Nitrogen Balances
for EU27 at NUTS II level
combing the farm gate
and soil surface approach

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Outlay

• Background
• Comparison of Farm-Gate and Soil-Surface Balances
• Data sources and data gaps in the calculation of regional balances
• Methodology and assumptions
• Main results
• Outlook
Background and Aims

• Integration of environmental indicators (nutrient balances, output of GHG and NH3, High Nature Value farmland characterisation, energy life cycle assessment of agricultural production activities, water abstraction …) in large-scale Pan-European economic modelling system (CAPRI) to allow for combined economic/environmental policy impact analysis

• Provision of time series (in most cases since 1985) of those indicators, and possibility to link them to projection and ex-ante scenario results

• Based on harmonized data bases at European level

• Consistent up-and-down scaling from Member State to NUTSII to 1x1 km grid cells

• Combined activity of different teams, financed by different projects, ongoing since 1997
Comparison of data needs and surplus calculation of Farm-Gate and Soil-Surface Balances

<table>
<thead>
<tr>
<th>Surplus</th>
<th>Farm Gate National</th>
<th>Farm Gate Regional</th>
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<tbody>
<tr>
<td></td>
<td>imports</td>
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<tr>
<td></td>
<td>(mineral fertilizer, feed bought, atmospheric deposition, bio. fixation)</td>
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<tr>
<td></td>
<td>– exports</td>
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<td></td>
<td>(crop and animal products sold)</td>
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? Needed to define consistent excretions factors
Animal system balance

- Domestically produced animal products
- Animals
- Feed intake
- Non Feed use of crop products
- Market balance

Soil nutrient balance

- Mineral N
- Deposition
- Fixation
- Crops
- Manure N
- Domestically produced crop products
- Imports crops Non-crop feed
- Surplus
- Removals
- Inputs
What are challenges at regional level?

• Major input data not available:
  – Mineral fertilizer use (needed for both approaches)
  – Feed import (needed for farm gate balance)
  – Fodder production (needed for soil-surface approach)

• Typical approach to close data gaps:
  (e.g. OECD Handbook on “Soil Surface Nitrogen Balances”)
  – Estimate regional mineral fertilizer use based on crop specific application rates, and statistical data on crop areas
  – Estimate regional use of tradable feed from industry data of concentrate use per animal type, and statistical data on herd sizes, correct where applicable crop production accordingly to derive at net trade of crop products
  – Estimate regional fodder production as the difference between use of tradable feed and feed requirement recommendations

=> Allows for consistency to national farm gate balance, if regional estimates are lined up with given national data (mineral fertilizers, use of tradable feed)
Data sources used in current study

- Use of tradable feedstuffs at Member State level from ZPA1 market balances, feed and trade statistics
- Regional yields, herd sizes and crop areas from REGIO (NUTS II, FSS not used as not available as time series)
- Expert based yields for grass land at Member State level (replace data from ZPA1, taken from recent study for DG-ENV)
- Total fertilizer use per Member State and mineral fertilizer application for major crops per Member State, both provided by EFMA
- Engineering information, e.g. extension data from DEFRA

=> Basically standard data set assumed to be available by OECD handbook on gross nitrogen balances
Providing the missing input data at regional level

• Regional fodder yields are estimated from herd sizes of ruminants in relation to fodder area
  – Regional and national energy needs from ruminants not covered by concentrates per ha of fodder area are used to estimate regional from national fodder yields

• Nutrient excretion factors per animal type are estimated as the difference between protein input from feed and protein removals with final and intermediate animal products
  – based on distribution of all feed stuffs (tradable, where quantities are known at national level, and regional produced as estimated above) to the regional herds
  – which takes animal requirements (energy, protein, dry matter, lysine, fibre..), typical feeding practise and feed costs into account
  – part of CAPRI data base, generated with statistical estimator

• Improvements compared to the OECD handbook on “Soil Surface Nitrogen Balances”
Estimation of regional surplus
– methodology and further assumptions

Application of Bayesian based statistical estimator
(Highest Posterior Density Estimator):

• Find most probable regional inorganic crop application rates and thus regional mineral fertilizer use

• Under the following constraints:
  – Regional N excreted must be distributed to the crops in the same NUTS II region ⇔ no inter-regional trade in nutrients
  – Total inorganic N at national level must be exhausted by the regional and crop specific application rates times given regional crop areas
  – Total N deliveries for group of crops (inorganic, organic, fixation, atmospheric deposition) must exceed N removals from those crops, accounting for estimates of gaseous and run-off losses
  – Certain minimum percentages of crop needs are covered by mineral nitrogen
  – Certain crop residues are taken into account as nitrogen removals and deliveries to account for nutrient exchange between arable crops

• Gas loss and run-off estimation from MITERRA/RAINS are taken into account
Estimation of regional surplus
– methodology and further assumptions (cntd.)

• Most probable solution (joint posterior density to maximize) takes into account:
  – Deviation of average national inorganic crop specific application rates for N,P,K from EFMA questionnaire data (but regional application rates are allowed to vary as a function of yields [nutrient removal per ha], manure availability, atmospheric deposition and soil/climatic conditions)
  – Deviation of organic N share for group of crops on total N uptake of the crops from assumed typical shares
  – Deviations from assumed loss rate for nitrogen in manure and crop residues
  – Deviations between regional and national crop specific mineral rates per kg removed nitrogen
  – Maximum bounds of manure application rates
Gross surplus at NUTS II level

Data are based on three-year average 2001-2003, total surplus is set in relation to Utilizable Agricultural Area.
Summary

• Time series of regional nitrogen balances are derived for NUTS II regions based on readily available statistical information
  – Combining farm-gate and soil-surplus approach
  – Leading to harmonized methodology applied to EU 27, Norway, and Western Balcans
  – Comprising already estimates of gas losses
  – Application of statistical estimators allows integration of additional information as engineering knowledge or results from farm questionnaires and guarantees closed balances
  – Methodology is also applied ex-ante in CAPRI for DG-AGRI baseline and counterfactual scenarios

• Main data gaps, currently closed by estimates or assumptions:
  – National/regional grass land and fodder yields
  – Regional inorganic application rates
  – Manure application rates
  – International/regional trade in manure and fodder
Further work

• Continued quality check, by comparing balance elements
• Estimation of a statistical meta-model from bio-physical models (DNDC, EPIC)
  – From surplus to nutrient fate (NH3 losses, leaching, further gas losses, changes in soil content)
  – Taking into account changes in Nitrogen content in agricultural soils
• Calculation of balances at 1x1 km grid for EU15, based on already generated data at grid level (cropping shares, yields, animal stocking densities; equally included: economic performance indicators including CAP Pillar I subsidies)
Gross nutrient balance for Belgium and Luxembourg at 1x1 km grid

Data are based on three-year average 2001-2003, total surplus is set in relation to Utilizable Agricultural Area.
Thanks for your attention

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