The impact of the Nitrates Directive on nitrogen emissions from agriculture in the EU-27 during 2000-2008

12 June 2013, Hans Kros

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High N emissions and losses in EU-27, but large regional differences among countries of the EU-27

Emission to air

Losses to groundwater and surface water

\[ N_{\text{output}} - N_{\text{input}} > 0 \]

Large regional differences

Sutton et al. (2011)
Outline

- Background and aim
- Quantification N emissions
- Data and scenarios
- Results
  - Trend in N losses
  - Scenarios with and without Nitrates Directive
- Conclusions
Objective Nitrates Directive

- Reduce water pollution caused or induced by nitrates from agricultural sources
- Prevent further pollution through:
  - Nitrate leaching Vulnerable Zones (NVZs)
  - Good agricultural practices
  - Action programmes (NVZ or whole country):
    - Limited periods fertilizer application
    - Balanced N fertilization
    - Limit to manure nitrogen application
    - Limitation to N fertilizers (on sloping soils, during wet conditions, and near water courses)
Aim and approach

- Quantify the effects of the implementation of the ND on:
  - NO$_3$ leaching and runoff
  - Emissions of NH$_3$, N$_2$, N$_2$O, and NO$_X$

- Effects of ND measures on N use were estimated

- N losses were calculated for 2000-2008:
  - With ND measures
  - Without ND measures
Miterra Europe model

- A simple model to assess the impact of measures on:
  - Leaching and runoff of N to groundwater and surface waters
  - Emissions of NH₃, N₂O, N₂, and NOₓ to the atmosphere

- Consisting of:
  - A database with activity data, emission factors and measures to mitigate N emissions and N leaching
  - A calculation and output module

- Calculating:
  - Annual fluxes, while assuming a steady state
  - At country level and regional level (NUTS2)

(Lesschen et al., 2011; Velthof et al., 2009).
Miterra Europe model

N excretion animals

- NH₃
- N₂O
- NOₓ
- N₂
- leaching

housing storage

manure

- NH₃
- N₂O
- NOₓ
- runoff

grazing

- NH₃
- N₂O
- NOₓ
- runoff

fertilizer

atmospheric deposition

N fixation

- NH₃
- N₂O
- NOₓ

soil

- N removal via harvested crop
- denitrification to N₂
- indirect N₂O emission

leaching below rooting zone

corrected soil N surplus

export

manure

N excretion animals

N fixation

atmospheric deposition

fertilizer

soil

grazing

manure

housing storage

N excretion animals
Nitrates Directive scenario

- Assumed that ND measures are reflected in the statistics of Eurostat and FAOstat of fertilizer use, animal numbers, crop yield etc.

- N emissions calculated using the existing statistical data include the effect of ND implementation

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<td>EU 15</td>
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- ND: Nitrates Directive adopted
- A: Accessed the EU
- E: ND effective
- ND not effective
Without Nitrates Directive scenario

- Estimate the effect of ND measures on activity data

- Outside NVZ: Good Agricultural Practice affect farms outside NVZ:
  - A decrease by 2% per year in mineral N fertilizer use in EU-15
  
  \[ N_{fe\text{without ND}} = N_{fe\text{FAO_stat}} \times 1.02 \]

- Within NVZ: corrections based on Action program

  - ‘Correct’ the statistics for the years in which the ND is effective

(Source: JRC)
## Without ND scenario: Action program corrections

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<th>ND affects</th>
<th>Correction without ND scenario</th>
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<tbody>
<tr>
<td>Chemical fertilizer inputs</td>
<td>$N_{fe}(\text{Stat, t}) \times \frac{N_{fe}(\text{pre ND})}{N_{fe}(\text{NDeff})}$</td>
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<tr>
<td>N excretion</td>
<td>Dairy cattle = $f(N_{input})$</td>
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<td>Pigs, poultry and beef cattle: no change</td>
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<tr>
<td>Animal numbers</td>
<td>1% more animals for farms in NVZ with &gt; 1.3 LSU / ha</td>
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<td>Area of productive agricultural land:</td>
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<td>- buffer strips</td>
<td>Extend area with 20m buffer near surface waters in NVZ</td>
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<td>- sloping soils</td>
<td>Allow N fertilisation/manure application on steep soils</td>
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<td>N losses due to:</td>
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<td>- closed periods man/fert appl.</td>
<td>$\text{NH}_3$ emission factor: $\text{EFNH}_3 \times 1.1$ for slurry application</td>
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<td>$\text{N leaching: increase in leaching fraction}$</td>
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N losses in 2008 for the EU-27 and per MS

N losses for the EU 27 in 2008 (kton N yr⁻¹)

- NH₃: 2692 kton N
- N₂O: 315 kton N
- NOx: 120 kton N
- N₂: 6707 kton N
- N leaching: 2841 kton N

Losses (kg N ha⁻¹ yr⁻¹)

- N leaching
- N₂
- NOx
- N₂O
- NH₃

Countries:
- AT: 47
- BL: 230
- BG: 187
- CZ: 67
- DE: 88
- DK: 47
- ES: 53
- FI: 91
- FR: 77
- EL: 45
- HU: 155
- IE: 83
- IT: 77
- LT: 47
- LU: 143
- MT: 32
- NL: 242
- PL: 129
- PT: 61
- RO: 32
- SE: 49
- SI: 43
- SK: 85
- UK: 85
Results – trend in N losses

**EU-27**

- NH3
- N2O
- NOx
- N2
- N leaching

**Netherlands**

- NH3
- N2O
- NOx
- N2
- N leaching

**Poland**

- NH3
- N2O
- NOx
- N2
- N leaching
Effect of ND on N emissions and N leaching EU-27

**NH₃ (Mton)**

- **With ND**
- **Without ND**

**N₂O (kton)**

- **With ND**
- **Without ND**

**Nₗₑ (Mton)**

- **With ND**
- **Without ND**

**NOₓ (kton)**

- **With ND**
- **Without ND**
Relative change in N emissions from agricultural land due to ND implementation
Effect of ND measures on N losses in 2008

Change in emission compared to scenario with implementation of ND, %

- Area
- Number animals
- Fertilizer
- Closed period
- Combined

NH3
N2O
NOx
N leaching

16%
9%
6%
3%
9%
Conclusions

- Trends and level of N losses clearly differ per EU country
- ND implementation within EU-27 has decreased N losses in 2008 by: 16% for N leaching, 3% for NH$_3$ emission and 6% for N$_2$O emission
- But much larger effect in countries with intensive agricultural: N leaching: 36-60%, NH$_3$: 12-16%, N$_2$O: 12-20%
- Decrease in chemical fertilizer use has the largest effect on N losses
- A further decrease in N emissions in the near future is expected due to increase in ND implementation and stricter Action Programmes
Thank you

Further reading:


This research was prepared as part of EU project ENV.B.1/ETU/2010/0009 “The impact of the Nitrates Directive on gaseous N emissions. Effects of measures in nitrates action programme on gaseous N emissions”.