Activity updates of A1.2

Jill Baron and Hideaki Shibata

Tasks and outputs of A1.2

- **Task 1.2.1: Initial identification of key nitrogen threats**
  - Output: Consultation document on key N threats and criteria for policy & other stakeholders

- **Task 1.2.2: Conduct stakeholder review & refine N key threats & criteria**
  - Output: Summary of stakeholder feedback and revised set of key N threats and criteria

- **Task 1.2.3: Workshop(s) to review assessment methodologies for different N threats**
  - Output: Workshop report(s) on N threat assessment methodologies with synthesis on links

- **Task 1.2.4: Drafting guidance on overall N threat assessment methodology**
  - Output: Guidance Document on integrated N threat assessment methodology & compendium of primary documentation

Meetings

- **INMS-2 meeting in Melbourne, Australia** | Dec 2016
  - Baron J, Shibata H, van Grinsven H, Gu B et al.
- **NitroPortugal workshop in Lisbon, Portugal** | May 2017
  - Baron J, Shibata H, Sutton M et al.
- **ILTER annual meeting in Nantes, France**| Oct 2017
  - Baron J, Shibata H, Forsius M, McDowell WH et al.
- **INMS workshop in Évora, Portugal** |Oct 2017
  - Shibata H, van Grinsven H, Sutton M, Weinmann T et al.
- **INMS East Asia regional meeting in Nanjing, China** |Oct 2017
  - Shibata H, Gu B, Jancinto G, Hayashi K, Yan X, et al.

Working group

- **Leading member**
  - Baron J (USA), Shibata H (Japan), Weinmann T (USA), Oita, A (Japan)
  - Collaboration with A1.4 | van Grinsven H (Netherlands), Gu B (China)
- **Core group**
  - 10 members (6 countries, 4 females/6 males)
- **ILTER-INMS task force**
  - 21 members (12 countries, 11 females/10 males)

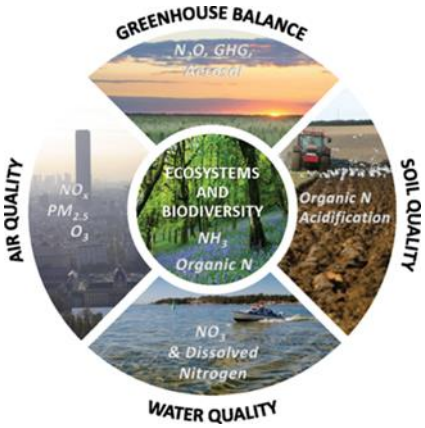
INMS activity 1.2 Core Team

Name	Affiliation	Expertise/Role
Hideaki Shibata	Japan	Ecosystem ecology, Co-Lead
Jill Baron	USA	Ecosystem/freshwater ecology, Co-Lead
Timothy Weinmann	USA	Biogeochemistry, support
Azusa Oita	Japan	Nitrogen valuation, support
Ming-Chien Su	Taiwan	Air and water quality, agriculture
Jason Holt	UK	Marine N cycling and threats
Adrianna Flores	Mexico	Water quality
Peter Groffman	USA	Ecosystem ecology, biogeochemistry
Wim de Vries	Netherlands	Nitrogen cycling and biogeochemistry
Mark Sutton	UK	Threats, benefits

10 core members (44 collaborators); multidisciplinary; 6 countries; 40% women;

Task A1.2.1
Initial identification of key nitrogen threats

- Developing the N threat-benefit matrix
  - Adapting WAGES (+ Food and Energy) cluster
  - Description of the N threat-Benefit
  - Threat-Benefit metrics
  - Indicators (Status)
  - Links to Nr cascade (Pressures)



✓ Many useful suggestions have provided (incl. East Asia regional group) for further updates (in progress).
Special thanks to de Vries W, Hayashi K, Egushi S, Nishina K and others

Planning joint workshop A1.2 & A1.4

- **September 10-13, 2018** | Powell Center, Fort Collins, USA
- Goals of the workshop are to:
  - **Identify threats and benefits of reactive N** in the environment and to human health, building on existing overviews for the EU and US, aiming at global coverage
  - Adopt existing, or develop new, **metrics for quantifying N threats and benefits** at multiple scales of policy and management, sector-specific, and a possible new index of evaluation that includes multiple metrics
  - Identify necessary **relationships between A1.2 and 1.4**
  - Discuss the need and added value of making an inventory and a review of "**N Dose - Response**" relations for all or a subset of impacts
  - Develop approaches for **threat and benefit valuation**, including economic valuation (monetization "expression in US$")
  - **Establish a timeline** for report and manuscript production
  - **Assignment of responsibilities** for the activities goals , reports and manuscripts
  - Establish a mode for **cooperation and communication with the INMS C2 and C3**

24 participants have been confirmed (incl. online participation).

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

Draft structure of the N threat assessment guidance

1. Executive summaries
2. Background
3. Methodologies to assess N threats and benefits related to ecosystem impacts
4. Methodologies to assess N threats and benefits related to human health impacts
5. Integrated methodologies to assess N threats/benefits
6. References

Draft structure of the N threat assessment guidance | Details

1. Executive summaries

1.1 Summary for policy maker

1.2 Summary for stake holders

1.3 Summary for science community

2. Background

2.1 General introduction

2.2 WAGES cluster – introduction/history

2.3 List of the N threat/benefits: link to the WAGES (-FE) clusters

2.4 Linkage to International conventions and programs (e.g., SDGs, CBD)

2.5 Instructions how to use this document for multiple users/readers

Draft structure of the N threat assessment guidance | Details

3. Methodologies to assess N threats and benefits related to ecosystem impacts

- 3.1 Threat-benefit framework on N cascades and DPSIR for ecosystem
- 3.2 Air quality related impacts
  - 3.2.1 Ozone (agricultural/arable land crops vs non-agricultural land/forests): growth vs biodiversity impacts
  - 3.2.2 Nitrogen (possibly NOx vs NH3)
- 3.3 Soil quality related impacts
  - 3.3.1 N-induced acidification (agricultural/arable land crops vs non-agricultural land/forests)
  - 3.3.2 N-induced eutrophication (agricultural/arable land crops vs non-agricultural land/forests): growth/carbon sequestration vs biodiversity impacts
- 3.4 Water quality related impacts
  - 3.4.1 N-Runoff and surface water eutrophication

Each section includes then metrics, indicators and Dose–Response (D-R) relation and thresholds.

Draft structure of the N threat assessment guidance | Details

4. Methodologies to assess N threats and benefits related to human health impacts

4.1 Threat-benefit framework on N cascades and DPSIR for human health

4.2 Air quality related impacts

- 4.2.1 Ammonium and nitrate aerosols (N-particulates)
- 4.2.2 NOx and other photo-chemical oxidants
- 4.2.3 Ozone

4.3 Soil quality related impacts

- 4.3.1 N- acidification induced Cd (metal pollution) etc

4.4 Water quality related impacts

- 4.4.1 NO3 leaching and runoff (drinking water issues)

Each section includes then metrics, indicators and Dose–Response (D-R) relation and thresholds.

Draft structure of the N threat assessment guidance | Details

5. Integrated methodologies to assess N threats/benefits

5.1 Global assessment and local/regional impacts

5.2 Nitrogen balance, fluxes and surplus in multiple spatial scales (incl. inputs from the Activity 1.1)

5.3 Critical level & load, Critical input to human environment, ecosystems and agriculture (incl. inputs from the Activity 1.5)

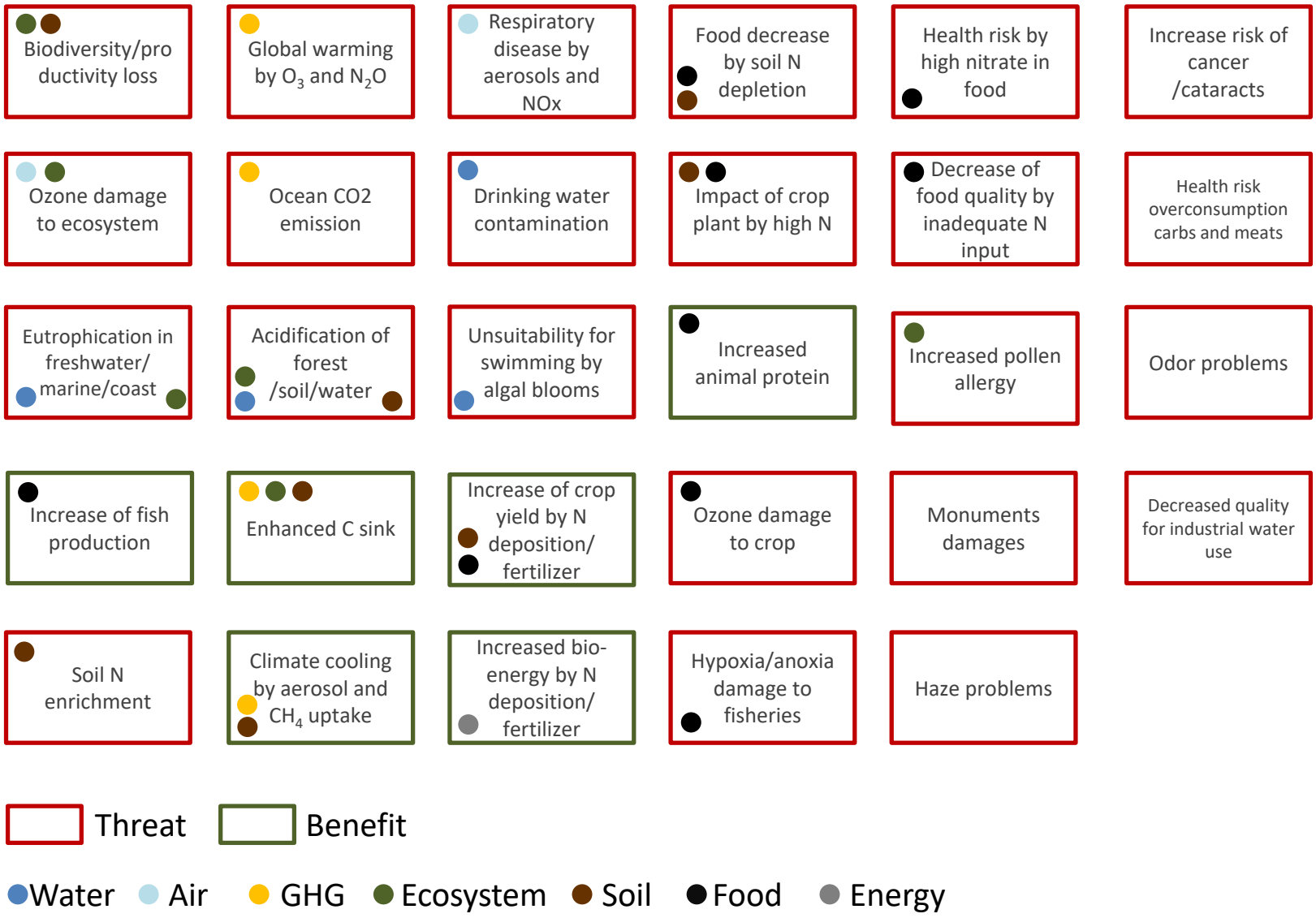
5.4 Water quality standards and load reduction approaches (e.g. EU approaches from Baltic Sea and US TMDL in Chesapeake Bay)

5.5 Integrated and comprehensive approaches (e.g. Ecosystem services, Planetary boundaries, a comprehensive N threat/benefit index)

Matrix of N threat-benefit

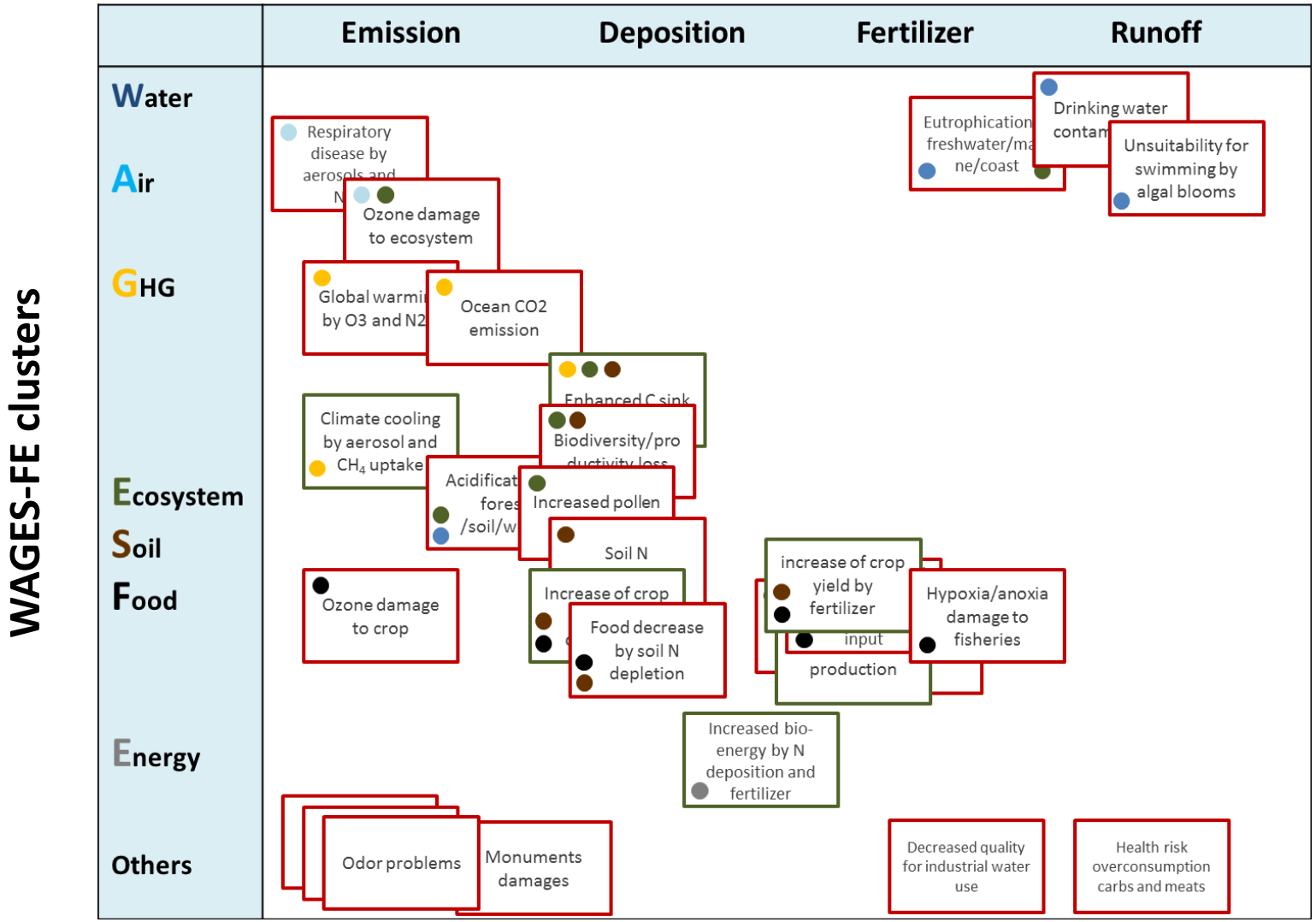
ID	Short_name	Threat_Benefit_description	Direct impact	Threat/ Benefit	Cluster: WAGES-FE	Threat metric	Indicator (Status)	Link to Nr cascade (Pressures)	Global scale derivation
1	Biodiversity/productivity loss	Eutrophication effects on productivity and biodiversity in terrestrial ecosystems (incl. Pests 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

29 items have been identified.



Mapping of the N threat-benefit items

Links to nitrogen cascades



Threat Benefit Water Air GHG Ecosystem Soil Food Energy

Mapping of the N threat-benefit items (Text)

Links to nitrogen cascades

WAGES-FE clusters

	Emission	Deposition	Fertilizer	Runoff
Water				Drinking water contamination Eutrophication in freshwater/marine/coast Unsuitability for swimming by algal blooms
Air	Respiratory disease by aerosols and NOx Ozone damage to ecosystem			
GHG	Global warming by N_2O and O_3 Climate cooling by aerosol and CH4 uptake			
Ecosystem	Ocean CO2 emission	Enhanced C sink Biodiversity/productivity loss		
Soil		Acidification of forest /soil/water Soil N enrichment		
Food	Ozone damage to crop	Increase of crop yield by N deposition Food decrease by soil N depletion	Increase of crop yield by fertilizer Decrease of food quality by inadequate N input Impact of crop plant by high N Health risk by high nitrate in food Increase of fish production	
Energy		Increased bio-energy by N deposition and fertilizer		
Others	Increase risk of cancer /cataracts Haze problems Odor problems	Monuments damages	Decreased quality for industrial water use	Health risk overconsumption carbs and meats

N threat-benefit metrics

- Growth reduction | Occurrence of lichen and moss | Biodiversity index
- Chlorophyll
- Macrophytes | Macrofauna |Fish
- Soil fauna
- Winter N loss
- Change of GWP
- % people exposed to > threshold | Increased incidence of disease
- Incidence and/or extent of HABs
- Crop yield |Animal yield
- Food quality index
- Energy yield
- Increased incidence of allergy
- Disability-Adjusted Life Years
- Cost for repairing
- Number of haze days due to N pollution
- Industrial water use

N threat-benefit indicators (Status)

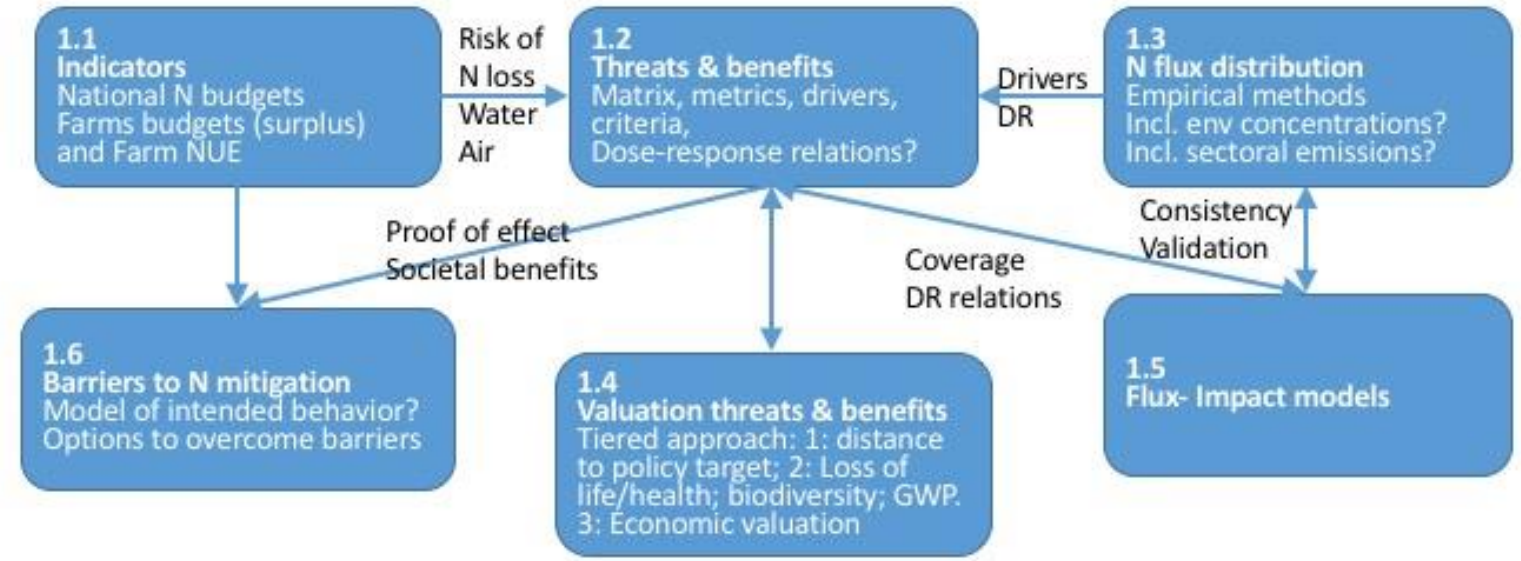
- Critical load of N (S) deposition (nature) | Critical N inputs (agriculture)
- Critical level of NH3
- POD1 (forests) | POD6 (vegetation) | AOT40 | WSL 126
- BOD | NO3 | Critical loads (nature/agriculture)
- Dissolved O2 | Algal taxonomy | Shellfish closures
- N and C conc. | C:N ratios (plant/soil)
- NOx | NHy| N2O | CH4 | CO2 conc. (air)
- Organic aerosol
- Al (and heavy metal) concentrations (soil)
- C stocks | NEP | Soil N
- PM2.5 | PM 10 | O3 |Particulate NH4 | Org-N(peroxidized) |PAN (air)
- NO3 | NO2 | PO4 conc (aq.)
- Chlorophyll A | Algal taxonomy
- Fertilizer N inputs (inorganic and organic)
- AFstY (O3 flux) | AOT40
- N content cereal | Food N intake
- Acidity prec., prec/T O3, PM
- Cations conc. (aq.)

Next steps

- Visualize the linkage of each item of the N threat/benefit metric, indicators and global scale deviation
- Update and revise them according to the opinions from multiple stakeholders through the interviews and workshops
- Use this matrix for N treat/benefit assessment
  - Methodology guidance documentation
  - Assessment in the Towards INMS locally, regionally and globally

Activity 1.2 Development of threat assessment methodology	17	2018				2019				2020				2021		
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Task 1.2.1: **Initial Identification of Key N threats**		R	M	R												
Task 1.2.2 **Conduct stakeholder review;** **refine key N threats and criteria**				R		R										
Task 1.2.3 **Workshop to review assessment methodologies for N threats**				W				W								
Task 1.2.4 **Draft guidance on overall N threat assessment methodology**												R				
Monitoring and Evaluation					R				R				R			

C1 – Hierarchy and connections



General criteria: global coverage, stakeholder interaction, practical

Risks: overlaps – inconsistencies between activities; too much application