Summary and recommendations from N-session

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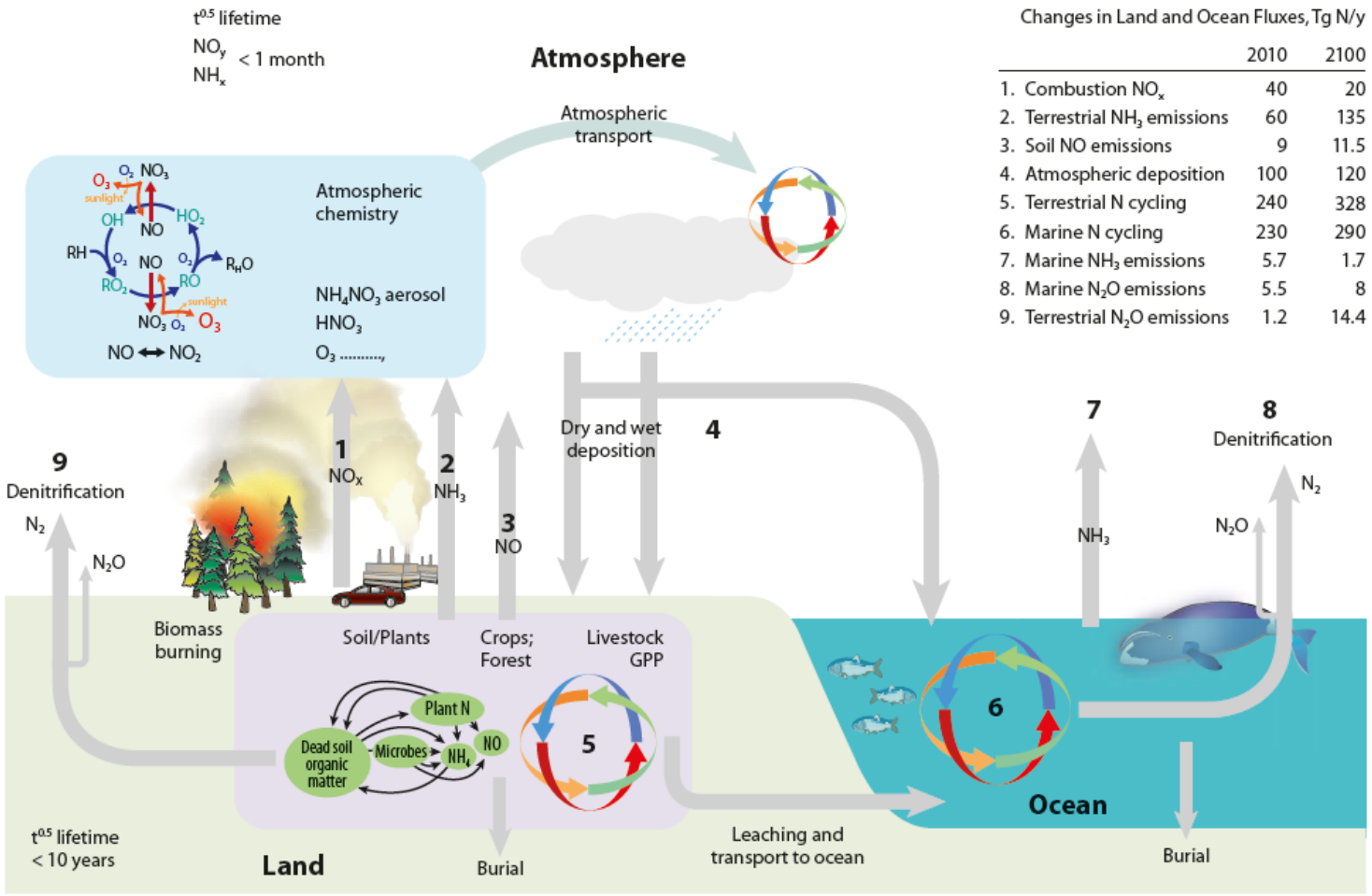
Global N-fluxes are mainly increasing and affected by climate change processes

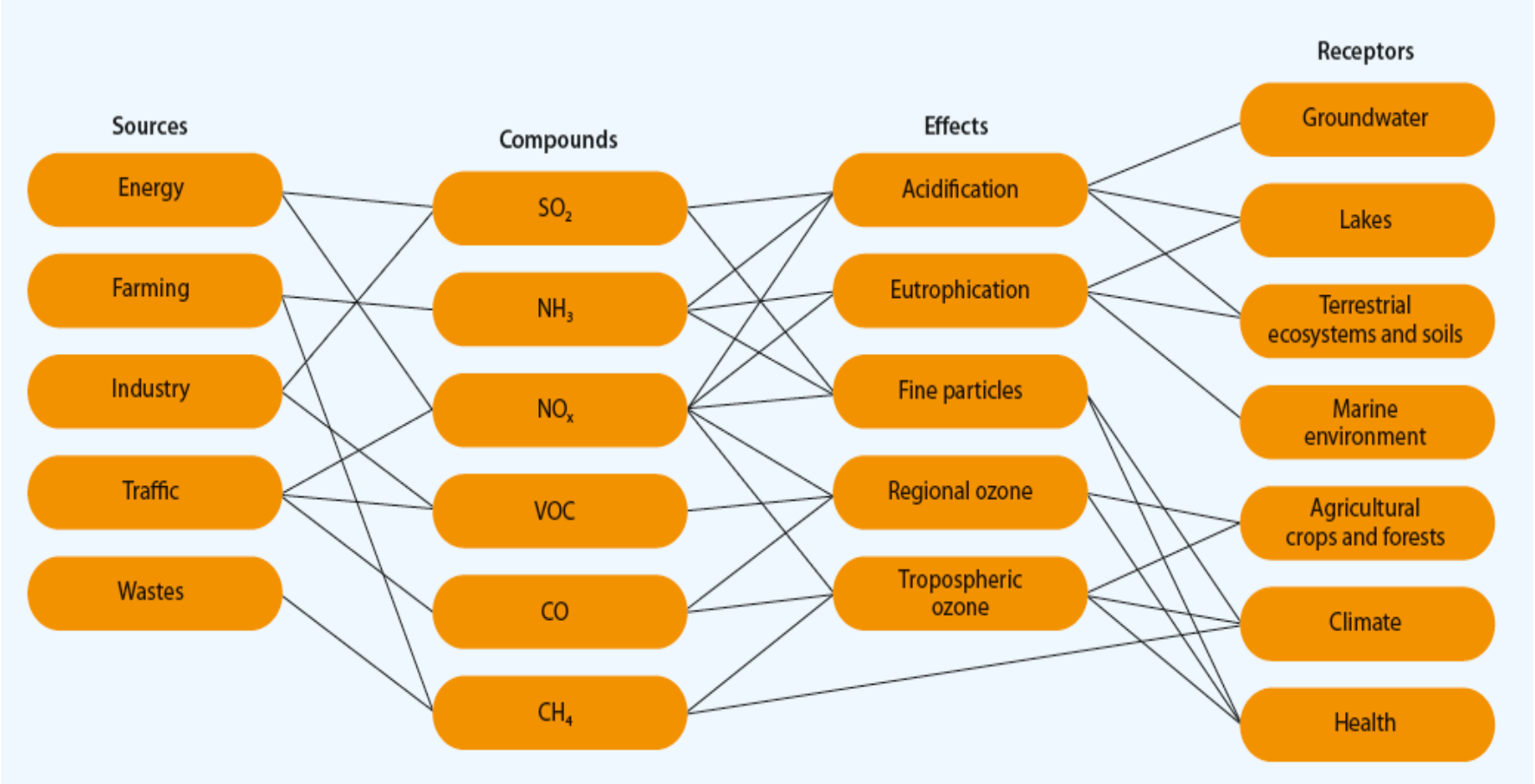


Changes in Land and Ocean Fluxes, Tg N/y

	2010	2100
1. Combustion NO_x	40	20
2. Terrestrial NH_3 emissions	60	135
3. Soil NO emissions	9	11.5
4. Atmospheric deposition	100	120
5. Terrestrial N cycling	240	328
6. Marine N cycling	230	290
7. Marine NH_3 emissions	5.7	1.7
8. Marine N_2O emissions	5.5	8
9. Terrestrial N_2O emissions	1.2	14.4

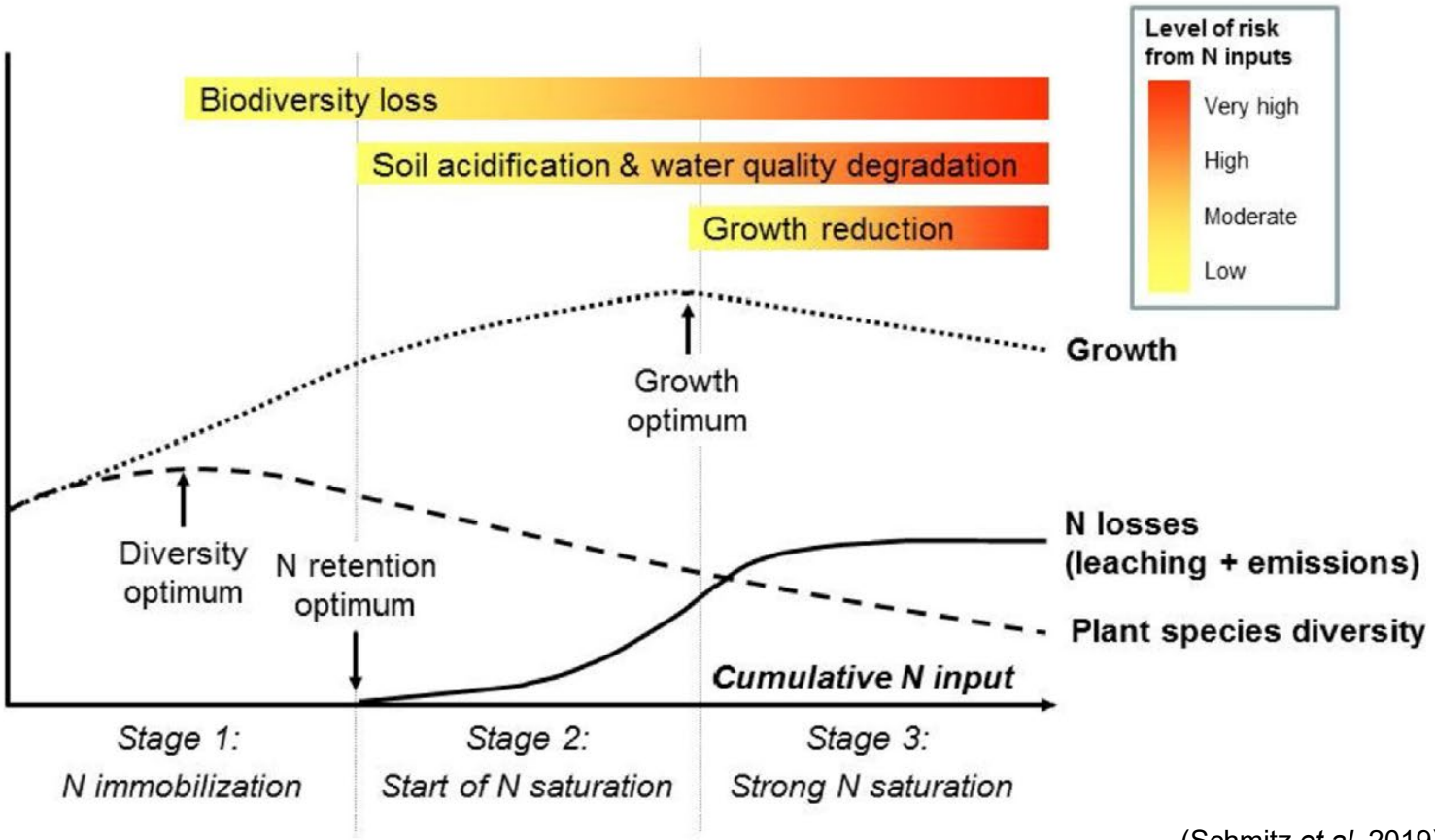
(Fowler *et al.* 2015)

N in a multipollutants – multieffects framework



(Revised from Grennfelt *et al.* 1994)

Risks increase as a function of cumulative N input



(Schmitz *et al.* 2019)

Concluding remarks (1)

- On the global scale, N is expected to be an increasing threat to human health, ecosystems and climate. The N cycle is very sensitive to changes in climate.
- N emission developments of the EMEP domain follow different patterns, with decreases in western parts and increases in the eastern regions.
- Model calculations predict that whilst oxidized N deposition will decrease substantially in the western part of the EMEP domain (and N-related PM), reduced N deposition will change little.
- For many of the most eastern countries, both reduced and oxidized N depositions are predicted to increase.
- Critical loads (CL) for eutrophication show large-scale exceedance:
  - In virtually all countries in the EMEP domain in 2017.
  - In about 64% of the ecosystem area.

Concluding remarks (2)

- During the last decades**, N deposition to ecosystems has caused impacts to plant growth and vitality, soil solution and catchment runoff chemistry, and biodiversity.** Ecosystem impacts show considerable spatial variability since the response is controlled by site-specific conditions.
- **Cause effect relationships between reduced N deposition, ecosystem, and biodiversity changes are still uncertain** due to interactions with climate change and atmospheric CO_2 concentrations.
- Some variables like soil solution, catchment runoff chemistry and foliar concentrations are expected to show faster and more pronounced responses than e.g. biodiversity
- **Currently legislated N emission reductions in the UNECE region will unlikely remove the pressure from species threatened by eutrophication.**
- A halt of biodiversity loss is uncertain in general since biodiversity is facing a number of additional threats such as habitat loss and fragmentation, and climate impacts.

Concluding remarks (3)

- More detailed dynamic models are required to adequately represent future non-linear and cumulative developments of N responses. Better representation of key processes (e.g. microbial soil N, other nutrients, and C cycling processes) are needed. The dynamic models are necessary tools to synthesise our knowledge for policy purposes.
- Under the expected limited future changes in N emissions and concentrations/deposition, other controlling factors like climate change and land-use management strategies will probably dominate future responses in many systems.
- Cost-effective, readily available measures could reduce NH_3 emissions by about 30%.
- Further NH_3 reductions would be needed to approach the WHO guideline for PM2.5.
- Integrated N solutions and measures that operate across the N system could deliver important co-benefits, including climate protection and health benefits.

Recommendations (1)

- Continue and improve long-lasting scientific infrastructures for N emission inventories, projections for air quality and deposition, and monitoring of air quality, health, material and ecosystem impacts.
- Develop better models, tools and databases for predicting future developments of CL exceedance and N responses.
- Develop integrated approaches taking into account the co-benefits of linking air policies with climate, agricultural, energy and transport policies to identify cost-effective N control measures.
- Improve N use efficiency (NUE) across the whole economic sector combined with optimization of transport and food consumption patterns, allowing reductions in N_r use, inputs to the atmosphere and impacts on sensitive ecosystems.

Recommendations (2)

- Increase cooperation and synergies with other international agreements and organisations to maximise efficient use of resources and possibilities to develop science-based control policy options.
- Mobilise new generations of dedicated N scientists and policymakers.