Agriculture and Air Pollution

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The Issues

• Nitrogen Flows and Pollution
  – Ammonia (NH₃) emissions from manure and fertilizers
  – Nitric Oxide (NO) emissions from fertilized soils
  – Other key routes for agricultural pollution
    • Nitrous oxide (N₂O)
    • Nitrate leaching (NO₃)
    • Di-nitrogen (N₂)

• Methane from livestock and rice cultivation

• Threats
  – Human health, Ecosystems, Agricultural Crops
Nitrogen oxides (NO\textsubscript{x})

Further emission of NO\textsubscript{x} & N\textsubscript{2}O carrying on the cascade

Natural ecosystems

Leached Nitrate (NO\textsubscript{3}\textsuperscript{-})

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Terrestrial Eutrophication

Soil acidification

Freshwater Eutrophication

Marine Eutrophication

Eventual denitrification to N\textsubscript{2}

Environmental concern from N\textsubscript{2}

N form in the cascade

Intended N flow

Unintended N flows

Crop biological nitrogen fixation

Fertilizer manufacture

High temperature combustion & industry

Ammonia (NH\textsubscript{3})

Ammonium nitrate (NH\textsubscript{4}NO\textsubscript{3})

Further emission of NO\textsubscript{x} & N\textsubscript{2}O carrying on the cascade

Particulate Matter

Tropospheric ozone formation

Urban air quality

Greenhouse gas balance

Stratospheric ozone loss

Terrestrial Eutrophication

Freshwater Eutrophication

Marine Eutrophication

European Nitrogen Assessment, 2011
The five key threats of excess Nitrogen

The WAGES of too much nitrogen

Water quality
Air quality
Greenhouse balance
Ecosystems
Soil quality
What is the priority for agricultural emissions?

Van Grinsven et al., ES&T, 2013 updating ENA
European nitrogen emissions expressed as lost fertilizer value

Loss as $N_r$ to air: 8 M tonne/yr
Loss as $N_r$ to water: 5 M tonne/yr
Loss as $N_2$: 9 M tonne/yr
Total N loss: 22 M tonne/yr
At €0.8/kg N = €18 billion per year

Values for EU27 from ENA.
Component N losses to air:
$NH_3$: 3.2  $NO_x$: 3.5  $N_2O$: 1.2 (M tonne/yr)

25% of CAP
10% of total EU budget
Gothenburg Protocol Revision
TFRN Five Priorities for Ammonia

1. Low emission land spreading
2. Animal feeding strategies
3. Covers on new slurry stores
4. Farm N balances
5. Low emission housing
Share of NO\textsubscript{x} emissions from agricultural soils is increasing – Need to include in future ceilings

http://ec.europa.eu/eurostat/data/database

Liu et al, Global Change Biology 23, 2017

Analysis from Ute Skiba, CEH
Agriculture and the Nitrogen Policy Arena

Nitrogen Coordination Mechanism?

Overarching Goals including
Economy Wide Nitrogen Use Efficiency
More food and energy with less pollution

INMS
International Nitrogen Management System
(Science Support Process linking threats & benefits)

Climate:
UNFCCC

Air Quality:
LRTAP
+ regional

Biodiversity:
CBD

Marine:
GPA
+ regional

Stratosphere:
Montreal Protocol

www.inms.international

How can the Air Convention
get the best from UNEA-3?
How do damaged ecosystems look?

Sphagnum Bog in Northern Ireland near a poultry farm

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Recovering Sphagnum Bog in Northern Ireland

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The bottom line

• Big emission reductions are possible for agriculture
  – it depends on political will

• Joining up agriculture and air pollution
  – NH$_3$ mitigation options are now the “low-hanging fruit”
  – NO$_x$ from agricultural soils needs to be integrated
  – Multiple co-benefits in linking the N cycle (WAGES)
  – Joining up can help overcome the barriers
  – Profit opportunities in N mitigation: the Circular Economy