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National Nitrogen Budget for Germany

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Objectives – Key questions

- National Nitrogen Budgets (NNB) aims to quantify sources and fate of reactive nitrogen (N_r).
- How much N_r is introduced into the nitrogen cycle each year in Germany?
- Where does this N_r come from and where does is go?
- How reliable are the results about the N flows?

Material and methods

- Scheme of the 'Guidance document on National Nitrogen Budgets' (ECE 2013) applied
- Main data bases for Germany
  - Official statistics (material flows)
  - Greenhouse gases National Inventory Reports
  - Model approaches (LOTOS-EUROS, MSC-W, MoRE)
- 8 Pools (with 20 sub-pools) calculated acc. to ECE (2013)
  - Atmosphere
  - Energy and Fuels
  - Material and Products in Industry
  - Humans and Settlements
  - Agriculture
  - Forest and Semi-natural Vegetation
  - Waste
  - Hydrosphere

  additionally Transboundary Flows (import & export)
- In total more than 150 N flows quantified

Results (details ref. UBA 2020)

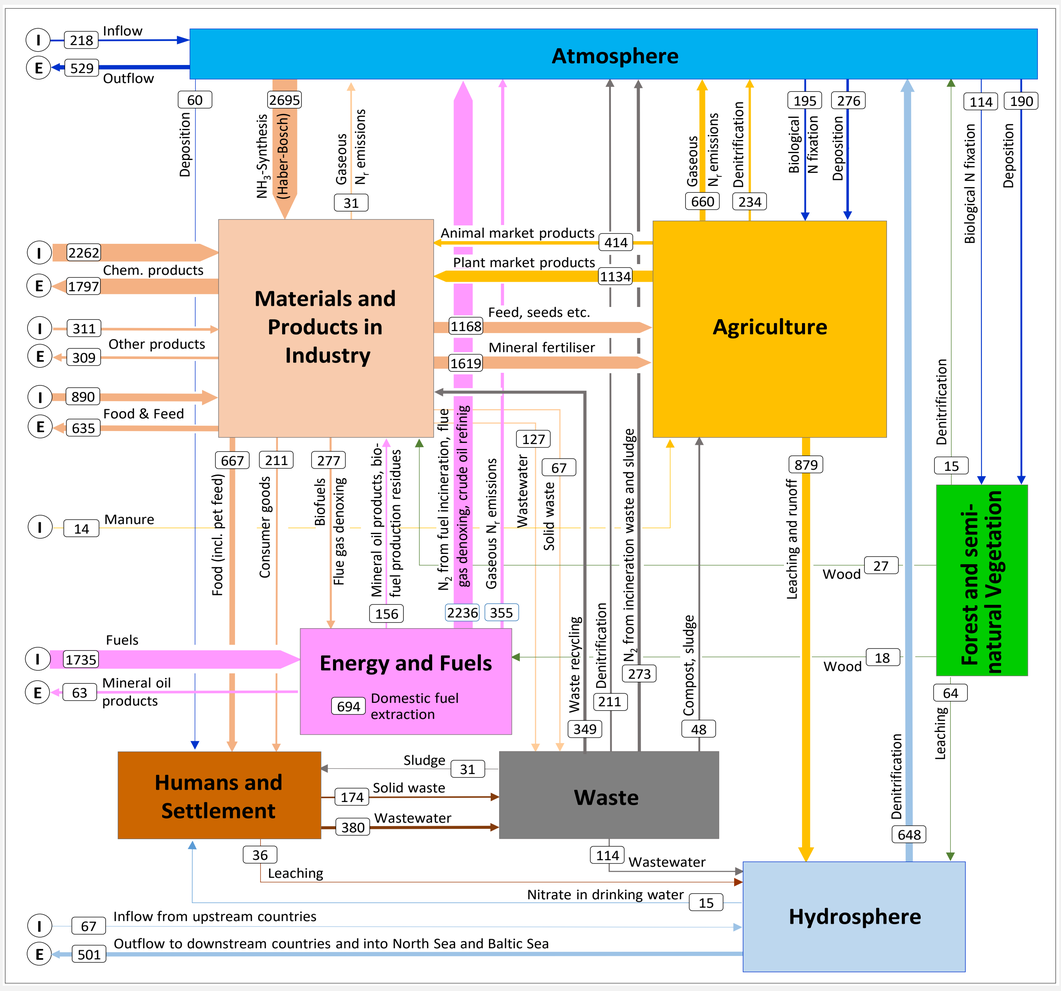

Figure 1: Flowchart on nitrogen pools and N flows (kt N a^{-1}) of the National Nitrogen Budget for Germany (mean 2010-2014)

Individual Pools (selected aspects)

- *Material and Products in Industry*
  German Production Survey (DESTATIS 2017): many double countings, discrepancy 1,400 kt N a^{-1} between inflow and outflow
- *Agriculture*
  Denitrification as most relevant biological Nr elimination process. Soil N stock accumulation: not probable for agricultural soils in Germany
- *Solid Waste*
  German Waste Generation Statistics and Waste Balance Statistics deviates considerably; no reliable figures on N flows
- *Transboundary N flows*
  Germany exports net 740 kt N a^{-1} via atmosphere and river transport to neighbouring countries and coastal seas

Source	NO_x-N	NH_3-N	N_2O-N	NO_3-N	Totals	
Agriculture	36	558	65	382	**1041**	**67%**
Transport	160	12	3	0	**174**	**11%**
Industry, Energy Conversion	184	17	12	30	**242**	**16%**
Households, wastewater treatment plants, urban areas	<1	3	2	84	**89**	**6%**
Totals	380	589	82	496	**1547**	**100%**

Table 1: Anthropogenic sources and emissions of reactive nitrogen into air and surface waters in Germany (kt N a^{-1})

Process	N species	N flow (kt N a^{-1})
Ammonia synthesis	NH_3	2,695
Domestic extraction and net import of fossil fuels	Norg	2,335
Formation of thermal No_x	NO_x	192
Biological N fixation in soils	Norg	308
Net import with food, feed and materials (without fuels)	Norg	745
Sum of sources		**6,275**
Conversion of N_r to N_2 with combustion and denoxing	N_2	-1,706
Nitrogen losses with refining of crude oil	N_2	-818
Denitrification total, of which	N_2	-1,107
- Soils	N_2	-248
- Waters (groundwater, surface waters)	N_2	-648
- Wastewater treatment plants	N_2	-211
Waste disposal (landfills)	Norg	-85
Net export via atmosphere	NH_3, N_2O, NO_x	-312
Net export with rivers	NO_3, Norg	-433
Sum of sinks		**-4,471**
Difference		**1,804**

Table 2: Sources and final sinks of reactive nitrogen in Germany (mean 2010-2014)

Conclusions

- Most complete dataset of Nr data in Germany
- Quantification of the flows is very uncertain (especially in industrial production and waste management)
- Agriculture causes 67% of Nr emissions into air and waters
- Denitrification is most important conversion process of Nr to N_2 in the biosphere
- Totals of inflow and outflow differs by ~1,800 kt N a^{-1} (29% of total inflow) ➔ overestimates sources, unknown sinks, underrated Nr release?

References

ECE (2013): Guidance document on national nitrogen budgets. Economic Commission for Europe (ECE), Executive Body for the Convention on Long-range Transboundary Air Pollution, ECE_EB.AIR_119

DESTATIS (2017): Produzierendes Gewerbe 2016. Fachserie 4, Reihe 3.1. Statistisches Bundesamt, Wiesbaden, Germany

UBA (2020): Reactive nitrogen flows in Germany 2010-2014 (DESTINO Report 2). Final Report. German Environment Agency, Dessau-Roßlau, UBA-Texte 65/2000, 152 p.

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