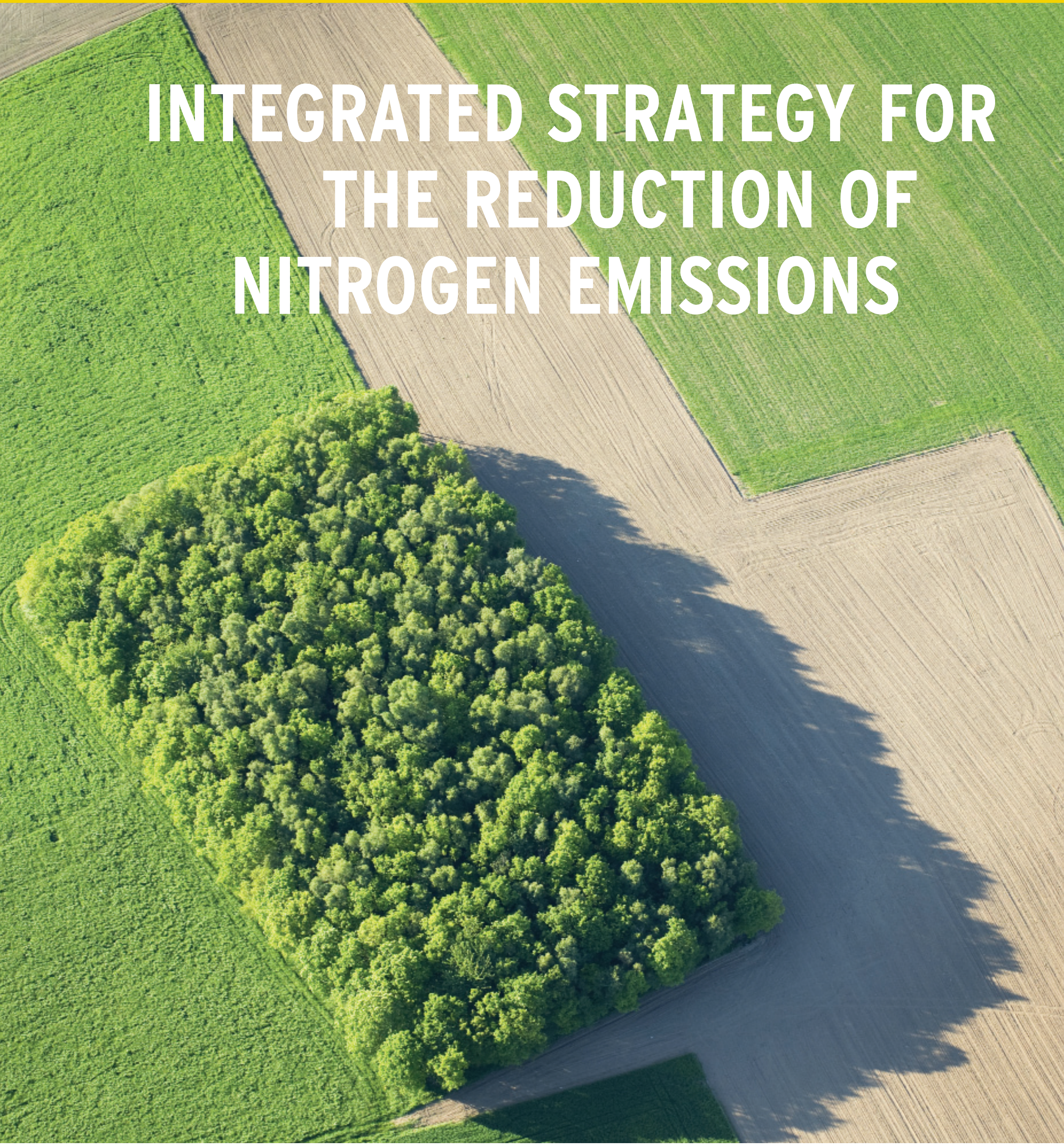
INTEGRATED STRATEGY FOR THE REDUCTION OF NITROGEN EMISSIONS



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INTEGRATED STRATEGY FOR THE REDUCTION OF NITROGEN EMISSIONS

Too much nitrogen harms the environment

Fluxes of reactive nitrogen compounds[1] caused or massively changed by human activity constitute a cross-cutting problem in environmental protection. The intensification of the nitrogen cycle makes it possible to supply a growing world population with protein-rich food, but has considerable adverse effects on the environment and human health.

Emissions from agriculture, transport, energy generation and industry are the main reason for the greatly increased availability of nitrogen in terrestrial and aquatic (especially marine) ecosystems in Central Europe. This disrupts natural substance cycles and ecosystem relationships considerably and on a large scale, and results in eutrophication and acidification. Both effects are among the main drivers of biodiversity losses.

Increased emissions of nitrous oxide as a result of greater nitrogen availability in ecosystems and as a by-product of industrial processes are increasingly contributing to climate change.

Reactive nitrogen compounds also pose a threat to human health: Nitrogen oxides pollute the air we breathe, and gaseous nitrogen compounds are major precursors of ground-level ozone and secondary fine particulate matter. Increased nitrogen emissions into water bodies as a result of agricultural activities and waste water management will ultimately lead to elevated nitrate concentrations in drinking water that are harmful to human health.

These and the following issues are discussed in detail in a background paper of the Federal Environment Agency (available in German at
http://www.umweltdaten.de/publikationen/fpdf-l/3982.pdf

Implications for existing environmental quality objectives and environmental action targets

Despite the efforts made over many years to reduce nitrogen inputs into the environment, most of the nitrogen-related environmental quality objectives and environmental action targets have not been achieved to date:

- Due to sustained eutrophication of terrestrial, marine and liminic ecosystems as a result of nitrogen inputs, biodiversity loss continues unabated.
- Existing guide and limit values for protection of human health from risks posed by nitrate in drinking water and by NO_2, fine particulate matter and ozone in ambient air are being exceeded.

[1] all nitrogen compounds other than elemental nitrogen (N_2)

- Without additional measures, Germany will probably not achieve the emission reduction objectives for NOx and ammonia defined in the Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone (UN ECE Convention on Long-range Transboundary Air Pollution) and the NEC Directive (EU).
- Stabilising greenhouse gas concentrations in the atmosphere in order to prevent dangerous human-induced interference with the climate system requires a significant reduction of emissions of nitrous oxide (N_2O).

The need for an integrated approach to reducing nitrogen emissions

The effects of reactive nitrogen occur on different spatial and temporal scales. For instance, high local concentrations of ammonia cause acute damage to plants on a small scale whereas nitrous oxide concentrations that are elevated globally affect the climate over a century. Therefore, contributions to solving the problems must be made at the global, continental, national and local levels.

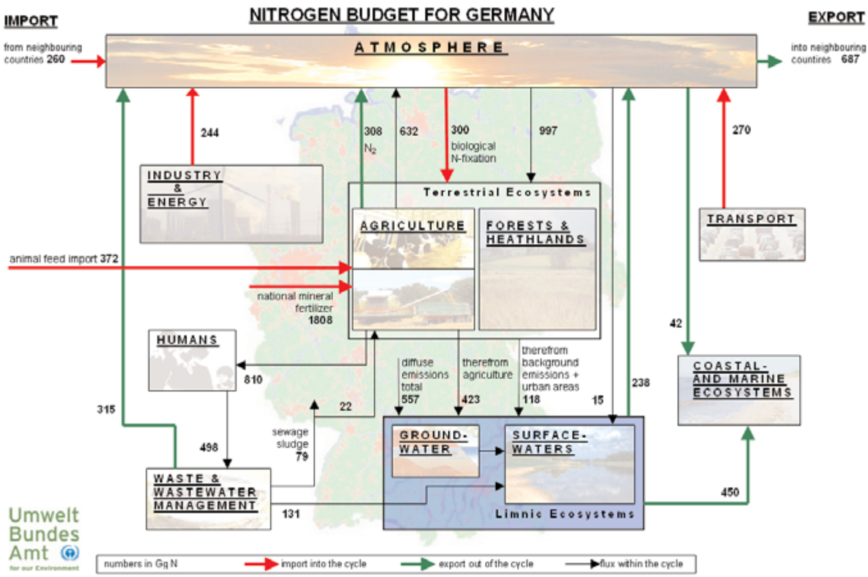
Agriculture is the main source of anthropogenic nitrogen emissions, followed by combustion processes (transport, energy, industry). Emissions to air exceed emissions to water.

Reactive nitrogen compounds are highly mobile. In a process known as the nitrogen cascade, reactive nitrogen compounds may undergo chemical reactions to sequentially exert different effects at different places. Therefore, regulations focussing on a single emission source category or environmental compartment, or on reducing a single effect, may be of little effect if they do not utilise potential synergies, or may even shift problems to another environmental compartment ("pollution swapping"). This means that environmental policies and policy goals are closely interlinked both spatially and through the nitrogen cascade.

For optimum effectiveness and cost efficiency, an integrated approach should therefore be applied in the assessment of measures.

An attempt at quantifying the nitrogen cycle

A survey of emission sources and fluxes of reactive nitrogen compounds forms the basis for the development, assessment and selection of measures and instruments with a view to tapping emission reduction potentials while avoiding potential side-effects in other environmental compartments. The quantification of the import and export of reactive nitrogen compounds enables an estimate to be made of their accumulation and the associated damage potential in Germany. The data presented below refer to the years 2000 – 2004 and are based on various publicly accessible datasets (cf. Figure below and Chapter 2 and Annex 1 of the background paper).



Survey of the main nitrogen fluxes in Germany, in kilotons N per year

Annual input of reactive nitrogen compounds (red arrows) into Germany's nitrogen cycle amounts to about 3200 kT of nitrogen. The most important fluxes are: sales of mineral fertilisers in Germany (1808 kT N/a), import of feedingstuffs (372 kT N/a), biological nitrogen fixation in agriculture and terrestrial ecosystems (300 kT N/a), transboundary atmospheric transport of nitrogen compounds into Germany (260 kT N/a), and emissions of reactive nitrogen from combustion processes at stationary and transport sources (514 kT N/a).

The removal of reactive nitrogen (green arrows) from the nitrogen cycle in Germany has been less quantifiable. Especially difficult to determine is the conversion of reactive nitrogen into harmless elemental atmospheric nitrogen (N_2) in terrestrial and aquatic ecosystems. Some 2000 kT N/a have been quantified so far: Nearly 700 kT N of reactive nitrogen compounds are removed annually by transboundary atmospheric transport; after denitrification, riverine systems release about 230 kT N into the atmosphere in the form of elemental N_2 and export about 450 kT of dissolved nitrogen per year into adjacent marine and coastal ecosystems. In addition, waste water treatment and microbiological processes in agricultural systems each remove an estimated 300 kT N per year as elemental N_2.

A number of the variables are subject to uncertainties. This is true of storage variables as well as of key flux variables, e.g. the difference between agricultural surpluses and the nitrogen outputs calculated in emission inventories.

Despite these uncertainties, the accumulation of reactive nitrogen compounds in Germany must be assumed to be considerable. A total import to Germany of around 3200 kT/a and an export of around 2000 kT/a mean that about 40% of all inputs of reactive nitrogen compounds remain in the ecosystems, which in turn means that the risk of adverse environmental effects increases year by year. The compounds mostly accumulate in terrestrial ecosystems.

Agriculture is the main source of emissions of reactive nitrogen to all environmental compartments, with 50 % or around 1060 kT/a. Transport, industry and energy generation as well as wastewater discharges and non-agricultural surface runoff each account for slightly less than 15% of total emissions.

Emission reduction potential and policy recommendations

An integrated consideration of measures and instruments for nitrogen reduction must use their emission reduction potential and cost efficiency as well as potential synergies and displacement effects as criteria. In a first step an approach of this kind shows the following (cf. Chapter 3 and Annex 2 of the Background Paper):

- Agriculture is the sector with the largest emission reduction potential. In particular, optional instruments or measures which have until now been voluntary in this sector are conspicuous for their large reduction potential and high cost efficiency. They include management, advisory and adaptation measures and instruments to improve fertilisation efficiency as well as economic instruments such a charge on nitrogen surpluses. It is not possible to say at present what emission reductions could actually be achieved, since this depends on the extent to which emission reduction measures of this kind will be implemented in future.
- Legally binding regulations, in contrast, guarantee a quantifiable reduction of nitrogen inputs – if effectively enforced. Existing regulations could be supplemented by requirements for area-based livestock farming.
- Emission reductions could also be achieved in a cost-efficient way by specifying and tightening up a number of regulations. This concerns in particular the requirement to use covered slurry containers, which may already be imposed in permitting today, the requirement to provide proof of an adapted, nitrogen-reduced feeding regime, and the tightening of the Fertilisation Ordinance, e.g. with regard to the inclusion of components of plant origin in fermentation residues in the maximum quantity of organic nitrogen allowed to be applied to land with farm manure.

- Measures and instruments for the agricultural sector also show the largest synergies: Increasing nitrogen efficiency (in fertilisation and feeding) leads to a reduced input of reactive nitrogen compounds into the N cycle. Many measures under the Nitrate Directive may be regarded as particularly effective since they additionally reduce emissions of NH_3 and N_2O and thus also work in the interests of air quality control and climate protection objectives.
- Instruments aimed at energy saving and improved energy use in order to meet climate protection objectives also have significant synergies, generally resulting in additional and clearly positive effects such as a reduction of NO_x emissions in energy conversion.
- In the transport sector, most of the measures that have large emission reduction potential and high cost efficiency are already mandatory today. A new regulation that deserves mention is the impending adoption of the EURO VI emission standards for heavy goods vehicles. Penetration of the fleet with EURO VI heavy goods vehicles could be accelerated by tax incentives and by extending the road toll to trucks weighing between 3.5 and 12 tonnes.
- Much potential for cost efficient reduction has also been exploited in the industry, energy conversion, waste water and waste treatment sectors. One exception are small firing installations, whose NO_x emissions can be reduced in the framework of the amendment of the First Immission Control Ordinance (1st BImSchV).
- Releases of reactive nitrogen to the environment strongly depend on consumer behaviour. Therefore, a change in consumer behaviour, such as reduced consumption of animal protein or compliance with speed limits on Federal motorways, has the potential to reduce emissions of reactive nitrogen. A communication strategy designed to promote such a change may thus be regarded as an effective measure.

Research and development needs, international cooperation

Knowledge of relevant effects, nitrogen fluxes and technologies and in the area of projections and scenarios must be steadily improved. There is a need for:

- A more detailed analysis of the effects of elevated nitrogen emissions on the environment and human health and of the interactions with climate change;
- Closing relevant gaps in the knowledge about the nitrogen cycle in Germany, in particular quantification and evaluation of global trade fluxes with respect to how they affect the nitrogen cycle;

- Improved quantification of the side-effects and synergy effects on other environmental compartments or regulatory regimes;
- Forecasts of the development of nitrogen fluxes and their effects;
- Quantification of costs as far as methodologically possible, especially of the costs of measures and instruments with synergistic and antagonistic ("pollution swapping") effects;
- Quantifying on an ongoing basis the degree to which environmental quality objectives and environmental action targets for different environmental sectors have been achieved

In addition, there is a need for participation in and exchange with international activities, e.g.

- international cooperation within the global International Nitrogen Initiative (INI) and European fora; participation in European Nitrogen Assessment,
- national coordinating body for relevant political bodies (Task Force on Reactive Nitrogen under the UN ECE Convention on Long-Range Transboundary Air Pollution) and EU-sponsored projects and activities (COST729, ESF Nitrogen in Europe).

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