Spatial and time variations in agricultural loss of nitrogen to 44 small Danish streams – 1990-2015.

Jørgen Windolf\(^1\), S.E. Larsen\(^1\), G. Blicher-Mathiesen\(^1\), H. Tornbjerg\(^1\), B. Kronvang\(^1\) & A. Højberg \(^2\)

\(^1\) Department of Bioscience and DCE, Aarhus University. E-mail: jwn@bios.au.dk

\(^2\) Geological Survey, Denmark (GEUS)

International Conference
Land Use and Water Quality
Effect of Agriculture on the Environment
National Environmental Monitoring Programme
Incl.;

1. Monitoring the linkages between agricultural production, mobilization, pathways and 1st order stream as receptor – **Intensively monitored agricultural catchments (N=5)**
2. Monitoring trends and the influence of agriculture, climate and mitigation options in **streams draining agricultural mini-catchments (N=44)**.
   - 55% measured
   - 45% Modelled
Landbased Nitrogen load of Danish coastal waters, 1990-2015

Denmark, Monitoring
55% measured
45% modelled

Actual climate

Normalized to mean annual discharge

Total Reduction 44%

Landbased Nitrogen load of Danish coastal waters, 1990-2015

Emission of nitrogen to the Sea in Denmark

Numbers in tonnes N

Target Loading

Department of Bioscience
AARHUS UNIVERSITY, DENMARK
Is Agricultural N loss generally increasing??

Monitoring data from 44 small catchments (1990-2015) might assist answering this ??

<table>
<thead>
<tr>
<th>Key characteristic</th>
<th>Mean (10 % 90% Fraq.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catchment area, km²</td>
<td>18 (3-40)</td>
</tr>
<tr>
<td>Run off, mm/y</td>
<td>280 (144 – 486)</td>
</tr>
<tr>
<td>Farmed area %</td>
<td>78 (67-85)</td>
</tr>
<tr>
<td>N-surplus, Kg N/ha (total catchment)</td>
<td>72 (39-96)</td>
</tr>
<tr>
<td>Livestock units LU/ha (total catchment)</td>
<td>0,4 (0,1-0,8)</td>
</tr>
<tr>
<td>Total N Stream, mg N/l</td>
<td>7,1 (3,7-11,1)</td>
</tr>
</tbody>
</table>
44 small catchment;
Change (%) in Nitrogen concentration
N surplus: Main driver for the N reduction…1990-2015..

44 small catchments

Nitrogen conc. (mg N l⁻¹)

N surplus, field (10³ ton N)

y = 0.0232x + 0.13
r² = 0.80

National figures
44 small catchment; Change (%) in Nitrogen concentration,
44 small catchment; Change (%) in Nitrogen concentration,

Differences ..
Interannually ??
Longterm reduction: 7-63%
Age (retention time) for oxidized water modelled using particle tracking techniques in (MIKE SHE national hydrological model)

Long term trend.....

Nitrogen leaching

Retention in groundwater

Oxidized
Reduced

Statistical models for retention in surface waters

Department of Bioscience
AARHUS UNIVERSITY, DENMARK
Long term trend.....

44 catchments variations in age of oxidized ground water

< 1 year
1-3 year
> 3 year

Modelled 95% Fraq for oxidiced water used in the age estimation, (proxy)
Long term trend.....

Significant differences in long term N reduction related to ‘Age Group’ of oxidized water

Min, max, 25 & 75Q & Mean

<table>
<thead>
<tr>
<th>Age group</th>
<th>Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: &lt;1 year</td>
<td>52%</td>
</tr>
<tr>
<td>(n=8)</td>
<td></td>
</tr>
<tr>
<td>B: 1 to 3 years</td>
<td>44%</td>
</tr>
<tr>
<td>(n=22)</td>
<td></td>
</tr>
<tr>
<td>C: &gt;3 years</td>
<td>38%</td>
</tr>
<tr>
<td>(n=15)</td>
<td></td>
</tr>
</tbody>
</table>
Interannual variation
Inter-annual variation

![Graph showing inter-annual variation of nitrogen reduction]

- **Y-axis**: Nitrogen reduction
- **X-axis**: Hydrological year
- **Legend**: Diffuse N load (%) and Part vinter runoff (%)
Inter_annual variation
Conclusions

• Diffuse loss of Nitrogen on average reduced 44%.
• Mainly governed by mandatory national regulations causing reduction in Nitrogen surplus.
• Huge variations in N reduction on local level (7-63%).
• Part of this variation can be explained by differences in oxic ground water age in discharge within the specific catchment.
• Huge inter-annual variations influenced by climate signal (temperature, precipitation). We found it difficult to filter out this climatic signal over the time series.
• Further work has to be conducted in order to optimize our possibilities for interpretation of short term changes in time series (valid early warning).