Development of Methodology for Nitrogen Fluxes
and Distribution (A1.3)
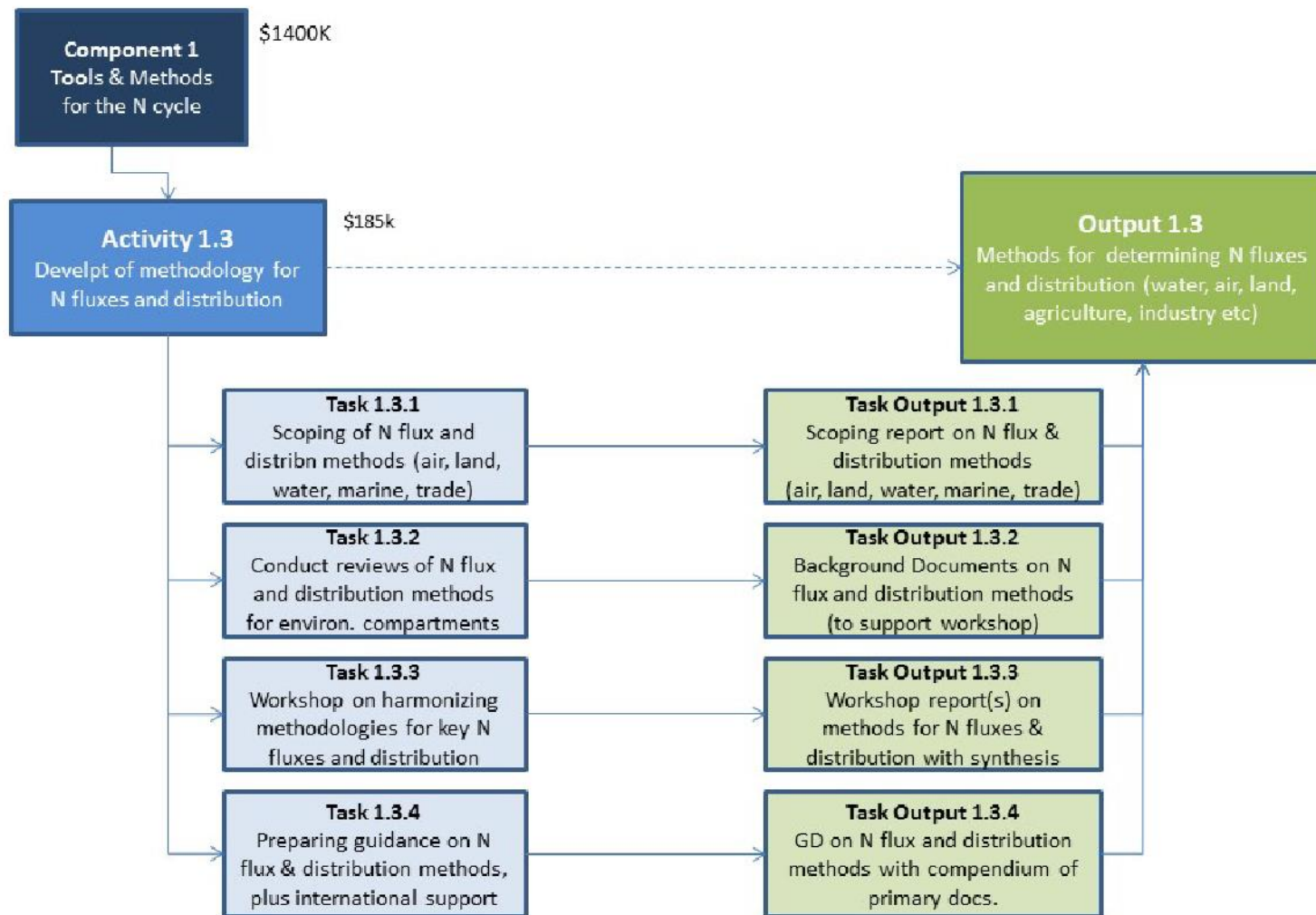
Bill Bealey (CEH) & Kevin Hicks (SEI, University of York)

INMS 3 Plenary Meeting, 16th - 19th April 2018, Edinburgh

Activity 1.3 Outline

Activity 1.3: INMS-3, Edinburgh, 16th-19th April

Activity 1.3 Storyline

"Development of the methodology for combined assessment of nitrogen fluxes and distribution, considering the linkages between air, land and water, and dispersion through trade, including review of methods for different N components and different environmental compartments, leading to the preparation of guidance methodology"

Activity 1.3 Storyline

- "Development of the **methodology for combined assessment of nitrogen fluxes and distribution**, considering the linkages between air, land and water, and dispersion

Consider a range of Methodologies linked to priority fluxes

- *Measurements*
- *Emission inventories -> models*
- *National datasets, N budgets, census data, maps*

Consider data at different scales

- *Plot/field/farm*
- *Catchment to national*
- *Region*
- *Global*

Activity 1.3 Storyline

- "Development ~~of~~ ~~methodology~~ for combined ass~~essment of nitrogen~~ fluxes and distributio~~n, including the~~ linkages between ~~land, sea, air an~~d dispersion through ~~trade, review~~ of methods for **different N components** ~~and different~~ environmental compartments, leading to the preparation of guidance methodology"

- NO$_x$
- NH$_3$
- NO$_3^-$
- N$_2$O
- more…

Activity 1.3 Storyline

• "Development of the methodology for combined assessment of sources and harling in air, land and water, through trade, including review of methods for different N components and **different environmental compartments**, leading to the preparation of guidance methodology"

Box (pointed to by arrow):
- Air
- Land
- Water
- Marine
- Trade links

Harmonization of methodologies across the N cycle

Activity 1.3 Storyline

Who are our Users?

*Government agencies
& regulators*

↓

National statistical bureaus

↓

Environmental planners

*Practitioners in developed and
developing countries*

With different information requirements

...e methodology for
...t of nitrogen fluxes
...sidering the linkages
...water, and dispersion
...review of methods
...one... and different
...artments, leading to
dance methodology"

Potential Users of Guidance

1. Site measurements: processes, budgets, impact quantification

- Users: practitioners at site/plot scale - research scientists in government institutes or universities, those interested in quantifying fluxes and linking to mitigation strategies.

Example User Story: I am an atmospheric scientist and am interested in methods for measuring ammonia from satellite data

2. Operational monitoring of key indicators

- Users: agency users, national or sub-national scale, government regulators (monitoring),

Example User Story: I am a regulator in Nepal and want to know about how to set up a monitoring network for ammonia and what measurements methods (links to 1 above) are out there.

3. Modeling flows and concentrations: overarching key principles

- Users: Policy audience, variety of scales, agencies and regulators

Example User story: I am from the ministry of environment in Zimbabwe interested in modelling N deposition footprints against a future scenario

Guiding Principles for Activity 1.3

- At proposal stage UN Environment requested guidance from INMS on quantifying fluxes and impacts ACROSS the nitrogen cycle

- Guidance produced will be aimed at policy makers, their agencies and practitioners – 'the customers'

- INMS community best placed to know what key fluxes are, which should then be agreed with 'customers'

- INMS will go in phases so need to determine key activities to tackle first in line with available resources

- A1.3 will communicate knowledge from other INMS activities and is not set up to provide data for them

Activity 1.3: INMS-3, Edinburgh, 16th-19th April

Planned Products for Activity 1.3

1. Guidance document for policy makers, their agencies and practitioners on key N fluxes and how to determine them

2. Web-based knowledge system that can evolve to meet 'customer' needs

Facilitated by various supporting Tasks:

- ***Task 1.3.1:*** Scoping of N flux and distribution methods

- ***Task 1.3.2***: Conduct reviews of N flux

- ***Task 1.3.3***: Workshop key N fluxes & harmonizing methodologies across the N cycle

Activity 1.3: INMS-3, Edinburgh, 16th-19th April

Proposed outline for Guidance document from Evora

0.   **Executive summary** (5 pages, most important information in the first 3 paras.)

1.   **Introduction** (5 pages)

2.   **Harmonizing paradigms of the N cycle** (5 pages)

3.   **Site measurements: processes, budgets, impact quantification (20 pages)** [*practitioner users, site scale*]

4.   **Operational monitoring of key indicators** (20 pages) [*agency users, national or sub-national scale*] WAGES

5.   **Modeling flows and concentrations: overarching key principles** (20 pages) [*Policy audience—NOT MODELER AUDIENCE, variety of scales*]

6.   **References** (10 pages)

Total length: 85 pages, the shorter and more focused the better. Convey key principles and refer users to more detailed manuals/literature.

Online Knowledge System

Searchable tool for N flux methods across the N cycle

|		
atmosphere	⇨	**terrestrial**
atmosphere	⇨	**water body (e.g. marine, freshwater)**
fertilizer	⇨	**land**
water body	⇨	**atmosphere**
terrestrial	⇨	**atmosphere**
terrestrial	⇨	**water bodies**
linkages	⇨	**trade**

Method Datasheets

Method title

- Method description

- Usage of the method including any factors to consider

- Relevant compartment (air, land, water etc.)

- Key references and documents

- Relevant datasets and data centres

Tagged by keywords – e.g. pollutant type, geographical reach, compartment, units

Searchable tool for N flux _methods_ across the N cycle

Activity 1.3: INMS-3, Edinburgh, 16th-19th April
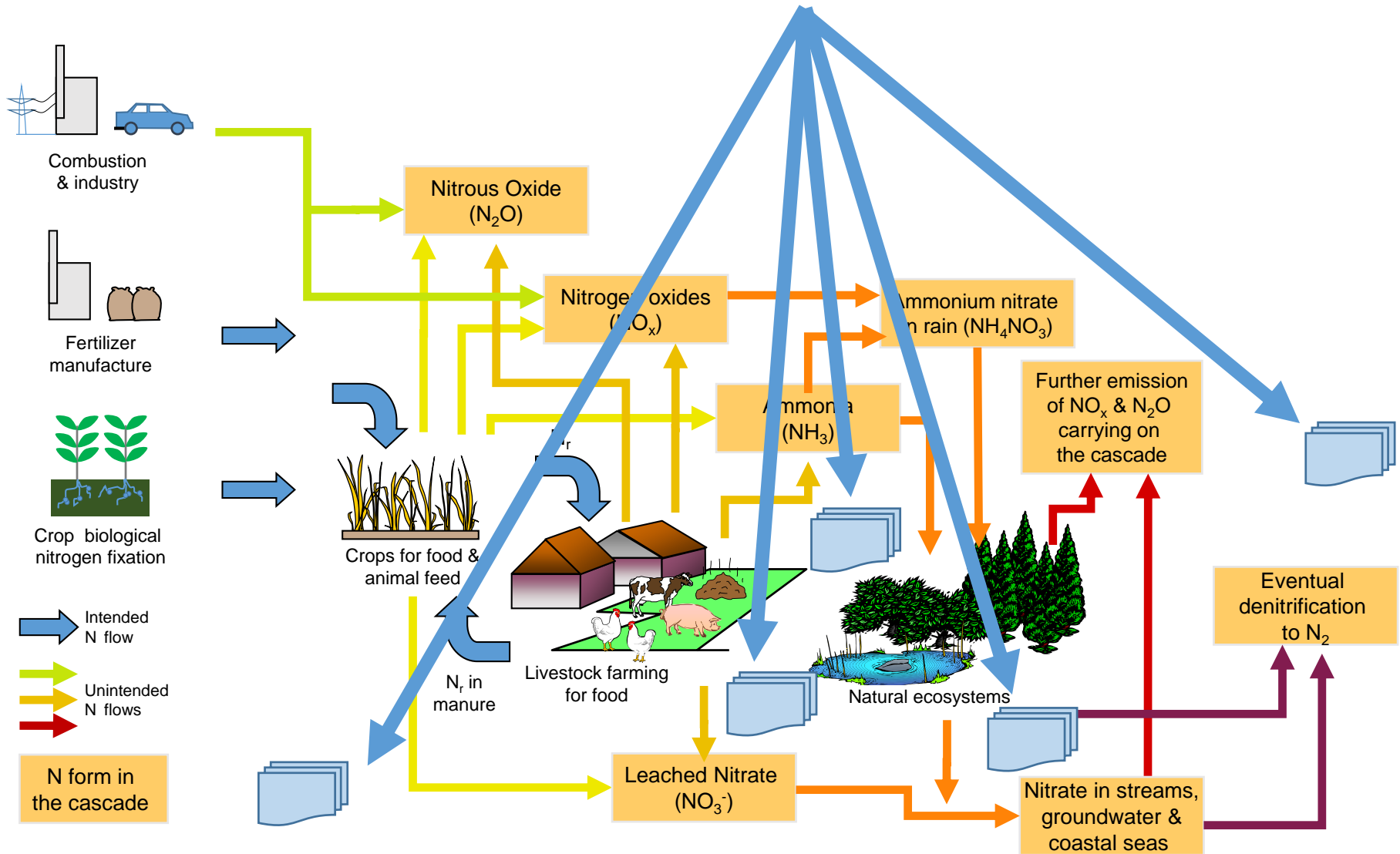
A1.3 Collaborators

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...Southern Hemisphere?

Building team to cover different compartments, sectors, scales, regions, methodologies, users....?

Activity 1.3: INMS-3, Edinburgh, 16th-19th April

Activity 1.3: Development of methodology for N fluxes and distribution

The choice of fluxes we provide guidance on will be our key discussion point and will include:

- the ambition of what we cover with the resources we have

- the different needs of more developed and developing countries and links to the demo regions in Component 3

- what the INMS community will be focussing on balanced against the needs of the 'customer'

The outcome of the Edinburgh meeting will be the outline of the Scoping Guidance Document for Activity 1.3.1

Tasks for this afternoon

Determine draft outline of scoping document with sections on key compartments:

- Start to determine key fluxes linked to threats/benefits identified in A1.2 and N budget components identified in A1.1 and headline impacts in A1.4 and allocate them to agreed compartment clusters based on suggestion below:

atmosphere	⇨	**terrestrial**
atmosphere	⇨	**water body (e.g. marine, freshwater)**
fertilizer	⇨	**land**
water body	⇨	**atmosphere**
terrestrial	⇨	**atmosphere**
terrestrial	⇨	**water bodies**
linkages	⇨	**trade**

Tasks for this afternoon

For each flux cluster determine key areas were guidance is needed on:

1. Site measurements (plot/field/point): processes, budgets, impact quantification
2. Operational monitoring of key indicators
3. Modelling flows and concentrations: overarching key principles e.g. and use of satellite data

POST-IT

- **Method title**
- **N species**
- **Policy area e.g. Air Convention**
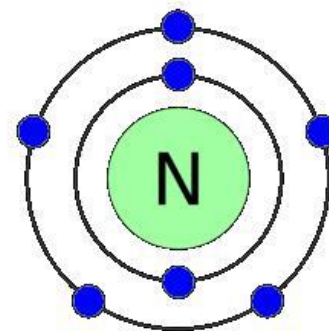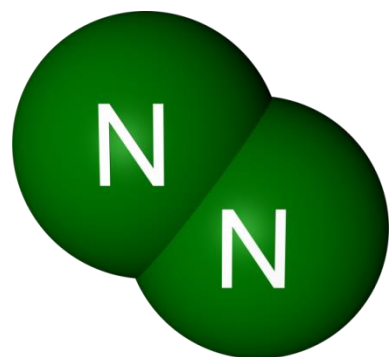- **WAGES**

1 Site measurement

2 Monitoring Network

3 Modelling requirement and potential link to satellite data

Matrix of N threat-benefit

	ID	Short_name	Threat_Benefit_description	Direct impact	Threat/ Benefit	Cluster: WAGES-FE	Threat metric	Indicator (Status)	Link to Nr cascade (Pressures)	Global scale derivation
	1	Biodiversity/productivity loss	Eutrophication effects on productivity and biodiversity in terrestrial ecosystems (incl. Pests and diseases)	Ecosystem	T	Ecosystem Soil	Growth reduction Occurrence of lichen and moss Biodiversity index	Critical load of atmospheric N deposition (nature) Critical level of NH3	N deposition	IMAGE-GLOBIO; based on D-R relationships SMB model; to be applied globally
	2	Ozone damage to ecosystem	Ozone damage to forests, and natural ecosystems	Ecosystem	T	Ecosystem Air	Growth reduction	POD1 (forests) POD6 (vegetation) AOT40, WSL 126	NOx emission	EMEP-Global plus D-R relationships; Currently no DGVM involved with this effect
	3	Eutrophication in freshwater	Eutrophication of freshwaters, lakes including hypoxia/anoxia (incl. Biodiversity)	Ecosystem	T	Ecosystem Water	Chlorophyll Macrophytes Macrofauna Fish	BOD NO3 Critical loads (nature)	N-Runoff N deposition	IMAGE-GLOBIO-aquatic based on D-R relationships IMAGE-GNM and Global NEWS (partly)
	4	Eutrophication in marine/coast	Eutrophication of coastal ecosystems inducing hypoxia/anoxia (incl. Biodiversity)	Ecosystem	T	Ecosystem Water	Chlorophyll Macrophytes Macrofauna Fish	BOD NO3 Critical N inputs (agriculture) Dissolved O2 Algal taxonomy Shellfish closures	N-Runoff N deposition	D-R relationships? Discussion
	5	Soil N enrichment	N enrichment in soil	Ecosystem	T	Soil	Biodiversity Soil fauna Winter N loss	N and C concentrations C:N ratios	N deposition	VSD/RothC model; to be applied globally LPJ or EPIC Crop growth models; D-R relationships
	6	Global warming by N2O	Global climate warming induced by emission of N2O or carbon cycle changes (CO2 and NH4) induced by excess nitrogen	Ecosystem Human	T	Greenhouse gas	GWP of additional N2O	N2O CH4 CO2	N2O (dir, indir) emission	A2.1; IMAGE, GLOBIOM, MAgPIE, MITERRA etc.
	7	Global warming by O3	Warming caused by Nr contribution to tropospheric ozone, and due to organic aerosols	Ecosystem Human	T	Greenhouse gas	Change of GWP	NOx N2O Organic aerosol	NOx and N2O emissions	Currently no DGVM involved which quantifies O3 effect; D-R relationships
	8	Ocean CO2 emission	CO2 emission by acidification of oceans	Ecosystem Human	T	Greenhouse gas	Change of GWP due to CO2 emission	NOx HNO3 NH4+ N2O	NOx and N2O emissions N deposition	D-R relationships? Discussion
	9	Acidification of forest/soil/water	Acidification effects on forests, soils, ground waters, and aquatic ecosystems. Incl. Degradation of coral reefs decreasing coastal protection	Ecosystem Human	T	Ecosystem Water Soil	Grown reduction	Critical load of atmospheric N & S deposition Al (and heavy metal) concentrations in soil	N deposition	SMB model; to be applied globally
	10	Enhanced C sink	Enhanced carbon sequestration (plant and soil) in natural systems by N deposition	Ecosystem Human	B	Greenhouse gas Ecosystem Soil	Change of GWP due to CO2 capturing	C stocks NEP	N deposition	LPJ?; D-R relationships
	11	Climate cooling by aerosol	Regional climate cooling induced by aerosol	Ecosystem Human	B	Greenhouse gas	Change of GWP	PM2.5	NOx and NH3 emission	IMAGE? D-R relationships?
	12	Climate cooling by low CH4	Net cooling effect of Nr by reduction of atmospheric CH4 life time and increased soil CH4 uptake	Ecosystem Human	B	Greenhouse gas Soil	Change of GWP	CH4 O3 N deposition	NOx deposition N deposition	D-R relationships? Discussion
	13	Respiratory disease by aerosols	Respiratory disease and cancers in people caused by exposure to high concentrations of fine particles including ammonium and nitrate aerosols	Human	T	Air	% people exposed to > threshold Increased incidence of disease	PM10 PM2.5 NH3 Particulate NH4	NOx and NH3 emission	D-R relationships? Discussion

Thank You for your Attention!

Let's talk about nitrogen…