Development of Methodology for Nitrogen Fluxes and Distribution

A1.3 /Component 1

Bill Bealey (UKCEH) & Kevin Hicks (SEI, University of York)

INMS-5 Meeting 7th July 2020

A1.3 Activities and Outputs

INMS

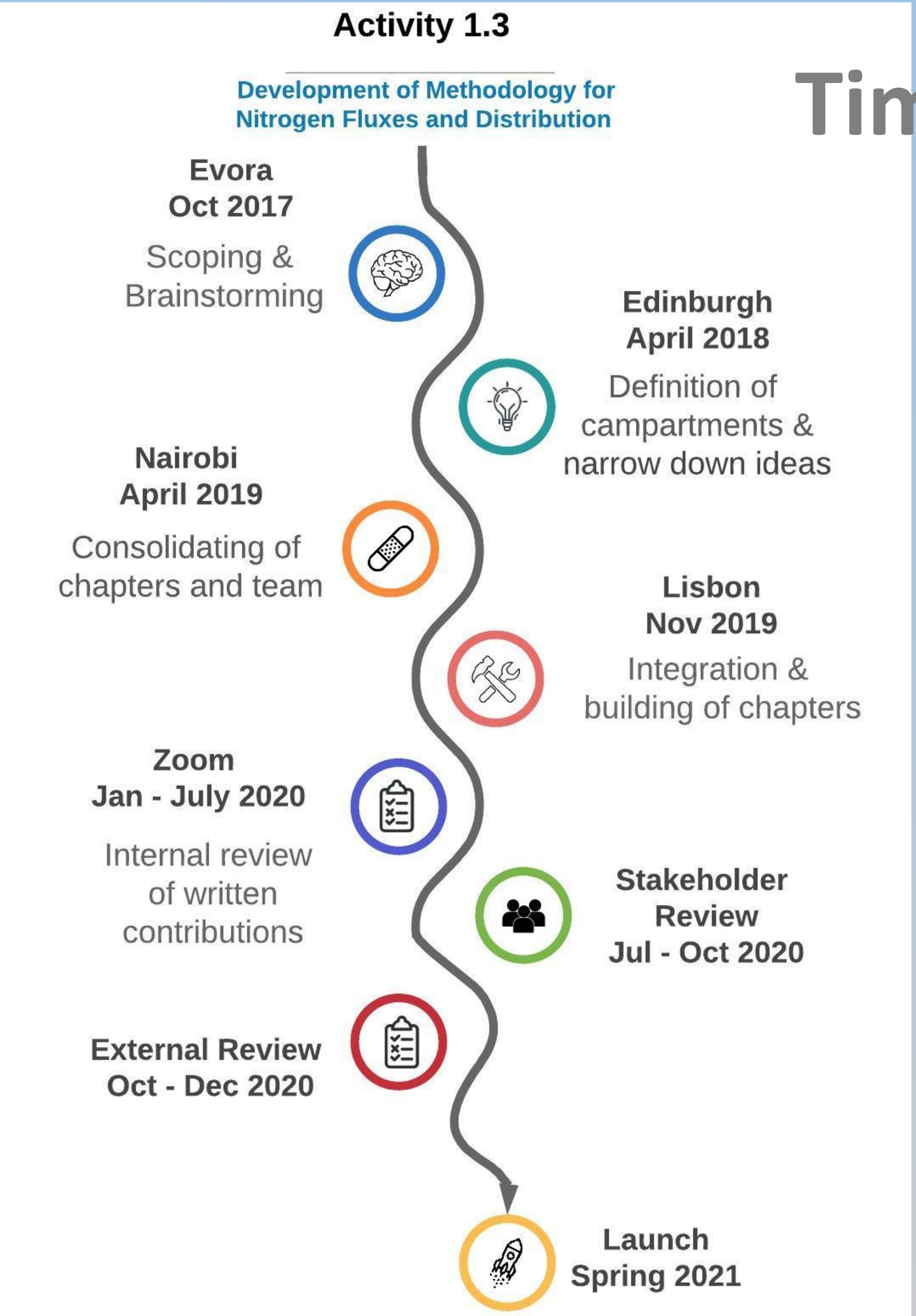
			Oct-Dec 2017							Oct-Dec 2019				Oct-Dec 2020		Apr-June 2021
Activity 1.3 Development of methodology for N fluxes and distribution																
		Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3
Task 1.3.1 Scoping of N flux and distribution methods (air, land, water, marine, trade)	W			~~R~~	~~R~~			R									
Task 1.3.2 Conduct reviews of N flux and distribution methods for environ. compartments								~~R~~		R							
Task 1.3.3 Workshop on harmonizing methodologies for key N fluxes and distribution											W						
Task 1.3.4 Preparing guidance on N flux & distribution methods, plus international support															R		
Monitoring and Evaluation						R				R				R			R

4

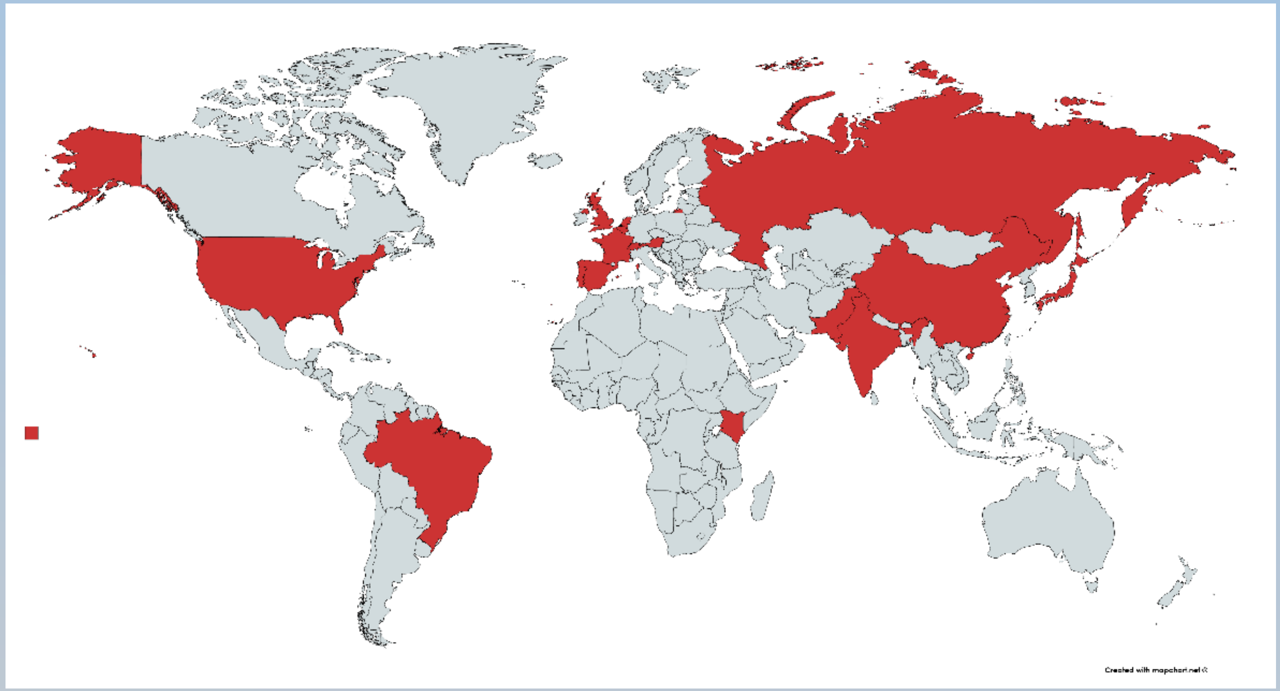
Key Outputs

1. Guidance Document - ~100pp printed and online document
2. Online N Flux tool with associated method records database
3. Contributing chapter to the International Nitrogen Assessment

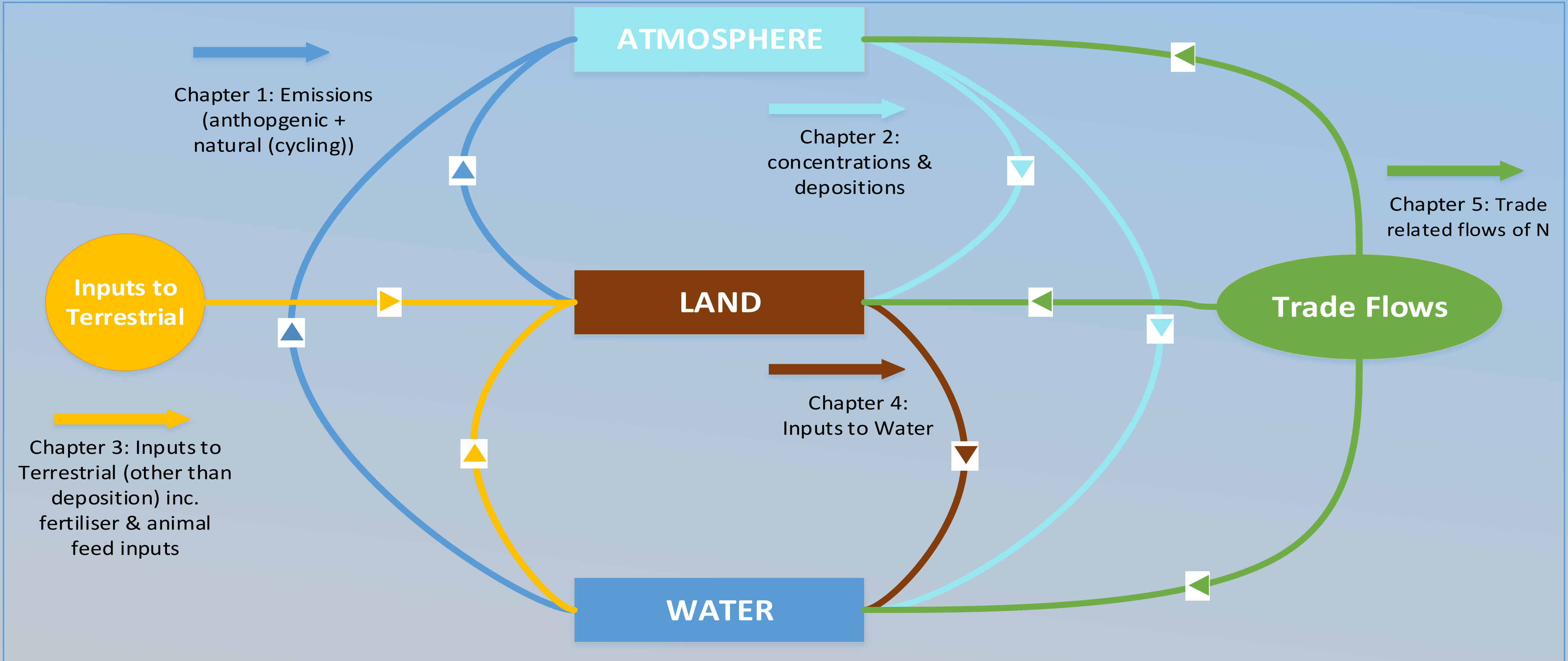
Timeline of Activities for Activity 1.3

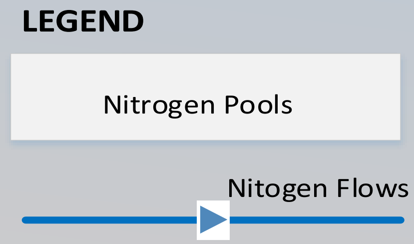


Growing author network (n > 30)

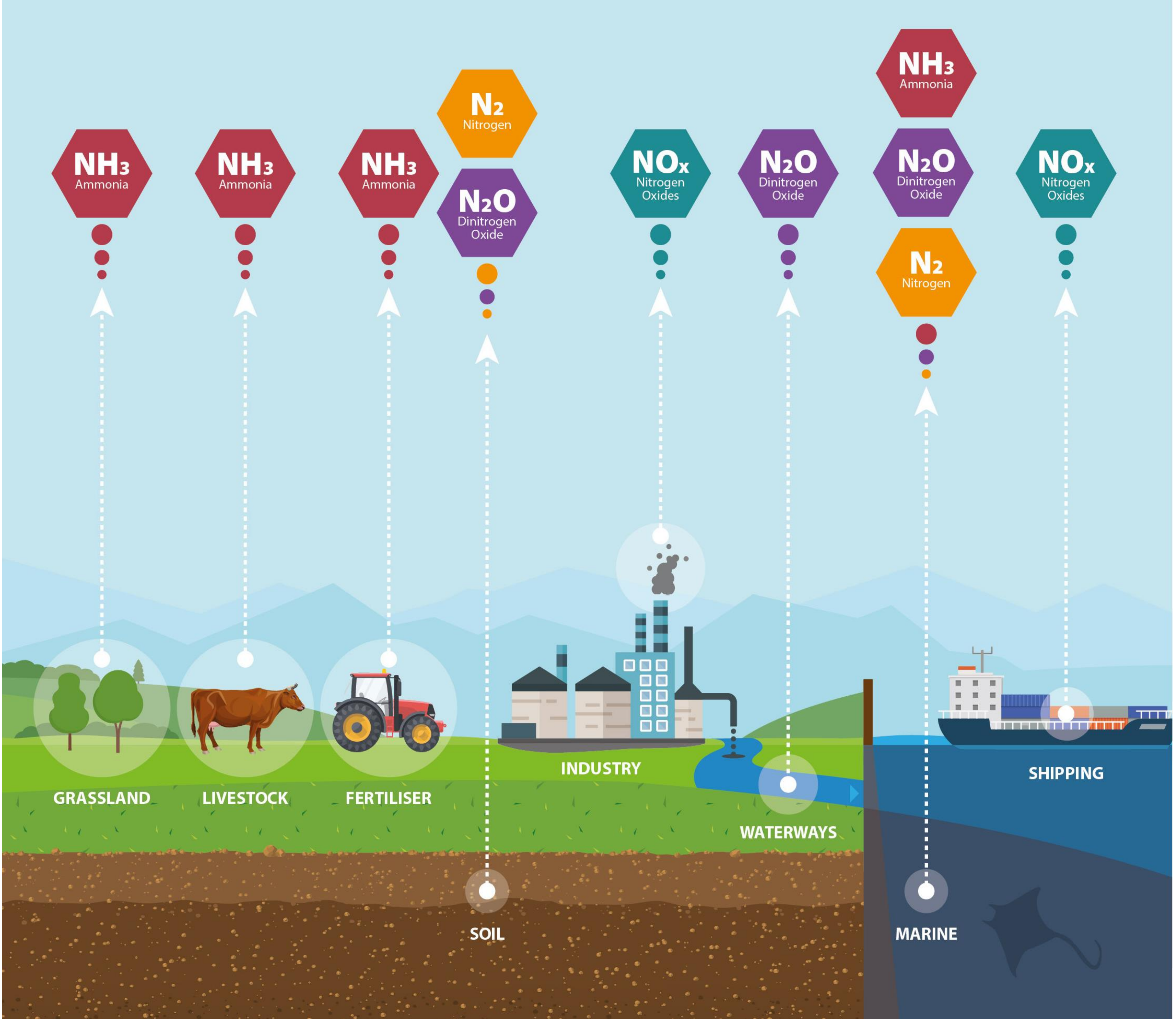


Chapter N Flux Scheme





Guidance produced will be aimed at policy makers, their agencies and practitioners – ‘the customers’ to give them appropriate methodologies to measure key N flows



Chapter 1: Emissions to atmosphere

Lead Authors

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Other contributors to date:

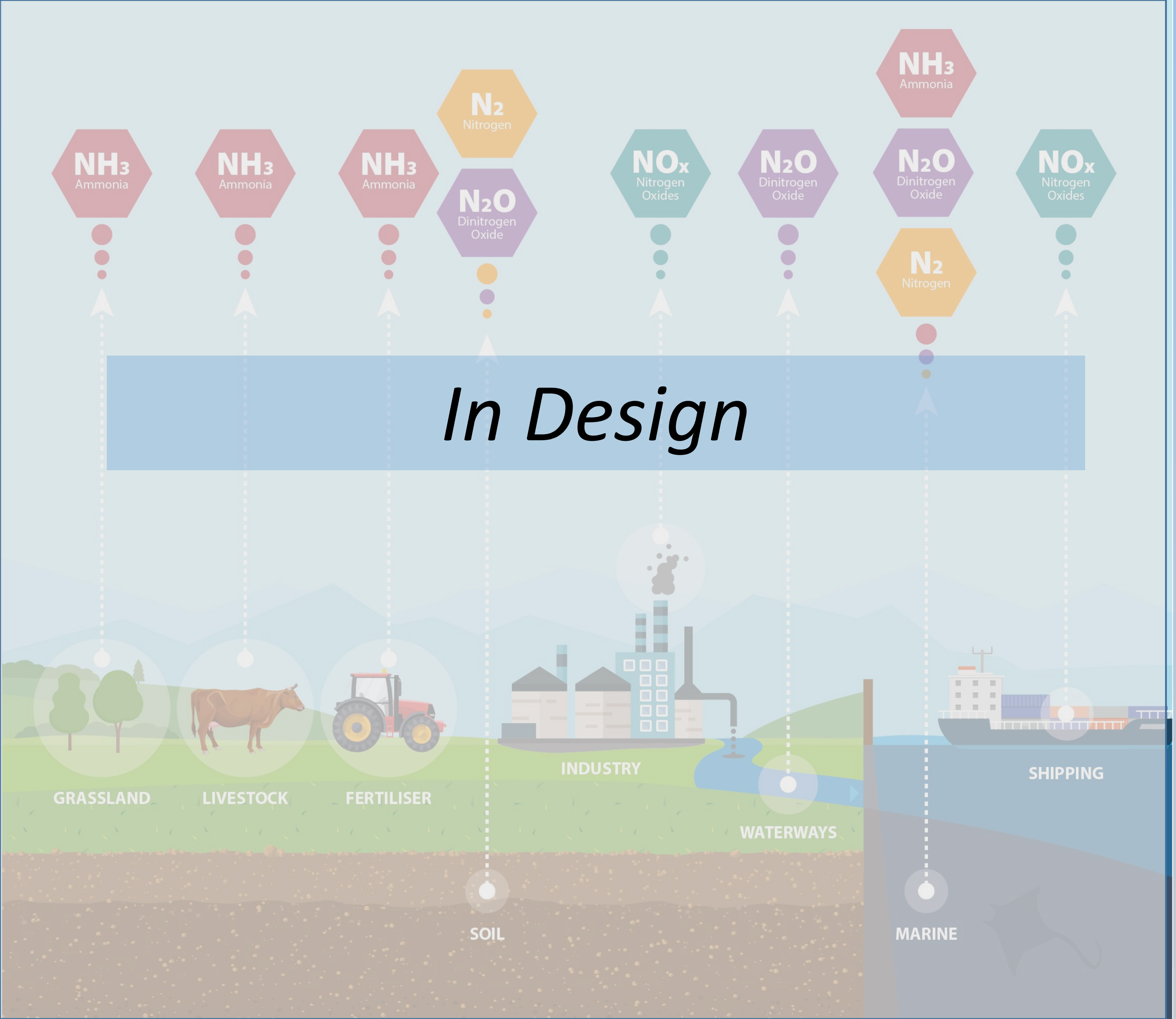
Pierre Cellier, Roy Wichink Kruit and colleagues , Tim Jickells, Stuart Painter, Wilfried Winiwater, Pascal Boeckx and Samuel Bodé, Ute Skiba and CEH colleagues, Umesh Kulshrestha, Kevin Hicks and SEI colleagues

Chapter 1: Emissions to atmosphere

1. **Introduction**
2. **Natural emissions: Land and water-based**
    1. Land-based natural emissions (from forest, grasslands, wetlands, and tundra)
    2. Freshwater, coastal and estuarine and marine sources related to nutrient cycling
    3. Emissions from wild-fires
    4. NO from lightning
3. **Anthropogenic N emissions**
    1. Emissions related to industrial/combustion processes
    2. Agriculture & livestock-related emissions
    3. Emissions related to crop residue burning and prescribed fires
    4. Emissions from waste treatments: landfill, wastewater facilities
    5. Land-use change emissions, e.g. consequences of changing from grassland to arable

Considerations:
- Inorganic and organic emissions
- Emissions inventories and direct measurement of sources as well
- Precursor emissions for Tropospheric Ozone referenced

Gaps:
- Authors for fires, wastewater, lightning, biogenic emissions



Chapter 2: Atmospheric nitrogen deposition

Lead Authors

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Other contributors to date:
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Chapter 2 : Atmospheric nitrogen deposition

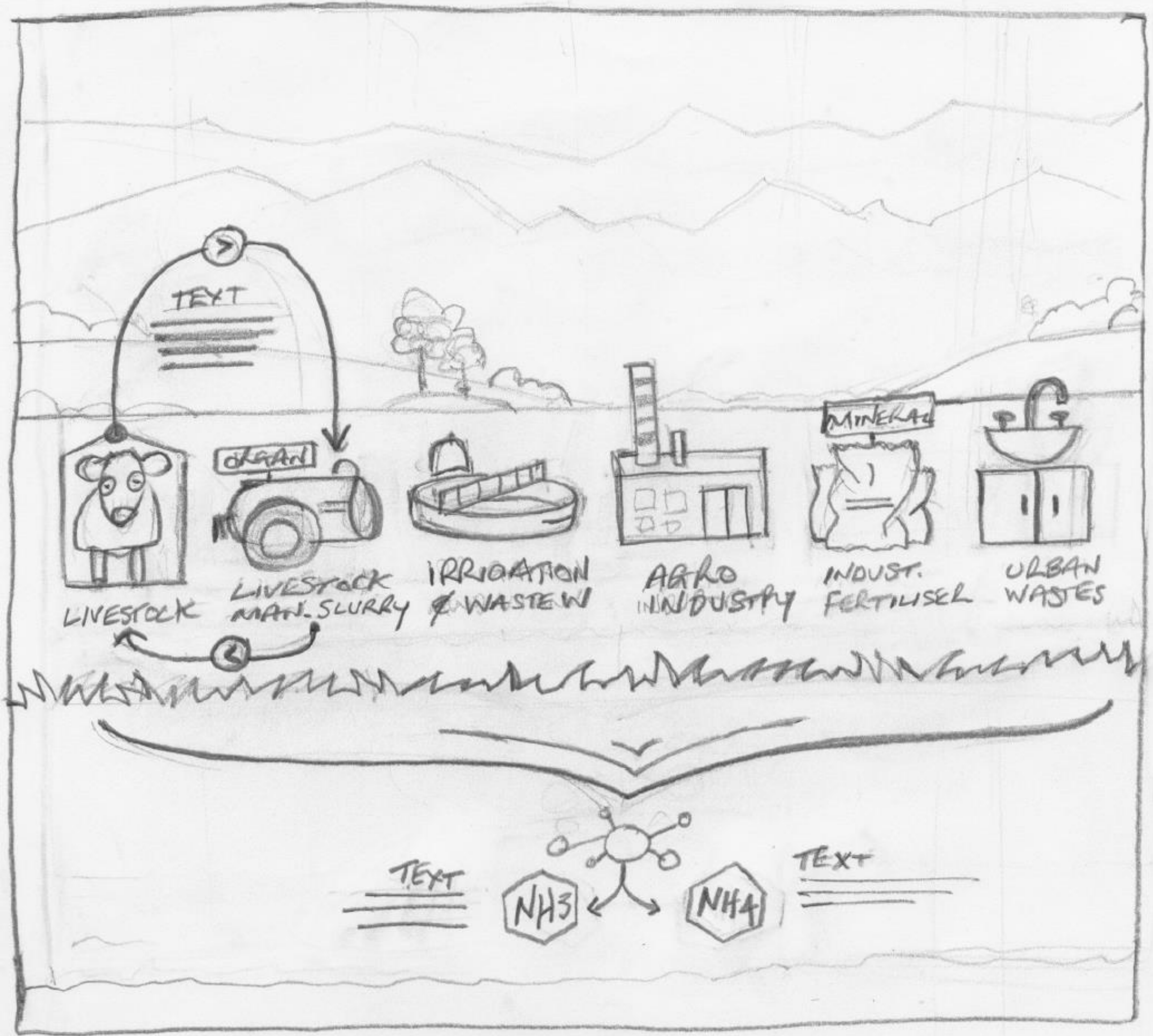
1. **Introduction**
2. **Wet deposition**
   1. Direct flux measurements (e.g. wet-only sampler)
   2. Indirect flux measurements (e.g. Bulk Sampler, throughfall and stemflow)
   3. Modelling approaches
3. **Dry deposition**
   1. Direct flux measurements (e.g. gradient approach, Eddy covariance)
   2. Indirect flux measurements (e.g. passive & active sampling, remote sensing)
   3. Modelling approaches
4. **Occult deposition**
5. **Total deposition**
   1. Biomonitoring
   2. Model calculations (e.g. Eulerean & Lagrangian modelling)
   3. Combining measurements and model calculations (e.g. Inferential modelling, Measurement-Model Fusion (WMO)

Considerations:

- Focus on deposition processes
- Promote measurement of organic deposition and dry deposition
- Remote sensing included
- Tropospheric ozone deposition not covered directly

Gaps:

- Authors for Eulerean and Lagrangian modelling, relaxed eddy accumulation for dry deposition



Chapter 3: Inputs to Terrestrial systems (other than deposition)

Lead Authors

Pierre Cellier (*INRAE*)

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Other contributors to date:

Peter Ebanyat (Makerere University & IITA),

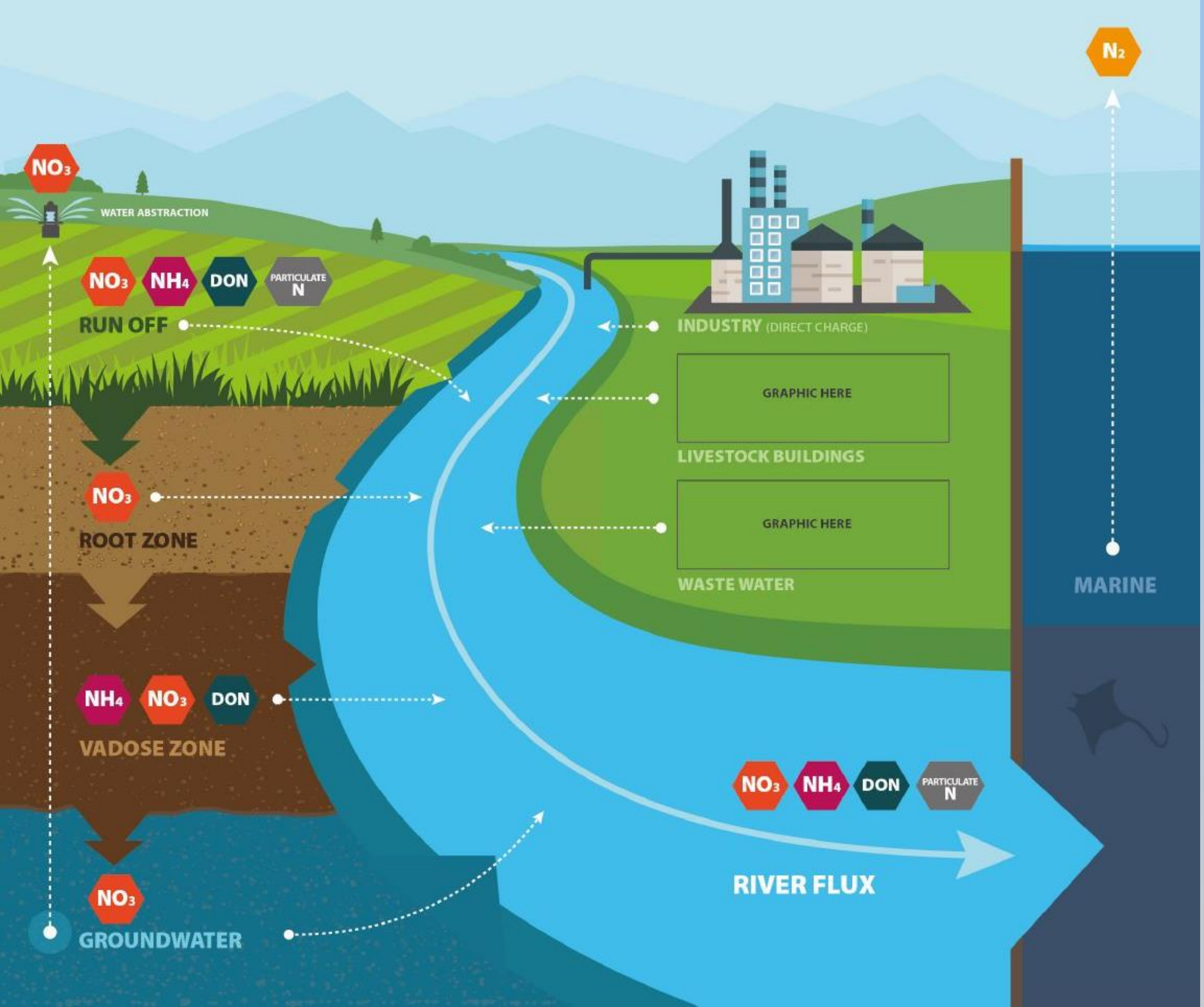
Wilfried Winiwarter (IIASA)

Chapter 3: Inputs to Terrestrial systems (other than deposition)

1. **Introduction - Global sketch of the N input to terrestrial systems**
2. **The different sources**
    1. Inputs of mineral fertilizers
    2. Inputs of organic manures (e.g. Livestock manure, agroindustry wastes, waste water treatment sludges, AD digestates, household & garden organic wastes)
    3. Natural processes providing reactive N
    4. Grazing (e.g. livestock over managed grassland, animals over rangeland)
    5. BNF
3. **Methods to estimate the different N input**
    1. Anthropogenic inputs (methods at different scales, compendium of available data)
    2. Inputs from natural processes (methods at different scales, compendium of available data)

Considerations:
- Mineral and organic inputs
- Fertilizer addition can lead to atmospheric and aquatic fluxes covered in other chapters

Gaps:
- Author on BNF
- Include flooding as an input for nutrients?
- Figures on global organic manure use for introduction



Chapter 4: Inputs to water bodies (other than deposition)

Lead Authors

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Other contributors to date:

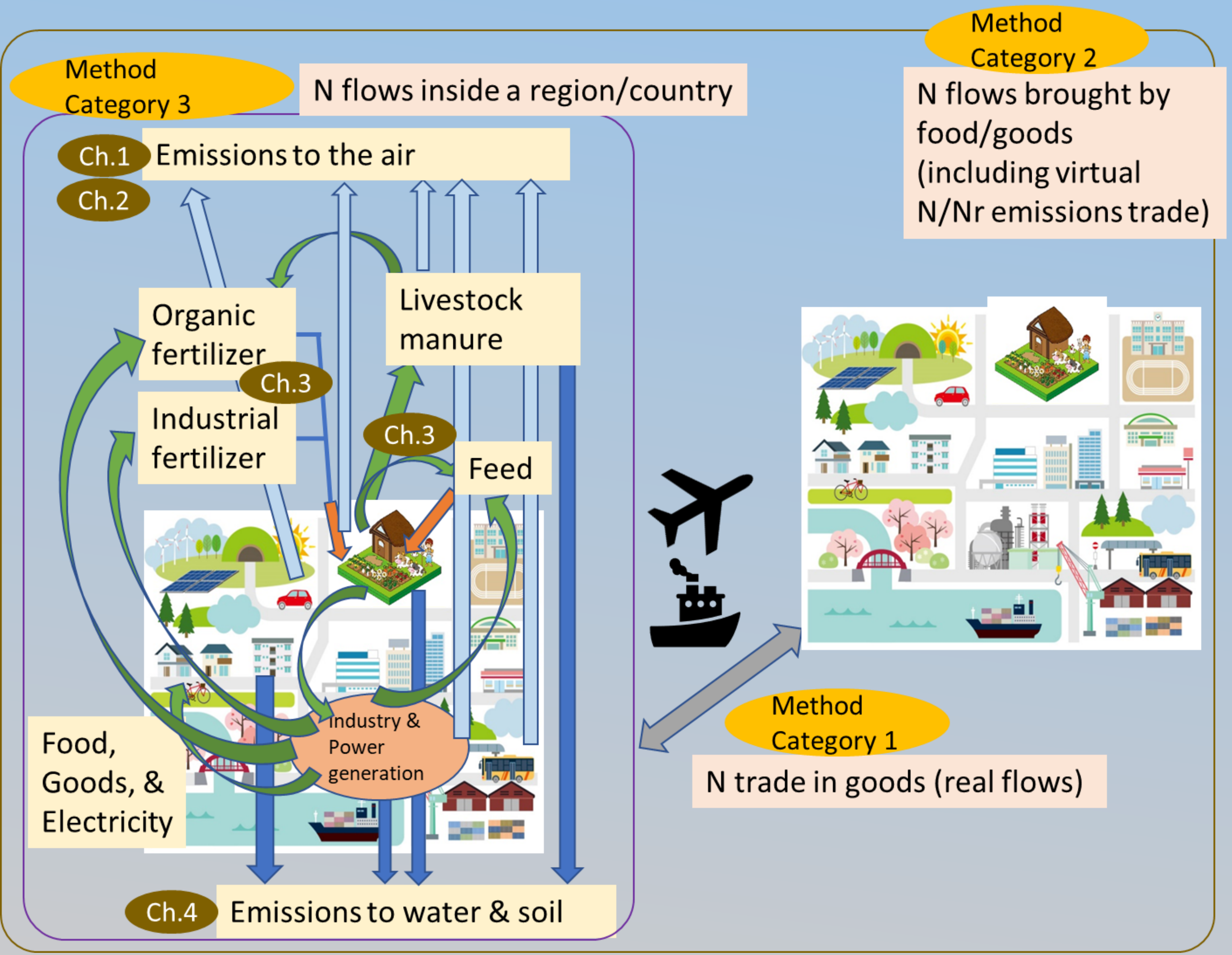
Patrick Durand (INRAE) Rita Fragoso (U. Lisbon), Claudia Cordovil (U. Lisbon)

Chapter 4: Inputs to water bodies (other than deposition)

1. Introduction
2. Direct (point source) discharge to water bodies
3. Surface/subsurface flows from diffuse sources
4. Rootzone flux to rivers
5. Abstraction (groundwater/aquifer to surface)
6. Rootzone to vadose zone flux
7. Vadose zone to aquifer flux
8. Submarine groundwater discharge
9. Riverine fluxes to the coastal ocean
10. Biological N_2 fixation as a flux to the ocean

Considerations:
-N sources need to distinguish between agricultural, industrial and residential sectors
- BNF in ocean considered important
- Considers water flux first and then N content of that flux

Gaps:
- Too Eurocentric at moment?



Chapter 5: Economy-wide anthropogenic flows of N-flows from trade and industry

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Allison Leach (University of New Hampshire)

Chapter 5: Economy-wide anthropogenic flows of N-flows from trade and industry

1. **Introduction**
2. **Method Category 1**
   1. N embedded (i.e. physically present) in traded goods
3. **Method Category 2**
   1. Virtual N flows caused by the production and transport of internationally/domestically traded goods
4. **Method Category 3**
   1. N flows in regions and countries
5. **Related Indicators**
   1. Pressure indicators (e.g. N footprint, full-chain (life-cycle) NUE)

Considerations:

- Assessing Nr flows to and from intermediate products (indirect flows for the final products)
- Quantifying Nr flows across country borders
- Needs for inventories related to Nr flows between industries and related international supply chains
- Pressure trade-offs between Nr emissions and other environmental pollution

Gaps:

-To help with MEAT model, Category 3, and full-chain NUE

- Felipe Pacheco (INPE, Brazil) and one more?

Method Datasheets - Attributes

Verification: who uses it, where?

Spatial: plot -> catchment -> global

Temporal: hourly -> daily -> annual -> decadal

Skill Level: Entry -> Intermediate -> Expert

$ Cost: low -> medium -> high

? Uncertainty: unverified-> quite reliable -> reliable

Precision, accuracy : low accuracy & low precision -> high accuracy & high precision

Online Flux Method Database tool

Towards the INMS
International Nitrogen Management System
www.inms.international

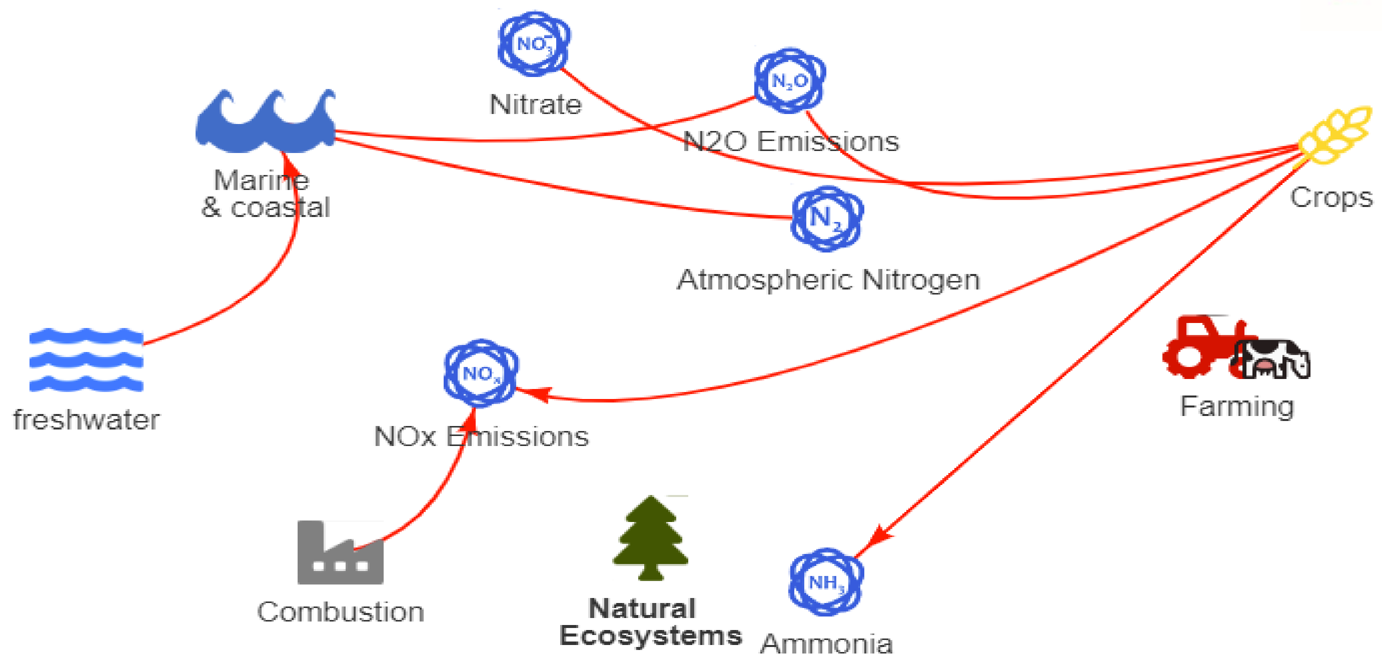
Nitrogen Cascade

Choose your network:

- ○ All the network
- ◉ Unintended flows
- ○ Intended flows
- ○ Atmospheric Processes and Deposition
- ○ Emmision

Unintended N flows
Intended N flows

Remove Tabs



instructions | Crops | Marine & coastal | Untended flux 1 | Combustion

Untended flux 1

The methods in this flux are:

Title Of the Method	Cost	Skill	Uncertainty	Temporal	Spatial
◉Dissolved Inorganic Nitrogen in seawater	$		???		
○flux 2	$ $		??		

Dissolved Inorganic Nitrogen (NOx) (in seawater)

Method Description

The measurement of NOx (NO3- and NO2-) in marine waters is traditionally achieved by wet chemical methods that use a gas-segmented

Linkages to other INMS Activities

- A1.1: e.g. the efforts of the EPNB TFRN, N farm budget work, and N flow patterns, simplified and harmonized approach based on the CHANS model
- A1.2: Covering Drivers–Pressures–States–Impacts–Responses (DPSIR) linkages

Pressures: *N inputs to terrestrial system; Atmospheric processes & deposition; Inputs to water bodies; Trade N flow*

Pressure Indicators: *N-Runoff; N-Leaching; N-dep; N2O, NOx, NH3 emission; N fertilizer input; Manufacturing N Addition; / N footprint*

- Component 3: Request of A3.1 (Regional demonstrations) to provide 'common indicators' between the demo regions

Timeline

- Priority 1 : Chapter text for Guidance Document - Review in October 2020
- Priority 2 : Text for International Nitrogen Assessment Chapter – January 2021 first review
- Priority 3 : Method datasheets to populate online N flux tool

Thank – you!

Agenda Item 5 : INA global book chapter

Title: Approaches and challenges to assess nitrogen pressures and distribution

Including:

i) Quantifying pressures and states (inc. History, Definitions, concepts and conventions);

ii) Key fluxes to, in and from (a) air, (b) terrestrial systems, (c) aquatic systems, (d) products and trade; I

iii) Measuring and monitoring;

iv) Inventories of nitrogen pressures and flows;

v) Relationship to global models.

(c. 20-25 pages; links directly to INMS Activity 1.3).