

INMS Component 2: Global & regional quantification of N use, flows, impacts & benefits of practices

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*First e-briefing for the Nitrogen Working Group of the
United Nations Environment Programme*

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Global scale integrated N assessment modelling

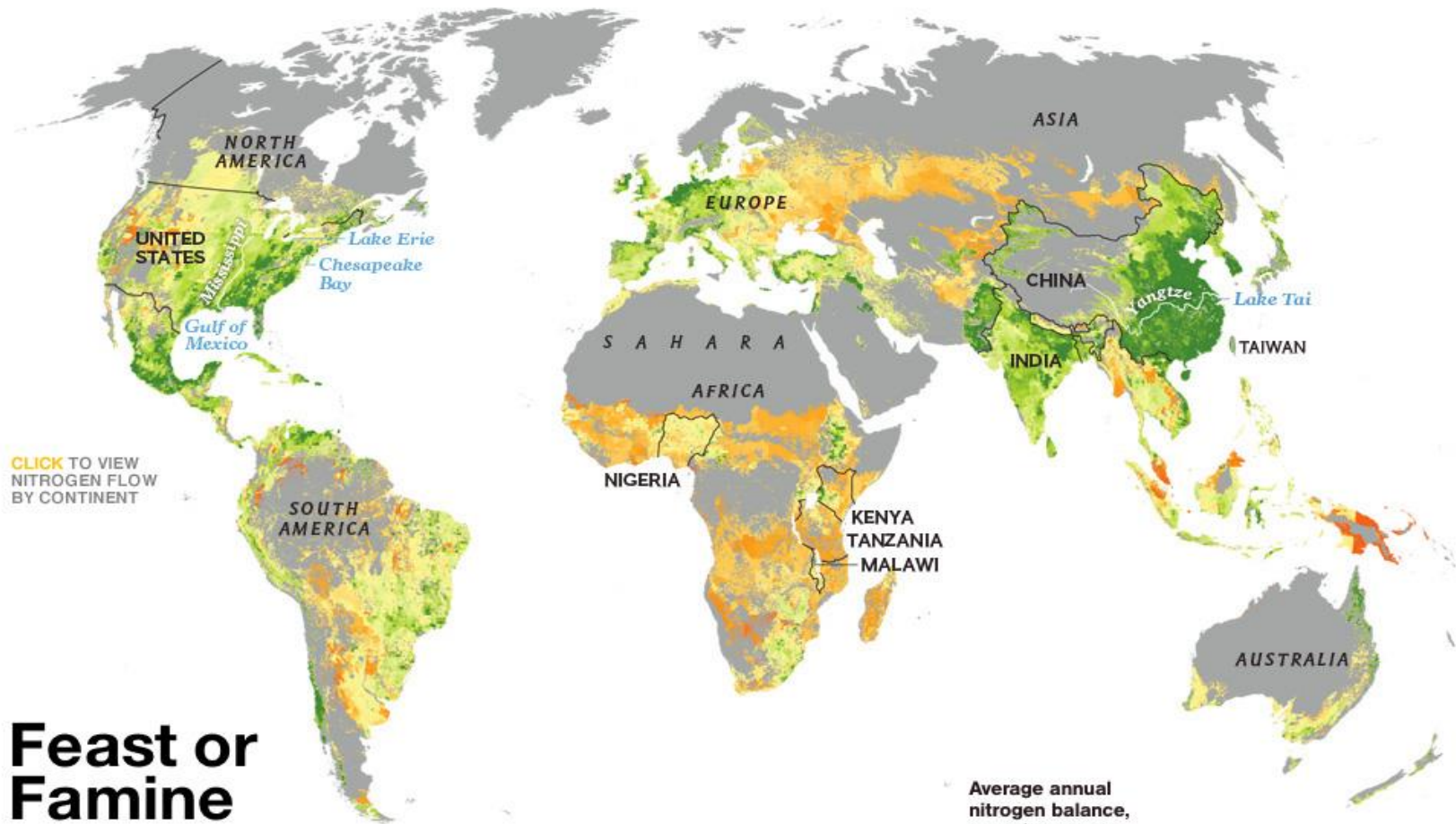
- The rationale: need for cost-benefit quantification of N policies
- The challenge: modelling interactions in the N cascade

INA part C: Global integrated assessment across the N cycle

- Outline and links to INMS modelling
- Examples of model results
 - Present (and past) N impacts
 - Future N impacts in response to scenarios and measures



Benefits: food and feed production



Feast or Famine

Nearly half the people on the planet wouldn't be alive if not for the abundant food made possible by nitrogen fertilizer. Yet its benefits have not reached everyone. In sub-Saharan Africa, where 239 million people go hungry in a year, crops fail as soil is stripped of nutrients, and farmers can't afford to buy fertilizer. Elsewhere overuse pollutes waterways and releases greenhouse gases.

Zero means the crop used exactly the amount of nitrogen applied. The ideal range varies due to local conditions.

Threats of N use in agriculture: Impacts on air, soil and water quality: health, climate and biodiversity

Biodiversity impacts



Climate change impacts



N inputs:
N fertilizer
N fixation
N deposition

N outputs:
harvested
crops

N outputs:
milk, meat,
eggs

Atmosphere

NH_3 N_2O NO_x N_2

Atmosphere

NH_3 N_2O NO_x N_2

Crop production

Animal production

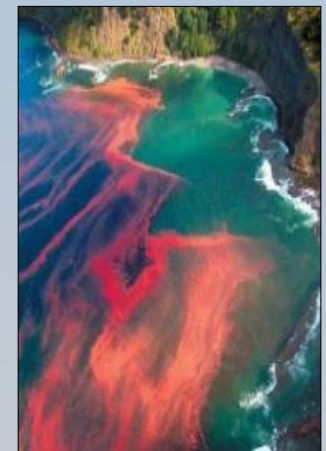
feed

manure

NH_4^+ NO_3^- DON N_{part}

NH_4^+ NO_3^- DON N_{part}

Ground water & surface water



In addition: Impacts of (industrial) N emissions on air quality and human health

Global scale integrated N assessment modelling in view of benefits and threats

A global integrated nitrogen assessment model needs to quantify effects of N management (N policies) on:

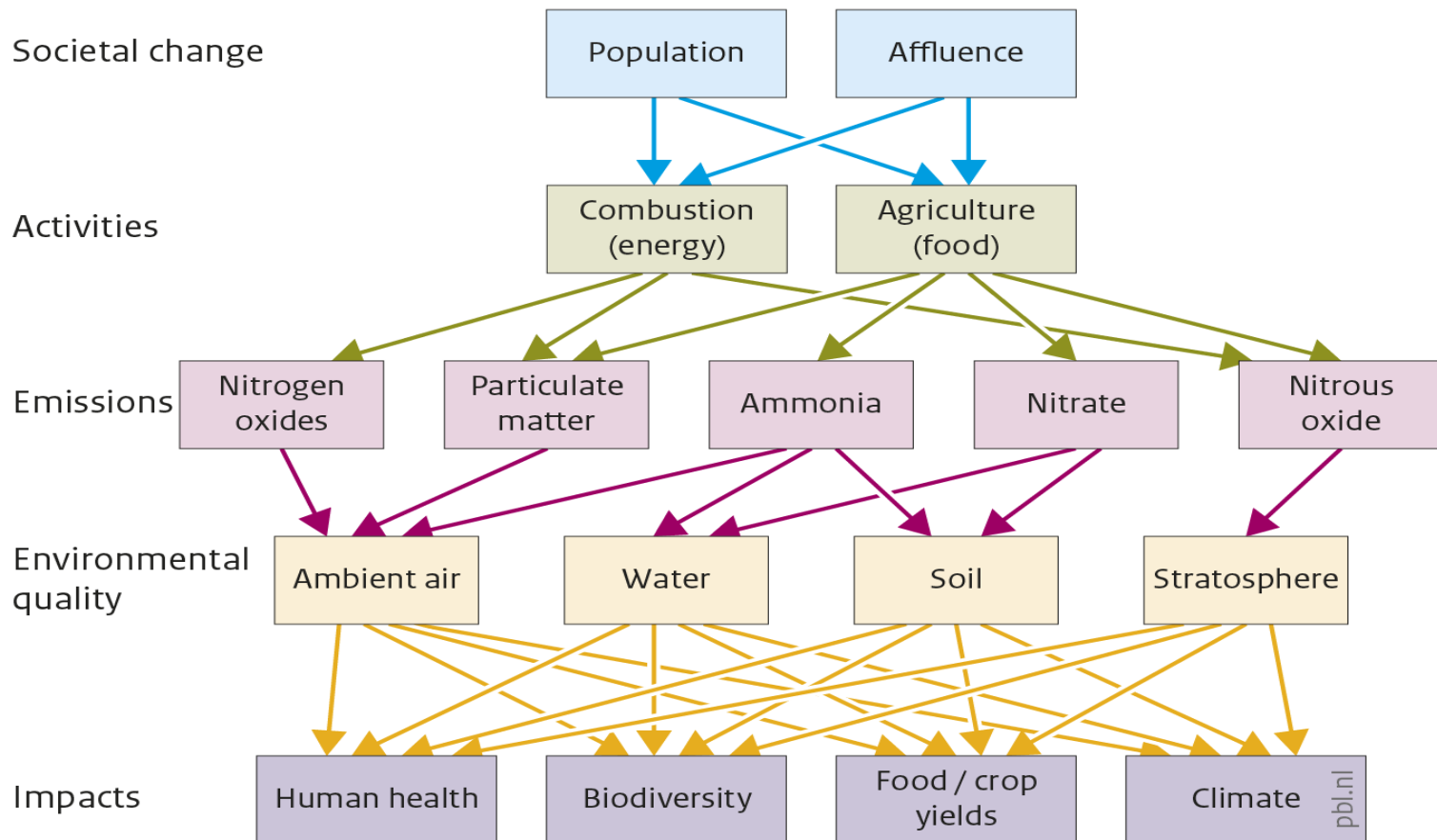
- food, feed and fiber production (benefits)
- quality of air, soil and water, and related human health, climate and biodiversity impacts (threats)

while

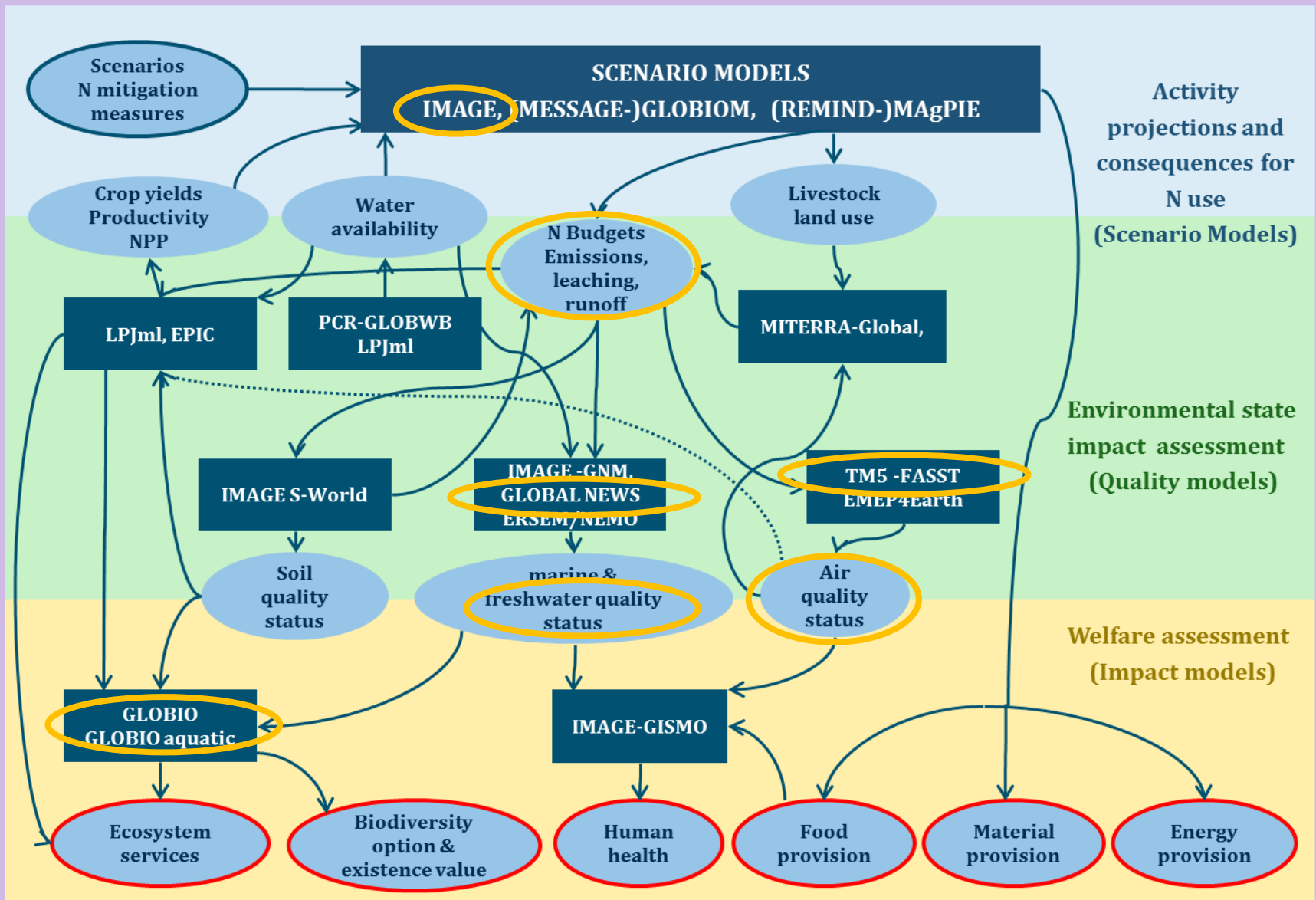
- being linked to socio-economic drivers (scenarios)
- accounting for variations in climate, soils, crops.

Global scale integrated N assessment: challenge to model the N cascade

Nitrogen cascade



Multi model approach: involved models and linkages

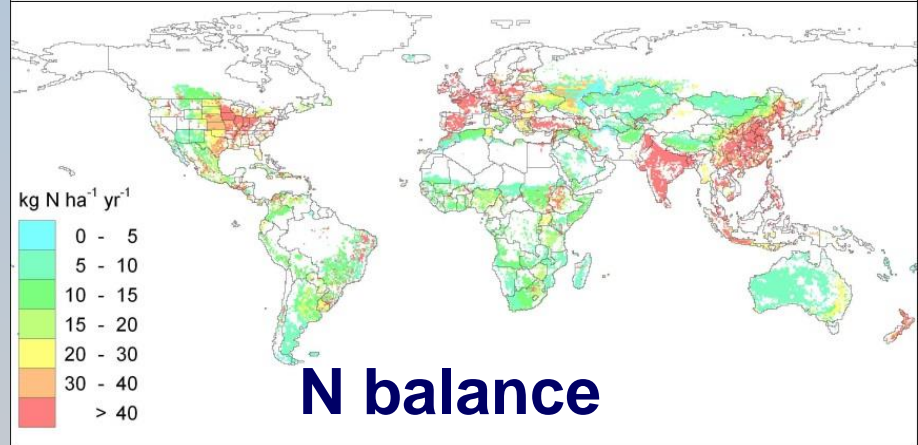
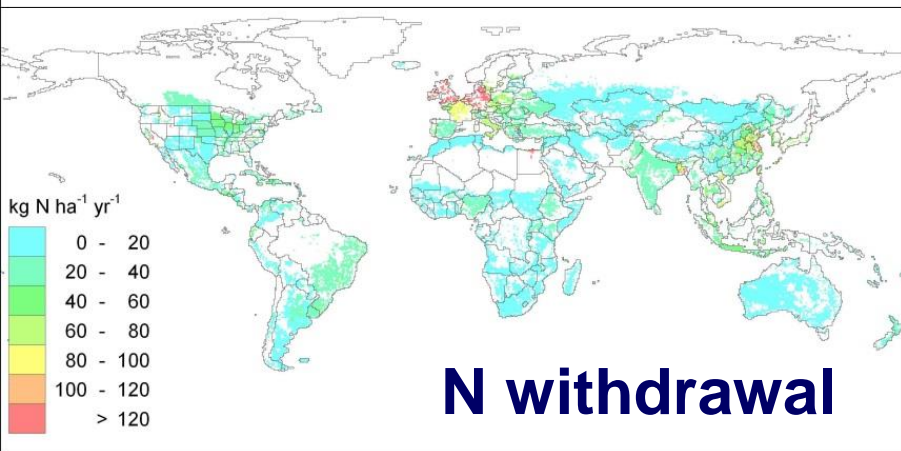
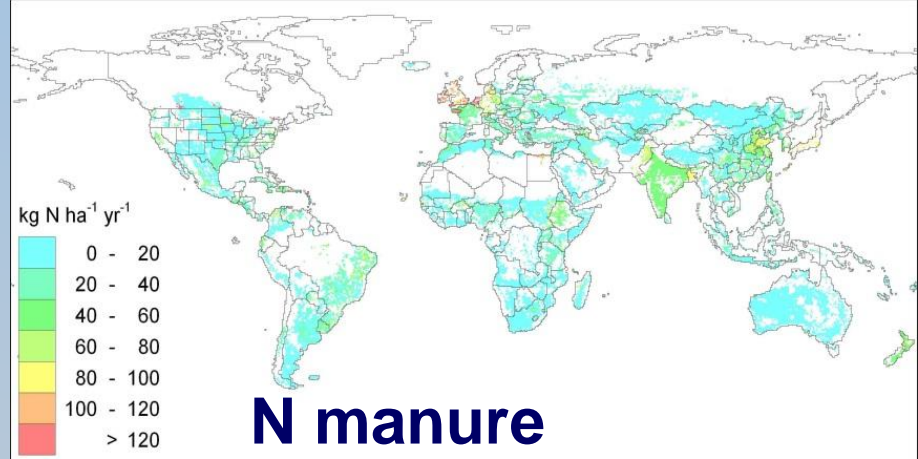
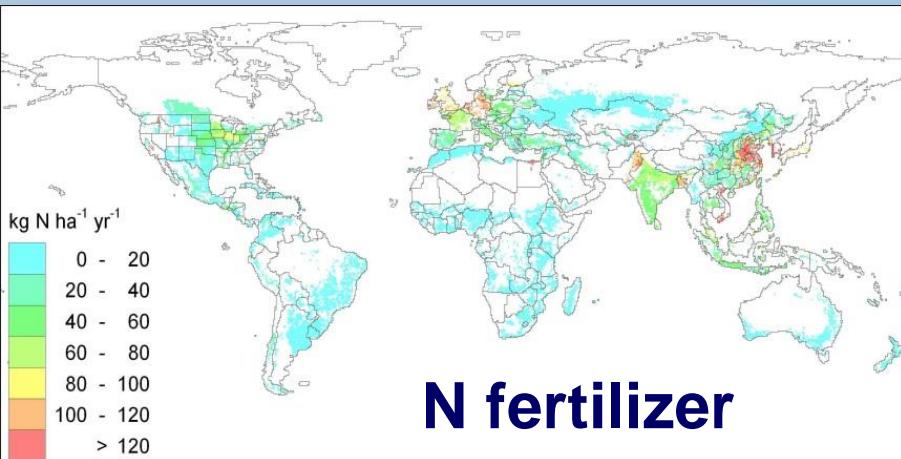


How will this be included in the INA part C

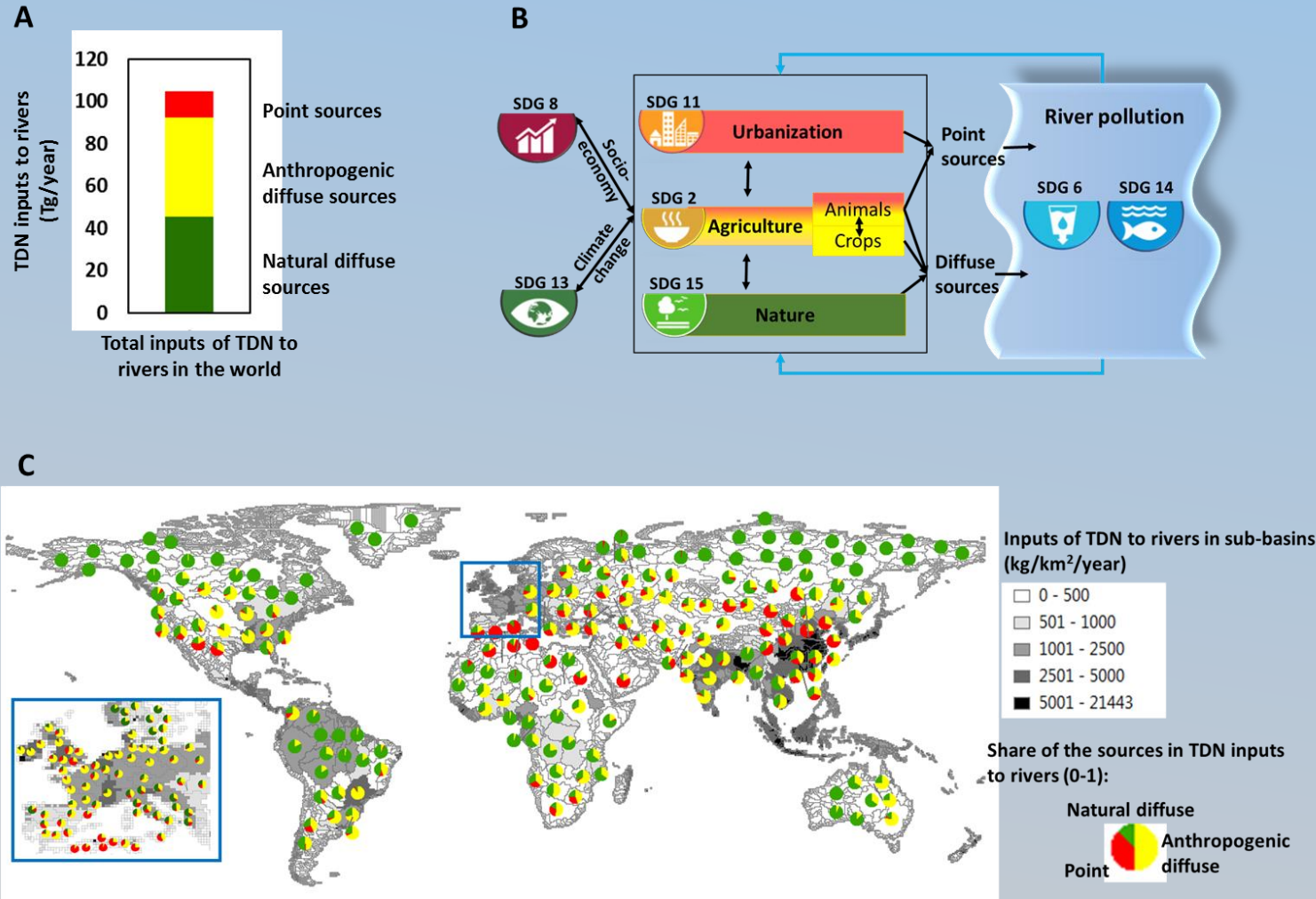
Impacts will be described by presenting current status and predictions up to 2050 (2010) based on WAGES

- Starting with *total N budgets*. C10
- **W**ater quality: linked to aquatic (marine) eutrophication C11
- **A**ir quality: linked to health C12
- **G**reenhouse gas emissions: linked to climate C13
- **E**cosystems: linked to terrestrial and aquatic biodiversity C14
- **S**oil: linked to soil N budgets (input, uptake, losses to air and water) and related soil acidification C15
- Finalizing with *cost-benefit analysis* C16

Example Chapter 10-15: Soil N budget results with IMAGE

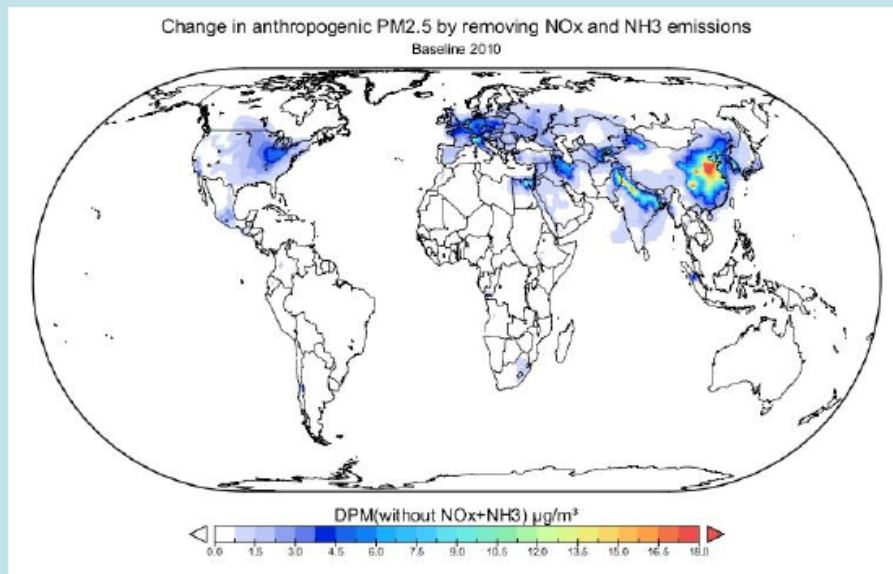


Example Chapter 11: Water quality assessment with Global NEWS

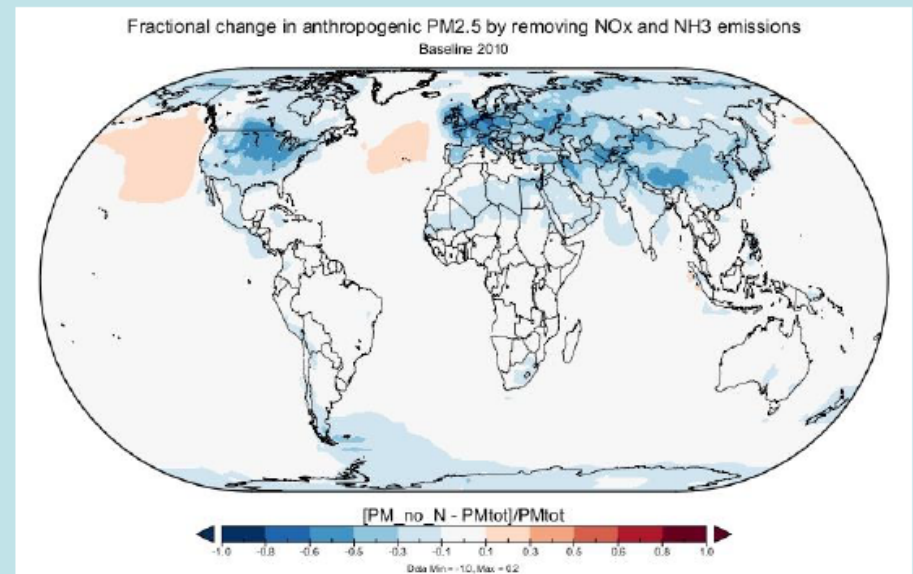


Example Chapter 12: Air quality assessment with TM5-FASST

Absolute change in PM_{2.5} by removing NO_x and NH₃ emissions



Fractional change in **anthropogenic** PM_{2.5} by removing NO_x and NH₃ emissions



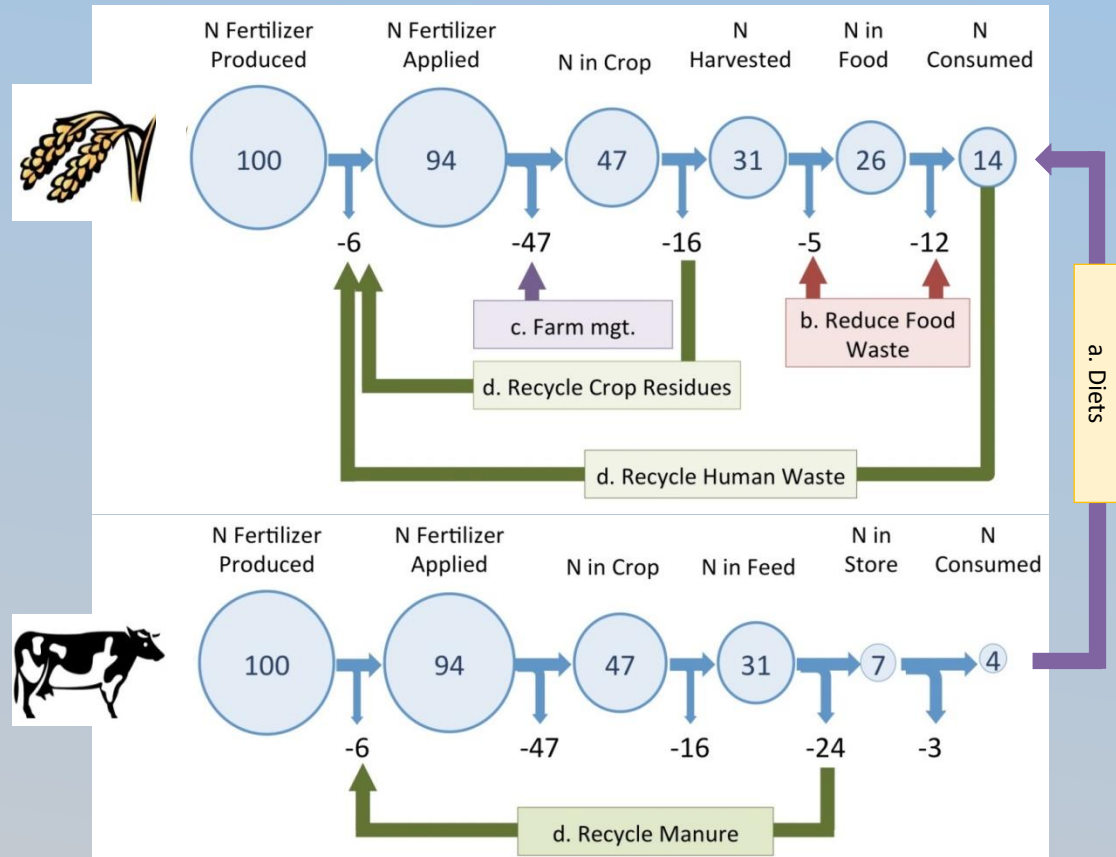
Impacts of NO_x and NH₃ emissions on PM_{2.5} affecting health: Van Dingenen et al. (2019)

Challenge ahead: systematic evaluation of scenarios and N mitigation measures

We use existing global scenario's, i.e. SSPs and RCPs, including dietary change propositions.

We assess separate N mitigation policies related to

- enhanced (animal, plant, human) waste recycling
- improved nutrient management.



Examples of good N management practices



INMS MAIN PAGE

Search a record...

Search

Climatic Zone - Any - **Geographic Region** - Any - **Sector** - Any - **Sector Category** - Any -

Nitrogen Species - Any -

Apply filters

Spreading liquid manure with trailing hose



Agri-Waste Composting



Acidification of slurry during application

Lowering protein consumption of cattle



Alternative Tile Intakes: Perforated Risers



Genetic variations in crops

Lowering protein consumption of pigs



Manure injection



Manure belt or manure scraper

Lowering protein consumption of poultry



Barnyard runoff control



Covering slurry with floating membranes

Optimising grazing time of cattle



Bedding area management

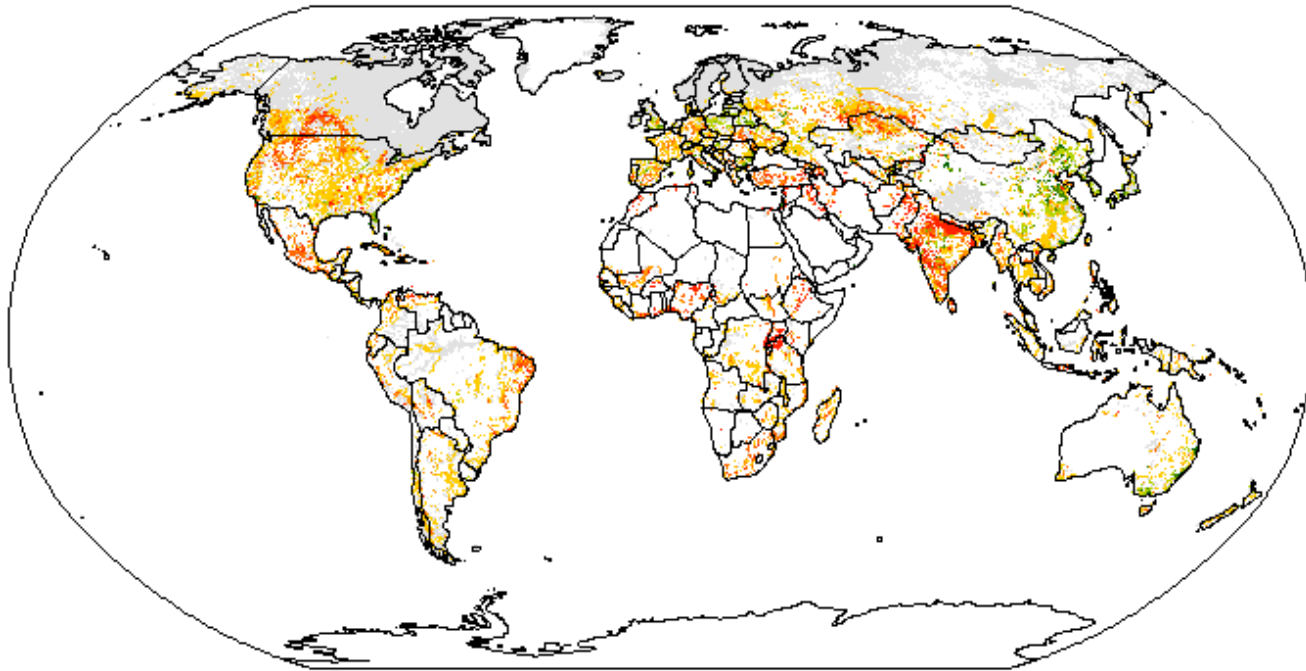


Gypsum Application

- Developing selection criteria, and methodology to select top ten measures, which may extend to regional top tens for each UN global region.

Examples of scenario results

Change in harmful algal blooms in lakes (2010 -> 2050) in response to SSP2 scenario



Deterioration in many regions due to increased N and P loading as well as temperature rise.

Janse et al (in prep)

So what is the main contents of part C INA

- Current status of N uses on soil, air and water quality and thus on biodiversity, human health and climate
- Evaluate impacts (costs and benefits) of scenarios and N related N policies/measures (management) on air, soil and water quality for:
 - food/feed supply
 - Biodiversity, human health and climate

Basis is result of coupled models evaluating scenarios (population growth, dietary patterns, bioenergy use) and N policies/measures

Questions?

