Land in the Earth System 2
04.11.2024

1. Nitrogen Cycle and Interactions with the Carbon Cycle Recap
(Dr. Fabrice Lacroix)

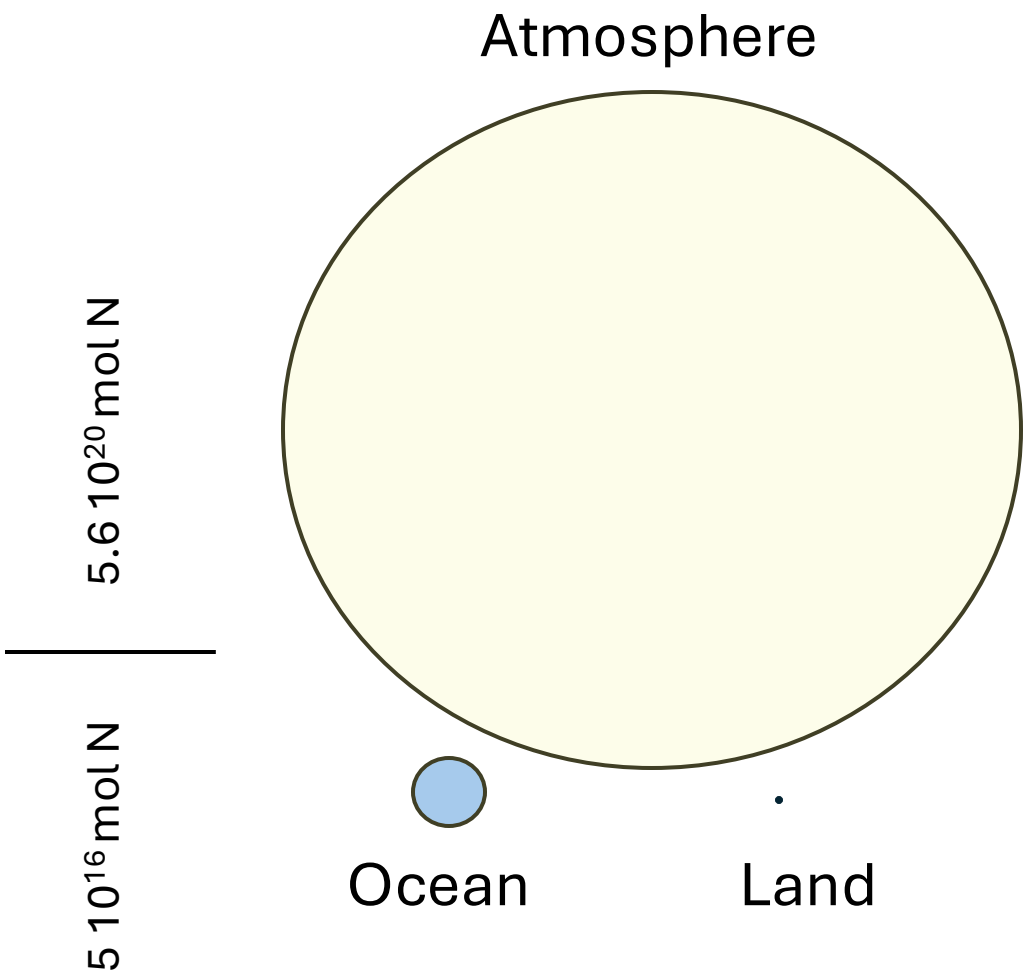
2. Terrestrial Greenhouse Gases
(Student Presentation)

Nitrogen in the Earth system

- Nitrogen vital for life on Earth

  → Needed for production of tissue, proteins, nucleic acids

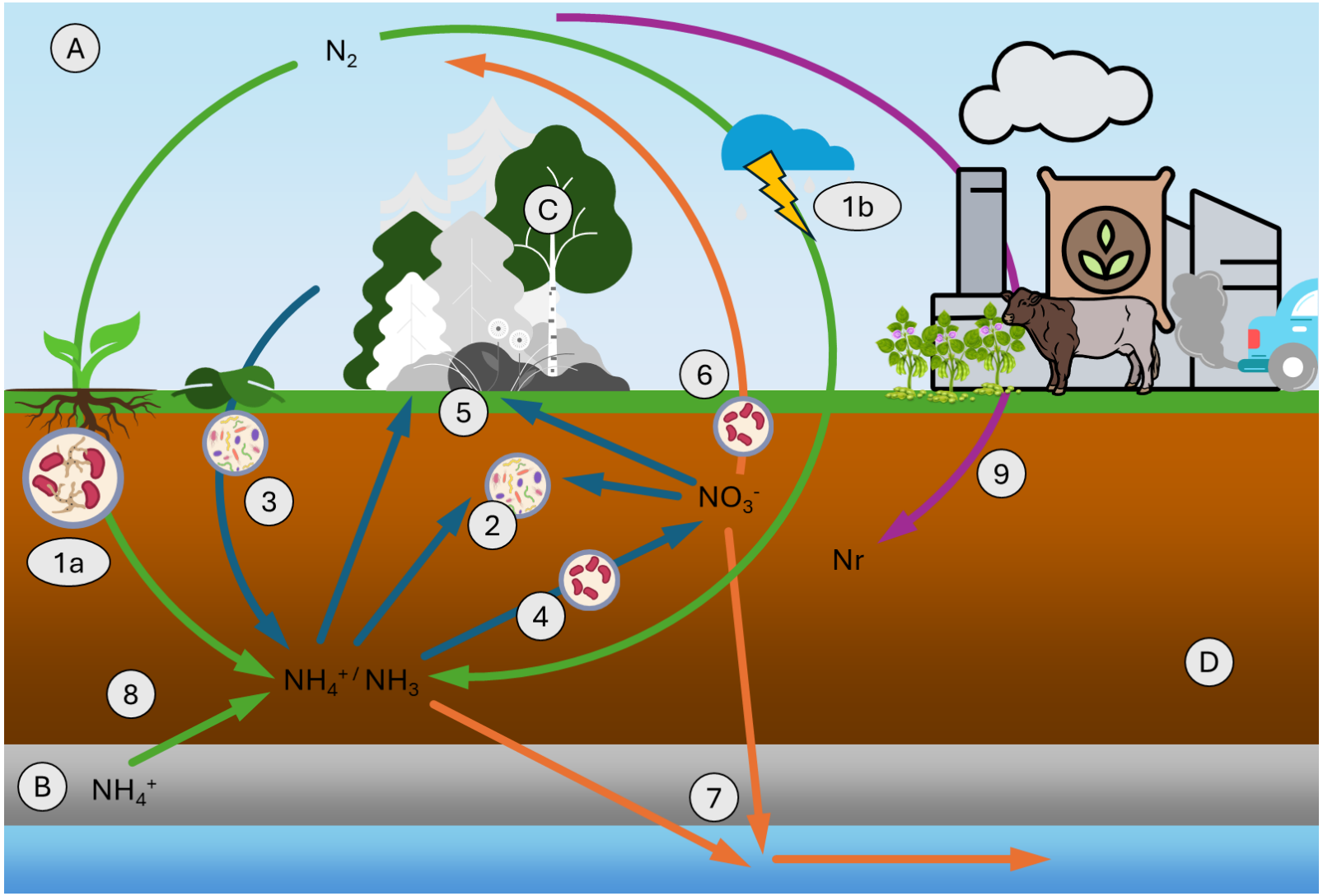
Nitrogen in the Earth system



- Nitrogen vital for life on Earth
- Largest pool of nitrogen is N_2 in the atmosphere

  (consists of 78 % of atmosphere composition)
- N_2 is not directly available to most terrestrial organisms

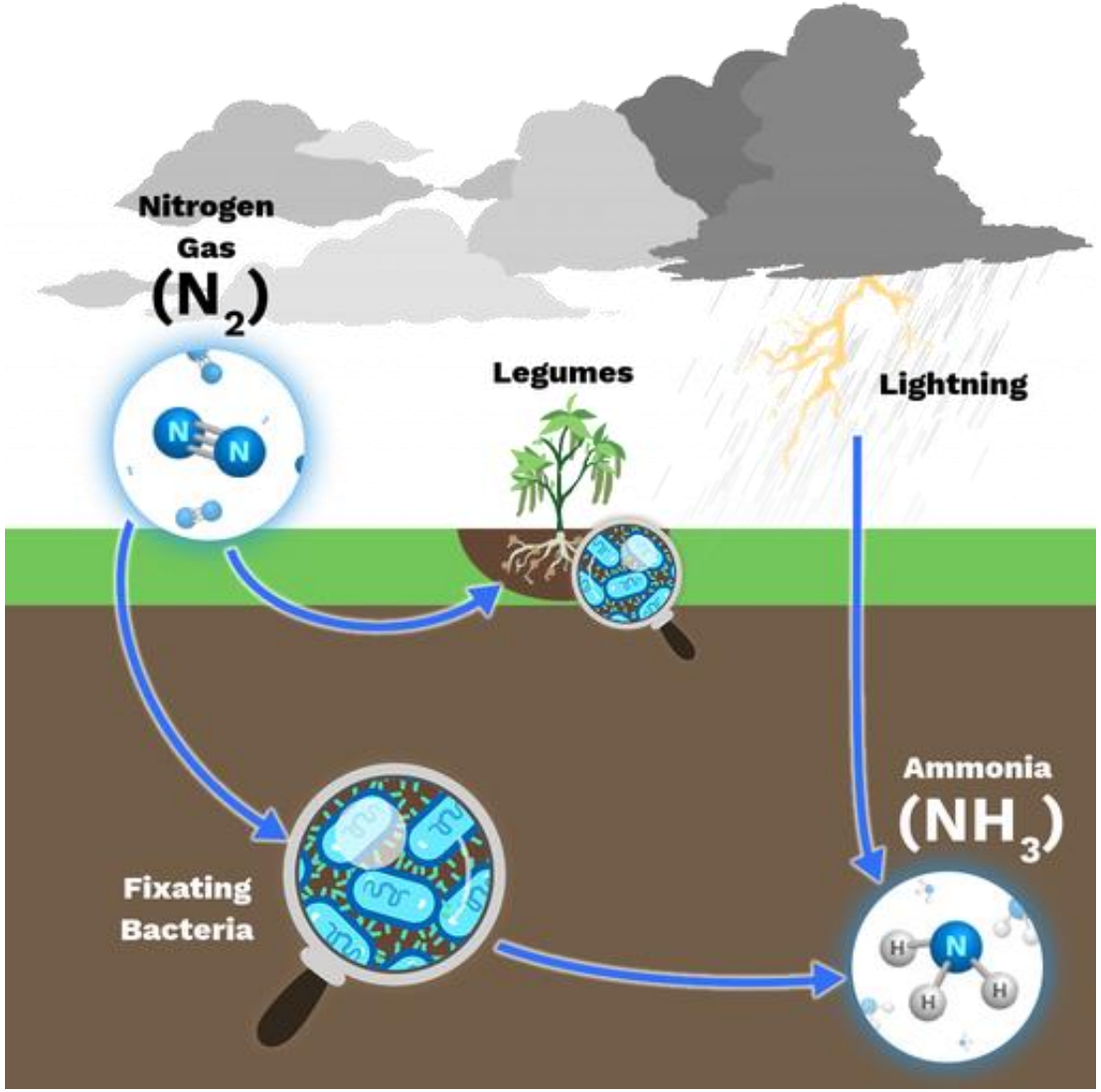
Nitrogen in the Terrestrial Ecosystem



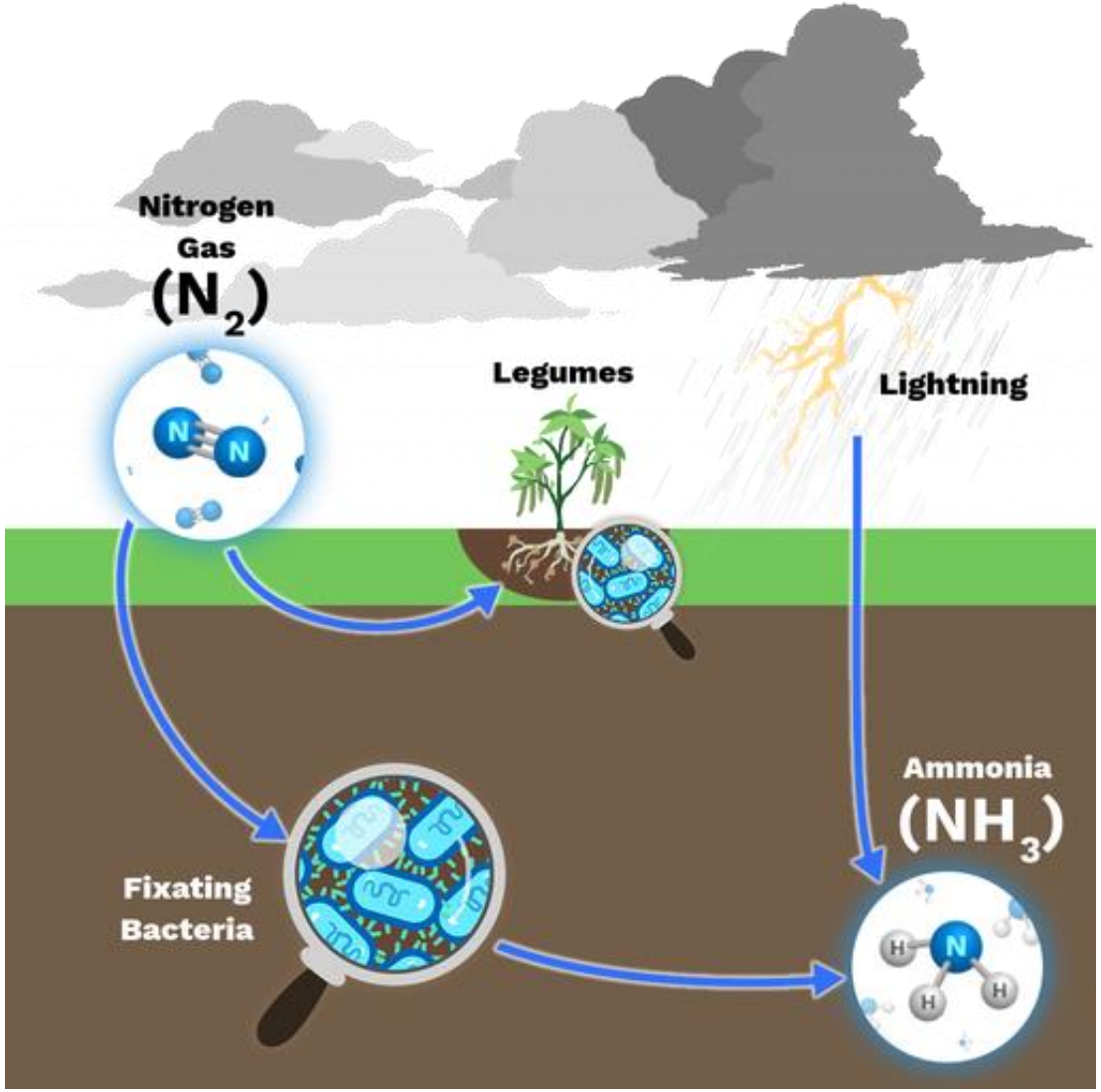
Interplay of

- Fluxes from the **atmosphere**
- **Soil** processing
- **Plant** dynamics
- **Freshwater** transport
- **Anthropogenic** Perturbation

Nitrogen Sources



Nitrogen Sources

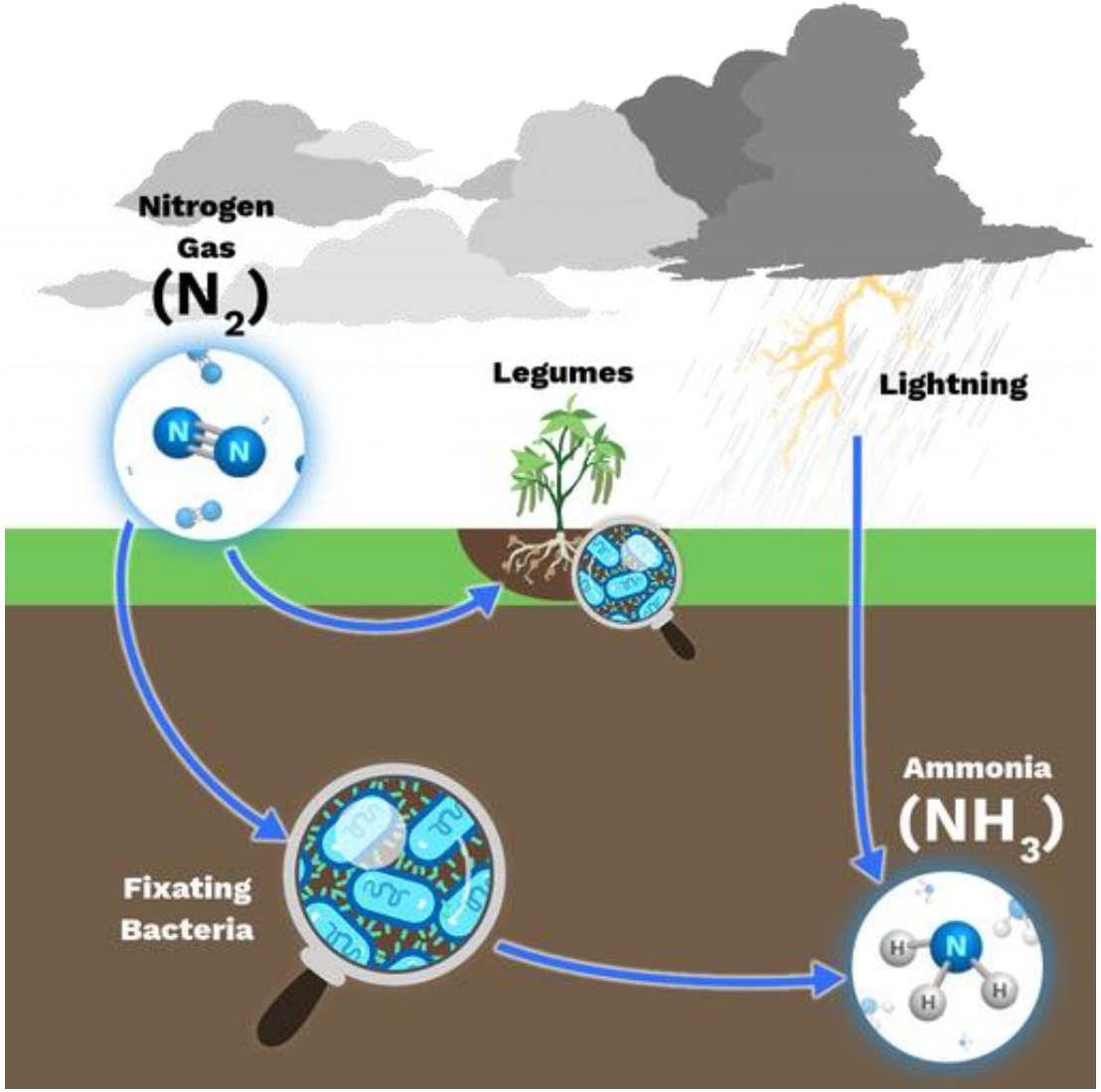


- N Fixation
  - Biotic

Nature in stock

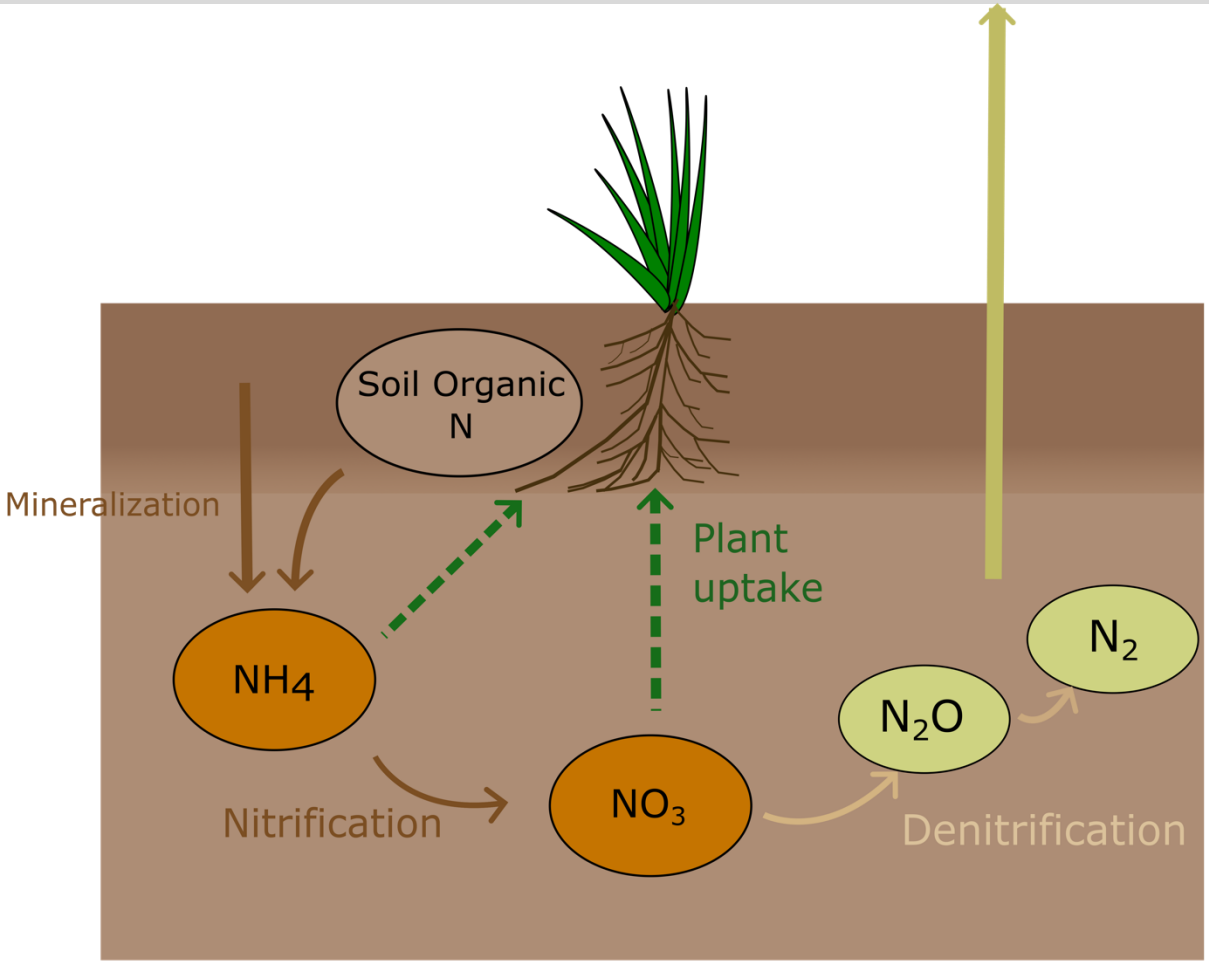
Root nodules

Nitrogen Sources



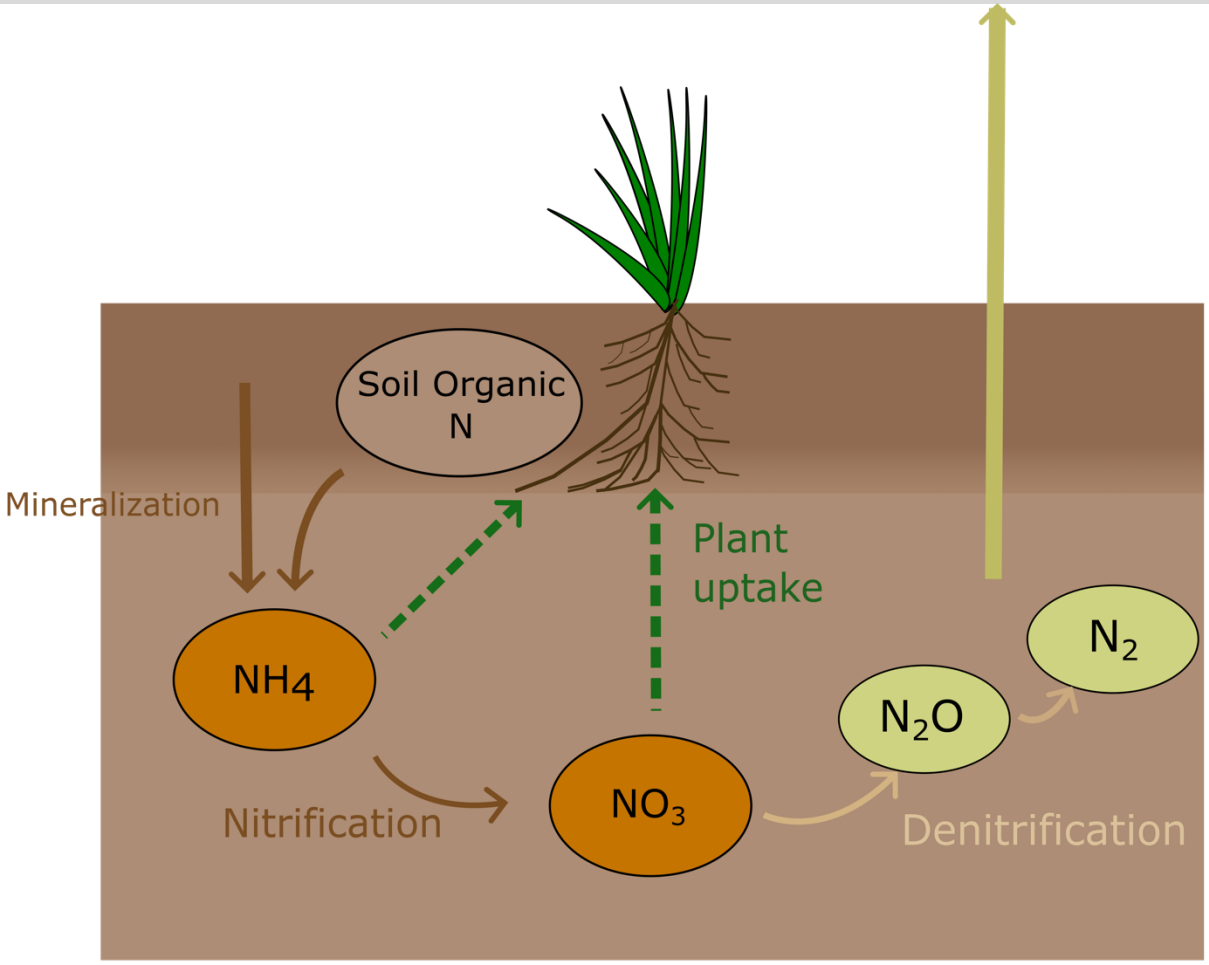
- N Fixation
  - Biotic
  - Abiotic
- N deposition
- Other anthropogenic sources (e.g., manure)

Microbial processing



- Use by microbes as an energy source or oxidant
  - Organic Matter Mineralization
    → NH_4^+

Microbial processing



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  - Mineralization Nitrification (aerobic conditions)
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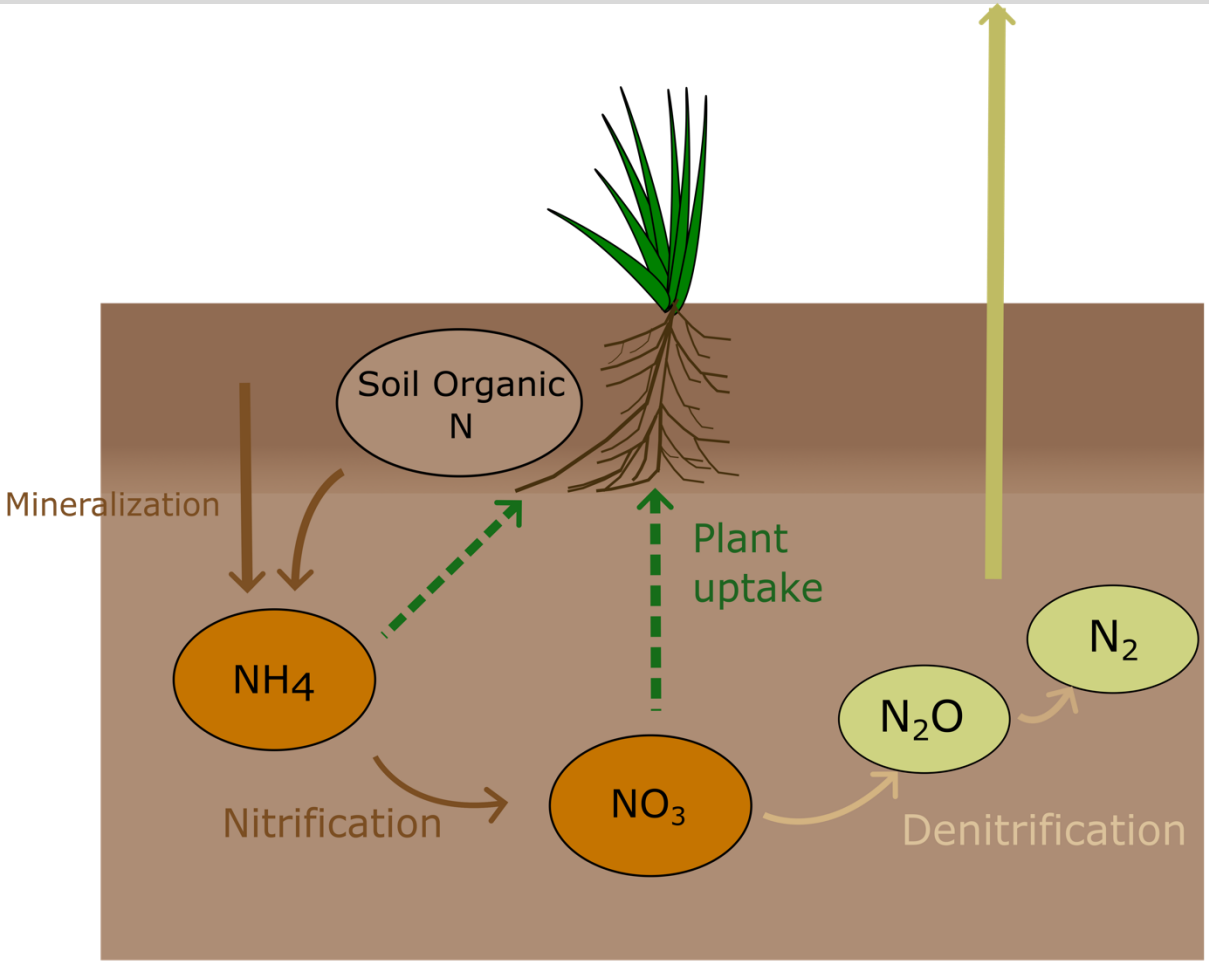
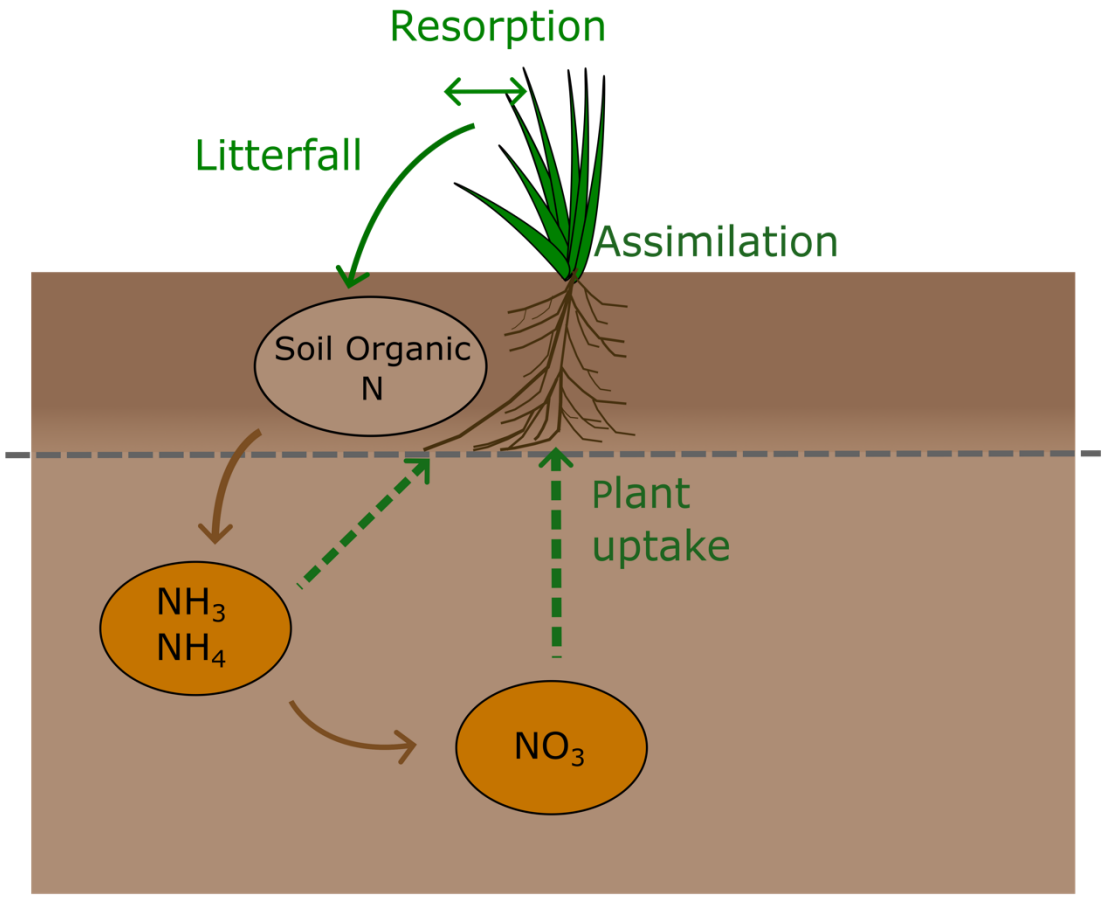
Microbial processing



- Use by microbes as an energy source or oxidant
  - Organic Matter Mineralization
    → NH_4^+
  - Mineralization Nitrification (aerobic conditions)
    → NO_3^-
  - Denitrification (anaerobic conditions)
    → N_2, NO_X, **N_2O** gas emissions

Plant uptake and litter inputs

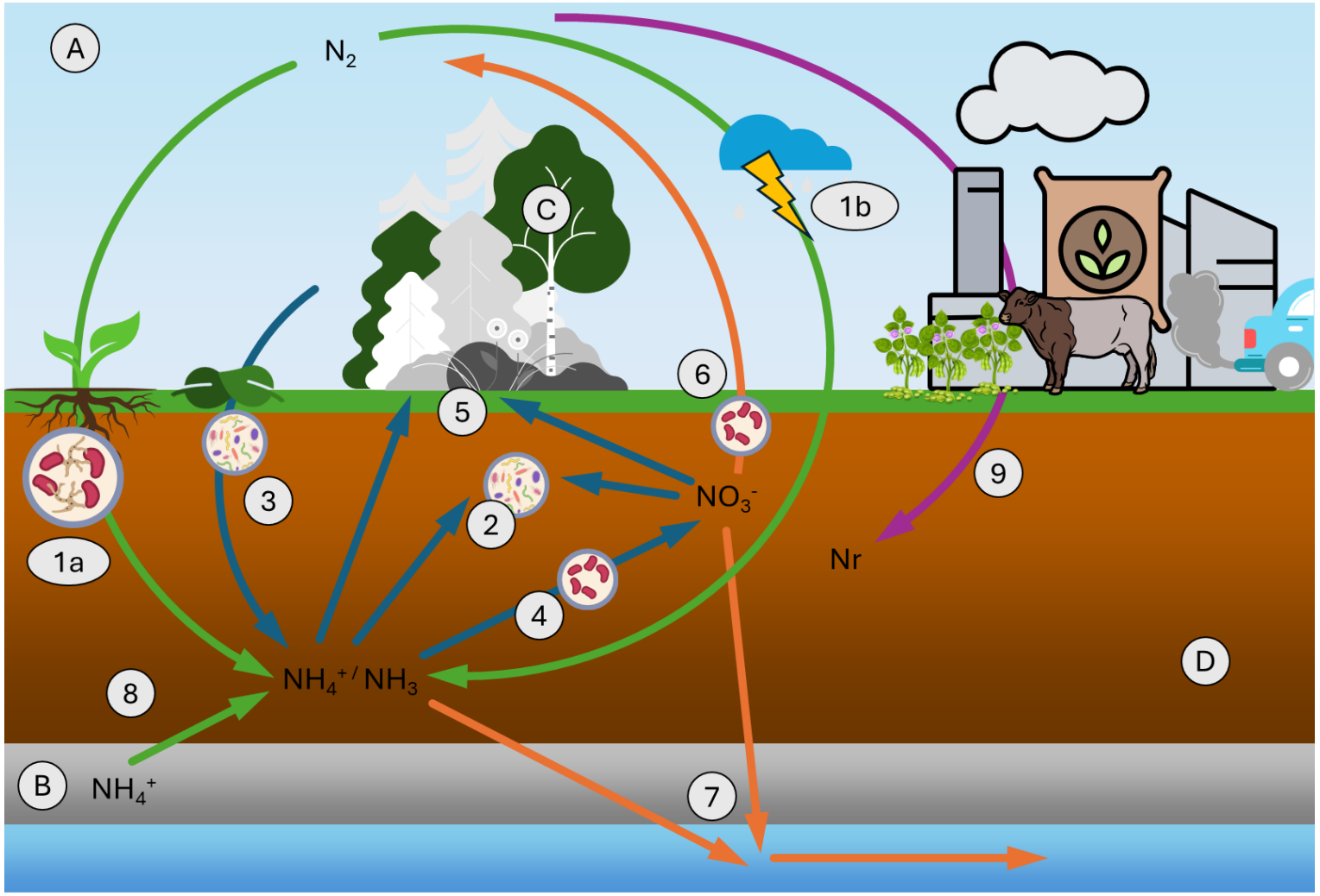


- Uptake by plants

- (Re)-use

- Return as litter

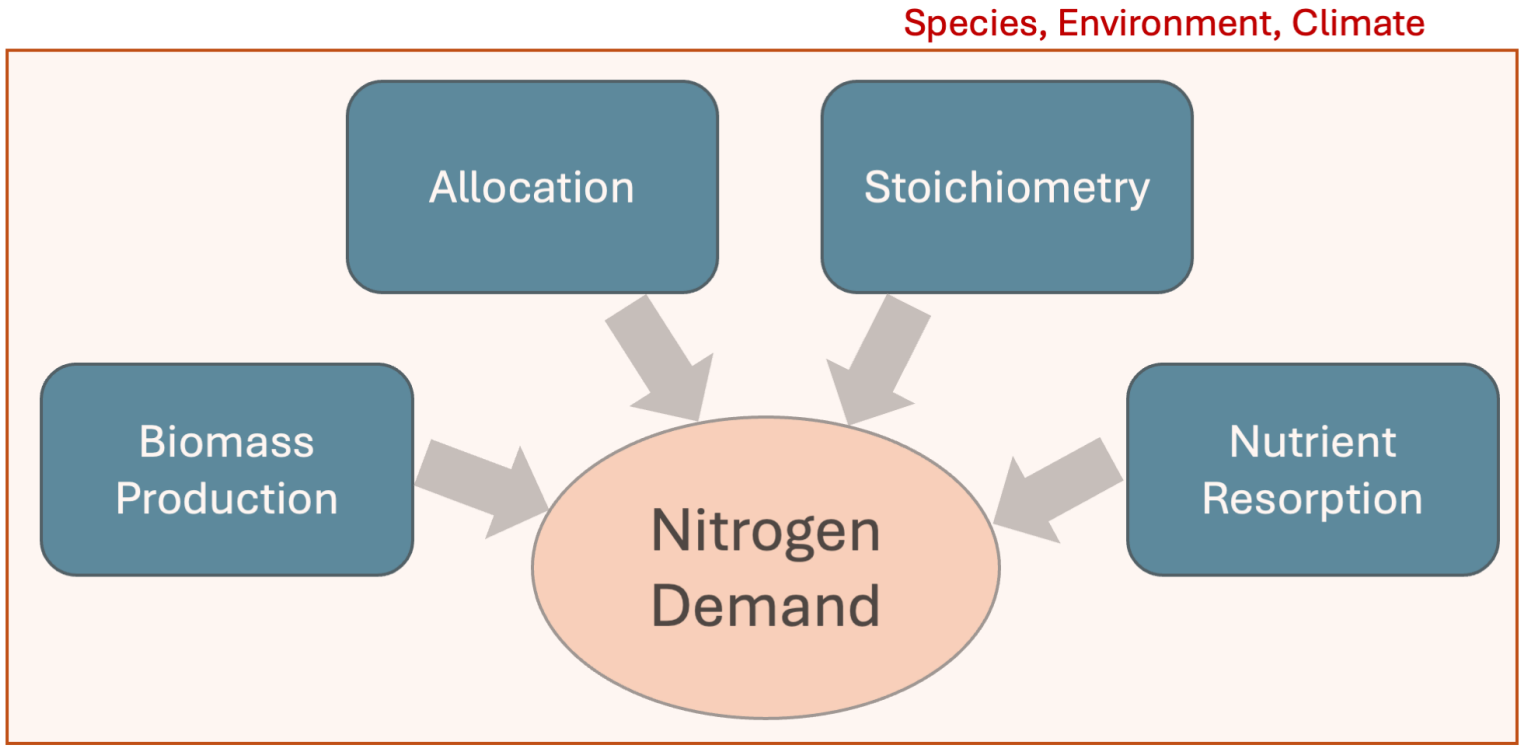
Leaching



- **Transport** of soluble or particle N to freshwaters/groundwater

Plant N demand

- Plants need N
  - Production of tissue, amino acids, DNA, RNA



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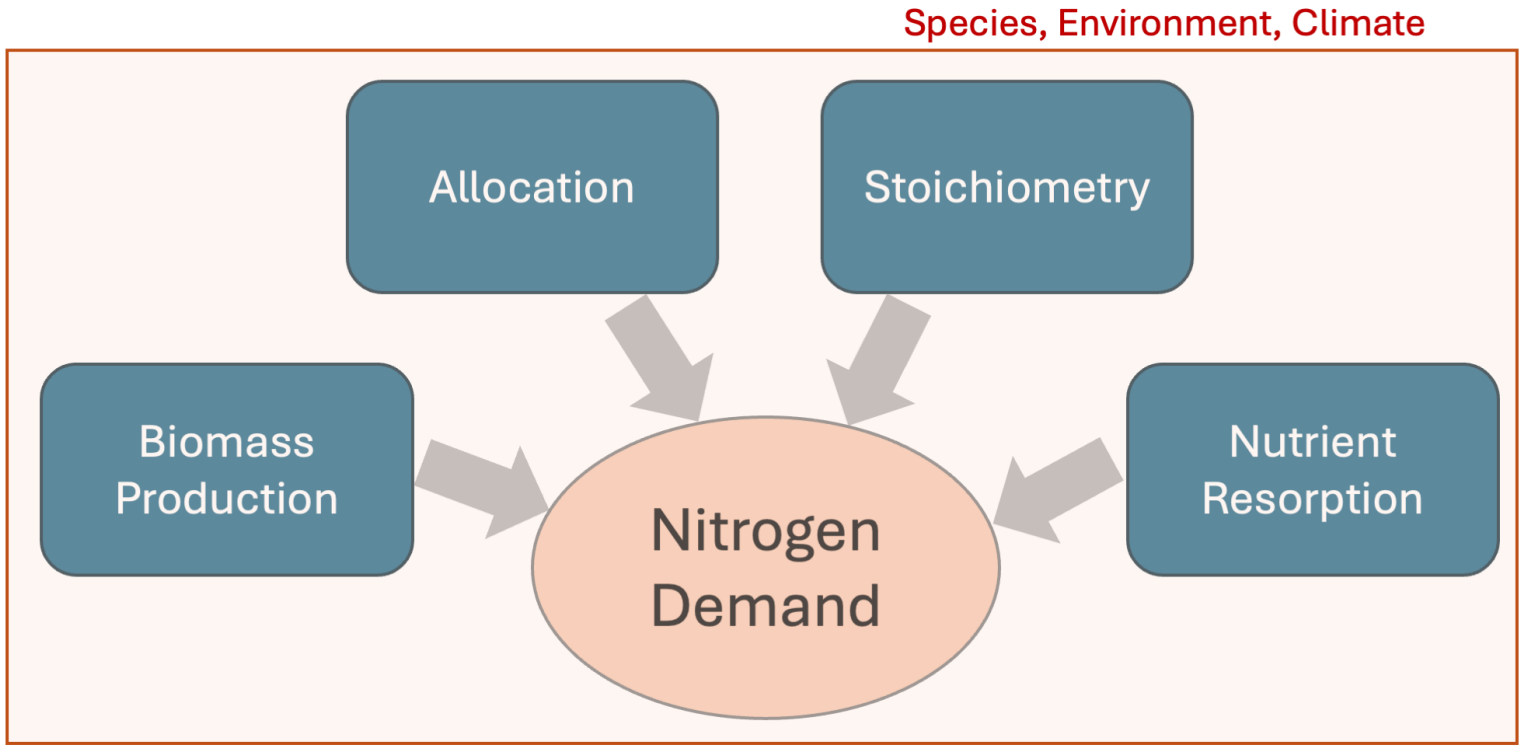


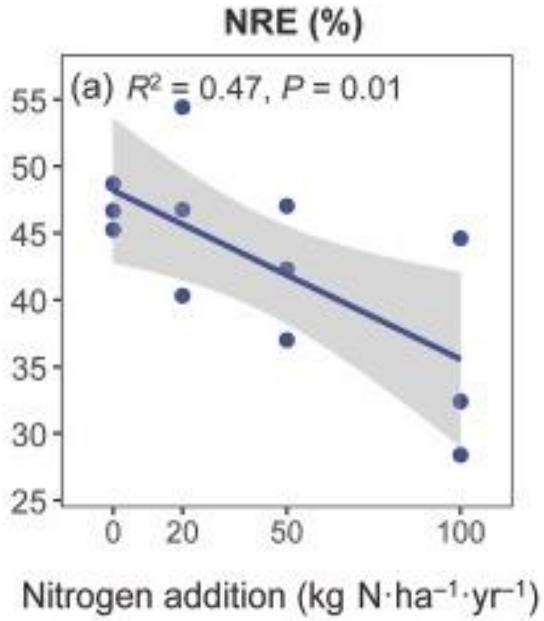
- Nitrogen limitation arises when this demand is not met

Plant responses to low nitrogen conditions

- Change in biomass allocation and stoichiometry

	C/N-ratio
Roots	190
Leaves	30-50

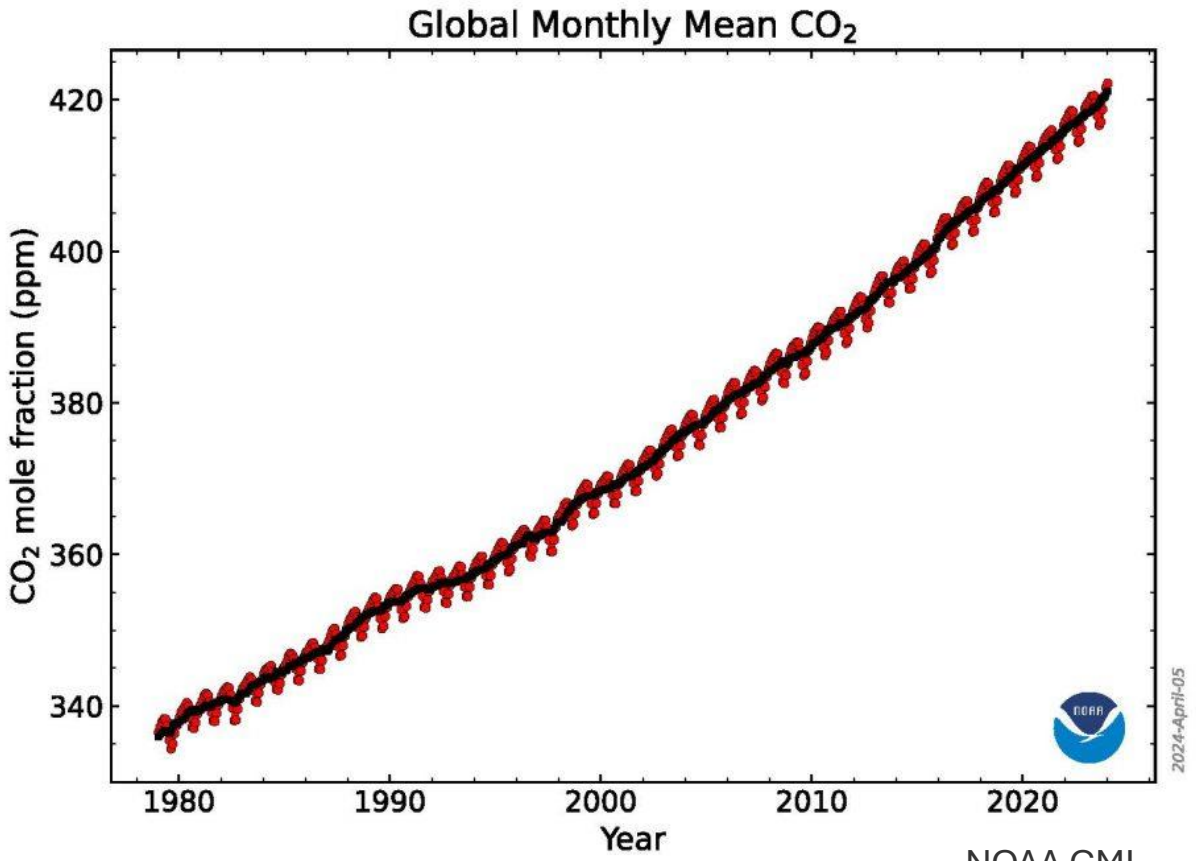
- Nutrient resorption (from their own leaves/roots)



Xin et al., 2024

Nitrogen limitation with increasing atmospheric CO_2

Impacts of Nitrogen Limitation for Vegetation response to increasing CO_2

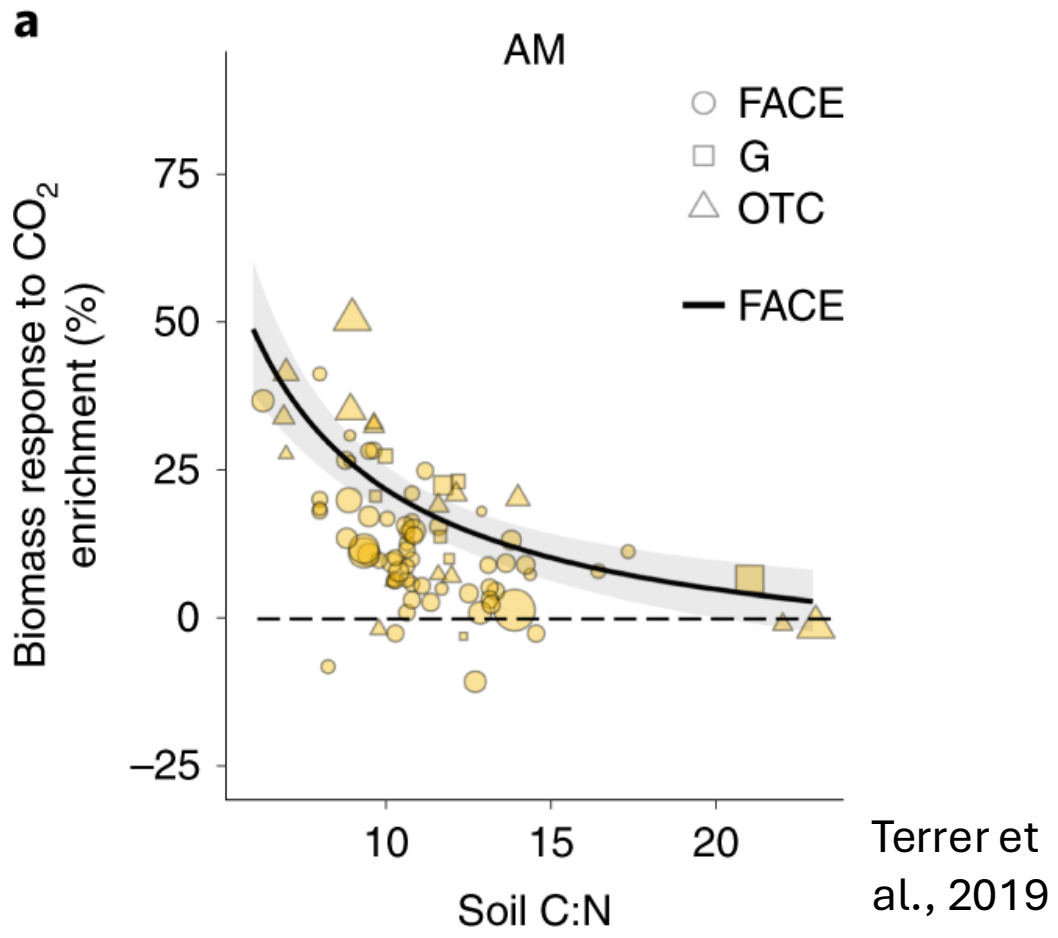


NOAA GML

- **CO_2 fertilization effect:**

Increased plant growth under increasing atmospheric CO_2

Impacts of Nitrogen Limitation for Vegetation response to increasing CO_2

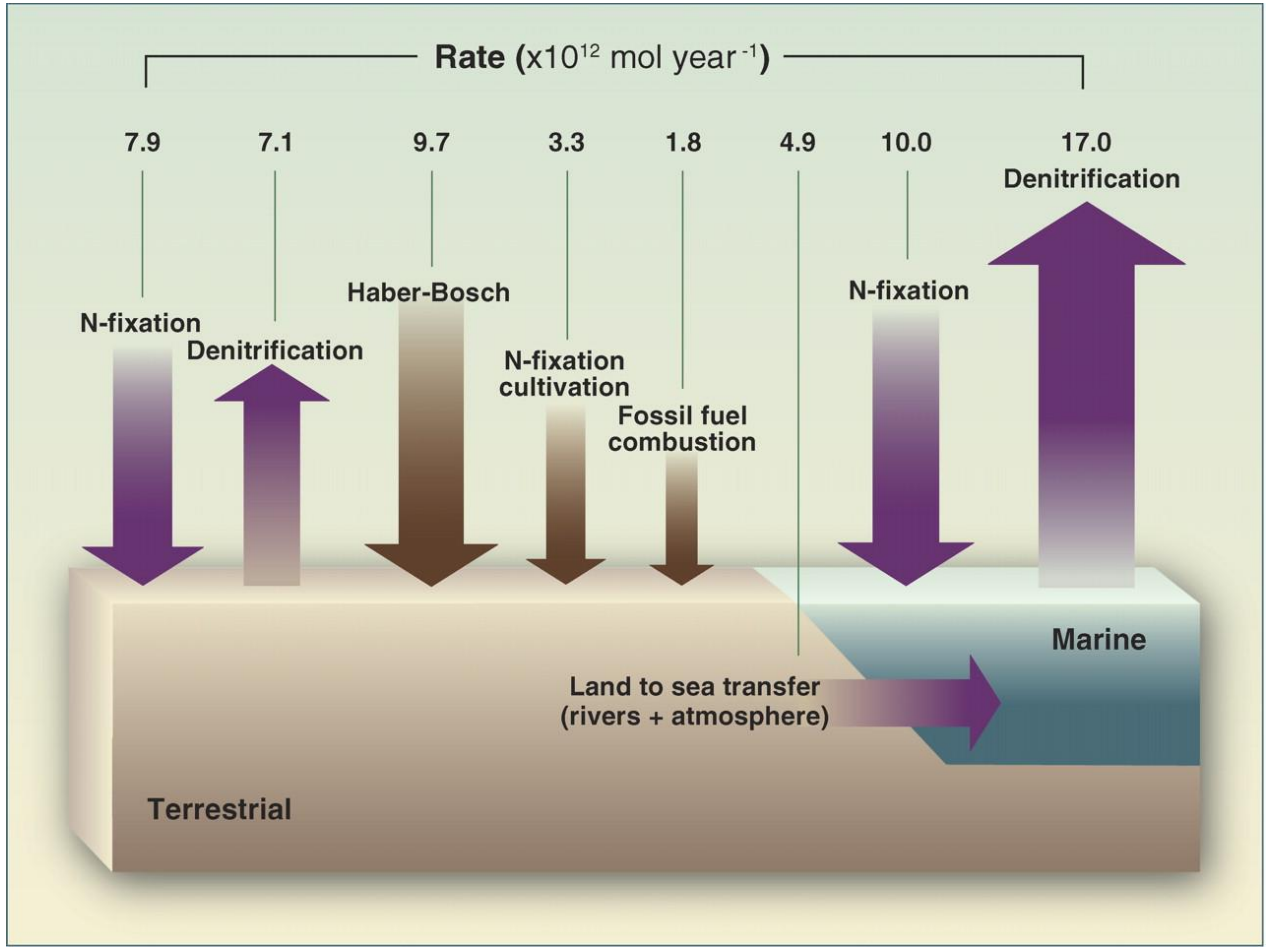


Terrer et al., 2019

- This increased growth and CO_2 uptake can be **inhibited by nitrogen limitation**

Nitrogen cycle facing anthropogenic perturbation

Anthropogenic Perturbation to Terrestrial Nitrogen Cycle



Canfield et al., 2018

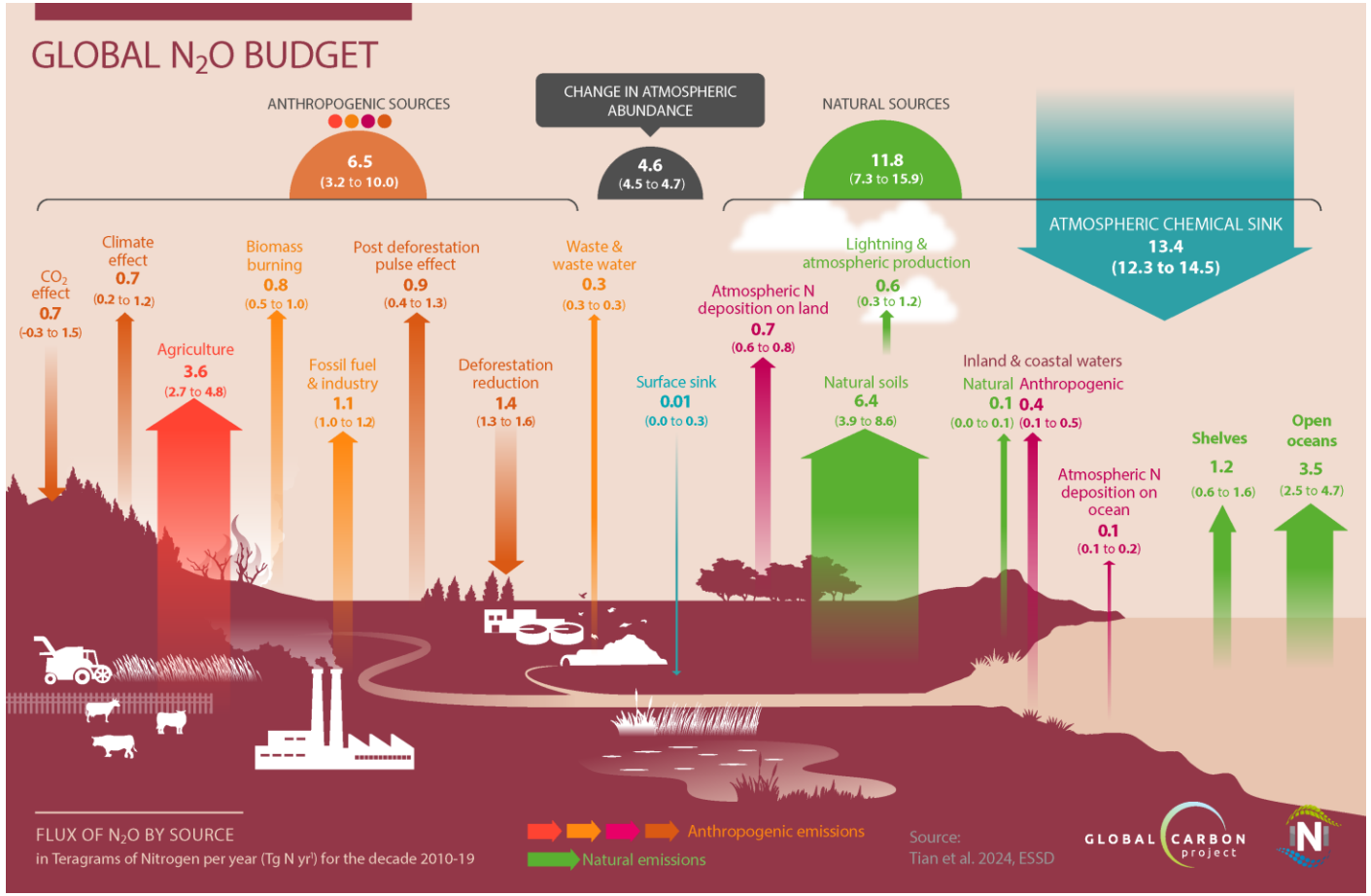
- Inputs of nitrogen to the terrestrial system have increased due to:
  - Food production
  - Fossil fuel burning

Anthropogenic Perturbation Consequences

- Increase in **N_2O emissions**

from terrestrial systems

Anthropogenic Perturbation Consequences



Tian et al., 2024

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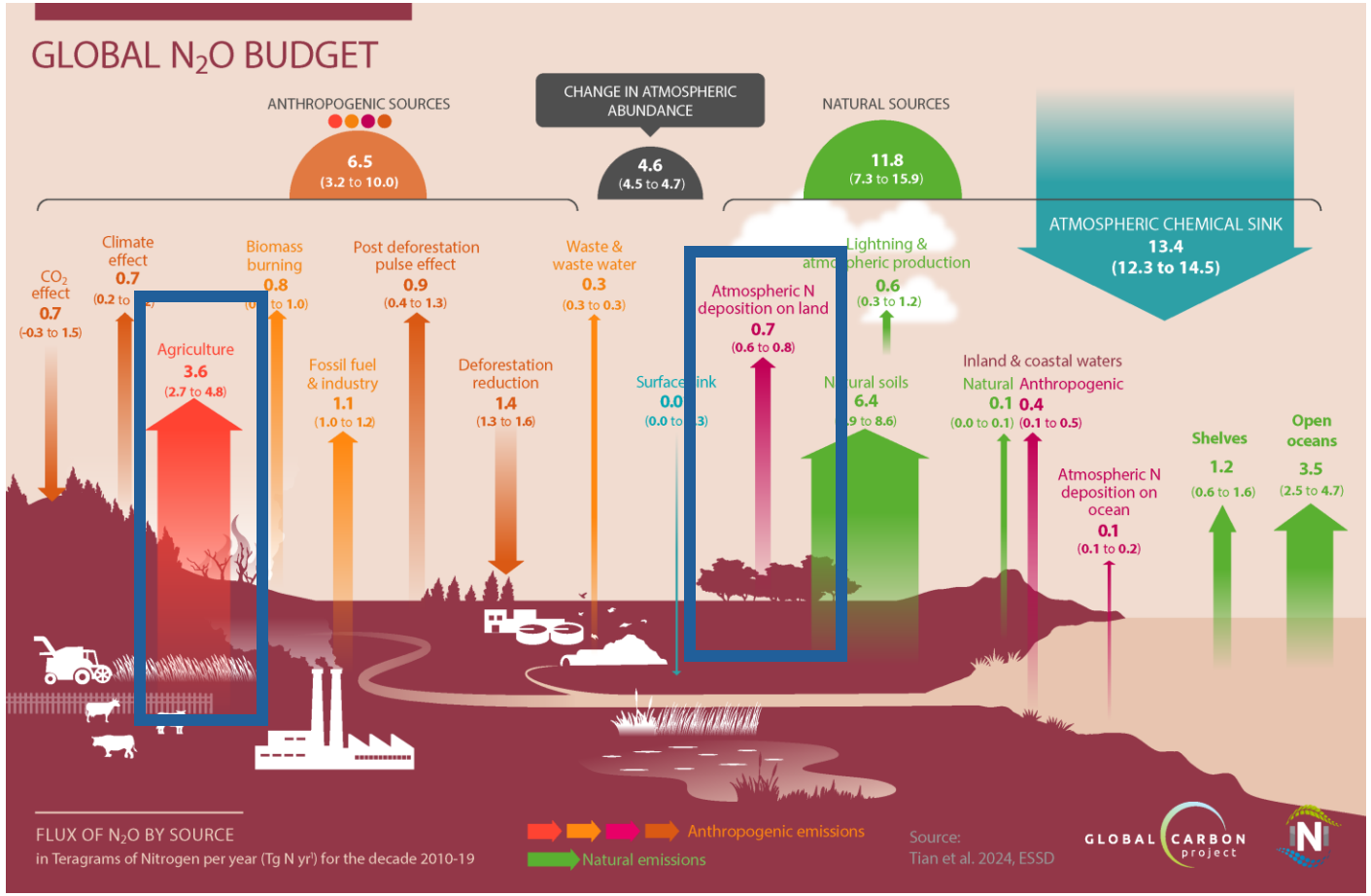
Anthropogenic Perturbation Consequences

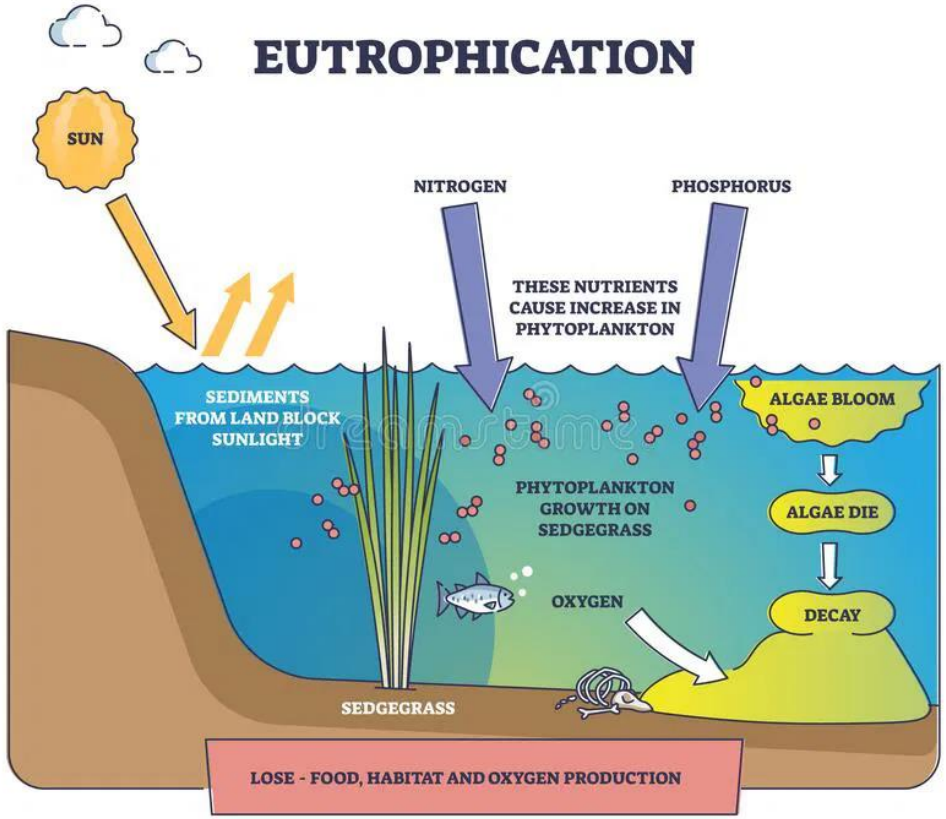


Tian et al., 2024

- Increase in **N_2O emissions** from terrestrial systems

Anthropogenic Perturbation Consequences

- Eutrophication in freshwaters, downstream systems



Nitrogen Cycle recap

1. Terrestrial Nitrogen Cycle:

- sources/loss pathways
- important processes that increase/reduce availability

2. Plant Nitrogen Demand:

- Drivers and factors
- How can plants respond to low nitrogen levels?

3. Nitrogen Limitation Impacts for CO_2 Uptake:

- Impact of nitrogen limitation under increasing atm. CO2
- Potential interplay with other nutrients (e.g. phosphorus)

4. Major Anthropogenic Perturbations and their Consequences