Development of N system indicators

A1.1

Kentaro Hayashi, Wilfried Winiwarter

INMS-5 Meeting

Tasks

Activity 1.1: Development of N System indicators	Year 1				Year 2				Year 3				Year 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	Q 4
Task 1.1.1 Development of National N budget approaches		M				M				M		R		M		
Task 1.1.2 Development of Farm N budgets		M				M				M		R				
Task 1.1.3 Development of NUE approaches		M			R	M				M R						
Task 1.1.4 Relating of Level & Effect Indicators to budget indicators		M	R							M				M R		
Monitoring and Evaluation					R				R				R			R

Task 1.1.1: Development of national nitrogen budget approaches

Co-leads: Wilfried Winiwarter & Kentaro Hayashi

Purpose of the task is to test and develop national nitrogen budget approaches and documentation reviewing the existing guidance developed by the Expert Panel on Nitrogen Budgets (EPNB) in Europe and other approaches, e.g., CHANS model in China

Output of the task will be a guidance document on national nitrogen budgets and to support the implementation of common methodologies to nitrogen budgets estimation in the Regional Demonstrations

United Nations ECE/EB.AIR/119

Economic and Social Council

Distr.: General
17 June 2013

Original: English

Economic Commission for Europe

Executive Body for the Convention on Long-range Transboundary Air Pollution

Guidance document on national nitrogen budgets

Summary

At its thirty-first session (Geneva, 11–13 December 2012), the Executive Body to the Convention on Long-range Transboundary Air Pollution adopted a guidance document on national nitrogen budgets which corresponds to the the guidance document referred to in article 7, paragraph 3 (d), of the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, as amended (ECE/EB.AIR/113/Add.1, decision 2012/10).

The present document contains the guidance document as adopted. It is designed to assist in the calculation of nitrogen budgets, nitrogen use efficiency and nitrogen surpluses and their improvements within the geographical area of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe.

Detailed Annexes to ECE/EB.AIR/119 – "Guidance document on national nitrogen budgets"

(https://www.unece.org/fileadmin/DAM/env/documents/2013/air/eb/ECE_EB.AIR_119_ENG.pdf)

21.09.2016

Editor: Wilfried Winiwarter and Expert Panel on Nitrogen Budgets (http://www.clrtap-tfrn.org/epnb)

European approach (EPNB)

Chinese approach (CHANS)

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

PNAS

Integrated reactive nitrogen budgets and future trends in China

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[a]Policy Simulation Laboratory, Zhejiang University, Hangzhou 310058, People's Republic of China; [b]College of Resources and Environmental Sciences, China Agricultural University, Beijing 100193, People's Republic of China; [c]College of Life Sciences, Zhejiang University, Hangzhou 310058, People's Republic of China; and [d]Department of Biology, Stanford University, Stanford, CA 94305

Contributed by Peter M. Vitousek, May 28, 2015 (sent for review March 13, 2015; reviewed by William H. Schlesinger and Xunhua Zheng)

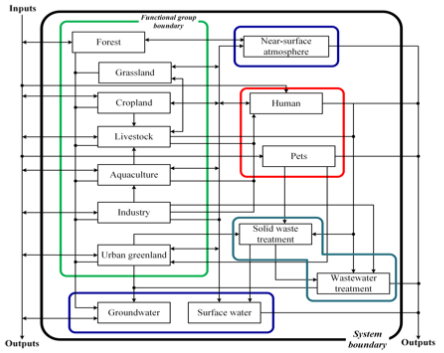
Reactive nitrogen (Nr) plays a central role in food production, and at the same time it can be an important pollutant with substantial effects on air and water quality, biological diversity, and human health. China now creates far more Nr than any other country. We developed a budget for Nr in China in 1980 and 2010, in which we evaluated the natural and anthropogenic creation of Nr, losses of Nr, and transfers among 14 subsystems within China. Our analyses demonstrated that a tripling of anthropogenic Nr creation was associated with an even more rapid increase in Nr fluxes to the atmosphere and hydrosphere, contributing to intense and increasing threats to human health, subsystems within China and left out some important connections among subsystems. Here we (*i*) analyze N sources, fluxes, and fates in China as a whole and among 14 different subsystems (cropland, grassland, forest, livestock, aquaculture, industry, human, pet, urban green land, wastewater treatment, garbage treatment, atmosphere, surface water, and groundwater) and (*ii*) use this subsystem-level budget to explore management scenarios and evaluate possible trajectories of N use and their consequences. Our overall objective is to evaluate how China can use Nr in support of sustainable development on a national scale.

Please cite the following reference if you used this model:

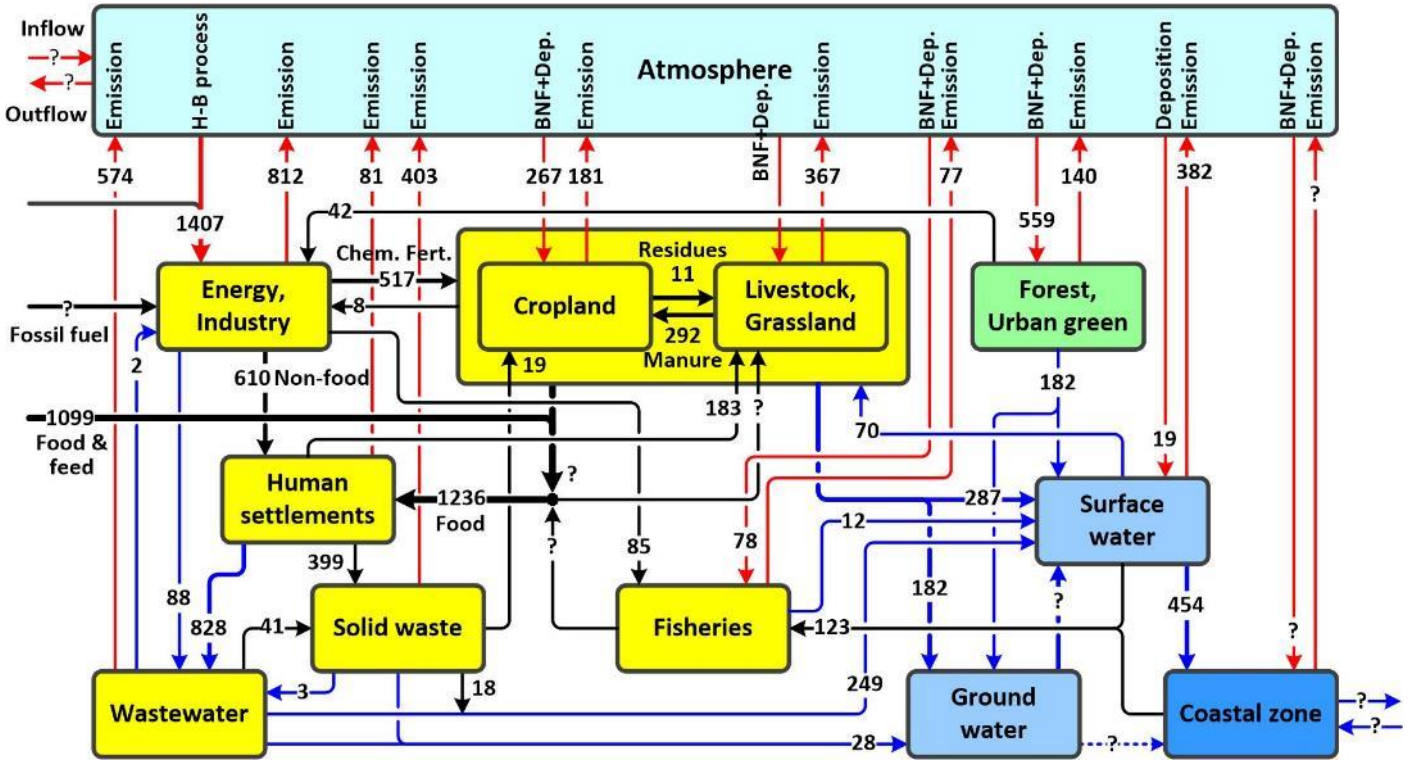
Gu B, et al (2015) Integrated reactive nitrogen budgets and future trends in China. Proc Natl Acad Sci USA 112 (28):8792-8797.

Main reference:

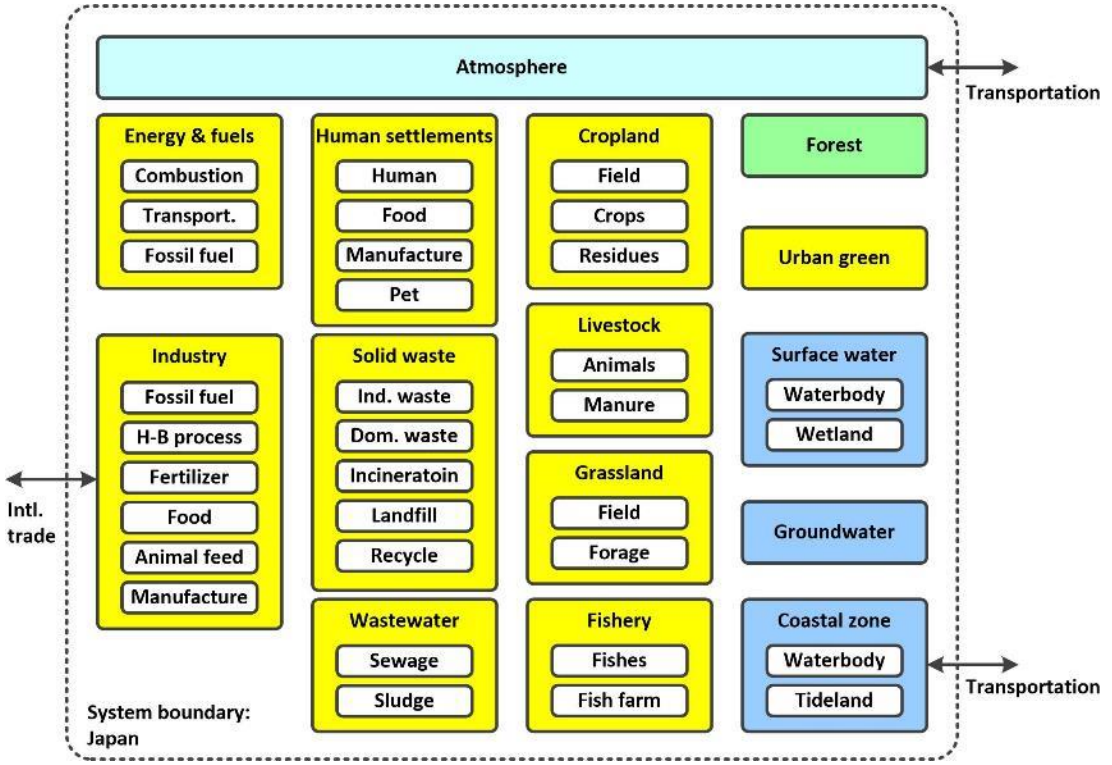
Cai Z, Gu B (2018) Guidelines for Nitrogen Flow Analysis in China (Science Press,Beijing, in Chinese)
Gu B, Ju X, Chang J et al (2015) Integrated reactive nitrogen budgets and future trends in China. Proc Natl Acad Sci USA 112 (28):8792-8797.
Gu B, Leach AM, Ma L et al (2013) Nitrogen Footprint in China: Food, Energy, and Nonfood Goods. Environ. Sci. Technol. 47 (16):9217-9224.
Gu B, Yang G, Luo W et al (2013) Rapid growth of industrial nitrogen fluxes in China: Driving forces and consequences. Sci. China Earth Sci. 56 (4):662-670.
Gu B, Ge Y, Ren Y et al (2012) Atmospheric Reactive Nitrogen in China: Sources, Recent Trends, and Damage Costs. Environ. Sci. Technol. 46 (17):9420-9427.
Zhang X, Wu Y, Liu X et al (2017) Ammonia Emissions May Be Substantially Underestimated in China. Environ Sci Technol. 51 (21):12089-12096.



$$\sum_{h=1}^{m} \mathrm{IN_h} = \sum_{g=1}^{n} \mathrm{OUT_g} + \sum_{k=1}^{p} \mathrm{Acc_k}$$



Japanese N budgets (Gg N yr^{-1}, 2000–2010 mean) using the default CHANS model



Modified pools and subpools for Japanese N budgets estimation (in progress)

Guidance Document on National Nitrogen Budgets

Authors: Wilfried Winiwarter, Baojing Gu, Xin Zhang, Kentaro Hayashi

1. Introduction
2. EPNB guidance (European approach)
3. CHANS guidance (Chinese approach with possible expansion to other countries, a test case in Japan)
4. Guidance on generic N models (Global models useful to evaluate a national scale nitrogen budgets)
5. Guidance on N budgets results based on case studies (European countries, China, Japan, Global estimation)

Appendix 1. Data source information

Appendix 2. Glossaries

Task 1.1.3: Development of nitrogen use efficiency approaches

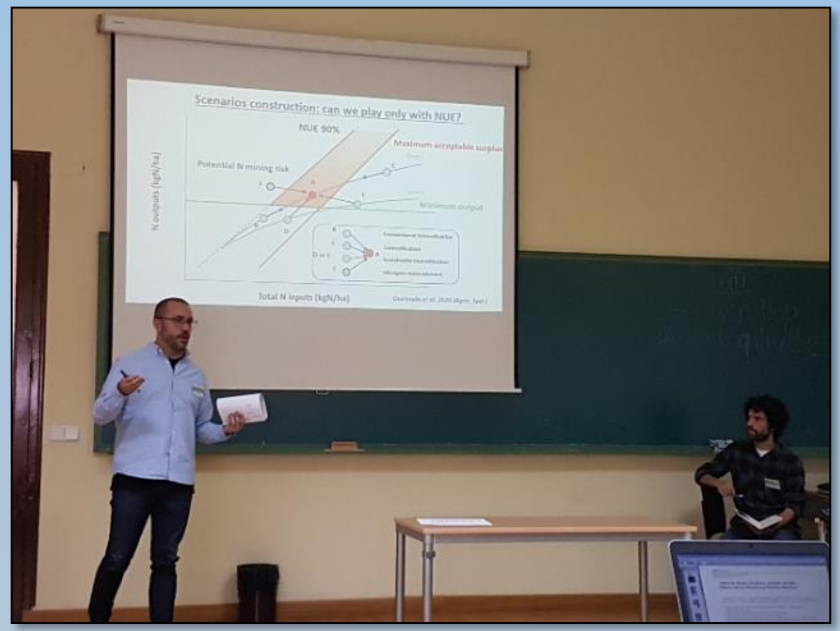
Co-leads: Luis Lassaletta & Oene Oenema

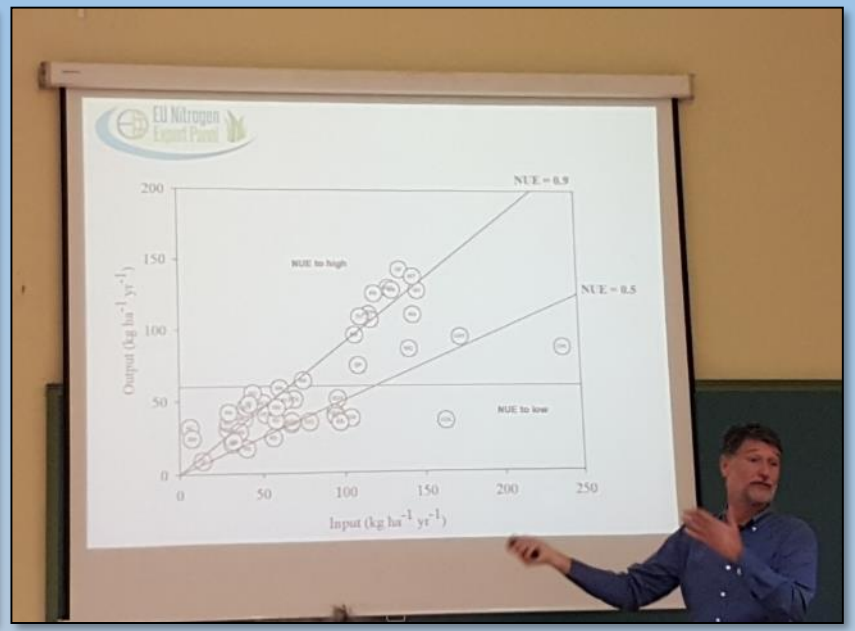
Purpose of the task is to **bring together existing initiatives and experts that address nitrogen use efficiency** from different perspectives and further develop consensus on approaches and formulation of NUE

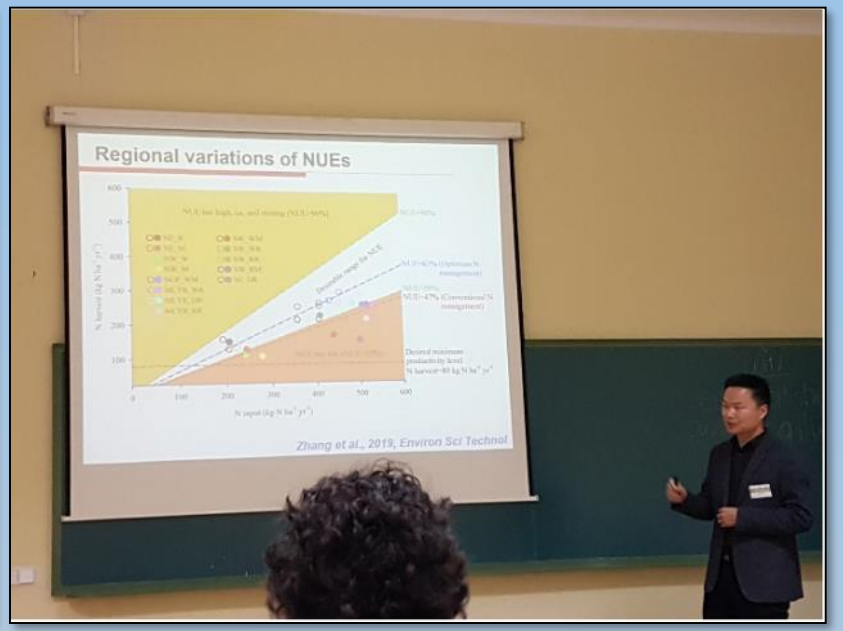
Output of the task will be a **guidance document on NUE methodology for different purposes** and to **support discussions** for different user groups, farms, industry, food supply, scientists, governments etc.

INMS Joint Workshop: NUE indicators for Demo Regions, Modelling and Barriers Assessment. Nov 2019 Madrid

- 34 attendants from 18 countries
- Discussion about the writing of the Guidance document
- Harmonizing approaches
- Contribution of people form Demo sites, modelling and barriers



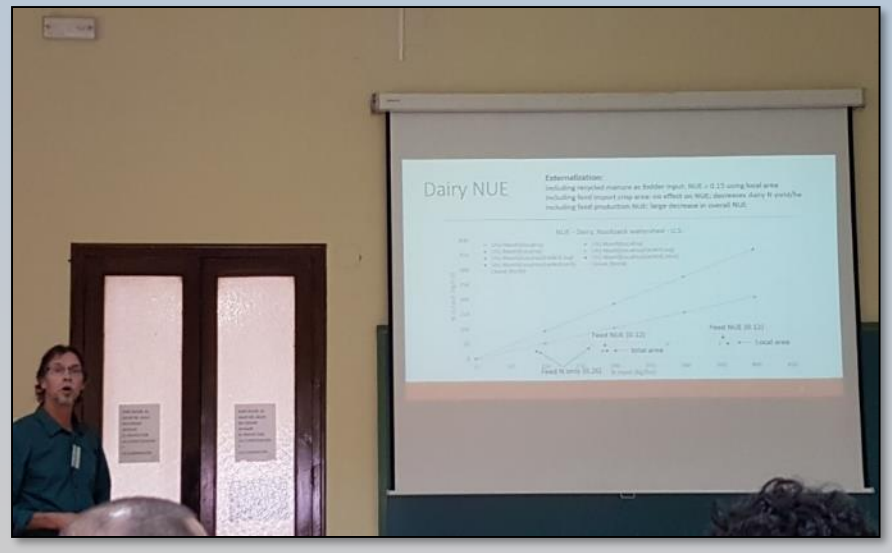




Harmonizing a methodology to estimate NUE indicators in INMS Demo Sites.

Very active interaction after the meeting to provide a **common way to express and represent NUE at INA book Demo Chapters**

(Contact people: A. Sanz-Cobena & J. Garnier)



The **Guidance Document** will cover different **methodological aspects**, **scales, systems uncertainties, approaches** and world regions that can be **unconventional**, less studied or that require particular attention

36 contributing **authors** from **16 countries**
6 sections and 18 chapters

1. **Introduction and context** *Lassaletta et al.*
2. **Boundaries: inputs and outputs** *Billen et al.*

3. Cropping systems

a. Ways to estimate NUE. *Johnes et al.*
b. Sources of uncertainty. *Zhang et al.*
c. Missing inputs and outputs *Serra et al.*
d. NUE in rotations. *Quemada et al.*
e. NUE of low protein crops. *Hayashi et al.*
f. NUE of fixing crops. *Pacheco et al.*
g. NUE in agroforestry systems. *Dong-Gill et al.*
h. Interactions NUE/PUE/WUE. *MacDonald et al.*

4. Animal systems

a. Ways to estimate NUE. *Bai et al.*
b. Externalization. *Godinot et al.*

5. Full chain *Erisman et al.*

6. NUE in Integrated Assessment Models *Bouwman et al.*

7. Ways to improve NUE

a. Fertilization strategies. *Guardia et al.*
b. Animal systems. *Uwizeye et al.*
c. Improving NUE while adapting to CC. *R-Ramos et al.*
d. Structural changes. *Garnier et al.*

Next steps: **complete draft** (by the end of the summer); **full GD** (by the end of the year)

Any question: luis.lassaletta@upm.es

Task 1.1.2: Development of farm nitrogen budgets

Co-leads: Cameron Gourley & Tom Misselbrook

Purpose of the task is the development of nitrogen performance indicators for dairy production systems on the global scale

Output of the task will be a Guidance Document, including details of dairy farm NUE indicators

Achievements –

- Denmark 2017 (Aarhu
- Australia 2018 (Melbo

Steps to finalize activities

- Compile dairy farm case studies (data available from UK, Aust, NZ, Scotland, NL, Portugal, Canada, Bangladesh, JA, among others)
- Project work to be finalized by the end of the year
- Scientific publication based on abstract accepted to INI2020

Task 1.1.4: Relating of Level & Effect Indicators to Budget Indicators

Co-leads: Jana Compton & Wilfried Winiwarter

Purpose of the task is to link N system indicators to effect based indicators

Output of the task will be a Guidance Document explaining how to link impacts with fluxes/drivers

Directions and achievements

- This activity builds on results of other INMS tasks
- Identifying indicators along the DPSIR concept
- Close connection to A1.2
- Work compilation by Allison Leach (together with task leads)
- Preparation meeting (Ft. Collins, March 14, 2019)
- A1.1, A1.2, A1.3 coordination meeting, WebEx, December 3, 2019
- A1.1, A1.2, A1.3 coordination meeting, Zoom, July 7, 2020
- A1.1 meeting, Zoom, July 7, 2020

Proposed timeline

Summer 2020

- Links with other INMS tasks (T1.1.1, 1.1.2, and 1.1.3)
- Mapping impacts to fluxes/drivers (based on A1.2 matrix)

Fall 2020

- Interim meeting & report on development of Guidance Document
- Guidance document outline

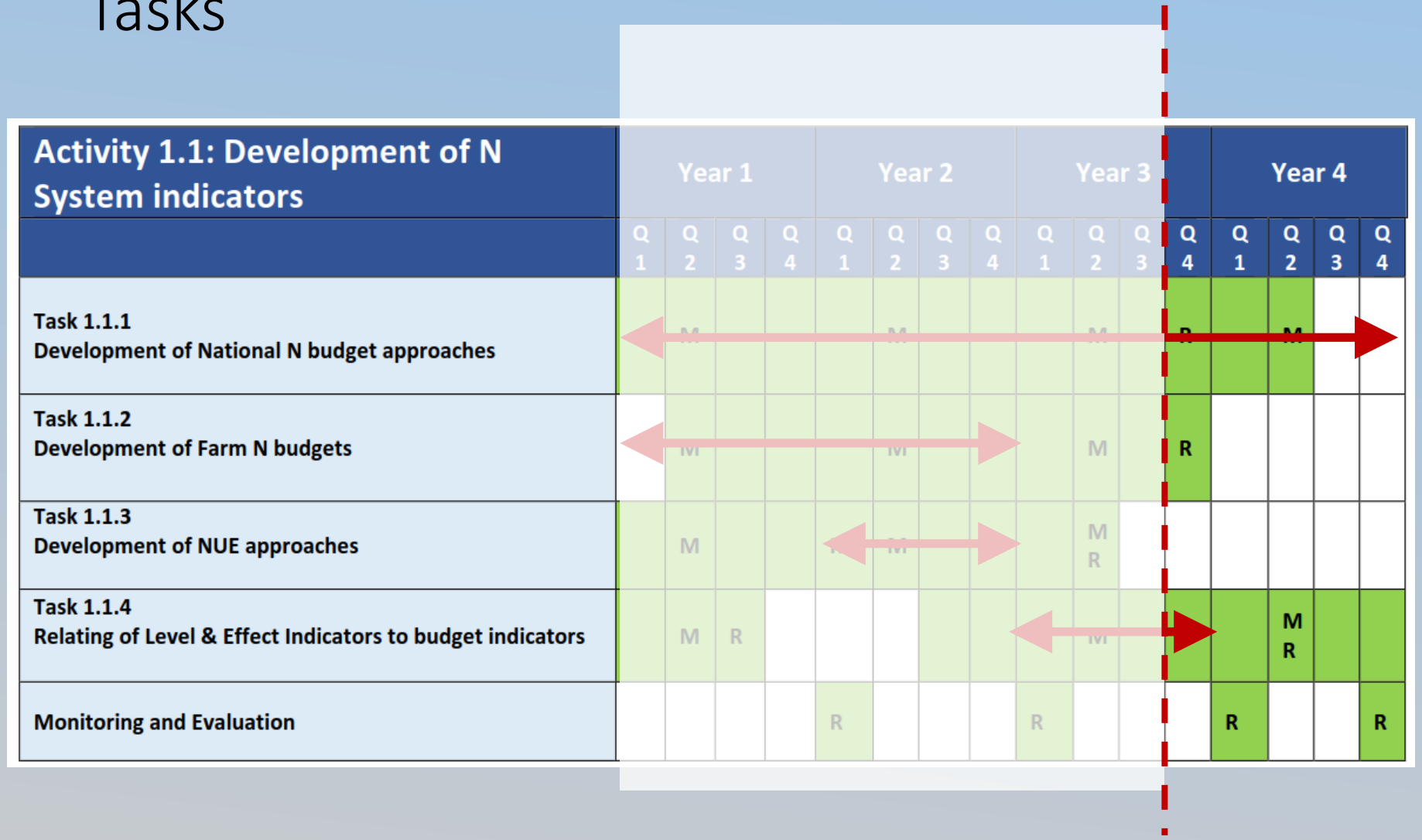
Winter 2020/21

- Share first draft of guidance document ahead of the postponed Berlin meeting
- Meet with task leads to discuss guidance document

Spring 2021

- Incorporate reviewer comments to guidance document
- Submit final version to INMS

Tasks



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Monitoring and Evaluation					R				R				R			R

Impact of COVID-19 crisis on work progress

- Great achievements over the first 2.5 project years, including meetings with personal interaction up to late 2019
- Three months lockdown (staggered)
- Unclear when international (intercontinental) travel can resume
- Doubtful if INMS lifetime allows further meetings

→INMS community formed successfully

→Wrap up available results, aiming for INA

→Make results useful for INMS demonstration areas