



# Grasping the global nitrogen challenge: a personal path from science to intergovernmental action

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Valuing Nature International e-Summit  
23 March 2021



International Nitrogen  
Management System

 @MarkNitrogen



## **Question: What is the secret to funding international science on valuing nature?**

- **Answer:** It is the wrong question.
- **Better Question:** How can one identify a gap/barrier in understanding or practice that really needs to be filled?
- If the work identifies a key need and is leading edge, then funding should follow naturally...
- Consider 10 Steps to making a difference...

# Overarching vision for my research

Understand processes of  $\text{NH}_3$  and N



Scale up the fluxes & interactions



Integrate nitrogen  
science disciplines



Develop nutrient management  
& mitigation options



Distil the messages & learn from society



# What is Nitrogen?

Di-nitrogen ( $N_2$ )



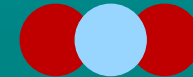
Ammonia ( $NH_3$ )



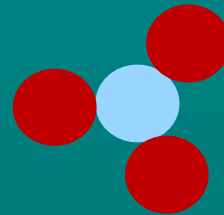
Nitric oxide ( $NO$ )



Nitrogen dioxide ( $NO_2$ )



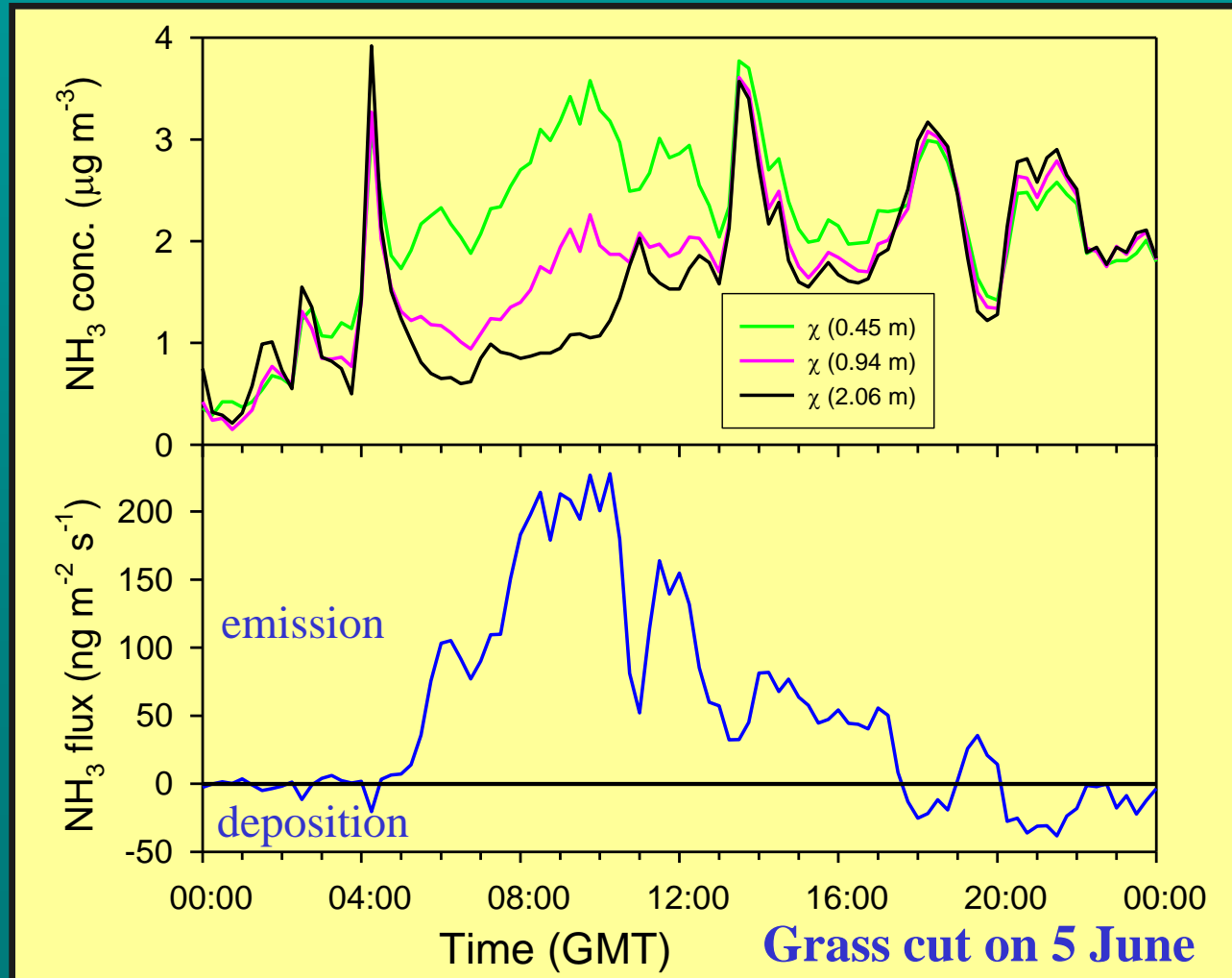
Nitrates ( $NO_3^-$ )



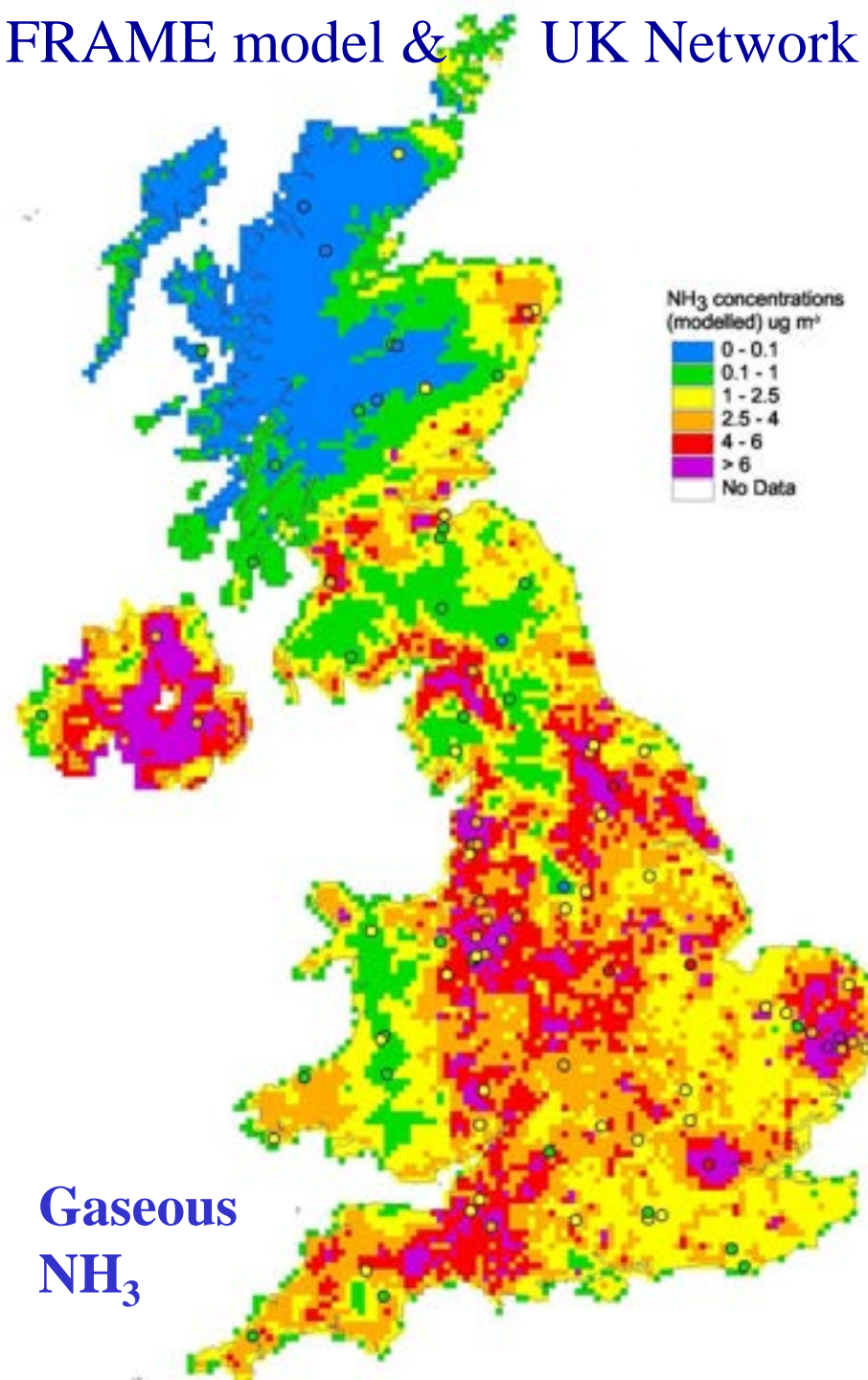
Nitrous Oxide ( $N_2O$ )



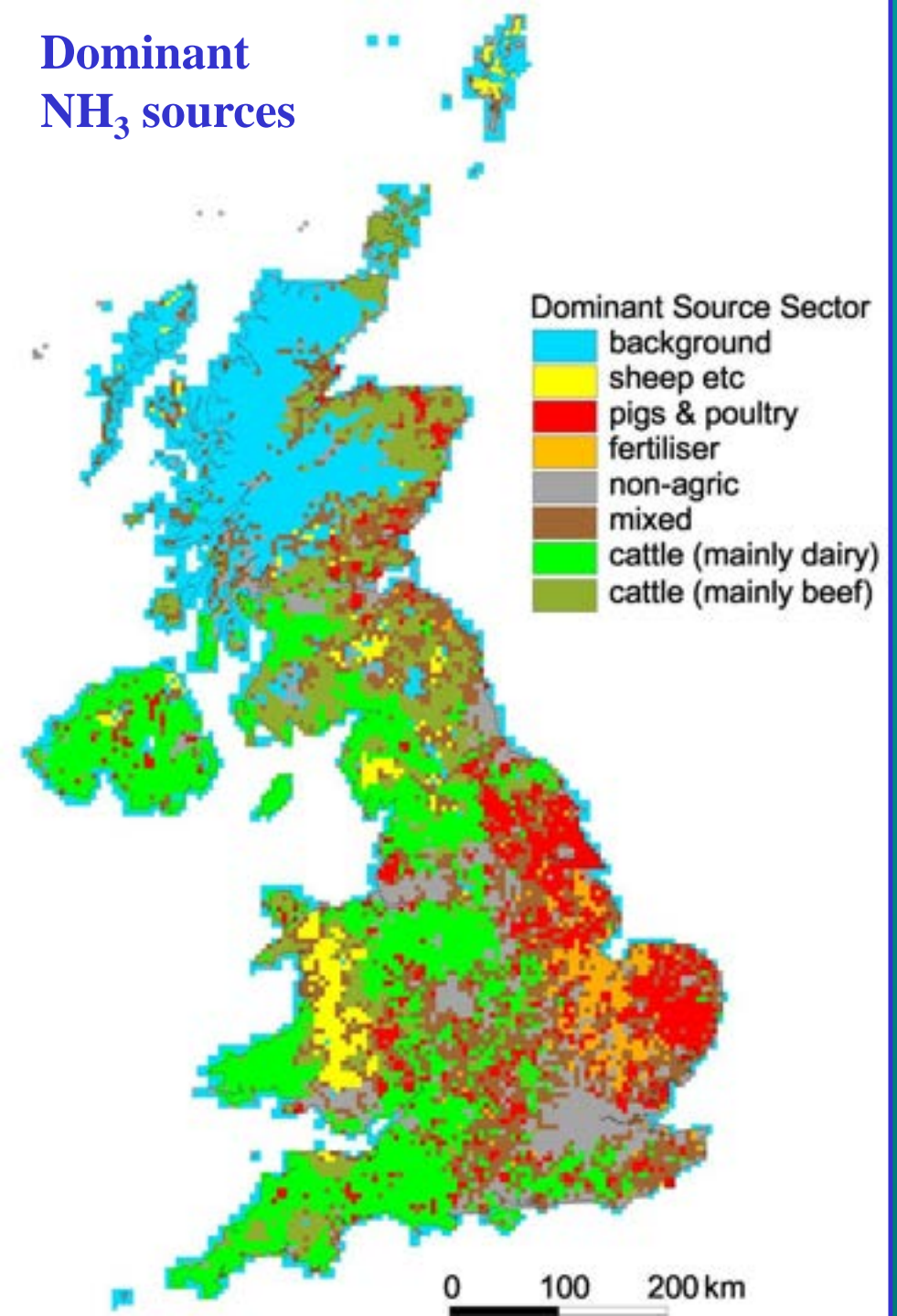
# Ammonia nitrogen is emitted to air from cut grass and also absorbed by vegetation



Developing core expertise



Gaseous  
 $\text{NH}_3$



# Research Funders & Projects

- 1991 Defra – request to increase fundamental understanding..
- 1994 EXAMINE EU (FP4) – 6 institutes (fundamental understanding)
- 1998 GRAMINAE EU (FP5) – 10 institutes (fundamental understanding)
- 2006 NitroEurope EU (FP6) – 60 institutes (understanding, integration, application)
- 2011 ECLAIRE EU (FP7) – 40 institutes (understanding integration, application)
- 2016 INMS (Global Environment Facility – 80 organizations (synthesis, global mobilization)
- 2019 SANH (UK Global Challenge Research Fund) – 50 organizations, South Asia, science to global transformation).

# The European Nitrogen Assessment

Sources, Effects and Policy Perspectives

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CAMBRIDGE

Farming

Union defends use of nitrogen in high-octane climate change debate

# COMMENT

Vervuiling met stikstof kost miljarden

Nitrogen taint alert

Warning over nitrogen footprint

Pollution à l'azote : une lourde facture pour l'Europe

## Too much of a good thing

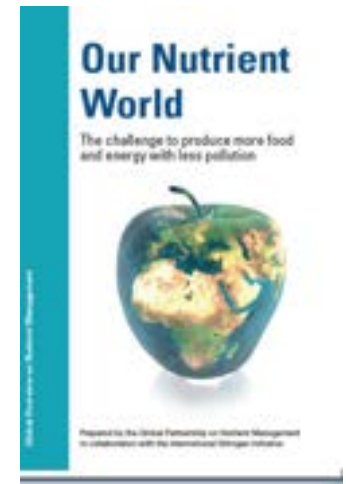
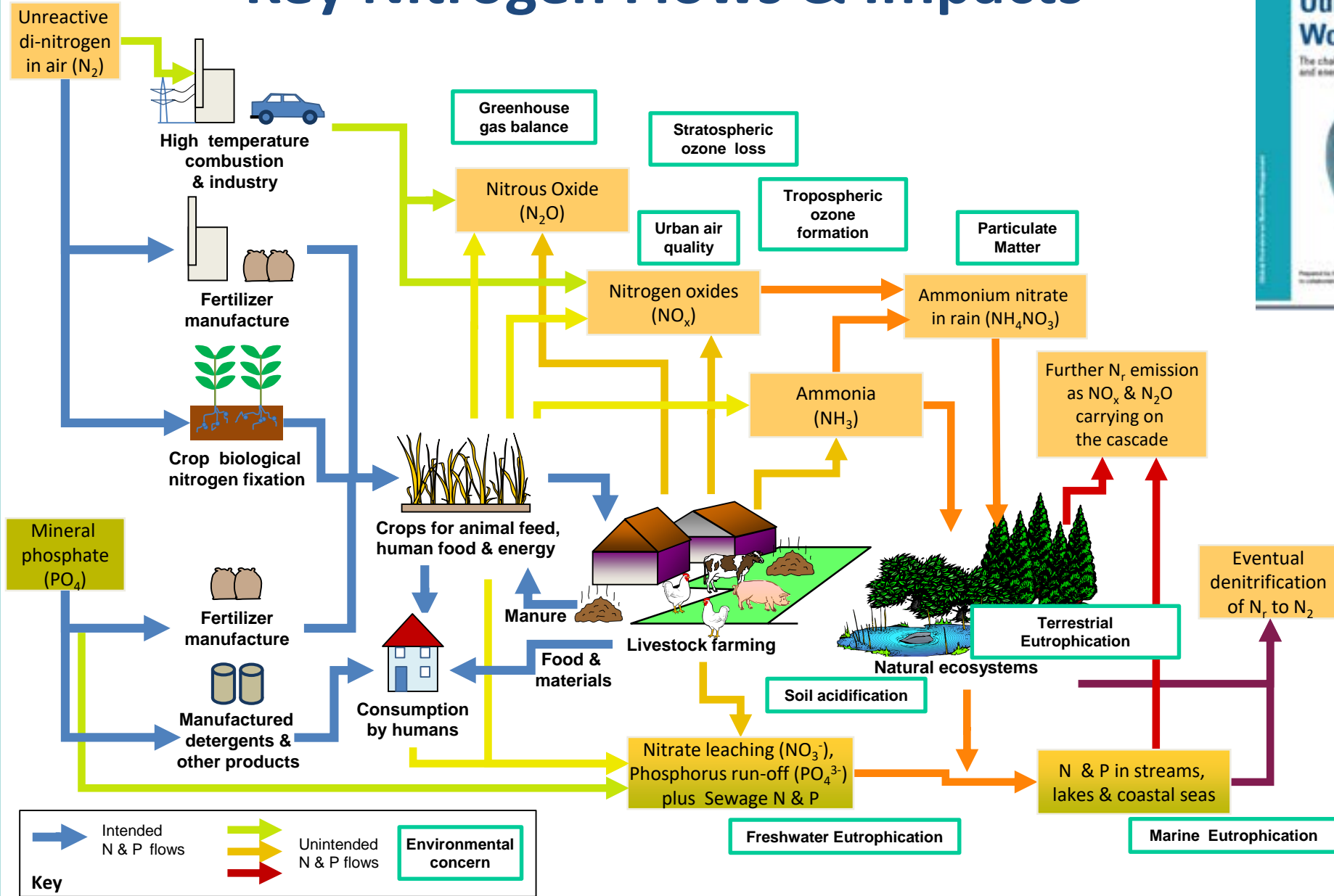
Curbing nitrogen emissions is a central environmental challenge for the twenty-first century, argue Mark Sutton and his colleagues.

*Nature* 14 April 2011

[www.nine-esf.org/ENA](http://www.nine-esf.org/ENA)



# Key Nitrogen Flows & Impacts



# Step 1: Simplify and Bring People Together

The WAGES of  
too much nitrogen

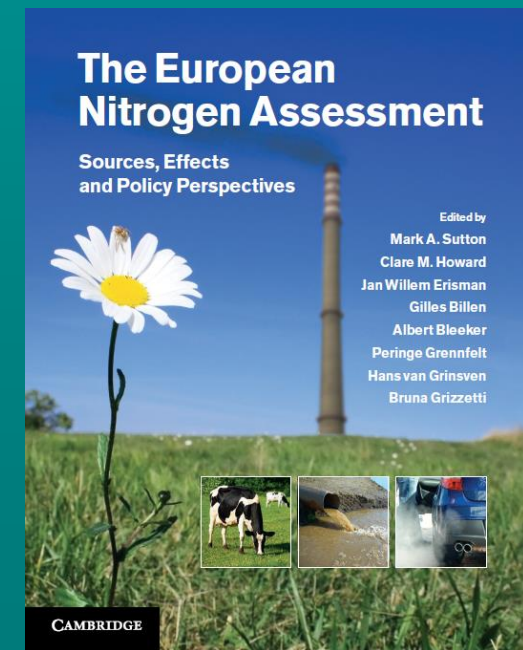
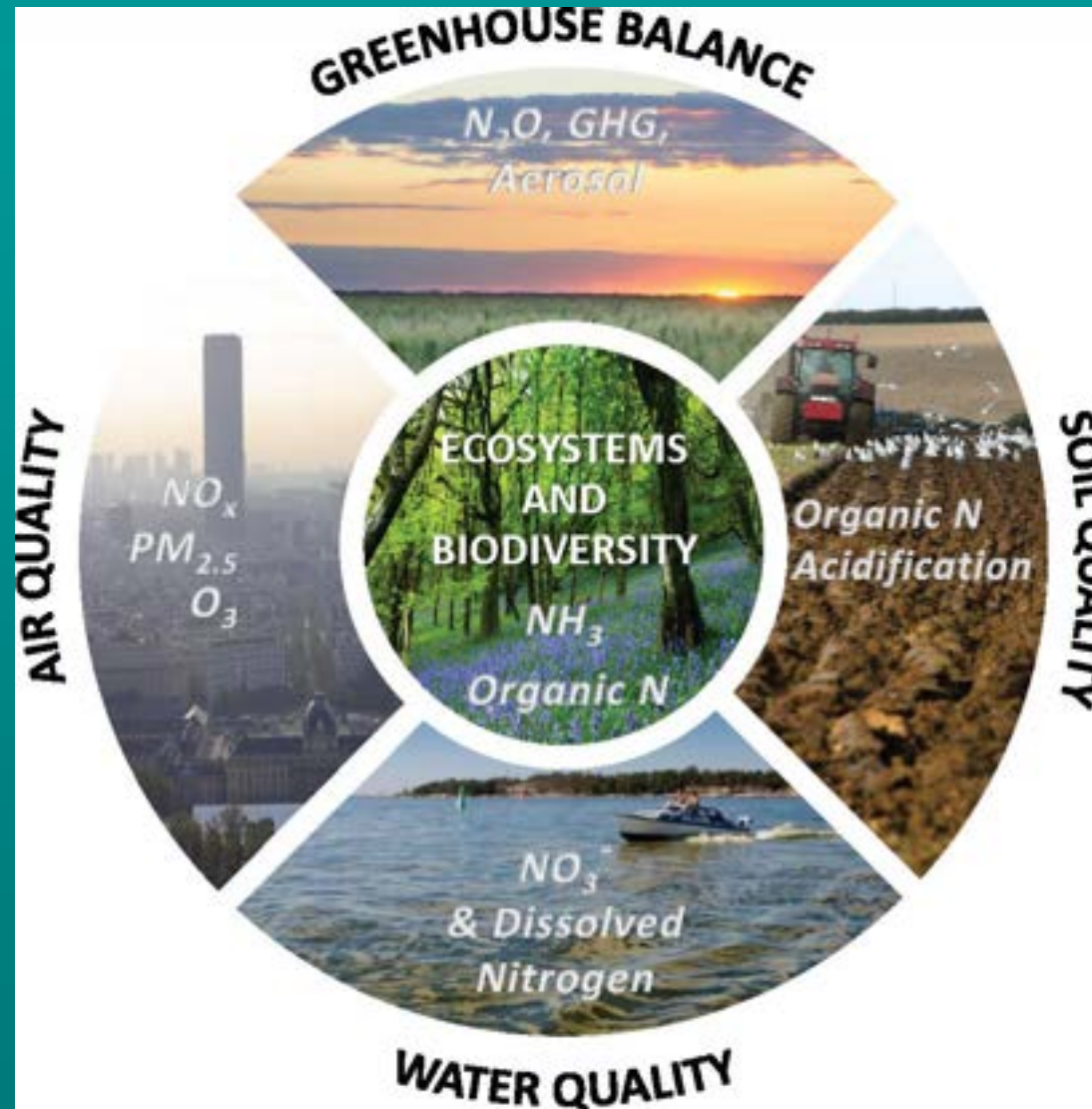
Water quality

Air quality

Greenhouse balance

Ecosystems

Soil quality

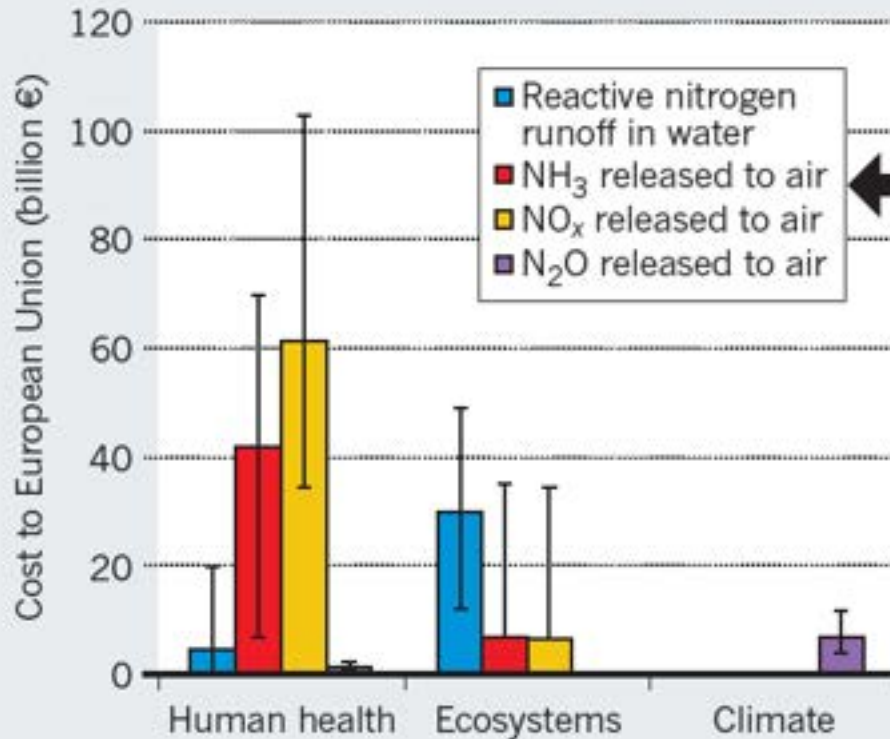


# Step 2: Speak their Language...

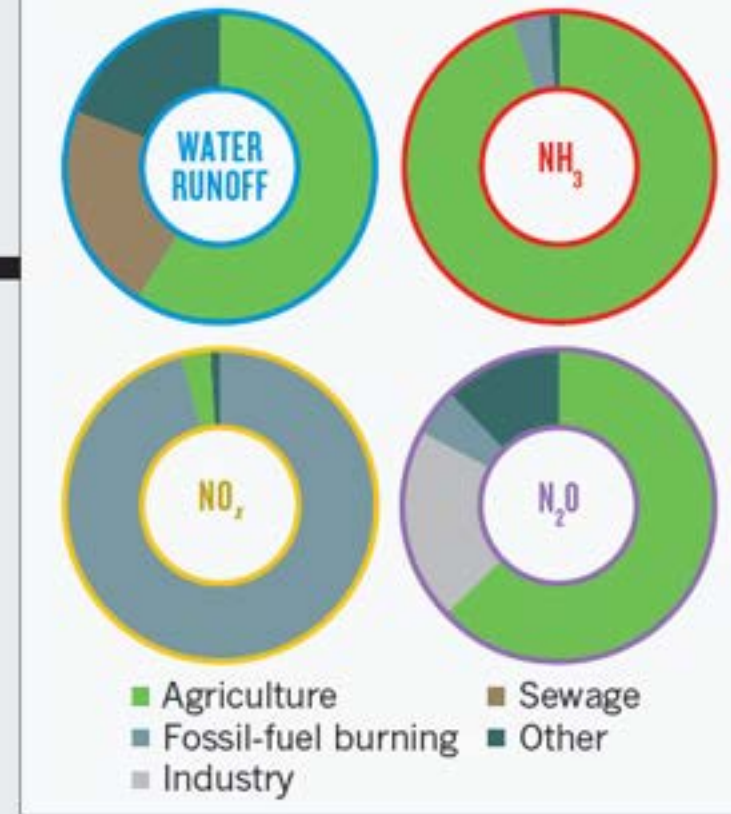
# Nitrogen and Money

## DAMAGE COSTS OF NITROGEN POLLUTION

Agriculture and fossil-fuel burning load the environment with reactive nitrogen, affecting water, soils and air.



## MAIN NITROGEN SOURCES



EU Damage cost: 70 - 320 billion € / year

ENA and *Nature* 14 April 2011

# 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:	<u>22 M tonne/yr</u>
At €0.8/kg N =	€18 billion per year

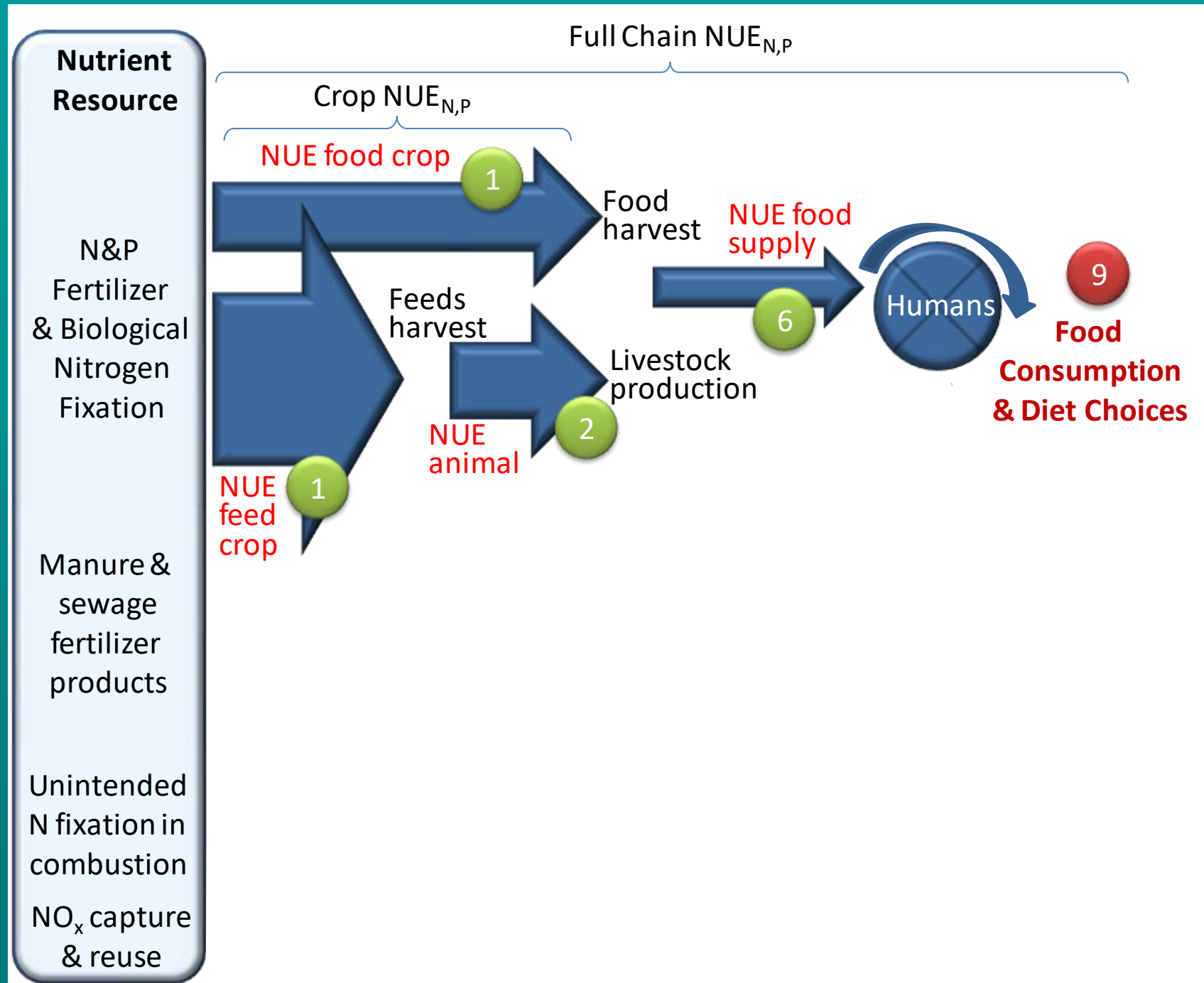
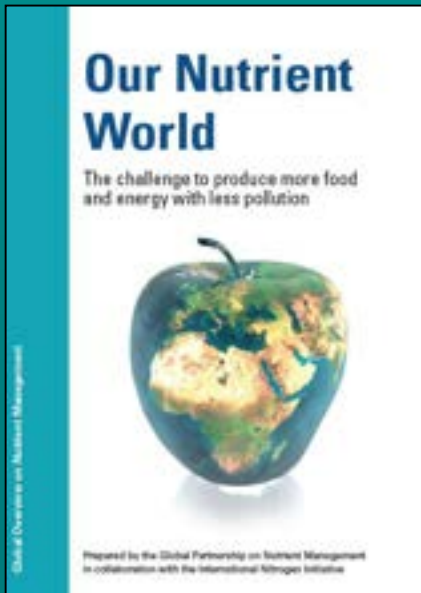
Values for EU27 from ENA.

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**

# Step 3: Identify Practical Solutions



# UNECE Guidance Document on Integrated Sustainable Nitrogen Management

- Brussels Workshops 2016, 2019
- TFRN/WGSR revision Apr-June 2020
- 24 principles; 76 specific measures
- Adopted by UN Air Convention on 13-17 December 2020

**Step 4: Build confidence through authoritative delivery**

**Step 5: Spend a lot of time in Geneva, Brussels, Nairobi....**



Dietary Measure 5: Adapt protein intake in diet (poultry)

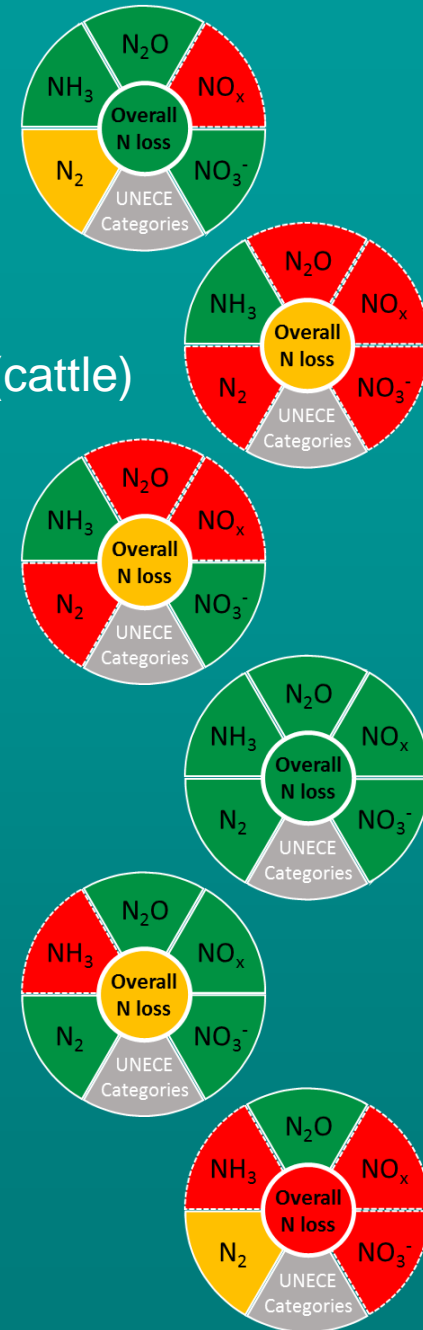
Housing Measure 1: Immediate segregation of urine and faeces (cattle)

Manure Measure 2: Covered storage of slurry (natural crust & impermeable base)

Nutrient Recovery Measure 5: Ammonia stripping and recovery

Field Measure 14: Nitrification inhibitors (with inorganic fertilizers)

Landscape measure 8: Drainage management





## Leading articles

28 January 2015



## Eat Less Meat

A vital message is buried in a new report on climate change

It is not alarmist to predict food shortages and price inflation within the next half century if we fail to change what we eat. The world's population, now roughly seven billion, is expected to rise to ten billion by 2050. More than 200 million hectares of forest have been cleared for farming in the past ten years and forest clearance in the Amazon alone continues at a rate equivalent to 93 football pitches an hour. In the meantime, by far the most costly use of farmland is for grazing cows and sheep.

Rising crop yields and better science will undoubtedly help with food supply, but rising prosperity will also give more humans a taste for beef and lamb. One option is to herd the bulk of the world's livestock indoors. The animals producing most of our red meat would never see the light of day or breathe fresh air. That might be economical but it would be neither compassionate nor healthy — for humans or the animals themselves. The right course is to raise livestock with due regard for animal welfare and retain meat as part of a balanced diet. That means eating less of it.

**How much less? For Britons, 40 per cent less,**

according to the Department of Energy and Climate Change. The figure comes from a report on changes that the department says will have to be made to our lives to do our "fair share" towards limiting global carbon emissions.

Meat production is a carbon-intensive business, and the political urgency behind the report is the need to appear serious about carbon emissions in the build-up to a UN climate conference in Paris in November. The environmental urgency is another matter. It will be hotly debated long after the conference, whether or not the heads of state attending reach any sort of accord and whether or not world temperatures actually rise in line with scientists' projections.

What is not in doubt is the compelling case for cutting back on meat, regardless of its impact on global warming. A 30 per cent reduction in meat consumption would, a former chief medical officer has said, prevent 18,000 premature deaths a year in Britain. Globally, meat farming is a big cause of acid rain because of the high ammonia content in animal waste. It is a principal cause of deforestation but also of desertification as a result

of over-grazing. The former drives down biodiversity. The latter hurts farm yields, and both trends will only worsen as demand for a more western diet grows among China's rapidly expanding middle class.

That demand will be used as an argument for more intensive factory farming of cattle and sheep. The technology exists and is being used to house huge new Chinese herds that live almost entirely indoors. This is neither an ethical nor a sustainable food future. The lesson of battery-farmed poultry and pork is that it depends on the over-use of antibiotics and produces meat that is too high in fat and low in protein to be worth the cost in animal welfare.

There is no doubt that freely grazing cattle are inefficient converters of farmland to food. A field the size of a football pitch produces, by weight, 60 times more fruit and vegetables than beef. This is not an argument for more industrialised farming, but for changing our habits. The US Department of Agriculture will shortly urge Americans to eat less meat. It is good advice. If we all did, we would be healthier and might even enjoy it more.

## Nitrogen on the Table

The influence of food choices on nitrogen emissions and the European environment.



Special Report of the European Nitrogen Assessment



- Halving EU meat intake would reduce nitrogen pollution by 40%
- NUE of the EU increases from 10% to 15%

## Raise taxes on meat to push us into a balanced diet

Ben Webster Environment Editor

Extra taxes could be imposed on meat to deter families from buying it, according to a United Nations task force which recommends halving consumption of meat and dairy products to reduce pollution.

Britain's livestock farmers would suffer a "severe" loss of income from such a change in diet but there would be environmental benefits, including less pollution of the air, water and soil, and lower greenhouse gas emissions.

A team of scientists advising the United Nations Economic Commission for Europe (Unesco) studied ways of reducing nitrogen pollution from chemical fertiliser and manure.

The task force on reactive nitrogen concluded that if everyone in the EU became "decentarian" — halving the amount of meat and other animal prod-

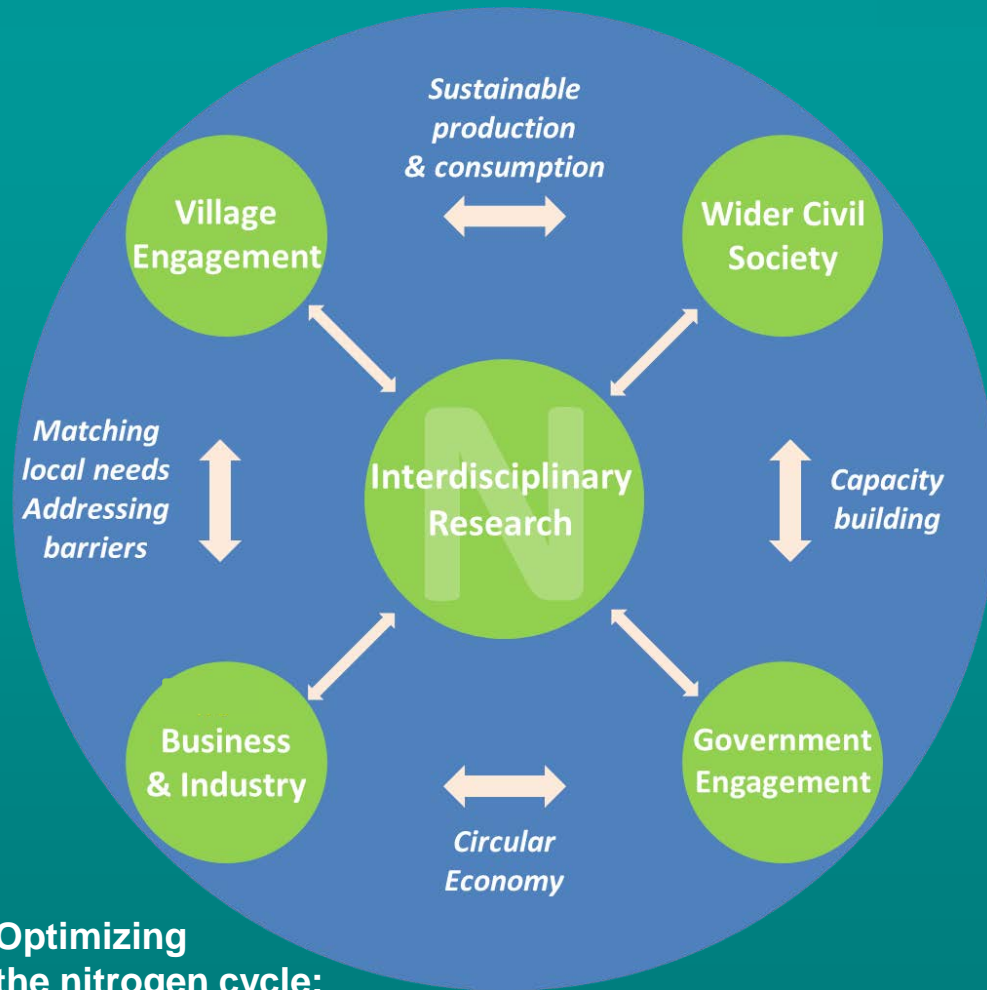
ucts to 50 per cent of current levels.

The team questioned whether people would be likely to cut consump-

tion of meat to feed livestock. The report says the land could be used for growing biofuels to replace fossil fuels. Professor

"Some of this land can only be used for pasture and goes some way to protecting our wonderful countryside."

# Step 6: Get some funding: UKRI GCRF South Asian Nitrogen Hub



Optimizing the nitrogen cycle:  
More food and energy with less pollution

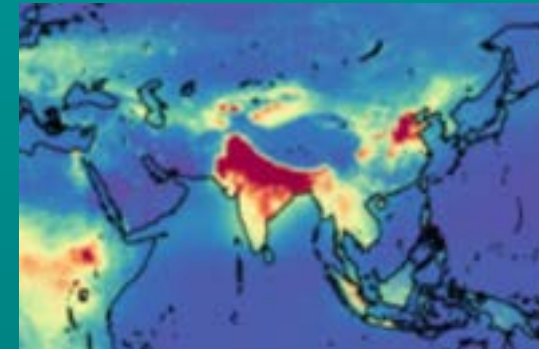


RP1: Building the Nitrogen Policy Arena for South Asia

RP2: Nitrogen solutions to maximize resilience, co-benefits & reduce trade-offs

RP3: Improving understanding & awareness of key nitrogen threats

RP4: Integrating regional nitrogen flows & impacts in South Asia



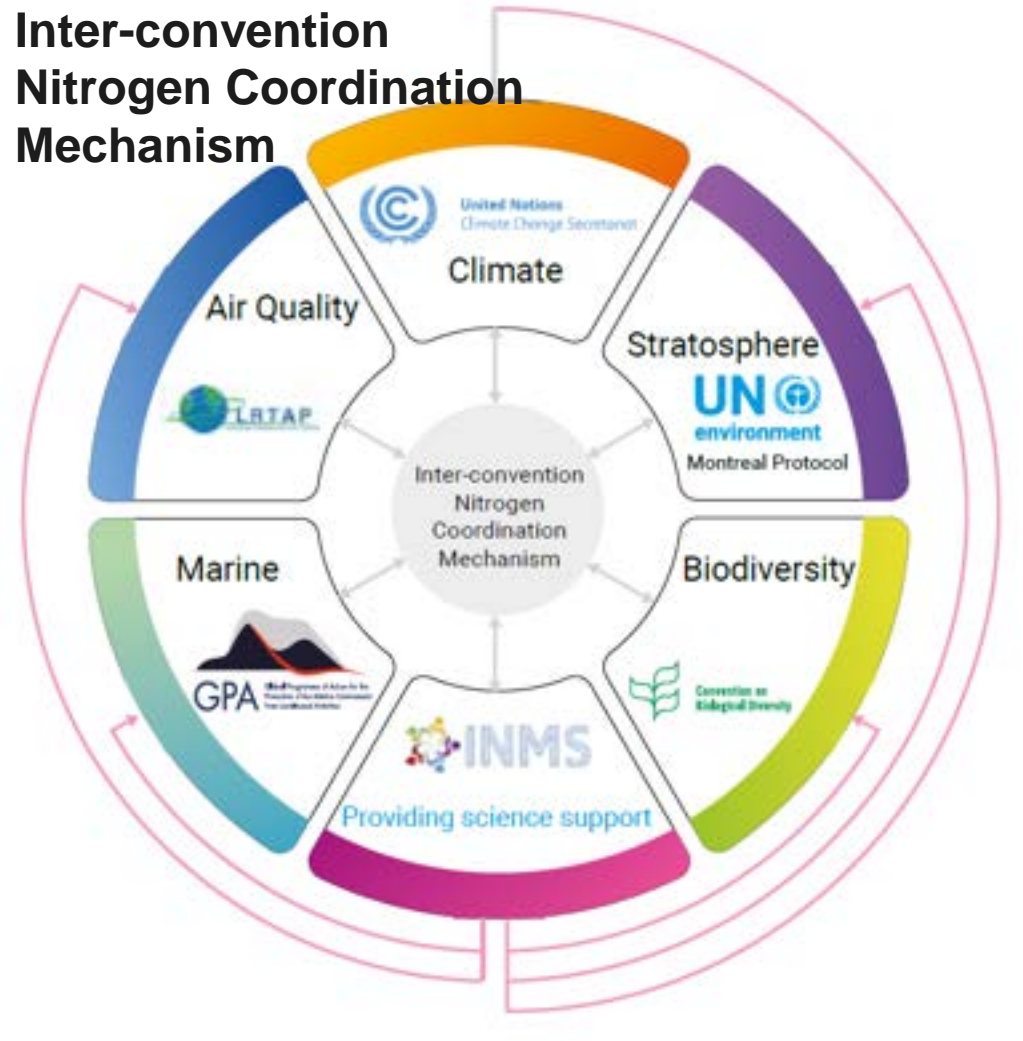
Ammonia from space – see Sutton & Howard, Nature 2018

**IMPACT:** Science, practice & diplomacy to reduce some of the world's worst nitrogen pollution, with multiple benefits



# Towards improved nitrogen science and policy coordination

## Inter-convention Nitrogen Coordination Mechanism



## Foreword



## FRONTIERS 2018/19

Emerging Issues of Environmental Concern



“Every year, an estimated US\$200 billion worth of reactive nitrogen is now lost into the environment, where it degrades our soils, pollutes our air and triggers the spread of “dead zones” in our waterways.”



Joyce Msuya  
Acting Executive Director  
United Nations Environment Programme

## Step 8: Establish a global process with visibility...

- International Nitrogen Management System established (2016)
- GCRF South Asian Nitrogen Hub established (March 2019)  
- Regional championship for global transformation
- Resolution 4/14 on Sustainable Nitrogen Management adopted at 4<sup>th</sup> UN Environment Assembly (March 2019)
- Launch of UN Nitrogen Campaign ‘Nitrogen for Life’ under lead of President of Sri Lanka (October 2019)
  - Colombo Declaration agrees to work on national roadmaps with “ambition to halve nitrogen waste by 2030”, preparing for UNEA-5
  - First Nitro-Innovation Exhibition
  - Premiere of the Nitrogen Song with Grammy<sup>®</sup> Award winner Ricky Kej
- First meeting of the Inter-convention Nitrogen Coordination Mechanism – INCOM (June 2020)



[www.inms.international](http://www.inms.international)

 @MarkNitrogen



United Nations  
Environment Assembly of the  
United Nations Environment  
Programme

UNEP/EA.4/L.16

Distr.: Limited  
9 March 2019

Original: English

## Resolution UNEP/EA.4/L.16 agreed UNEP/EA.4/Res.14 final

United Nations Environment Assembly of the  
United Nations Environment Programme  
Fourth session  
Nairobi, 11–15 March 2019

### Sustainable nitrogen management\*

*The United Nations Environment Assembly,*

*Recognizing* the multiple pollution threats resulting from anthropogenic reactive nitrogen, with adverse effects on the terrestrial, freshwater and marine environments, contributing to air pollution and greenhouse gas emissions, while acknowledging the benefits of nitrogen use for food and energy production,

*Recognizing also* that global crop production in the world and the world's food security is dependent on nutrients, including nitrogen and phosphorus resource use,

*Calls on* the Executive Director of the United Nations Environment Programme to:

- (a) Consider the options to facilitate better coordination of policies across the global nitrogen cycle at the national, regional and global levels, including consideration of the case to establish an intergovernmental coordination mechanism on nitrogen policies, based primarily on existing networks and platforms and consider the case for developing an integrated nitrogen policy, which could enhance the gravity of common cause between multiple policy domains,

# Launching of the United Nations Global Campaign on Sustainable Nitrogen Management

23 -24 October 2019

Colombo, Sri Lanka



## Colombo Declaration on Sustainable Nitrogen Management

We, the Member States of the United Nations Environment Programme (UNEP) participating in the Ceremonial Launching of the United Nations Global Campaign on Sustainable Nitrogen Management,

'Nitrogen for U

Recognizing t  
Ministries suc  
stakeholders,

2. Call upon UN agencies and other international organizations, development partners, philanthropic agencies, academic and civil society organizations, to support the implementation of this Declaration, through the establishment of mechanisms of cooperation to mobilize human, financial and technical resources, including capacity building and transfer of know-how and technology, for this purpose;
3. Agree that countries should consider, in line with their national circumstances and where relevant, to:
  - 3.1 Develop and implement comprehensive policies on Sustainable Nitrogen Management;
  - 3.2 Develop national roadmaps for sustainable nitrogen management, with an ambition to halve nitrogen waste by 2030;
  - 3.3 Conduct comprehensive assessments on quantitative and qualitative nitrogen cycling covering scientific aspects, policy, regulation and implementation;
  - 3.4 Promote innovation on anthropogenic nitrogen use and recycling, emphasizing the opportunities for the circular economy;

# Next Steps to “Halve Nitrogen Waste”

- Pin-ball multiplier:  
UN Decade of Ecosystem Restoration  
“Halve nutrient pollution by 2030....”
- Equitable approach: more waste means more action needed
- Massive economic & environmental benefits for climate, air, water, health biodiversity etc.
- Business opportunities for circular economy (*30% of fertilizer made from recycled sources by 2030...?*)
- Action for Glasgow COP26...

*Feedback to our science agenda!*



**Step 9: Build our narratives with evidence to colour the picture**

# 10 steps to Selling Nitrogen the Idea... & Mobilizing Global Action

- Step 1: Simplify and bring people together
- Step 2: Speak their Language... Nitrogen and Money
- Step 3: Identify Practical Solutions
- Step 4: Build confidence through authoritative delivery
- Step 5: Spend a lot of time in Geneva, Brussels, Nairobi...
- Step 6: Get some funding...
- Step 7: Mobilizing... Find your Nitrogen Champions
- Step 8: Establish a global process with visibility
- Step 9: Build our narratives with evidence to colour the picture
- Step 10: Building a durable process...