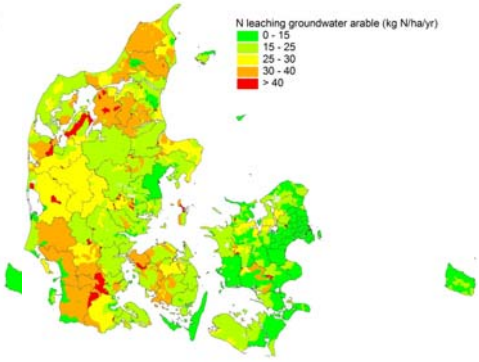
Nitrate leaching flux to groundwater for arable and grass 2000



INTEGRATOR-DK Grass



INTEGRATOR-DK Arable

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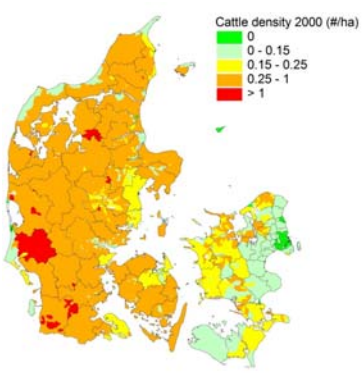
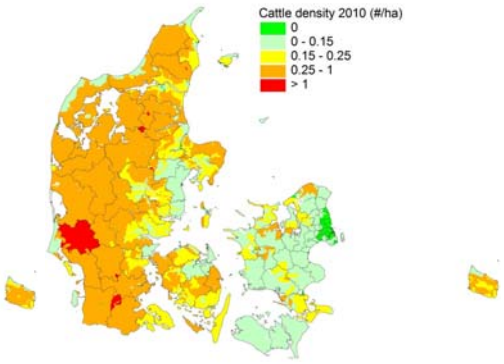
Disaggregated agricultural N budget for Denmark with detailed data for 2000-2010

Stocking density cattle 2000-2010

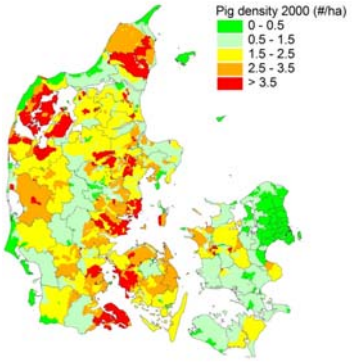


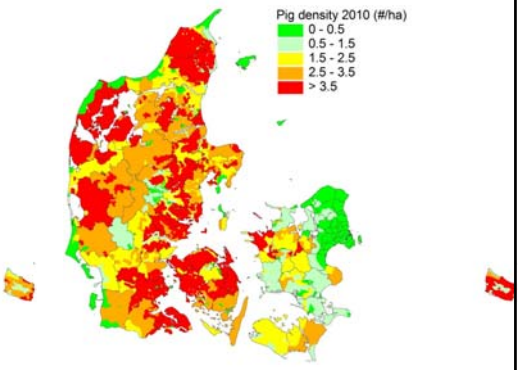
2000



2010

Stocking density pigs 2000-2010





2000 2010

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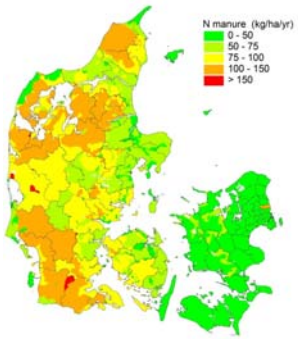
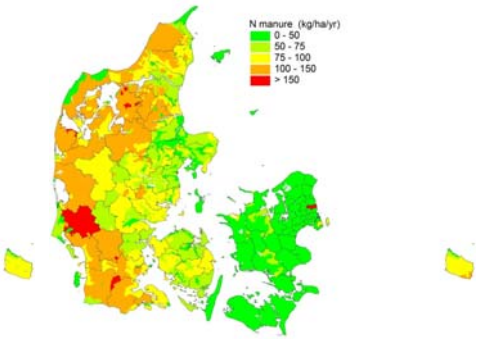
Manure application agricultural land 2000-2010





2000 **2010**

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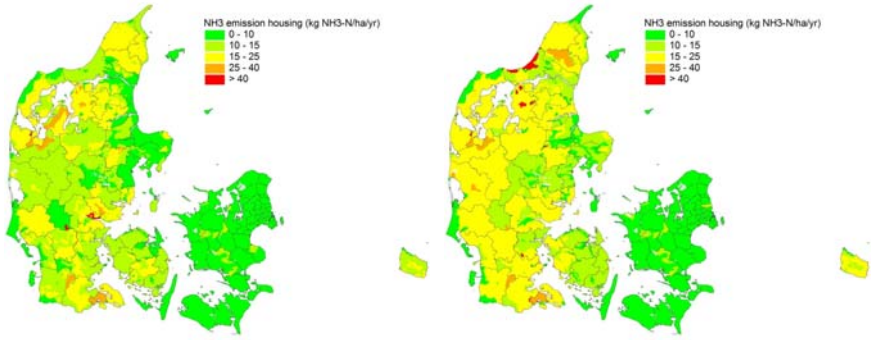
Housing emission of ammonia from agriculture 2000-2010



2000 2010

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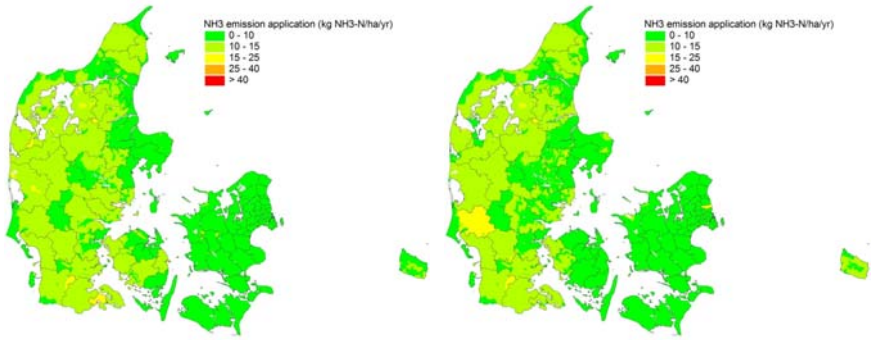
Application emission of ammonia from agricultural soils 2000-2010



2000 2010

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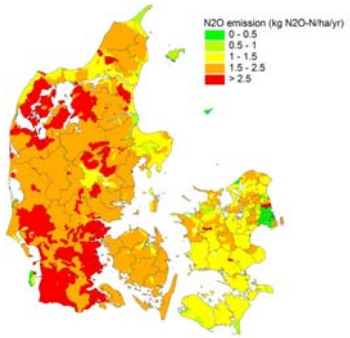
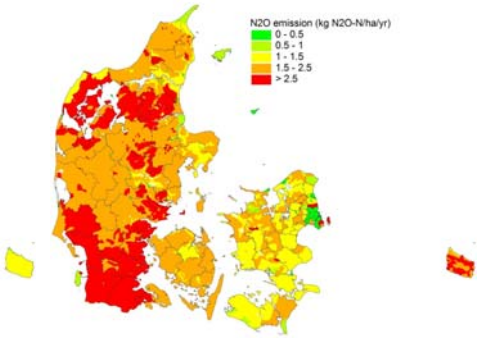
Total N_2O emission from agriculture 2000-2010



2000



2010

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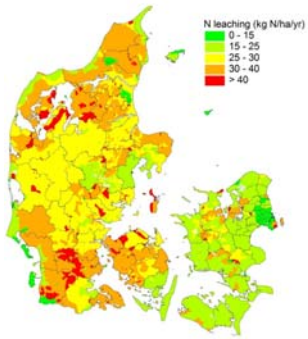
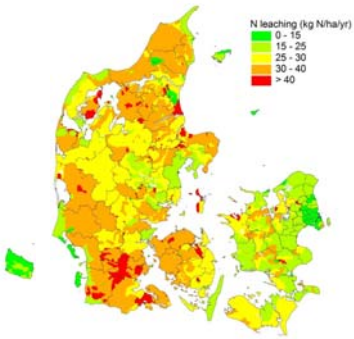
Total N leaching flux from agriculture 2000-2010



2000



2010

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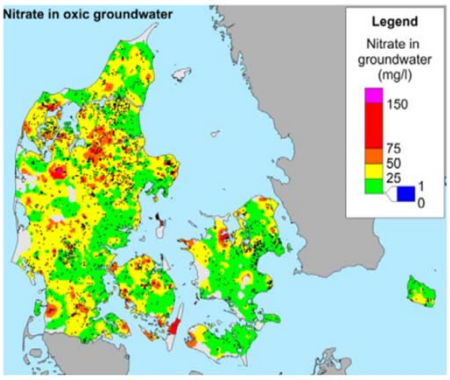
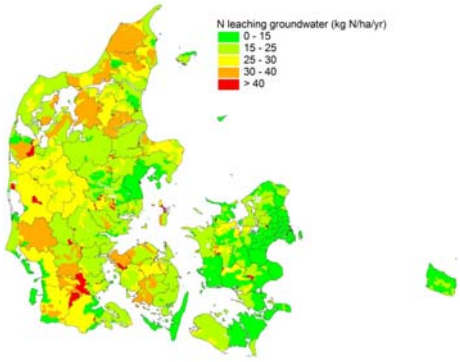
Comparison of nitrate concentration groundwater: observed vs INTEGRATOR-DK





Observed nitrate in groundwater, 1988-2010
(based on results from Hansen et al. 2012).

INTEGRATOR-DK 2010
(agricultural land)

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Comparison of various national DK budgets

kton per year	Integrator-EU 2000	Integrator-DK 2000	Integrator-DK 2010	DK budget RC1 2010
Manure excretion	220	227	246	238
Fertilizer	206	182	194	198
Deposition	43	35	33	21
Fixation	15	12	13	41
Mineralisation	86	47	48	(77)
Total input	570	503	534	(575)
Uptake	352	271	290	302
Emission NH_3	60	57	61	51
Emission N_2O	5	5	6	11
Emission NO_x	2	2	3	11
Emission N_2	74	96	100	54
Leaching	59	56	59	151[1)]
Runoff	18	17	17	
Total output	570	508	534	580

[1)] Leaching+runoff

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Conclusions

- INTEGRATOR-DK results show more spatial variability:
  - Mainly relevant for N leaching and NH_3 emissions
  - Especially variability in N leaching is high
- Use of DK data resulted in lower N inputs and losses as compared to EU data
- Results at national level looks plausible, but regional budgets need to be validated in more detail
- N leaching remain more or less constant over the period 2000-2010, but the excretion and NH_3 emission show a gradual increase until 2009

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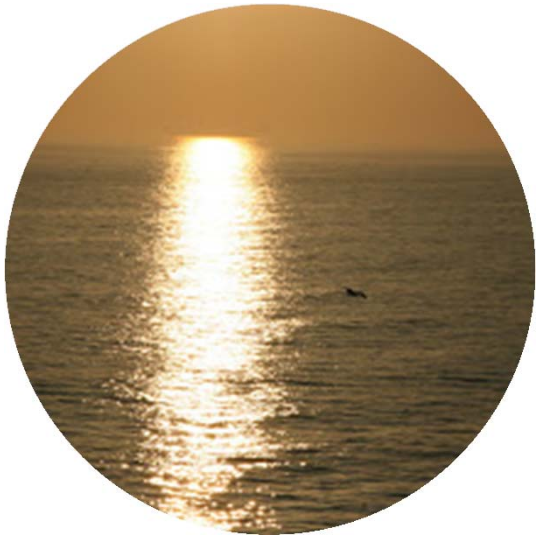
Thank you!



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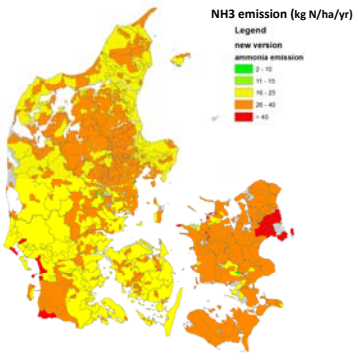
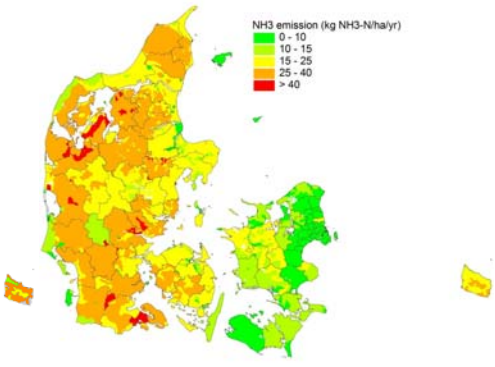
Danish data currently included

- Animal numbers at NCU: 2000 – 2010
- Crop area at NCU: 2005 - 2010
- Grassland area at NCU: 2005 - 2010
- N excretion per animal category: 2005 - 2010
- N fertilizer use per NCU: 2005 – 2010

Total ammonia emission from agricultural 2000

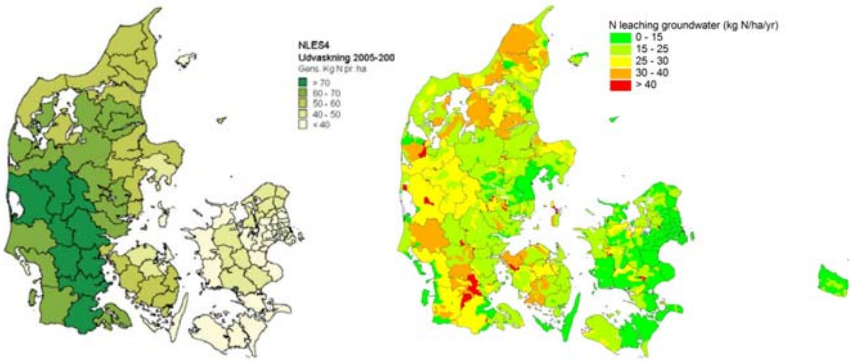


INTEGRATOR-EU



INTEGRATOR-DK

Comparison Nitrate leaching (NLES) with INTEGRATOR (agricultural land)



NLES 2005-2007

INTEGRATOR-DK 2010

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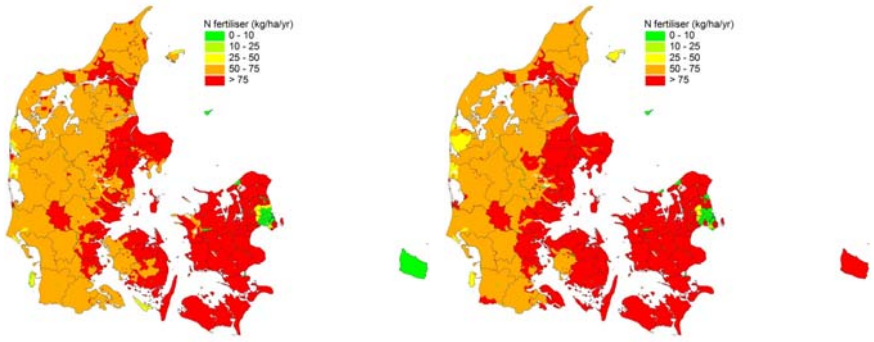
Fertilizer use agricultural land 2000-2010



2000

2010

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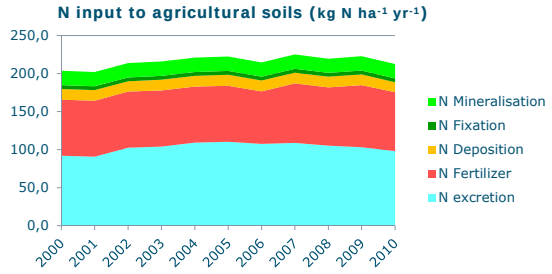
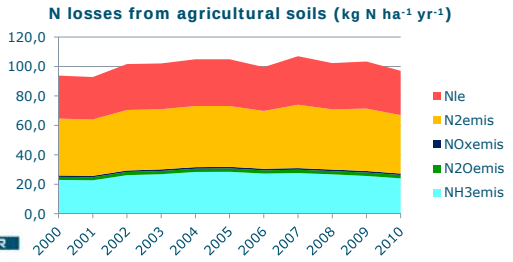
Calculated N balances 2000 – 2010





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