

# The Netherlands contribution to the EMEP air quality assessment report

*Acidification and air quality in the past decades and policy targets for 2010*  
2003

Adopted from the Netherlands Environmental Balance, 2002 & 2003 editions  
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## Summary

- In implementing the current policy, the 2010 EU emission ceilings for sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs) will not be reached, while the EU objective for ammonia is expected to be met. The National Environmental Policy Plan 4 (NEPP4) targets for 2010, which are sharper, are still far from attainable for any of the above-mentioned substances.
- The current policy offers enough possibilities for realising the 2010 EU limit values for ozone. The annual average standard for particulate matter in 2005 is attainable, but not the daily average standard.
- The improvement in air quality with respect to nitrogen dioxide (NO<sub>2</sub>) is expected to continue under current policy, so that exceedances will become more and more of a local occurrence. The EU limit value is expected to be still exceeded in 2010 for 3000 to 30,000 inhabitants.
- The decrease of emissions of VOC's, NO<sub>x</sub>, SO<sub>2</sub>, particulate matter (PM<sub>10</sub>), Benzene, and Ammonia (NH<sub>3</sub>) is confirmed by measurements of the Dutch Air Quality Monitoring Network.
- There is evidence that  $\gamma$ -HCH concentrations in the precipitation in the Netherlands have significantly decreased since 1980.

## Policy targets

The objective of the Dutch and European acidification and air quality policy is to protect both nature and public health against exceedances of critical values of acidifying compounds, nitrogen, ozone, particulate matter and  $\text{NO}_2$ . This is why policies have been introduced to address both air quality and emissions. Air quality policy is EU policy, which has been set down in the EU framework directive on air quality (EU, 1996). National Emission ceilings have been stipulated in the Gothenburg protocol (UNECE, 1999) and in the stricter EU directives for 2010 (EU, 2001). Emission targets from the National Environment Policy Plan (NEPP4) in turn, are stricter than EU directives but, as opposed to the EU directives, are not obligatory (VROM, 2001). The NEPP4 deposition targets are formed by an average deposition of 2150 mol/ha potential acid and of 1550 mol/ha nitrogen over the nature areas in the Netherlands in 2010. Because the amounts of especially the ammonia deposition in nature areas show uncertainties, target ranges have been calculated: 1350-1650 mol/ha for nitrogen and 1950-2300 mol/ha for potential acid. The top of the range has been chosen as re-calculated NEPP4 deposition targets.

### 1. Acidification

Direct harmful effects on vegetation caused by high concentrations of nitrogen and sulphur compounds in air no longer occur at current levels. However, deposition of these compounds in nature areas leads to acidification and eutrophication. Now that the sulphur deposition is decreasing, the ecological effects of acid deposition are being increasingly determined by nitrogen (RIVM, 2002).

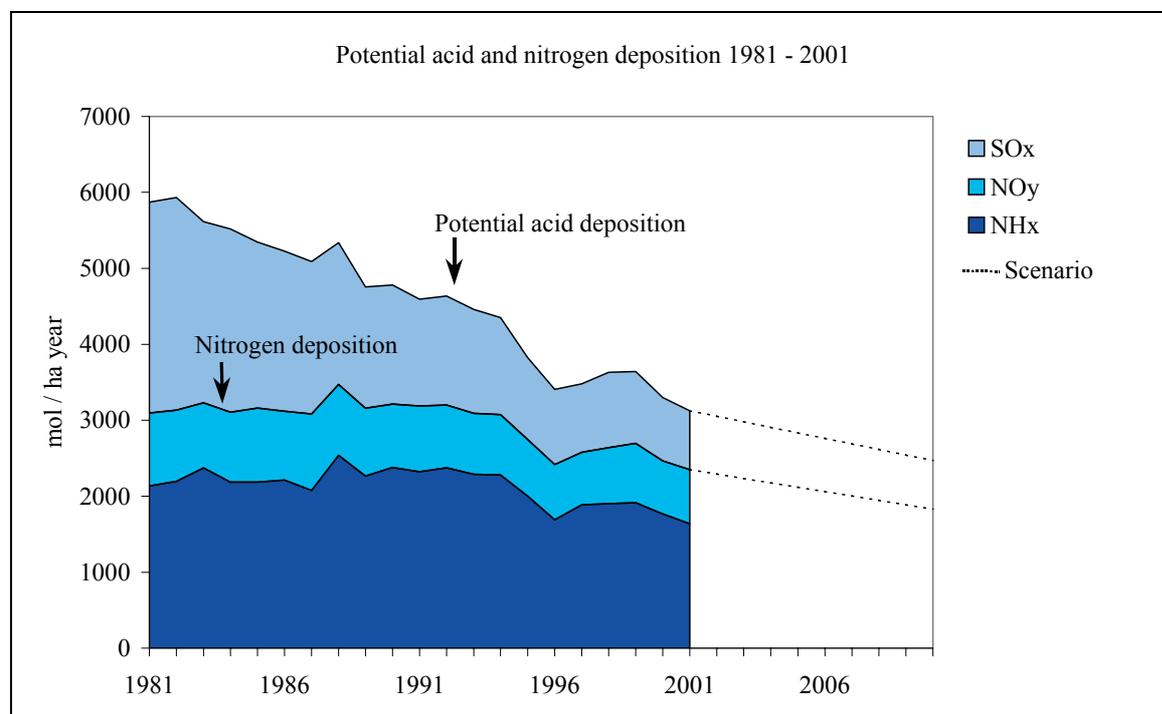


Figure 1. Deposition of potential acid and nitrogen in the Netherlands, 1981-2010.

The nitrogen deposition in the Netherlands has slightly decreased the last few years, see Figure 1, with the average deposition in 2001 amounting to 1900-2400 mol/ha. The acidifying deposition of sulphur has decreased sharply the last few years, contributing considerably to the drop in potential acid deposition in the Netherlands of 50% in the last 20 years. The average deposition of potential acid in nature areas was 2750 to 3250 mol/ha in

2001, for which the range was determined by uncertainties in the ammonia deposition. At the moment about 10% of the nature areas are sustainably protected against acidification and eutrophication. It is estimated that the deposition of nitrogen and acidifying substances will both still be on average 0-20% above the deposition targets in NEPP4. Because about 45% of the potential acid deposition and 35% of the nitrogen deposition originate outside the Netherlands, this will be highly dependent on emission reductions in the surrounding countries.

## 2. Air quality

The exposure of humans to air pollution is on the decrease. The public health gain of this decreased exposure is, however, at the moment not determinable. Annual average concentrations of NO<sub>2</sub> and particulate matter have decreased by about 20% and 30%, respectively in the last decade (Hammingh et al. 2002). The EU limit value for ozone for 2010 has not been exceeded in the last 10 years. In 2001, however, there were still quite a number of locations in the Netherlands where the EU air quality standards were exceeded. The daily limit value for particulate matter for 2005 is exceeded among half the inhabitants of the Netherlands (about 8 million). About 160,000 inhabitants are exposed to concentrations of particulate matter above the annual average limit value for 2005. About 600,000 inhabitants are exposed to concentrations of NO<sub>2</sub> above the annual average limit values for 2010. As a consequence of the decrease in emissions both inside and outside the country, air pollution caused by particulate matter and NO<sub>2</sub> is increasingly becoming a local (traffic) problem (see textbox on NO<sub>2</sub>: Bottlenecks and solutions).

The annual average EU limit value for particulate matter is, under current policy, a feasible target for 2005, although local exceedances cannot be completely ignored. Realisation of the daily average limit value in 2005 does not seem possible. The European Union (EU) will be evaluating the air quality criteria in 2004. At that time the standards for particulate matter and NO<sub>2</sub> will be evaluated according to new insights on health effects and feasibility.

### **NO<sub>2</sub>: Bottlenecks and solutions**

The number of inhabitants who were exposed to NO<sub>2</sub> concentrations above the EU limit value decreased from 4.5 million to about 0.6 million between 1990 and 2001 (RIVM, 2002). Implementation of current policy still shows locations where the EU limit values for 2010 are not being met, especially along motorways and in urban areas. In 2010, 3000 - 30,000 inhabitants are expected to be exposed to NO<sub>2</sub> concentrations above the EU limit value (Beck et al., 2002). If this target is to be realised in 2010, supplemental measures will be needed. These have to do with general NO<sub>x</sub> emission reductions on European or national scale, and specific measures for traffic bottlenecks (reducing speeds, detours, improving traffic flows) and the infrastructure (house demolition, tunnels, pitched barriers). The extra funds reserved for realising these targets are limited, and because of the sober financial-economic situation in the Netherlands there is no money available for reconstruction along roadways. Besides these adaptations to infrastructure, such as covering of motorways, are relatively very expensive measures for solving air quality problems alone (CPB, 2002).

For this reason the Dutch government is, in the European framework, aiming at postponing the EU target for NO<sub>2</sub> from 2010 to 2015 (VROM, 2002). Moving up the target year will allow more time to see the effect of the existing policy and to take extra NO<sub>x</sub> measures at European level, for example; these include a further tightening up of the emission standards for road traffic, mobile machinery and shipping. In this way, the limit values in 2015 can be realised in 2015, either without or with fewer costly measures. Furthermore, we can not expect the

feasibility of NO<sub>x</sub> measures to be more problematic in a large number of other EU countries. Far-reaching NO<sub>x</sub> reduction in the countries surrounding the Netherlands will also have a positive effect on air quality in the Netherlands by lowering their transboundary contributions to background concentrations in the Netherlands. The largest part of the concentration reduction will, however, have to come from local and national emission reductions. This is because the contribution from abroad to the background concentration at hotspots for NO<sub>2</sub> in Amsterdam and Rotterdam is relatively small, i.e. less than 10% (Folkert, 2003).

### 3. Emissions

The air quality for NO<sub>2</sub>, particulate matter and ozone has improved as a result of a decrease in the emissions in the Netherlands and the surrounding countries. Because of the European regulations for road traffic, vehicle emissions since 1990 have decreased by 50% for VOCs, and 45% for particulate matter, 35% for NO<sub>x</sub> and almost 20% for SO<sub>2</sub>, despite the growth in traffic of 30%. For particulate matter and NO<sub>x</sub>, standards have been set for installations by tightening up of degree on emission stocks of heating installations (BEES), and the Netherlands Emission Guidelines (NER). In meeting these requirements Dutch industrial plants have realised a reduction in particulate matter and NO<sub>x</sub> since 1990 of 60 and 40%, respectively. No emission targets have been agreed to in the EU framework and NEPP4 for particulate matter.

#### Nitrogen oxides - NO<sub>x</sub>

The NO<sub>x</sub> emission in 2001 was about 30% lower than in 1985. In the absence of current policy emissions this would have increased by 35% since 1985 (Figure 2.). The NO<sub>x</sub> emission reduction is stagnating at industrial plants because of the usually inevitable choice of existing installations for cheaper measures (see textbox on Cost effectiveness) and because the NO<sub>x</sub> emission trading system announced has not yet started up. If the current policy is carried out, the EU ceiling for NO<sub>2</sub> for 2010 is not expected to be realised. The policy target for realising the EU ceiling for NO<sub>x</sub> will, in 2010, come to several dozen million kilograms (see textbox on Uncertainties).

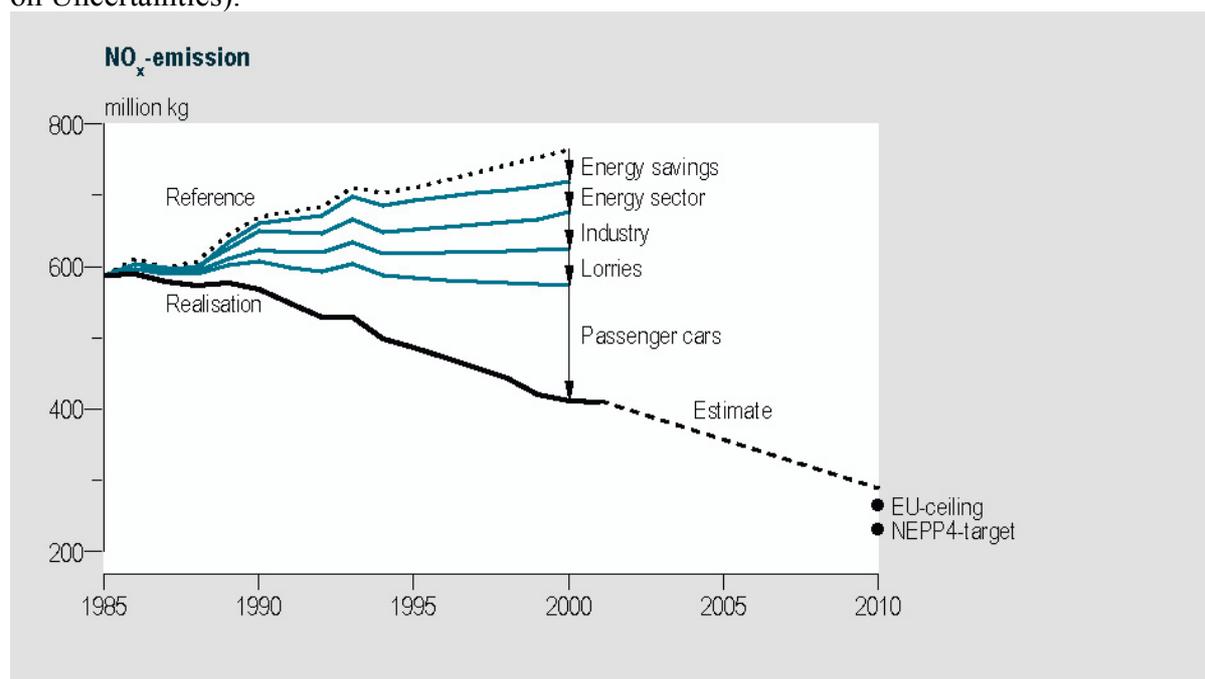


Figure 2. The contribution of different measures to the NO<sub>x</sub> emission reductions, 1985-2010.

## Sulphur dioxide – SO<sub>2</sub>

Since 1985 the SO<sub>2</sub> emission has decreased at a fairly even pace (Figure 3). Emissions from industrial companies are decreasing too under the influence of agreements (energy sector) and BEES criteria (energy sector, refineries, industry). The European fuel requirements are responsible for a decrease of more than 50% of the SO<sub>2</sub> emission reduction since 1990, despite a 30% increase in traffic volumes. Fuel requirements for shipping and (agricultural) machinery are not as strict, causing the SO<sub>2</sub> sources in this same period to increase by 16%. Implementing the current policy is not expected to be enough to realise the EU ceiling for SO<sub>2</sub> in 2010. The extent of reductions for realising the EU ceiling for SO<sub>2</sub> is expected to be met in 2010 comes to between 10 and 20 million kg (see textbox on Uncertainties).

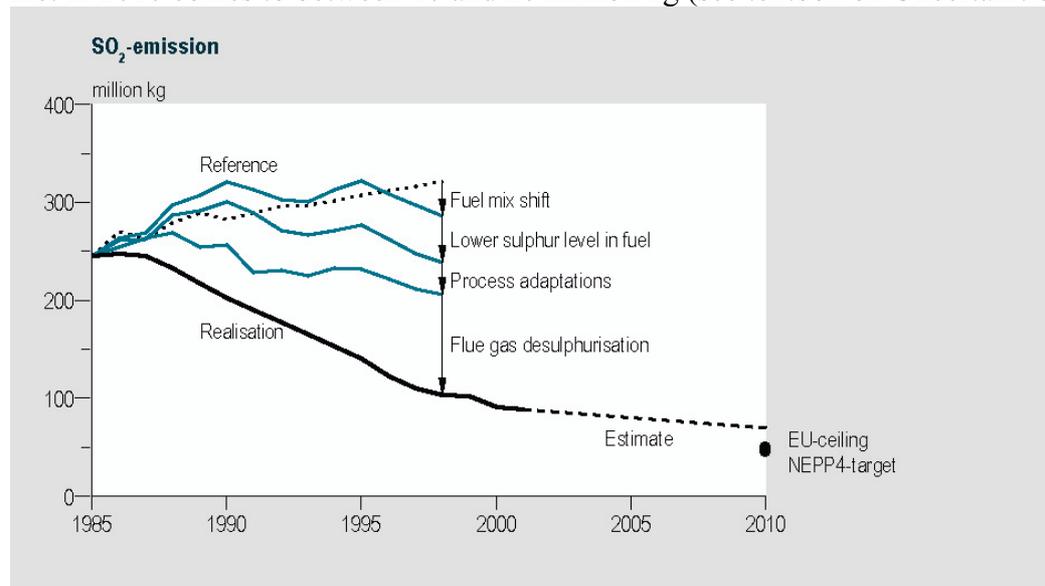


Figure 3. The contribution of the different measures to the emission reductions for SO<sub>2</sub>, 1985-2010.

### Uncertainties in EU policy tasks for NO<sub>x</sub>, SO<sub>2</sub>, VOC and NH<sub>3</sub> in 2010

#### *Methodological change*

To 2003, the emission estimates for acidifying compounds have always been based on ‘the Dutch soil method’. This Dutch method forms the starting-point in determining the EU ceilings and the national NEPP4 targets. On the basis of this method the policy task for realising the NEC guideline in 2010 is about 30 million kg for NO<sub>x</sub>, about 20 million kg for SO<sub>2</sub> and about 35 million kg for VOC. The EU emission ceiling for NH<sub>3</sub> is expected to be realised. Recently, it has become clear that the Dutch method diverts from the EU method, in that emissions from international shipping are not calculated and those from fisheries on the Continental Flats are. The policy efforts in realising the NEC guidelines for SO<sub>2</sub> and NO<sub>x</sub> will, because of this, not be as great as expected to date; the indication is now 8-10 million kg SO<sub>2</sub> and 10-25 million kg NO<sub>x</sub>. The exact amounts targeted are being further investigated at the moment. The methodological adaptations have, of course, no influence on the concentrations and depositions of these substances in the Netherlands.

#### *Technological windfalls and shortfalls*

The change in method does not automatically imply that the policy efforts will be fewer. A number of other developments can increase the chance of a policy falling short. For NO<sub>x</sub> the emissions from freight traffic are certain to be higher than assumed up to now, considering the new insights into emission factors. On the other hand, lower emissions are, in fact, expected in domestic shipping. The extent of these windfalls and shortfalls is now being further investigated.

#### *Uncertainties in the emission estimates and policy implementation*

Uncertainties in the emission estimates of NO<sub>x</sub> are mainly concerned with the effectiveness of

the announced emission trading and the implementation and enforcement of existing environmental measures (including technical performance of small gas engines and central heating units).

As far as estimates are concerned, the SO<sub>2</sub> emissions may increase within the boundary conditions of the BEES regulations because of the termination of the agreement with the electricity sector. The reason for this is that then more relatively cheap sulphur-rich coal can be purchased.

In the emission estimate for VOC the greatest uncertainty is the estimated decrease in the solubility level of paints (consumer, and building and industrial paints). If we assume a further autonomous development to use of low-solubility paints than now prescribed via regulations (especially the Arbo regulation on occupational safety and health), the estimate may turn out to be maximally 15 million kg lower (Smeets et al., 2002).

Uncertainties in the emission estimates of NH<sub>3</sub> are mainly focused around the regulation introducing green label stables under the Dutch implementing regulation for Housing coming into force, the implementation and enforcement of the manure policy, acknowledgement of the Dutch request for derogation from the EU Nitrate Directive, the autonomous reduction in cattle stocks and the reduction of nitrogen levels in manure through adjustment to animal feeds (under influence of MINAS) and possible by a ban on poultry batteries.

#### **Cost-effectiveness measures for NO<sub>x</sub> and SO<sub>2</sub>**

The cost-effectiveness of measures against acidification under current policy for 2000 is on average about 3 Euro per kg NO<sub>x</sub> and 1 Euro per kg SO<sub>2</sub> (RIVM, 2000). Energy savings, the implementation of BEES and the placement of Selective Catalytic Reduction installations (SCR) in industry were relatively cheap measures: 0-2 Euro per kg NO<sub>x</sub>. Furthermore, the estimated costs for SCR seem not have been that great: costs that were estimated at 2 to 4.5 Euro per kg NO<sub>x</sub> before, in practise the measure turned out to be on average not more than 1.5 Euro per kg. The catalytic converter in road transport was relatively expensive: about 5 Euro per kg NO<sub>x</sub>. Besides NO<sub>x</sub>, however, emissions of VOC, carbon monoxide and particulate matter were reduced. The pollution by traffic also takes place in residential areas as opposed to industrial activities, for example, so that local air quality is strongly influenced by traffic. According to an indicative estimate 1 kg NO<sub>x</sub> reduction in traffic emissions in 2010 is more effective - 3 to 17 times - in reducing NO<sub>2</sub>- concentrations in hotspots than the same reduction in other target sectors.

There are enough techniques available that can be used to realise EU emission ceilings for the Netherlands in 2010. In an exploratory study on the effects and costs of a number of policy options to reduce NO<sub>x</sub> and SO<sub>2</sub>, the average cost effectiveness was estimated at about 4 Euro per kg for both NO<sub>x</sub> and SO<sub>2</sub> (Smeets et al., 2002). On the basis of these figures we conclude that the marginal costs of emission reductions are increasing, both for NO<sub>x</sub> and SO<sub>2</sub>.

For shipping (domestic and deep-sea) a few relatively cheap measures are still needed. These can, however, only be realised at the international level. For the Netherlands measures for shipping do not contribute to realising EU emission ceilings (see textbox on Uncertainties), but do contribute to the reduction of deposition and concentrations. Compared to other European countries the costs of extra measures in the Netherlands per kg of emission reduction are high when expressed as unit GDP and expressed per upper-average inhabitant (EEA, 2003). This is because still cheaper measures are available abroad.

### Ammonia - NH<sub>3</sub>

The NH<sub>3</sub> emission decreased from about 232 million kg in 1990 to about 148 million kg in 2001. The most important cause was the reduction of NH<sub>3</sub> emissions through fertiliser application measures. Ammonia emissions have also been brought down by reducing (cow) cattle stocks and a more efficient use of nitrogen in cattle feeds. Considering the relative few number of low-emission stables built, this measure's contribution to emission reduction is relatively small.

According to recent calculations made by the Agricultural Economics Research Institute and Netherlands Environmental Assessment Agency (RIVM), the national emissions are estimated at 121 million kg and so the EU emission ceiling of 128 million kg is expected to be reached in 2010 (Hoogeveen et al., 2003). The reduction from 2001 to 2010 is the effect of the manure policy which shows a reduction of approximately 15 million kg NH<sub>3</sub>, of which 8 million kg are due to the Regulation for terminating activities in the cattle sector (RbV) and 7 million kg as a result of the mineral registration system (MINAS), and 11 million kg is the effect of the legislation on low-emission stables (figure 4). The NEPP4 target for NH<sub>3</sub> is, at 100 million kg, sharper and will be exceeded. Even with extra measures in agriculture, such as low-emission manure application, low-emission stables for cow cattle and less nitrogen in feeds for dairy cattle, the NEPP4 targets will not be reached.

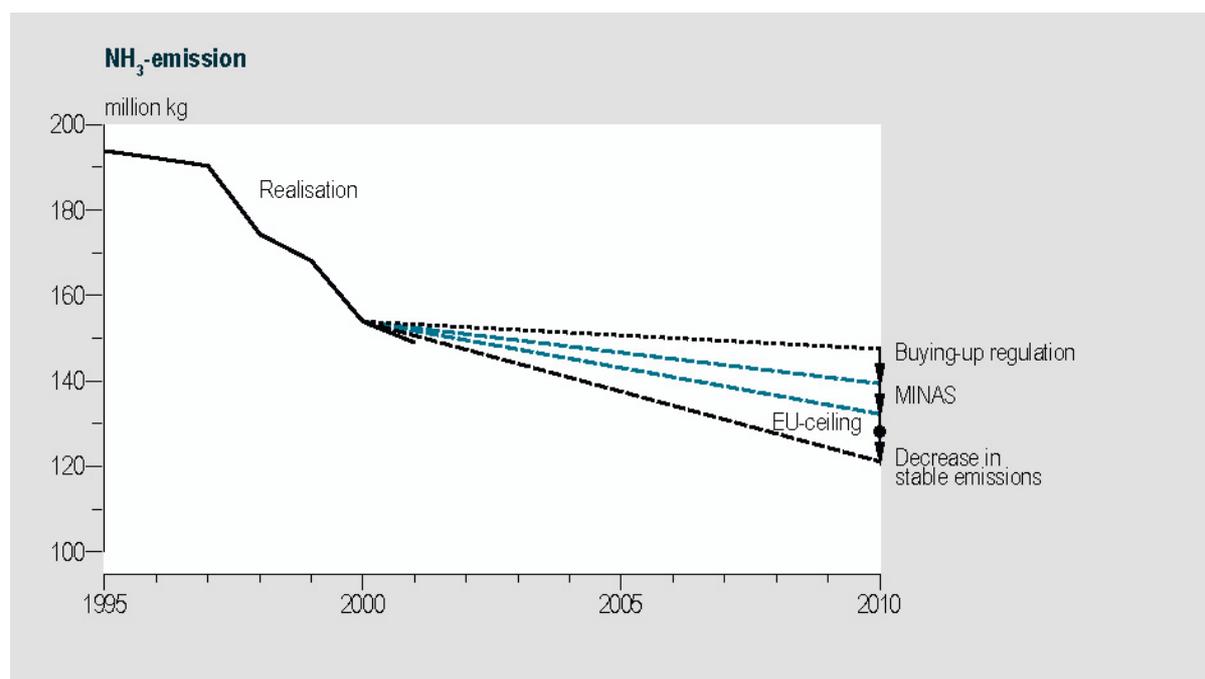


Figure 4. Emissions of ammonia in the Netherlands and effects of policy, 1995-2010 (Hoogeveen et al., 2003).

### Non Methane Volatile Organic Compounds - NMVOC

In the period 1985-2002, the NMVOC emissions were reduced by 50% to 244 million kg. Most of the reduction (240 million kg) has been accomplished by the European regulations for road traffic. The 'Hydrocarbon programme 2000' for reducing the VOC emissions from stationary sources resulted in a similar reduction as road traffic regulation. The EU ceiling for 2010 will not be attained under current policy.

## 4. Comparison of emissions and concentrations

### Comparison of measured and calculated NH<sub>3</sub> concentrations

The trend in the calculated ammonia concentration is similar to the trend in the measured ammonia concentration. This means that the trend in the ammonia emissions is correct. However, there is an absolute difference in level of about 30% in measured and calculated concentrations of NH<sub>3</sub>, see Figure 5. This difference may be explained by a possible underestimation of emissions and an overestimation of the dry deposition of ammonia. The uncertainty in the parameterisation of the dry deposition process of ammonia is still quite large.

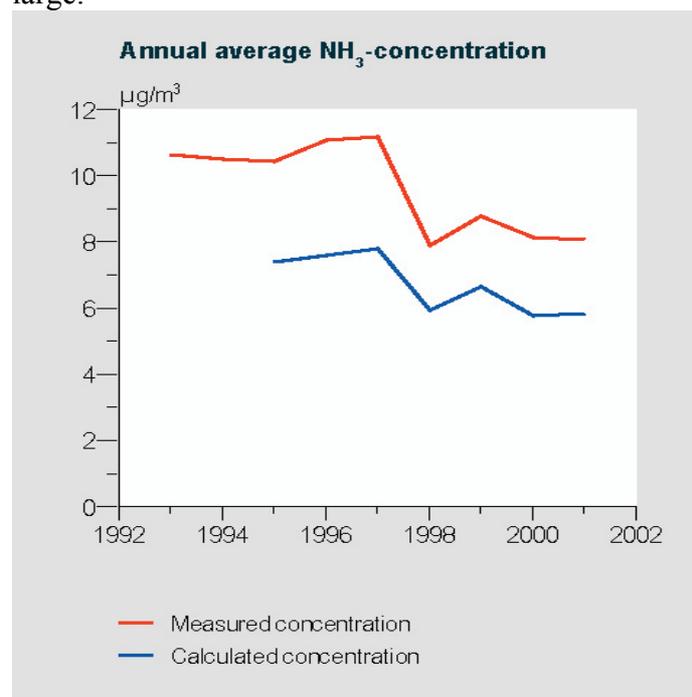


Figure 5. Measured (1993-2001) and calculated (1995-2001) NH<sub>3</sub> concentrations in air. Calculations carried out on the basis of 500 x 500 m resolution available for the 1995-2001 period.

### NO<sub>x</sub>, SO<sub>2</sub>, VOC, PM<sub>10</sub>

The air quality measurements from the Dutch Air Quality Monitoring Network allow independent validation of emission trends and resulting calculations.

The emissions and concentrations of VOC, NO<sub>x</sub>, particulate matter, benzene and SO<sub>2</sub> from Figure 6 show a downward trend. The concentration in busy streets keep tread with the traffic emissions in cites; however, in the last few years concentrations have decreased more sharply than the emissions reported. This is also true for large-scale VOC, a group of substances contributing to ozone formation. The SO<sub>2</sub> emissions and concentrations are decreasing at the same rate. The peaks in concentration are the result of increased concentrations during periods of frost. The relationship between emissions and concentrations is not as simple to explain for particulate matter and therefore the comparison is less certain. In north-west Europe the concentrations seem to decrease less rapidly than the emissions. This may partly be the result of the very sharp emission reductions in Eastern Germany, since these emissions contribute less. There is also the possible effect of the particulate matter that is formed in the atmosphere from gasses. These formation processes do not occur in complete proportion with the emissions.

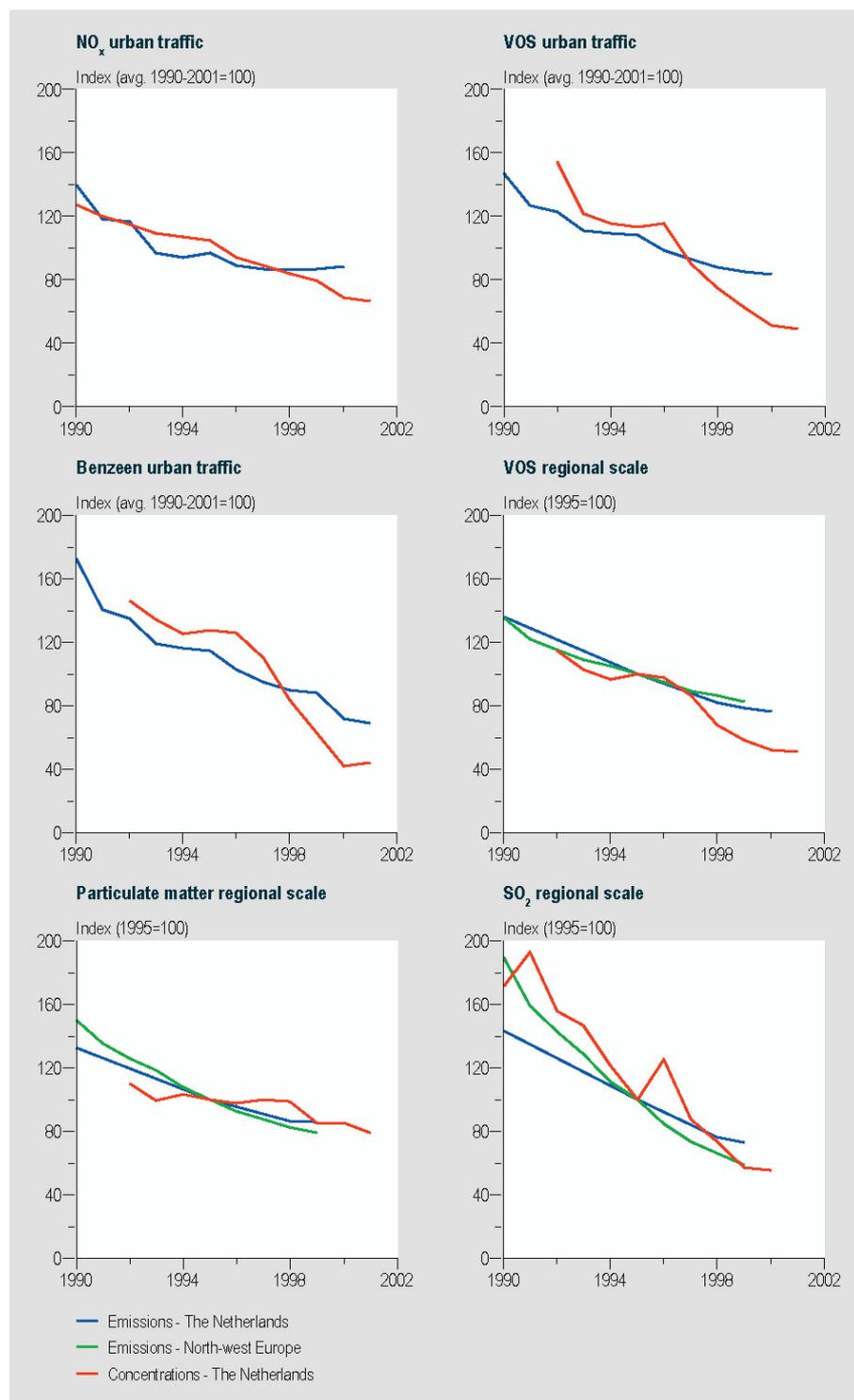


Figure 6. Indexed emissions and concentration for NO<sub>x</sub>, VOC, benzene, particulate matter and SO<sub>2</sub>, 1990-2001. In the comparisons at urban level the increases in concentration in urban estimates are plotted against those in urban road traffic emissions. For the large-scale comparisons, regional concentrations are plotted against emissions from the Netherlands and surrounding countries, weighted according to their contribution to Dutch concentrations. The concentration trends of NO<sub>x</sub> and particulate matter are corrected for fluctuating meteorological influences (Dekkers and Noordijk, 1997; Noordijk and Visser, 2003).

## 5. Long-term measurements of $\gamma$ -HCH

The long-term measurement of  $\gamma$ -HCH in precipitation in the Netherlands (figure 7) covers the period from 1980 to the present (Buijsman and van Pul, 2003). Concentrations of  $\gamma$ -HCH in precipitation show a systematic seasonal behaviour, with generally low concentrations throughout the year. During a short period in April/June concentrations rise. There is evidence that  $\gamma$ -HCH concentrations in the precipitation in The Netherlands have significantly decreased. Moreover, measurement results from the last three years (1999–2001) show a clear downward trend as well and suggest a decline in lindane emissions.

Measurement results from neighbouring countries shows a similar pattern: enhanced concentrations in precipitation during the same period. This supports the hypothesis that  $\gamma$ -HCH in precipitation is a large-scale occurrence. Major sources of  $\gamma$ -HCH in precipitation in The Netherlands (and the neighbouring countries) are most probably source areas in France, where, until recently, lindane was used extensively.

Long time series of  $\gamma$ -HCH measurements are a useful tool in evaluating its emission trend. Given the large uncertainties in emission estimates and in modelling of atmospheric transport and deposition up to now, measurements are considered to be a better tool for monitoring the changes in environmental levels of  $\gamma$ -HCH.

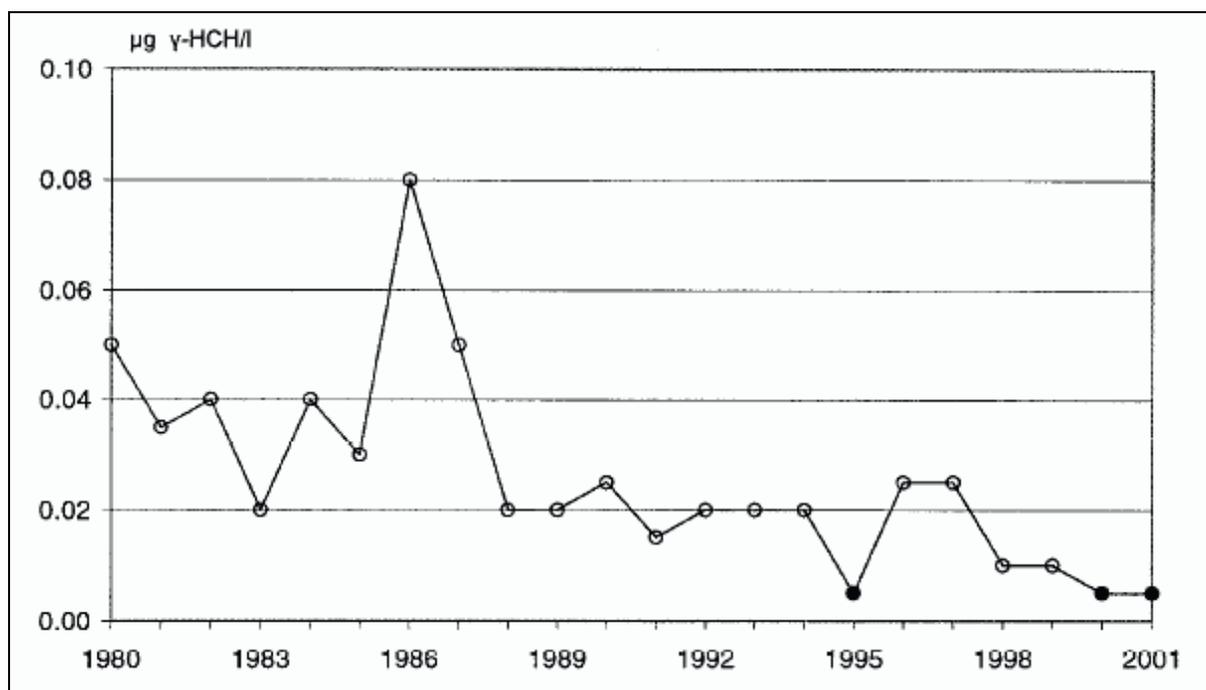


Figure 7. Annual median concentrations of  $\gamma$ -HCH in precipitation in The Netherlands, 1980–2001. For the sake of convenience, median values which fall below the limit of detection of the analytical method used ( $0.01 \mu\text{g L}^{-1}$ ) has been arbitrarily given the value of  $0.005 \mu\text{g L}^{-1}$ . These data points are marked black (●).

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