SRU German Advisory Council on the Environment

Towards an integrated approach for nitrogen

May 2015

Partial translation of the Special Report
„Nitrogen: Strategies for resolving an urgent environmental problem“

Contents

Towards an integrated approach for nitrogen

In January 2015, the German Advisory Council on the Environment (SRU) published its special report “Nitrogen: Strategies for resolving an urgent environmental problem”. This draws attention to an environmental topic which has been underestimated. For decades, environmental policies have been addressing specific nitrogen compounds in selected environmental media. However, the interactions between the specific problem areas did not receive the attention they deserved. Therefore, in addition to making various specific recommendations, the SRU also proposes that a nitrogen strategy should be developed by the German government and the federal states.

The 7th Environmental Action Programme of the EU has developed a vision of “Living well, within the limits of our plant”. Transgressions of planetary boundaries by excessive nutrient releases continue to play a prominent role in the programme. The 7th EAP calls for “further efforts to manage the nutrient cycle in a more cost-effective, sustainable and resource-efficient way”.

The following extract from the special report of the SRU shows how critical limits can be determined for nutrients and how an integrated strategy can be implemented to ensure compliance with these.

1. A “safe operating space” as a basis for nitrogen reduction targets

In order to protect human health and to maintain good water and air quality there have for some time been limit values for individual environmental media and individual nitrogen compounds. However, such a selective, media-related approach is not sufficient to address

the long-term, systemic and global impacts of reactive nitrogen. A selective approach necessarily leads to an underestimation of the scope of the problem, in particular regarding the loss of biodiversity.

It is therefore necessary to adopt a more comprehensive approach. An environmental policy for nitrogen requires a well-founded goal, specifying the extent to which the total input of reactive nitrogen into the environment must be reduced. This can then be used in order to assess current development trends, previous environmental measures, and the needs for further actions.

In its Environmental Report 2012, the German Advisory Council on the Environment (SRU) recommended using the concept of planetary boundaries as a guideline for environmental policies and making increased efforts to remain within the “safe operating space” (ROCKSTRÖM et al. 2009a). Meanwhile, anthropogenic pressures on the biosphere have reached such a scale that some critical thresholds for a “safe operating space” have already been transgressed, and others could soon be exceeded. ROCKSTRÖM et al. (ibid) estimate that humanity has already transgressed three planetary boundaries: rate of biodiversity loss, changes to the global nitrogen cycle, and for climate change.

The aim of the concept of a “safe operating space” is the maintenance of the natural foundations of life on our planet. The key criterion for this is the stability and buffering capacity of the most important natural and near-natural systems against disturbances (resilience). But resilience can only be ensured by a precautionary and timely reduction of anthropogenic disturbance, because the critical boundaries cannot be determined in advance with any precision.

The concept of a “safe operating space” offers a basis for the formulation of long-term environmental quality goals and policies for action. Acceptable overall limits can be derived from the environmental quality objectives for individual environmental media which provide the basis for reduction targets and action goals for the use of natural resources or for inputs of harmful substances into the natural environment (WBGU 2009; for reactive nitrogen: de VRIES et al. 2013; SRU 1994).

The concept of the “safe operating space” is a synthesis of research by natural scientists and social scientists and adopted in the international environmental policy discussion (in summary: PISANO and BERGER 2013; for Germany the Study Commission on Growth, Wellbeing and Quality of Life 2013; WBGU 2014; EEAC 2014). On this basis, a pragmatic approach towards an overall reduction target is proposed in the following.

2. Towards an overall reduction target

An overall reduction target can fulfil a range of functions:

- It is useful in political communications. An overall target as a symbol of the need to act is easier to communicate than differentiated indicators for individual compounds, sources or environmental media (SRU 2015, No. 618). However, the overall target will only be able to supplement these and not replace them.
- It provides information about the range and depth of necessary changes. It makes it clearer that incremental measures or more efficient technology will not be sufficient to reduce nitrogen inputs into the natural environmental to a sustainable level (SRU 2015, No. 52 f.).
- It can be used to monitor the success of policy measures. In the past, integrated environmental policy measures have played an important role in amending political measures and have contributed to “policy acceleration” (JÄNICKE 2010; 2012a; 2012b).
- It is an early-warning indicator of whether individual measures have indeed eased the overall situation or have only shifted the problem from one location to another. If the total reactive nitrogen in the environment has not been significantly reduced by a programme of measures, this is an indication that a hotspot may have been addressed in one place but that a new problem has developed somewhere else.

In order to determine an acceptable total budget it would hardly be appropriate to adopt a top-down approach on the basis of equal per capita shares of the global safe operating space (cf. NYKVIST et al. 2013). Such a concept would have little to offer. For example, the critical levels for more sensitive natural resources, above all ecosystems, could already be exceeded before the overall limits have been reached. Specific, local “bottom-up boundaries” are more relevant for a practicable national nitrogen strategy (cf. SCHLESINGER 2009; GLASER et al. 2012a, p. 211).

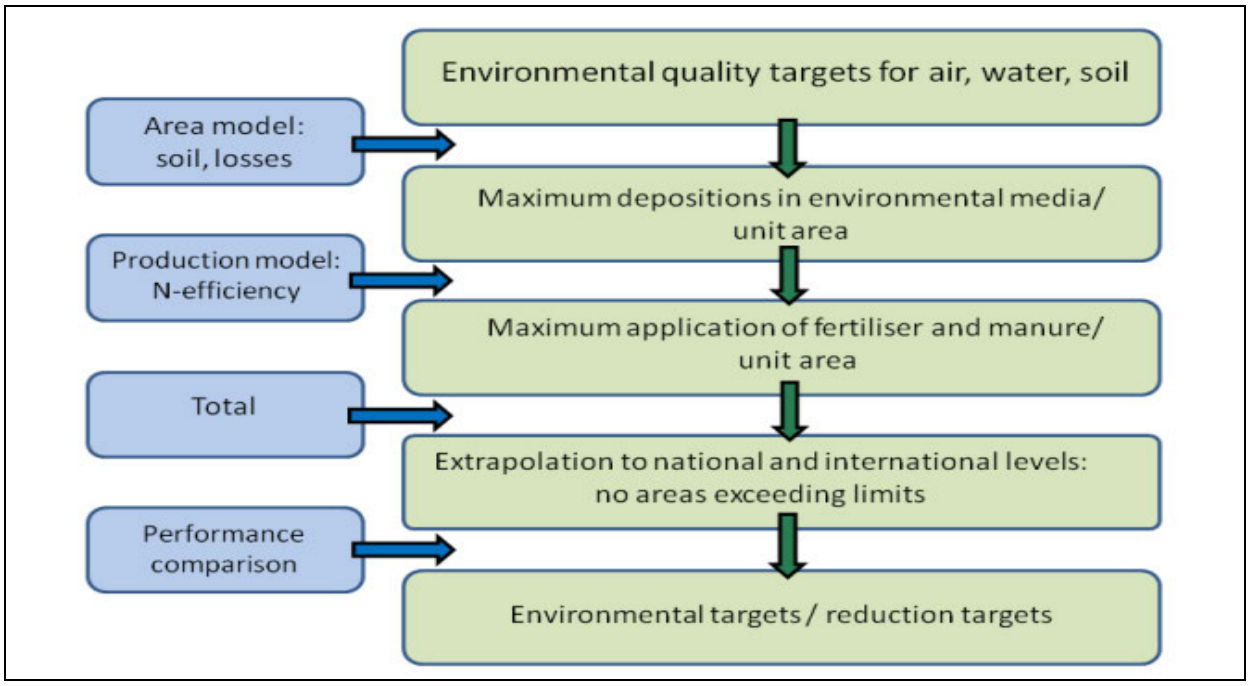
A combined approach is therefore appropriate which formulates national, European, and global budgets with upper limits for the input of reactive nitrogen which should not be exceeded because of the systemic interactions. At the same time, it is also important to have local or regional limits for individual compounds for the various media (soil, air, water), in order to avoid damaging sensitive natural resources. There are already numerous quality limits for the latter, but these should be developed further for locally vulnerable natural resources, along with reduction requirements for compliance with these limits (SRU 2015, Nos. 551 and 618 f.).

A methodologically interesting approach for such a bottom-up calculation of acceptable region-specific nitrogen budgets for agriculture has been developed for the Netherlands (ERISMAN et al. 2001; de VRIES et al. 2001) and for the global level (de VRIES et al. 2013). However, it should be noted that the approach does not include the environmental effects of the combustion of fossil or biogenic fuels, but only the impacts of using reactive nitrogen in agriculture.

The calculation of a total budget begins with agreed quality objectives, e.g. the critical loads for air pollutants (ammonia), the legally specified limit concentration for nitrates in groundwater and drinking water (50 mg nitrate per litre), and the acceptable nitrogen concentration for the good water quality in surface water bodies (2.2 mg nitrogen per litre). By means of material flow analysis, the maximum nitrogen surplus of an area can be determined which would still be acceptable for compliance with the quality values. On this basis an integrated budget and a reduction target can be determined (Figure 1).

Figure 1

Calculating limits for N_r



Source: SRU/SG 2015, after de Vries 2013

Such an integrated, spatially differentiated approach for specific natural resources for the Netherlands from 2001 came to the conclusion that reactive nitrogen applications in agriculture should be decreased by 50 to 70 % and regionally optimised. If other sources also contribute to the pollution inputs, then the overall reduction would also have to be correspondingly higher in order to meet a given target. Even though the results only represent a first approximation, as the authors acknowledge, they nevertheless indicate the minimum order of magnitude of a reduction and highlight the need for action (ERISMAN et al. 2001, de VRIES et al. 2001).

For the planetary boundaries, de VRIES et al. (2013) estimate that a reduction of nitrogen-inputs by 50 % would be necessary in order to avoid exceeding the critical loads for eutrophication and to make an appropriate contribution to the 2-degree target. BODIRSKY et al. (2014) report a global reduction potential of 60 % by 2050 for the use of reactive nitrogen in comparison with a trend scenario (cf. SRU 2015, No. 48).

The model developed for the Netherlands can be used to examine the effects that compliance with certain limit values can have on other parameters. This integrated, spatially differentiated approach makes it possible at an early stage to identify cases where a problem is merely being shifted from one medium to another (de VRIES et al. 2001, p. 904). This would be the case, if the surplus for a certain medium is reduced, but the overall nitrogen balance remains the same. For example, local water management targets are often met by transporting liquid manure to another location, sometimes a long distance away, where this may create a new source of atmospheric pollution (ammonia, nitrous oxide

An integrated budget system on the basis of the maximum ceiling levels also provides information about the required reductions for the integrated planning of measures. Models show that measures designed to increase the efficiency with which nitrogen is used in arable farming, animal husbandry, and mineral fertilisation also result in significant reductions in water pollution and the emissions of air pollutants including nitrous oxide (OENEMA et al. 2009). In practice, however, most programmes and cost calculations address the various issues separately for each medium. This leads to an underestimation of the numerous co-benefits of a measure.

In addition to the overall targets, sub-targets should also be developed, in particular for agriculture and the combustion of fossil and biogenic fuels. On the basis of an overall target, economically efficient sectoral reduction targets can be developed which take into account not only the avoidance costs in each case, but also the potential local and national impacts of the various compounds.

In view of the systemic nature of the nitrogen problem, preliminary work has begun on integrated budgeting at the international level (OECD 2013, UNECE 2013). An important step towards an integrated approach can also be found in the proposal of the European Commission for a new NEC Directive (cf. SRU 2015, No. 334).

3. Developing and implementing a national nitrogen strategy for Germany

The starting point for the development of a nitrogen strategy should be a scientific review of the reduction requirements and the ensuing need for action. This analysis should also take into account the mobility and reactivity of nitrogen compounds. Programmes of measures should be oriented on the need for action. In order to overcome the institutional shortcomings of current policies and existing legislative instruments concerning nitrogen, the strategy for Germany should be developed jointly by the Federal Government and the *Länder* (federal states). All key ministries should participate (in particular: Economic Affairs and Energy, Transport, Agriculture). A nitrogen strategy can only be implemented successfully if it addresses all levels of governance.

A contribution towards generating broad acceptance can also be made by integrating relevant interest groups from an early stage. Attention should be paid to achieving a balance between the representatives of the interests of causers/originators, the public interest, and economic interests.

The national nitrogen strategy must be developed in the context of other strategy processes at the national and European levels, because there is no point in piling up strategies which have little or no influence on political decision-making processes, as critical observers of the European strategy processes have noted (JORDAN et al. 2008, p. 174; SRU 2008; 2012). Developing the strategy, it is important to draw on existing targets from other strategies, European Union directives, and national programmes. In the context of a nitrogen strategy for Germany, these strategies, directives and programmes can then be further developed and underpinned.

When developing a nitrogen strategy, use should also be made of the experience gained in formulating corresponding national strategies (the German National Strategy on Biological Diversity and the National Strategy for Sustainable Development). In addition, the process of developing the strategy can also contribute to resolving perceived conflicts of departmental interests, e.g. between the concerns of the Environment Ministry about the protection of biodiversity and the interest of the Ministry of Agriculture in increasing agricultural production, or between environmental clean air policies and the protection of economic interests by the Ministry of Economic Affairs and Energy. The process can also contribute to turning conflicts into joint activities by demonstrating the benefits of reduced reactive nitrogen emissions. The strategy should develop approaches to solve problems in the various relevant policy fields and take account of interactions and interrelationships between them. Such a broadly-based approach seems appropriate to create a comprehensive understanding of causes and effects so that all the parties involved take responsibility and do not pass problems on to others.

3.1 Action approaches for a Nitrogen Strategy

In terms of environmental protection, nature conservation, and public health, a strategy for the reduction of emissions of nitrogen compounds in Germany has to pursue a number of interrelated approaches (SRU 2015, Nos. 175, 203, and 315):

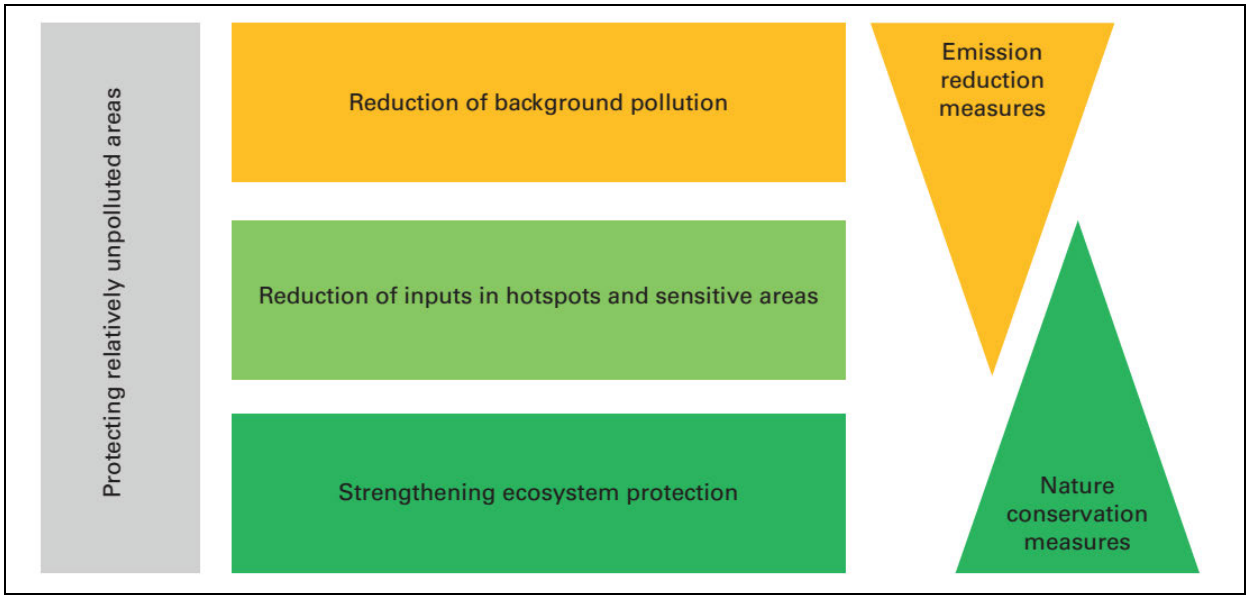
- The pollution of ecosystems must be reduced: reactive nitrogen emissions must be lowered considerably nationwide. This leads moreover to reductions in emissions of the greenhouse gas nitrous oxide. The reduction of background pollution levels also serves to protect human health.
- In addition local and regional reduction measures should be adopted in areas with high levels of nitrogen inputs affecting soil and water bodies, and sensitive ecosystems; air pollution situations in agglomerations require reduction measures in order to protect public health.

– Strengthen ecosystem protection through nature conservation measures.

– Protection of relatively unpolluted areas. It is crucial that nitrogen loads should not be permitted to rise any further.

Figure 2

Four interrelated approaches to reducing reactive nitrogen pollution



Source: SRU/SG 2015/Figure 4

The experience gained from the German Sustainability Strategy and the Biodiversity Strategy can be used to learn lessons about what makes a strategy successful with the general public and with policy makers. In the following section, necessary elements of a successful nitrogen strategy are outlined.

3.2 Guiding principles and guidelines as a framework for action

A strategy should provide a framework for actions on the basis of a guiding principle as an orientation point. The model for the development of a nitrogen strategy should be formulated in accordance with the intention of achieving a long-term reduction of both nitrogen inputs (e.g. as fertiliser) and environmental impacts. Links should be made to the objectives of the other strategies, in particular the Biodiversity Strategy, which has quality goals and quantified goals.

The Sustainability Strategy demonstrates that the framework for actions can be defined more clearly by introducing core principles. These provide an orientation for the implementation of the strategy. All the instruments used and the measures that are implemented must serve at least one of the core principles, without contradicting any of the others. Where appropriate, the core principles can also be very useful for communications. The SRU has identified four interrelated approaches that a nitrogen strategy should pursue. If formulated

programmatically, they can fulfil a similar function to the core principles of the German Sustainability Strategy.

The SRU recommends that the development of a nitrogen strategy should be based on these core principles and that all concrete measures for the implementation of the strategy should be assessed to ensure that they do not contradict any of them. Core principles have the advantage that they transmit the goals of the strategy, which also makes them useful for communicating to the general public. In order to ensure broad acceptance for a nitrogen strategy both in the political sphere and in the public realm, the framework for actions and the relevant core principles should be discussed in open dialogue.

3.3 Fields of action

Specifying fields of action and the focal points of a strategy can be important both for the detailed formulation and implementation of policy measures as well as for communications. In addition, fields of action are necessary when it comes to allocating responsibilities. In the case of the nitrogen strategy, the definition of fields of action makes it possible to assign specific responsibilities to the individual government departments and authorities, as well as emitters and drivers. It is also important that the fields of action are reflected in further elements of the strategy, in particular the system of targets (e.g. integrated reduction targets, sector-specific targets, or timelines) and in the monitoring processes. When determining a national budget, for example, the ceiling levels defined for environmental media in fields of action play a central role. Fields of action can also be used for structuring a programme of measures that contributes to the implementation of the strategy.

The central fields of action for a nitrogen strategy lie in agriculture, transport, energy (in particular bioenergy policies), water management and nature conservation, and in clean air and climate protection. When selecting the focal points for a nitrogen strategy, various criteria can be applied, for example the focus can be placed on fields of action which had not received enough attention in the past (for example soil management or the impact of nitrogen emissions on the climate). Alternatively, the focus can be placed on fields of action which are subject to time constraints (e.g. implementation measures for the Water Framework Directive). It is important to make a judicious selection on the basis of transparent criteria in order to avoid overloading the strategy.

3.4 Reduction targets for the total input

The SRU recommends the development of a target value for the total input of reactive nitrogen in Germany that is compatible with the boundaries for terrestrial and aquatic ecosystems, climate change mitigation strategies and targets, and public health objectives.

It can be assumed that it will be necessary to at least halve the nitrogen inputs in Germany in order to meet existing national and European quality goals. A first approximation can be

derived from a synopsis of some of the reduction targets in the scientific and political discussion (see below). Some are the results of political agreements, while others have been recommended in studies. The table shows that in order to achieve a generally acceptable environmental quality it will be necessary to reduce depositions of nitrogen compounds by some 50 % or more. If the overall reduction target is measured on the basis of the environmental quality target requiring the highest reduction (SRU 2015 No. 41), then the higher reduction target value given for a nitrogen compound in the table applies.

Table 7-3

Modelled nitrogen reduction targets

Quality target	Scope	Reduction target	Status
Germany			
Reduction of the proportion of ecosystem areas affected by eutrophication	Reduction of NH_3 and NO_x emissions	39 % (NH_3) and 69 % (NO_x) by 2030 (compared with 2005)	Proposed directive [1]
A good ecological status in coastal waters	Reduction of the nitrogen loads in German rivers flowing into the North Sea	30 – 48 % by 2021 (compared with 2001 – 2005); equivalent to a target concentration of 2.8 mg N/l at river estuaries	Proposal of a specialist commission[2]
A good ecological status in the Baltic Sea	Reduction of German nitrogen inputs in die Baltic Sea	12 % by 2021 (compared with the mean for 1997 – 2003)	Ministerial declaration[3]
Netherlands			
Compliance with legal quality targets for water and critical loads for ammonia	Reduction of N-inputs (mineral fertiliser and manure) in agriculture	50 – 70 % compared with the situation in the year 2000	Report[4]
EU and Europe			
Halving the proportion of ecosystem areas affected by eutrophication (for the EU: 77 %/2=38.5 %)	Reduction of NH_3 and NO_x emissions	73 % (NH_3) and 50 % (NO_x) by 2030 (compared with 2005)	Impact Assessment for proposed directive [5]
A good ecological status in the Baltic Sea	Regional reduction of total nitrogen inputs into the Baltic Sea	13 % by 2021 (compared with 1997 – 2003)	Ministerial declaration[3]
Global			
Good water body quality, none exceeding the critical loads for eutrophication, meeting the 2 °C-target	Global reactive N-input in agriculture	50 % (eventual reduction from 121 to approx. 62 Tg N)	Report[6]

SRU/SG 2015/Tab. 7-3; Data source: [1] European Commission 2013; [2] ARGE BLMP Nord- und Ostsee 2011; [3] HELCOM 2013; [4] de VRIES et al. 2001; [5] AMANN et al. 2014; [6] de VRIES et al. 2013

In order to derive an overall reduction target for the inputs of nitrogen compounds it is necessary to carry out an integrated review of the nitrogen inputs, their impacts and their reduction potentials. One approach would be to use the models for Germany already mentioned. However, this is methodologically demanding, in particular if all nitrogen compounds and all environmental media have to be taken into account. It involves non-linear

causal relationships and variations in local conditions. There are also numerous interactions between the nitrogen compounds and with other environmental stressors. It is therefore only possible to present results as ranges and orders of magnitude.

For an overall reduction target it is necessary to compare the critical loads for the environment with the current levels in an overall nitrogen balance. The Federal Environment Agency has drawn up such an overall balance for Germany (SRU 2015, ch. 3.2.1), although gaps remain in the data.

In the course of strategy development, special attention should be paid to the integrated nitrogen reduction target in view of its overriding importance and the range of functions involved. The SRU recommends involving a wide range of actors in this process. The starting point should be the findings of scientific experts (see above). The total reduction target should then be discussed and further developed in an interactive process by scientists, representatives of the emitters and other affected parties, environmental and nature conservation bodies, as well as politicians, for implementation as part of a nitrogen strategy. The process should result in an ambitious overall reduction target for which there is broad societal and political support and which would ideally correspond broadly to the scientifically determined critical loads and the corresponding reduction requirements.

An overall reduction target augments but does not replace a locally differentiated approach. It addresses the problem of excessive nitrogen loads in the natural environment and thus excessive background pollution levels. The overall reduction target does not provide sufficient information to address the effects of hotspots. This calls for additional locally specific measures (SRU 2015, Nos. 35 f. and 203).

3.5 Sector-specific targets and timelines

Some sectors and emitters may not feel addressed by an overall reduction target. In order to avoid this, additional sector-specific reduction targets should be developed. This ensures that the strategy is oriented directly to the relevant addressees and will contribute to increasing the pressure to take action. It is also possible to draw on existing proposals. Some time ago, the Federal Environment Agency (UBA 2009) recommended that the nitrogen surplus target of 80 kg per hectare in the Sustainability Strategy should be lowered to 50 kg per hectare. Whether this proposal would actually be sufficient to avoid quality targets being exceeded everywhere remains a matter for further analysis. For the nationwide reduction of air pollution, the proposed new NEC Directive offers reference points for interim goals with its reduction targets for 2030 for ammonia and nitrogen dioxide (SRU 2015, No. 338).

The above-mentioned partial targets address the main contributors to the nitrogen problem: agriculture, the energy sector, and transport. It is also possible to derive synergy effects from these targets of the nitrogen strategy for climate change mitigation targets and thus also for the German climate change action plan.

The targets of the nitrogen strategy should extend beyond 2030 and thus beyond the horizon of the existing regulations, because the impacts of reactive nitrogen inputs and also of future measures, for example on biodiversity or the status of groundwater bodies, can only be assessed over longer periods. However, such a longer-term orientation should not lead to any further delay in tackling problems. Rather, a comprehensive approach should be implemented with specific interim targets across all media. As with the targets for reductions of greenhouse gas emissions, this could involve targets or budgets in ten-year steps. Together with the long-term budget these form the basis for the monitoring of progress.

The nitrogen strategy should bring together the qualitative and quantitative targets already established in existing laws and regulations, but should also include strategic targets and above all ambitious deadlines. As with the Biodiversity Strategy, the targets of the nitrogen strategy should be linked to those of the existing strategies.

The experience gained with the other strategies shows that when formulating the targets it is important to ensure that they are not too broadly scattered, because this can lead to a loss of focus. On the other hand, the system of targets must address the complexity of the problem without appearing to be arbitrary. Like the overall reduction target, the system of targets should be developed in a process involving fair representation of the various parties involved, so that both resource conservation interests and economic interests can be integrated.

3.6 Monitoring performance and progress

The positive experience gained in the existing strategies with monitoring indicators for the various targets should be drawn on for the nitrogen strategy. Indicators offer a simple and unambiguous way of presenting the progress made towards meeting a target and also of highlighting where action needs to be taken. In the Biodiversity Strategy, the links with existing sets of indicators offer the advantage that the relevant data are already available and medium-term or even long-term trends could be identified. When selecting indicators for a nitrogen strategy it would be beneficial to draw on existing datasets, but reference must also be established to the legal framework of critical loads and targets and to the fields of action. Therefore additional indicators should be included, or where necessary developed, in order to reflect aspects which had not previously been taken into account. For example, this could apply for nitrate concentrations in groundwater bodies, the water quality with reference to the Water Framework Directive, or indicators relating to soil conservation.

3.7 Responsibilities for a strategy

The pollution of environmental media and ecosystems with reactive nitrogen is an environmental problem, so that it is natural that in Germany the Federal Environment Ministry should play a leading role in setting the targets for nitrogen reduction and in monitoring compliance with a nitrogen budget. Where specific measures influence sectors for which the

responsibility lies with other departments, appropriate steps must be taken to ensure that the targets can be met. Increasing the integration of environmental matters in other departments is one such step. This applies in particular for the Agriculture Ministry, but also for other departments with responsibilities for the energy and manufacturing sectors, or transport. This requires greater awareness of the environmental consequences of the initiatives and decisions under discussion. Passing on knowledge about reactive nitrogen could be made an obligatory part of in-house further training curricula, provided that support is forthcoming from the federal government or of the relevant ministries. It would also be possible to create internal structures which would ensure examination of the impacts that proposed measures would have on nature and the environment. In addition, more formalised steps could contribute to the greater integration of environmental concerns. Various other options would provide the Environment Ministry with opportunities to intervene to a greater or lesser extent, but the introduction of such measures requires careful consideration.

If the environmental policy requirements are to be integrated more effectively in implementation measures, it is necessary to have a more binding and enforceable regulatory framework. A nitrogen strategy would not make this requirement superfluous – on the contrary it should be supported as a priority field of action for the strategy.

It is also necessary to place greater emphasis on the nitrogen problem within the Federal Environment Ministry itself. This could be anchored in the process of developing an environmental programme including a focus chapter on nitrogen. Given the importance of the topic and the need for close cooperation it would be desirable for responsibility to be exercised at least formally at the level of permanent state secretary. This would ensure that the topic received appropriate recognition within the ministry.

The development of the strategy and the regular reporting could be monitored by an independent “Specialist Commission Nitrogen”. Such a commission could be made up of scientists from various disciplines, and representatives of associations and bodies from the fields of the environment, nature conservation, agriculture, consumer protection, energy and transport – in other words representatives of the emitters and also of the parties affected by negative impacts of reactive nitrogen. The remit of the commission could be to carry out its own scientifically-based assessments of the progress and developments and to publish these at regular intervals. The advantage of such a specialist commission is its neutrality and its independence from the outcomes and the political decision-making process, which would increase the credibility of the results and recommendations. The “Specialist Commission Nitrogen” would also be able to contribute to raising public awareness about the problem and prepare the social framework for political decisions.

In addition to the horizontal integration of relevant nitrogen policies, the vertical integration also plays a significant role, because while as a rule the targets are set at the European level, these targets are adopted by the German federal government and transposed into laws

and ordinances, which in turn are implemented and supervised by the *Länder* and local authorities. The SRU therefore proposes that a Federal Government-Länder working group should be formed as a joint sub-committee of the Conferences of Agricultural Ministers and Environment Ministers. As far as possible, the methods and procedures developed in similar working groups should be adopted and use made of the experience gained in them.

The nitrogen strategy should be given broad support at the national level and by the *Länder,* with responsibility being assumed by prominent representatives ('ownership'). This corresponds to the experience with the existing strategies, because even though the support provided for the National Sustainability Strategy by the German Chancellor and the head of the Federal Chancellery is not immediately apparent to outside observers, it nevertheless receives more attention in the ministries and in parliament because of this high level backing than for example the Biodiversity Strategy, which lacks such high-ranking 'ownership'. In addition, it is advantageous if the public can identify the nitrogen strategy with an individual face – an effect which is reinforced by regular public appearances.

3.8 Implementation

Special attention must be given to the implementation of a nitrogen strategy. Because it is not legally binding, there is a risk that it will be formulated and approved but will then have no further influence on the everyday political process. In this respect, an important contribution can be made by the experience with the existing strategies and the analysis of the factors contributing to their success (LAWS 2014; HEINRICHS and LAWS 2012). Aspects such an institutional anchorage, the support provided by specific measures, and the communication of the strategy and its contents are important in order to raise awareness about the problem and the need for action, as well as to secure the necessary resources for the implementation.

3.9 Institutional anchorage

The existing strategies in Germany are anchored in different ways. The Biodiversity Strategy focuses above all on a close dialogue with the actors at various levels. The measures adopted go beyond those which are conventionally used for communications in a ministerial setting. The objective is to promote the implementation of the strategy above all outside the political framework. In contrast, the Sustainability Strategy has strong structural links within the political system, above all due to the leading role played by the Federal Chancellery, which coordinates exchanges between the Federal Government and the *Länder*, and with the State Secretaries' Committee for Sustainable Development. These links are reinforced by the institutional integration in parliament through the advisory body there and the German Council for Sustainable Development (RNE). However, it does not have any broad public anchorage. Dialogues and participation only take place in connection with the progress reports.

Lessons for the nitrogen strategy can be drawn from both these examples. Firstly, the complexity of the problem and the interactions between the various instruments involved call for an institutionalisation in the political system. Only then will it be possible to make use of existing synergies and to reach decisions which are sufficiently coherent. At the same time, it is important to anchor the strategy at lower levels, because the problems present themselves locally, in particular in hotspot regions, so that this is where the solutions have to be implemented. Individual decisions can also play a key role, in particular with regard to food consumption and mobility, so that anchorage in the society is called for. In order to achieve this it is necessary to implement closely coordinated communication measures.

Neither of the other two strategies directly addresses the sectors which contribute to the problems. But this is a necessary component of the Nitrogen Strategy. In view of the pressing nature of the problem and the complexity of the impacts, an increased sense of responsibility is necessary if the problem is to be tackled. Since the sectors that are the main contributors to the problem have been clearly identified, they should be addressed directly by the strategy and involved in the process of formulating it.

4. Conclusions

A national nitrogen strategy will help to ensure that the nitrogen problem in Germany receives the appropriate and necessary attention from policy-makers, administrators and the public realm. By bringing together existing targets and ordinances, the strategy will help to overcome the current fragmented approach. Viewing the nitrogen problem in terms of individual sectors or the conservation of specific resources, and deriving targets and measures on this basis runs the risk that impacts will simply be shifted elsewhere. A national strategy not only helps to avoid this by means of an integrated approach, but also makes it possible to identify unintended consequences at an early stage.

The proposed nitrogen strategy draws on the concept of planetary boundaries in the form of scientifically determined overall reduction targets. Various calculations can be used to derive targets and on this basis a national strategy can be developed to meet the demands. If it is possible at an early stage to establish broad participation at the various political levels and among societal groups as well as among emitters and those affected by impacts, the national nitrogen strategy will be able to draw on a wide range of knowledge and generate a high level of acceptance during the development phase.

A national nitrogen strategy can be politically initiated through the German environment programme which is currently being formulated. A nitrogen strategy can be developed along the lines of the structures of the National Strategy for Sustainable Development and National Strategy on Biodiversity, drawing on the lessons learned from their implementation. It is necessary to maintain close links with the other two strategies so that common elements can be identified and overlaps avoided. With such a nitrogen strategy, Germany can contribute to

the implementation of the 7th Environmental Action Programme and play a prominent role in tackling an urgent local, regional and global environmental problem.

5. Literature

SRU (Sachverständigenrat für Umweltfragen) (2015): Stickstoff: Lösungsstrategien für ein drängendes Umweltproblem. Sondergutachten. Berlin: Erich Schmidt.

A detailed list of references is provided in the special report, which can be downloaded at http://www.umweltrat.de.

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