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Uncertainty assessment of NO_x, SO_2 and NH_3 emissions in the Netherlands

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1. Introduction

1.1 General

In 2001 the RIVM performed a TIER 1 uncertainty assessment for the emissions of SO_2, NO_x and NH_3 in the Netherlands. This assessment was performed on an aggregated emission source level. The results were not directly suitable to prioritise cost-effective actions to reduce the uncertainty of emission data in the Netherlands.

In the current project the uncertainty assessment is elaborated on the most basic source level (source codes) for the year 2000 of the Dutch Emission Inventory. This study comprises:
- Key sources analysis
- Quantification of probability density functions (PDFs) by expert elicitation;
- Assessment of emission data pedigree by expert elicitation;
- Propagation of data uncertainty in the calculation of the emissions using Monte Carlo simulation;
- Dissemination of knowledge concerning methods for expert elicitation and uncertainty assessment in the Dutch Emission Inventory circuit.

The project was commissioned by the RIVM to a consortium of TNO Environment, Energy and Process Innovation and the University of Utrecht, Copernicus Institute for Sustainable Development and Innovation.

1.2 Goal

Two goals were formulated for the project:
1. Dissemination, within the Emission Inventory circuit, of knowledge on the approach on uncertainty analyses (including expert elicitation). In this way awareness of the compilers of the emission figures is raised with regard to uncertainty and will contribute to quality improvement in this regard.
2. Providing a transparent and uniform foundation of information on the Dutch emission data for the environmental theme "acidification", including a qualitative and quantitative assessment of the uncertainties in emission estimates.

The uncertainties associated with the Dutch acidification data are obtained by elicitation of sector-specific experts. Knowing the social and technological processes behind the emissions and the background data used for calculation of the emissions, the experts are able to draw a probability distribution function for emissions and activity data in their sector.

The uncertainty of the emissions of individual activities propagates into the uncertainty of the total emission. This propagation can be calculated in several ways. In

2001 RIVM conducted a study on acidification data, using the IPCC error propagation calculation technique, also called Tier-1. This study was the starting point of the current project. Furthermore the Monte Carlo based Tier-2 method can be used. This enables implementation of PDFs other than normal distributions, and provides for implementing dependencies among emission inventory items.

In this study, both Tier-1 and Tier-2 analyses are made for the emission data for the year 2000.

1.3 Project plan

The project consisted of five chronological steps:

	Project step	Tasks	Org.
1.	Preparation	Quick scan* (RIVM) Key source Analysis (TNO)	RIVM/TNO
2.	Briefing on uncertainty estimation and quality assurance	Briefing for experts to be questioned and other individuals from the Emission Inventory circuit (UU)	UU
3.	Expert elicitation	Questioning the taskforce** experts (UU)	UU
4.	Uncertainty analysis	Tier-1 and Monte Carlo analysis on uncertainty data	TNO
5.	Report	Analysis of the results	UU/TNO

* According to “Guidance for uncertainty scanning and assessment at RIVM” (see Appendix 6, in Dutch)

** group of experts responsible for estimating Dutch emission figures

In the final phase of this study the Monte Carlo uncertainty analysis was used to calculate the uncertainty of the Dutch emissions of acidifying compounds split up according the Dutch sector split. The results of these calculations are given in Annex 5.

1.4 Reader

Chapter 2 and 3 describe the followed approach for the key source identification and the expert elicitation respectively. The uncertainty analysis is discussed in chapter 4. The results are presented in chapter 5.

2. Key source analysis and Knowledge Dissemination

2.1 Introduction

The next three paragraphs elaborate on the approach in carrying out the key source analysis, expert elicitation and the preparation of the uncertainty analysis respectively.

2.2 Key source analysis

The key source analysis on the contribution to emission totals for 2000 and the emission trend between 1990-2000 is based on techniques described in chapter 6 of the IPCC report" Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories [1] and the Atmospheric Emission Inventory Guidebook, Third Edition [2], part B: Methodology chapter "Good Practice Guidance for CLRTAP Emission Inventories".

2.3 Prioritising

The basis for the key source analysis is the Dutch national emission inventory. Data on emission of NO_x, SO_2 and NH_3 in both 1990 and 2000 were used [1]. We used the most detailed level for the sources from the emission inventory. This means that every unique source in the inventory (represented by the so called RAPCODE) was included in the analysis. Furthermore the sources were differentiated per activity rate (fuel use or activity data).
The unique items in the key source analysis in this report will be referred to as "source-activity combination". No dependencies between the emission estimates from different source-activity combinations were assumed at this stage of specifying the key sources.

In the Dutch environmental policy the emissions for SO_2, NO_x and NH_3 are integrated to the so called acidification equivalents (AE). Therefore the results of the key source analysis for the individual components were combined to yield a key source analysis for AE.

For each of the source-activity combinations an acidification equivalent (AE) was calculated based on the emissions of NOx, SO_2 and NH_3 due to this source. This was done for both 1990 and 2000. Next, the contribution to the trend 1990 --> 2000

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1 These are the emission levels as estimated in the 2001/2002 inventory round. They are not equal to the current estimates for 2000 due to recalculation of the emissions.

was calculated for every source-activity combination, using the following formula from [1] :

$$T_{x,t} = L_{x,t} \bullet |((\frac{E_{x,t} - E_{x,0}}{E_{x,t}}) - (\frac{E_t - E_0}{E_t}))|$$

In which:

t	2000
0	1990 (base year)
$T_{x,t}$	Trend assessment (contribution to the total trend)
$L_{x,t}$	Level assessment (contribution to the total emission in 2000)
$E_{x,t}$, $E_{x,0}$	Emission in 2000 and 1990 respectively for activity x
E_t, E_0	Total emission in 2000 and 1990 respectively

The results of this calculation[1] for all source-activity combinations were listed in two ways:

- The source-activity combinations which were responsible for 95% of the total AE emission in 2000;
- The source-activity combinations which were responsible for 95% of the trend in AE emissions from 1990 to 2000.

The two lists were combined resulting in a listing of 92 source-activity combinations which were identified as key sources (of a total of 419 source-activity combinations in the inventory contributing to acidifying emissions).

2.4 Knowledge Dissemination

The list of key sources was presented during the briefing on uncertainty estimation and quality assurance in the fall of 2002. The goal of the briefing was to provide the experts with a basic understanding of theory and concepts of uncertainty prior to the individual expert elicitation interviews. The briefing dealt with state of the art in uncertainty assessment, the representation of uncertainty by (subjective) probability density functions, a brief introduction in distribution theory with a focus on normal, uniform, triangular and lognormal distributions and conditions under which each of these can be used, the importance of covariance in the propagation of uncertainty, and the concept of data pedigree. Further the experts were made familiar with the procedure for expert elicitation used in this project. This procedure is outlined in section 3. Special attention was paid to creating awareness of a range of pitfalls in expert elicitation known from the literature (table 2.1). Ways to avoid these pitfalls during the elicitation process were discussed.

1 The Key Source Analysis has been carried out in a spreadsheet, which selects the 95% largest contributors to the total AE emission and the 95% largest contributors to the trend of 1990 to 2000 for acidification equivalents. The spreadsheet is made available to the RIVM and the resulting key source list is included in Appendix 1.

Table 2.1 Common pitfalls in expert elicitation [4;5]

Pitfall / bias	Description
Anchoring	Assessments are often unduly weighted toward the conventional value, or first value given, or to the findings of previous assessments in making an assessment. Thus, they are said to be 'anchored' to this value.
Availability	This bias refers to the tendency to give too much weight to readily available data or recent experience (which may not be representative of the required data) in making assessments.
Coherence	Events are considered more likely when many scenarios can be created that lead to the event, or if some scenarios are particularly coherent. Conversely, events are considered unlikely when scenarios can not be imagined. Thus, probabilities tend to be assigned more on the basis of one's ability to tell coherent stories than on the basis of intrinsic probability of occurrence.
Overconfidence	Experts tend to over-estimate their ability to make quantitative judgements. This can sometimes be seen when an estimate of a quantity and its uncertainty are given, and it is retrospectively discovered that the true value of the quantity lies outside the interval. This is difficult for an individual to guard against; but a general awareness of the tendency can be important.
Representativeness	This is the tendency to place more confidence in a single piece of information that is considered representative of a process than in a larger body of more generalized information.
Satisficing	This refers to a common tendency to search through a limited number of familiar solution options and to pick from among them. Comprehensiveness is sacrificed for expediency in this case.
Unstated assumptions	A subject's responses are typically conditional on various unstated assumptions. The effect of these assumptions is often to constrain the degree of uncertainty reflected in the resulting estimate of a quantity. Stating assumptions explicitly can help reflect more of a subject's total uncertainty.

The power-point presentation used for the briefing (in Dutch) is available from the authors.

2.4.1 Clustering

Based on information of the experts the gross list of key sources was clustered. A cluster is defined as a number of source-activity combinations with the same common ground. The common ground can for instance be an identical basic statistical data set or an identical emission estimation methodology used for all sources in the cluster. For example all emission figures for the agricultural combustion emissions are based on the fuel use data for the different types of fuels. These fuel data have all the same uncertainty and can thus be treated as one item, thereby capturing dependencies between activities. The advantage of this procedure is that the uncertainty for a larger number of sources (including non key sources) can be elaborated with the same elicitation effort.

The clustering was done in such a way, that all 92 source-activity combinations selected in the previous step were included. The clusters cover 238 source-activity combinations (of a total of 419).

Every selected cluster was assigned to one or more sector experts who participated in the expert elicitation.

3. Expert elicitation

Expert elicitation is a structured process to elicit subjective judgements from experts. It is widely used in quantitative uncertainty analyses in cases where there are insufficient statistics or reliable data-sets available to quantify uncertainties. Usually the subjective judgement is represented as a subjective probability density function. Several elicitation protocols have been developed but the most widely used on which most of the others have built is the Stanford Protocol [6;7].
Expert elicitation can also be used to elicit subjective judgements on other aspects of uncertainty than the part that can be quantified and represented as a PDF. Risbey et al. [8] have developed and applied a protocol to elicit sources of error, conceivable sources of motivational bias, parameter pedigree and PDFs all together in one protocol [9]. This protocol was a starting point for this project.

The steps involved in the expert elicitation interviews, aimed at eliciting probability density functions (PDFs) to represent uncertainty in data, and pedigree to represent strength of the data are outlined below:

Explaining the elicitation procedure
Explain to the expert the nature of the problem at hand and the analysis being conducted. Give the expert insight on how their judgements will be used. Discuss the methodology and explain the further structure of the elicitation procedure. Discuss the issue of motivational biases and encourage the respondent to make explicit any motivational bias that may distort his judgement.

Discuss strengths and weaknesses in the knowledge base
In this step the expert is asked to comment on and discuss the strengths and weaknesses of the knowledge base for the quantity at hand.

Elicit pedigree scores
To further structure the assessment of strengths and weaknesses in the knowledge base, a pedigree assessment is carried out. Pedigree analysis is a part of the NUSAP system (Numeral, Unit Spread Assessment, Pedigree for uncertainty assessment and communication) [5]. It conveys an evaluative account of the production process of a quantity and indicates different aspects of the underpinning of the numbers and scientific status of the knowledge base. Pedigree is expressed by means of a set of pedigree criteria to assess these different aspects. Criteria used in this study are *proxy*, *empirical basis*, *methodological rigor* and *degree of validation* [6;7]. These criteria are used as indicators for data- and parameter strength. Assessment of pedigree involves qualitative expert judgement. To minimise arbitrariness and subjectivity in measuring strength, a pedigree matrix is used to code qualitative expert judgements for each criterion into a discrete numeral scale from 0 (weak) to 4 (strong) with linguistic descriptions (modes) of each level on the scale (Table 3.1). Note that these linguistic descriptions are mainly meant to pro-

vide guidance in attributing scores to each of the criteria for a given parameter. It is not possible to capture all aspects that an expert may consider in scoring a pedigree in a single phrase. Therefore a pedigree matrix should be applied with some flexibility and creativity. The pedigree matrix used here is documented and discussed in Risbey *et al,[8]*

Table 3.1 Pedigree matrix for emission monitoring.
Note that the columns are independent [8]

	Proxy	Empirical basis	Methodological rigour	Validation
4	Exact measure	Large sample of direct measurements	Best available practice	Compared with independent measurements of same variable
3	Good fit or measure	Small sample of direct measurements	Reliable method commonly accepted	Compared with independent measurements of closely related variable
2	Well correlated	Modelled/derived data	Acceptable method limited consensus on reliability	Compared with measurements not independent
1	Weak correlation	Educated guesses / rule of thumb estimates	Preliminary methods, unknown reliability	Weak / indirect validation
0	Not clearly related	Crude speculation	No discernable rigour	No validation

Structuring
In this step a unit and scale are chosen that is familiar to the respondent in order to characterize the selected variable.

Elicit extremes
In this step the expert is asked to state the extreme minimum and maximum conceivable values for the variable.

Extreme assessment
Ask the respondent to try to envision ways or situations in which the extremes might be broader than he stated. Ask the respondent to describe such a situation if he can think of one, and allow revision of the extreme values accordingly in that event.

Assessment of knowledge level and selection of distribution
Before letting the respondent specify more detailed information about the distribution it is important that this be done in a way that is consistent with the level of knowledge about the variable. In particular, we seek to avoid specifying more about the distribution shape than is actually known. A heuristic for choosing the shape for a distribution is given in table 3.2.

Table 3.2 Heuristic for choosing the shape of distribution.

Distribution	Use when
Uniform	– Minimum and maximum value are fixed – Knowledge lacks to decide which values in range are more plausible than others – (or) All values in range are equally plausible
Triangular	– Minimum and maximum are fixed – You can specify a most likely value in that range – Additional details on distribution are unknown
Normal	– Some value of the uncertain variable is the most likely – Uncertain variable could as likely be above mean as it could be below mean – Uncertain variable more likely to be in vicinity of the mean than far away – Physical quantities > 0, σ should be < 30%
Lognormal	– Quantity cannot be negative – Distribution is positively skewed – Uncertainty can be expressed as multiplicative order of magnitude (factor 2) – (or) Probability of obtaining extreme large values – Coefficient of variation > 30%
Custom	– You have good information or good arguments to choose a different shape

Specification of distribution
If the respondent selected a uniform distribution you do not need to elicit any further values. If the respondent selected a triangular distribution, let him estimate the mode. If he chooses another shape for the distribution (e.g. normal), you have to elicit either parameters (e.g. mean and standard deviation for normal distribution) or values for for instance the 5th, 50th, and 95th percentiles. Let the respondent briefly justify his choice of distribution if other than uniform or triangular.

Check
Verify the probability distribution constructed (e.g. on a laptop computer) against the expert's beliefs, to make sure that the distribution correctly represents those beliefs.

Discuss covariance issues
The parameters and data in emission monitoring need not be independent. Some quantities may be related through common processes and may covary with one another as a result. This is important for the Monte Carlo analysis, since if we sample one variable at one extreme of its distribution, this may require that we sample other variables from a specific part of their distribution in order to preserve the relationship between the variables. This dependency can affect the final quantitative result.

4. Uncertainty analysis

4.1 Data acquisition

The uncertainty analysis in this study is based on techniques described in chapter 6 of the IPCC report “Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories” [1].

For every source-activity combination within the clusters of the Key Source Analysis, an uncertainty profile is created, which consists of a lower value, an upper value, a code for the probability distribution function (PDF) and a comment line (explaining dependencies between sources). This is outlined in paragraph 4.3.

The experts provided uncertainty data for either the emission aggregate (EM) or the emission factor (EF) and activity rate (AR) based on their expert judgement. These data were used for the uncertainty assessment.

For some source-activity combinations no (full) expert data were provided; in these cases, the missing figures are completed with default data. This procedure is illustrated in figure 4.1.

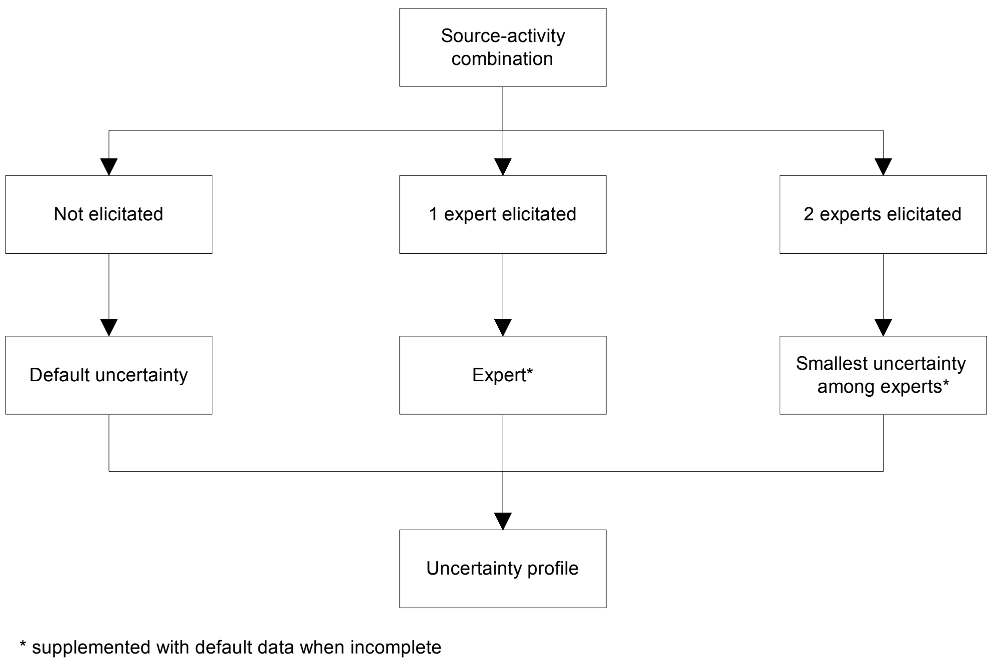

Figure 4.1 Decision diagram for uncertainty data acquisition

We are aware of the fact that the choice to use the smallest uncertainty in case of "2 experts elicitated" creates a bias towards underestimating uncertainty. This is justified by the fact that the use of default uncertainties for "not elicitated" creates a bias towards overestimation.

The choice whether to use separate uncertainties for AR and EF or the uncertainty for the emission aggregate only, is based on the availability of expert data. Whenever an expert has given a PDF for either AR or EF or both, separate uncertainties are used (from experts, and when needed these were completed with default uncertainty data). Otherwise, the PDF for the EM is used.

The default uncertainty data were based on the "Good Practice Guidance for CLRTAP Emission Inventories" – draft chapter for the ENECE Corinair Guidebook on Emission Inventories [3], which provides an uncertainty class per SNAP category (Selected Nomenclature for Air Pollution). For this purpose, every source-activity combination was linked to a SNAP category by TNO.
The uncertainties per substance per category can be found in table 4.1 and 4.2.

Table 4.1 Uncertainty classes per substance per SNAP category

Code	Main SNAP category	Uncertainty class		
		SO_2	NO_x	NH_3
1	Public power, cogeneration and district heating	A	B	n.a.
2	Commercial, institutional & residential combustion	B	C	n.a.
3	Industrial combustion	A	B	n.a.
4	Industrial processes	B	C	E
5	Extraction & distribution of fossil fuels	C	C	n.a.
6	Solvent use	n.a.	n.a.	n.a.
7	Road transport	C	C	E
8	Other mobile sources and machinery	C	D	n.a.
9	Waste treatment	B	B	n.a.
10	Agriculture activities	n.a.	D	D
11	Nature	D	D	E
-	Non key sources	C	C	C

n.a.: not applicable

The classes in table 4.1 are intended for use on emission aggregates only.
In this study, we used these uncertainty classes also for the emission factors (EF). For the activity rates (AR), we chose to use the uncertainty classes for NO_x, which is considered a worst case scenario. The reason for this arbitrary choice is the fact that for NO_x all relevant SNAP categories are covered and that the use of the uncertainty classes for SO_2 were reckoned to be too optimistic.

In table 4.2 the (derived) default 95%-uncertainty intervals per uncertainty class are given for EM, as well as for AR and EF. These intervals were used in this study for all sources where no expert PDFs could be established. For the non key sources we used the uncertainty classes for EM.

Table 4.2 Default uncertainty classes (half 95%-confidence intervals)

Class	Typical error range (from [3])	Half 95%-confidence interval (EM)*		Half 95%-confidence interval (AR and EF)*	
A	10 to 30 %	20%	(10 %)	15%	(5 %)
B	20 to 60 %	40%	(20 %)	30%	(15 %)
C	50 to 150 %	100%	(50 %)	70%	(35 %)
D	100 to 300 %	200%	(100 %)	130%	(70 %)
E	order of magnitude	1000%	(1000 %)	405%	(405 %)

* Between brackets, values used for NO_x default uncertainty in scenarios 3 and 6 (table 4.5) to emulate the assumed current Dutch knowledge on emission figures (based on measurements for major sources). These values correspond with the lowest value of the default error ranges for the calculation of the confidence intervals.

To derive the numbers in the last column of table 4.2 we used the fact that the uncertainty of the emission aggregate (EM=AR × EF) can be easily expressed in terms of the uncertainties in AR and EF, if the latter uncertainties are independent:

$$CV_{EM} = \sqrt{CV_{EF}^2 + CV_{AR}^2 + CV_{AR}^2 \cdot CV_{EF}^2} \ .$$

Here CV denotes the coefficient of variation, which is defined as the ratio $CV = \sigma / \mu$ of the spread σ and the mean μ. From this relation it can be easily deduced that - in case CV_{AR} and CV_{EF} are equal - they are equal to

$$\text{CVAR} = \text{CVEF} = \sqrt{\sqrt{(1 + CV_{EM}^2)} - 1} \ .$$

For CV_{EM} equal to 0.1, 0.2, 0.5, 1 or 5, this will lead to CV_{AR} equal to 0.07, 0.14, 0.34, 0.64, or 2.02, which refers to uncertainty intervals (2×σ) of approximately 15%, 30%, 70%, 130% and 405%, as indicated in table 4.2.

We assumed a log-normal probability distribution function for the default uncertainty, which prevents the occurrence of negative values.

4.2 Dependencies

The activity level of a source is used for the emissions for all three acidifying emissions from that source. This is for instance the case in some combustion processes. In the uncertainty analysis this is called a dependency. Furthermore, based on the expert elicitation some dependencies between different source-activity combinations were detected. In most cases these can be described as complementary dependencies. These are characterized by the fact that the sum of the activity levels from different sources is limited to a maximum. The dependencies that could be implemented within the scope of this investigation and on the level of source activity combinations are summarized in table 4.3.

Table 4.3 Dependencies implemented in the uncertainty assessment

Code	Type	Clusters	Effect on	Description
C1	Complementary	40A	AR	The total emission can be affected by shifts among paper industry, basic chemicals industry and food industry. The three categories have different emission factors.
C2	Complementary	9, 10	AR	Dependency between the AR of vans running on diesel, gasoline, gasoline with catalytic converter and LPG. Total diesel kilometres are calculated from the results of other fuels.
C3	Complementary	3, 7, 8, 9, 10, 15	AR	Dependency between the AR of diesel vehicles. Van kilometres are known (see C2), trucks with and without trailer are sampled, and the amount of kilometres by personal cars is calculated from data for the other vehicle types.
C4	Complementary	14, 15, 16, 17, 4, 6, 8	AR	Dependency between the AR of personal cars running on diesel, gasoline, gasoline with catalytic converter and LPG. Total km by gasoline cars with catalytic converter is calculated out of the other fuels.
C5	Complementary	5, 12, 13	AR	The activity of mobile machines for agriculture, building sector and other sectors is summed up to 100%.
C6	Cascade	1lb, 2lb, 3lb, 4lb, 5lb, 7lb, 8lb, 10lb	NH_3	MAM nitrogen model. The NH3 emission of animal housing systems, storage, use (and eventually grazing) sums up to 100% for each animal species.

All but one applied dependencies are complementary, which means that emissions or activities from a set of source activity combinations add up to a given amount (100%). For instance, the total of personal car kilometers is assumed to be well known, while the division over the various fuels is subject to uncertainty. In this example, the car kilometers for diesel, LPG and gasoline without catalyst have a PDF. The number of kilometers for gasoline with catalyst is the only unknown value, and is therefore calculated.
In general, the following rule is applied: C = 100% – A – B, where C is the activity with the largest absolute emission.

This is done to reduce the occurrence of unlikely values (e.g. negative kilometres) in the Monte Carlo analysis (see paragraph 4.3.2.2).

For the NH_3 emission from animal husbandry a specific dependency (cascade) had to be defined. The reason for this is the algorithm which is used to calculate NH_3 emissions in the so called MAM model. As a first step the model calculates the N-excretion per animal type based upon the national total for the N-excretion. The uncertainty of the national total is based on an earlier study [10] (95%-confidence interval of +/- 11%).
In this study we used the same methodology for the uncertainty calculation as for the Environmental Balance 2001 [11]. The excretion for each animal type is distributed over three compartments: pasture, animal housing system and manure storage. The percentage of the nitrogen which is excreted in the pasture has its own uncertainty. Using this uncertainty, the remaining N-excretion in the animal housing systems and storage is calculated. Knowing the N-excretion in the different compartments the NH_3 emission from these compartments is calculated using evaporation factors (with their respective uncertainty).

Other dependencies mentioned by the experts were not implemented, for (one of) the following reasons:
- the dependency is on a more detailed level than the source codes, for instance on the level of calculating the emission factor;
- the contribution of the subsequent sources to the absolute emission is too small;
- the dependencies cannot be quantified, because it is an indirect relation, or the relation is too complicated.

The full set of identified dependencies is included as appendix 3.

4.3 Uncertainty calculations

In this section the different parameters and settings used in the uncertainty assessment will be highlighted.

4.3.1 Tier-1 approach

A Tier-1 approach was performed for each substance per source-activity combination according to chapter 6 of the GPGAUM report [3].
The input for this calculation was either AR x EF or EM.(see paragraph 4.1). In cases where both activity rate and emission factor were available, the Tier-1 approach was also used to combine these uncertainties. The Tier-1 uncertainties for the acidification equivalents have been calculated by converting the total emissions from the individual substances to AE.

To be able to use the PDFs provided by the experts in a Tier-1 approach these had to be translated to 95%-confidence intervals (see table 4.4).

Table 4.4 Translation of expert PDF parameters to Tier 1 Uncertainty Parameters

PDF	Parameters	Tier-1 translation
Normal	Mean, standard deviation	s.d. x 4 = 95%-confidence interval.
Lognormal	Mean, standard deviation	s.d. x 4 = 95%-confidence interval.
Uniform	Lower limit Upper limit	lower limit = 2,5 percentile; upper limit = 97,5 percentile

Triangular	Lower limit
	Most likely
	Upper limit
		lower limit = 2,5 percentile;
		most likely is not taken into account;
		upper limit = 97,5 percentile;

As shown in table 4.4, all “advanced” expert information is disregarded in the Tier-1 calculations; every source-activity combination is dealt with as if it were normally distributed.
Note that we use for the Tier-1 calculations the symmetric bandwidth $\text{mean} \pm 2 \times \text{s.d.}$ around the mean as representative for the 95%-confidence interval. This bandwidth corresponds with 4 times the standard deviation.

4.3.2 Monte Carlo analysis

The actual uncertainty calculations were performed using Monte Carlo simulation using the PDF for EM or for both the PDFs of AR and EF for each source-activity combination, for each substance. The commercial Excel add-in called @RISK, version 4.5. was used.
The program iteratively samples input values (EM or AR & EF for individual source-activity combinations) according to the given distribution function(s), and creates a combined distribution function for the output (total emission of NOx, SO_2, NH_3), taking into account the defined dependencies.

4.3.2.1 Dependencies

The dependencies as described in paragraph 4.2 are applied to the model inputs. For complementary dependencies, the values with a PDF (e.g. A and B) are sampled independently by @RISK, while the remaining unknown value (e.g. as in the case that C=100-A-B) is calculated by subtracting the samples from the total emission or activity rate (which is a fixed value). A drawback of this procedure is the fact that the calculated value can be below zero. Therefore, the iterations yielding negative values were removed from the results by a filter.

4.3.2.2 Calculation settings

As a starting point, a value of 10000 iterations was set. When taking into consideration the negative values issue described above, this resulted in less than 1000 invalid iterations. Only when using default uncertainties for all source activity combinations about half the iterations were invalid
As a sampling technique, Monte Carlo was used. The default method of @RISK, Latin Hypercube, has its advantages, but was not used since removing samples by applying the filter-strategy destroys the Latin Hypercube structure, which can lead to undesirable biases.

In order to make the results reproducible a fixed random seed was used for the calculations. Each calculation run for the three substances (simultaneously) was based on one random seed.

4.3.2.3 Model outputs

The output from the model consists of:
– an estimate of the total national emissions of NO_x, SO_2 and NH_3 ;
– the corresponding uncertainty intervals.
Furthermore, for each source-activity combination, an acidification equivalent value was calculated and from these the total national acidification equivalent emission. Further, total acidification equivalents from all substances aggregated per economic sector were calculated and presented.

4.4 Robustness scenarios

In order to assess whether the extra effort put into expert elicitation and assessing dependencies is effective in getting more detailed data on the uncertainty of the acidifying emissions in the Netherlands, several robustness scenarios were calculated.

In the base scenario (scenario 1) we used the results (PDFs) as proposed from the expert elicitation (“expert” scenario). However, a part of the source-activity combinations were not provided with expert data (for instance the PDF for the EF was given but not for the AR) and had to be completed with the appropriate default uncertainty.

In the second scenario (“defaults”) we used the ETC/ACC default uncertainties for all source-activity combinations, neglecting the PDFs from the expert elicitations.

To examine the robustness of the results against this completion of the expert elicitation with default values, a third scenario was calculated. In this scenario we lowered the default uncertainties compared to the “expert” scenario (see default values in brackets in table 4.2). This was also done for scenario 6.

Furthermore we were interested in the effect of the dependencies on the uncertainty. In theory, dependencies might affect uncertainty, but it is not known how prominent this effect is on the chosen aggregation level. With dependencies switched off (scenarios 4 to 6), all related source-activity combinations were sampled independently.

The full overview of the robustness scenarios (calculation runs) is given in table 4.5. At the bottom, the Tier-1 calculations are also included.

Table 4.5 Calculation runs

Run no.	Scenario	Dependencies	Uncertainty data	Iterations
1	Base case: “Expert”	yes	Expert data*	10000
2	“Defaults”	yes	all defaults	10000
3	Lower default for NOx	yes	Expert data*	10000
4	“Expert”, no dependencies	no	Expert data*	10000
5	“Defaults”, no dependencies	no	all defaults	10000
6	No dependencies, lower default for NO_x	no	expert data*	10000
7	Tier-1	-	expert data*	-
8	Tier-1	-	all defaults	-

* Where available

4.5 Calculation spreadsheet

For the calculations a set of spreadsheets was developed in which:
- the choice between expert data and default ETC/ACC data is made possible;
- the Monte Carlo calculations are carried out using the @RISK Excel add-in.

In the first spreadsheet the user can choose whether to use expert data or defaults, and the level for the defaults (e.g. run 3 and 6). The second spreadsheet contains the PDFs that are used as an input for @RISK, and contains the dependencies. The implicit dependency between the emissions of NO_x, SO_2 and NH_3 for the same activity was implemented by using the same activity rate sample for all the three substances.
The dependencies described in paragraph 4.2 are applied in the spreadsheet, rather than in the @RISK Monte Carlo model. All complementary items but one are sampled by @RISK, and the latter one is calculated. The @RISK add-in monitors the output of the calculated items and filters out the iterations yielding negative results.

The set of spreadsheet files were made available to the RIVM.

5. Results

5.1 Key source analysis

The key source analysis results in a list of clusters containing the source-activity combinations that make up for 95% of the total acidification equivalent emissions and 95% of the trend in the period 1990 to 2000. The list of key sources is included as appendix 1. Please note that the results were ranked according to the total emission from the cluster which includes one or more key sources. Furthermore the ranking of the individual sources per cluster in the level- and trend- analysis is indicated.

5.2 Expert elicitation

Five experts were interviewed for the expert elicitation (see table 5.1) in October and November 2002. The experts were selected based on their expertise and chosen in such a way that their joint expertise covered the source-activity combinations that resulted from the key-source analysis.

Table 5.1 Experts interviewed for this study. (See appendix 1 for cluster codes).

Expert (institute)	Domain of expertise	Clusters elicited*
E. Zonneveld (CBS)	ERI, SBI, Annual reports, NEH	23201, 40A, 3.3A, 1A, 3.4A, 241B
J. Klein (CBS)	Road traffic data	1, 2, 3.3A, 11
K. van der Hoek (RIVM)	NH_3 emissions from agriculture	2lb, 4lb, 3lb, 5lb, 6lb, 7lb, 8lb, 10lb
J. Hulskotte (TNO/MEP)	Ocean ships and inland shipping, Emission factors NO_x	3, 1, 4, 5, 6, 7, 8, 9,10, 13
D. Heslinga (TNO/MEP)	Industry, refineries, energy sector, waste treatment	23201,40K, 40A, 3.4A, 241B, 241A, 26A, 2415

* The clusters are listed in the order in which they were discussed in the elicitation

For each cluster of source-activity combinations (see 2.3.1) a score-card was made. The upper half of each card summarized the information from the key source analysis for the source-activity combinations grouped in that cluster. The lower half of the card contained a fill out table for the pedigree scores, the quantification of the uncertainties (minimum and maximum of the uncertainty range, shape of the distribution, further specifications of the distribution) and the eventual dependencies with other source-activity combinations. There was also space to write down the arguments for the pedigree scores and choices for the distribution shape and parameters. The clustering structured and streamlined the elicitation process because

source-activity combinations which were similar or which stemmed from the same knowledge base were grouped together, making the pedigree analysis easier (in many cases a group of source activity combinations in a cluster could be given the same pedigree scores).
The expert was free to choose between specifying the uncertainty of the emission aggregate or of the activity data and emission factor(s) for each given source-activity combination, depending on what he felt was most convenient. The cards were discussed and filled one by one. For each card the steps outlined in section 3 were followed. Each interview took about four hours. All cards were filled out by the interviewer (J. van der Sluijs) with the exception of the PDF specifications for NH_3 emissions from agriculture. These were filled out by K. van der Hoek in a spreadsheet after the interview because he wanted to be sure that these were consistent with the PDFs he had provided for an other study.

The elicitation yielded results for 31 clusters, covering together about 160 source-activity combinations (including non key sources). For some source-activity combinations PDFs and pedigree scores were elicited only for activity data or only for emission factors. The full results of the elicitation of pedigree scores and PDFs are listed in Appendix 2. In addition, about 20 qualitative descriptions of dependencies were identified during the elicitation. These are listed in Appendix 3.

If we average all pedigree scores, the overall data quality turns out to be medium for proxy (2.4), empirical (2.3), and method (2.5) and poor for validation (1.2).

Table 5.2 provides an aggregated overview of pedigree scores for different data types in the emission monitoring.

Table 5.2 Average pedigree scores (see table 3.2) for different data types. Between brackets the standard deviation. Colour coding: <1.4 red, 1.4-2.6 amber; >2.6 green (traffic light analogy)

	Proxy	**Empirical**	**Method**	**Validation**
Activity Data	2.7 (0.5)	2.4 (0.7)	2.6 (0.6)	1 (0.9)
Em. Factor NO_x	2.2 (1.1)	2.1 (0.6)	2.5 (0.8)	1.4 (1.3)
Em. Factor SO_2	2.6 (1.4)	2.3 (0.9)	1.7 (0.7)	1.1 (1.2)
Em. Aggregate NO_x	2.3 (0.6)	2.6 (0.9)	2.5 (0.6)	0.6 (0.7)
Em. Aggregate NH_3	2.7 (0.7)	1.4 (0.6)	2.3 (0.5)	2 (0)

It shows that validation scores poor for all data types. The table further shows that in general the knowledge base for activity data is stronger then the knowledge base for emission factors. In some areas there are weak spots. The data from individual registered firms may contain errors, especially regarding the data of smaller firms. Validation of Environmental Annual Reports of firms is limited. For a number of activities, indirect measures (proxies) are used for activity data. For instance gas-use in agriculture is partly derived from agricultural production figures or areas of agricultural lands. Fuel of inland waterway shipping is derived from shipping kilometres. Fuel use of sea ships is not measured directly but is derived from tons of goods transhipped in Rotterdam and Antwerp. The latter is an imperfect proxy because it does not account for shifts in categories of ships. A factor of 2 in emissions per ton transhipped is conceivable between different ship categories.

In general, emission factors of NO_x are partly based on assumptions and model calculations, whereas emission factors of SO_2 are determined more directly. SO_2 emission factors only depend on the fuel type, whereas NO_x emission factors depend also on combustion conditions and equipment. This is compensated for by the fact that more effort has been put in obtaining good measurements of NO_x emission factors. Sulphur content in coal is not regularly measured, while the composition of coal varies over time because of the dynamics of the coal market. Sulphur content in rest-gasses and bio-gasses from industry is poorly known and not all rest-gasses are being reported.
As regards NH_3 emissions from cattle farming, the knowledge base of NH_3 emission factors is quite weak for grazing ('beweiding'). It is based on a few point measurements that might not be representative and variation in soil types is not accounted for. The knowledge base for NH_3 emissions from animal housing systems is poor for a number of cattle types (‘jongvee fokkerij, melkkoeien, fokvarkens and vleeskalveren’)[1] because in these cases only one type of animal housing system has been measured whereas there is quite some variation in animal housing system types. The knowledge base is fair for animal housing systems of other types of cattle (‘vleesvarkens, leghennen, vleesvee, vleeskuikens’)[2] because more measurements were done or less variation in animal housing system types exists. The knowledge base regarding NH_3 emission factors from application of chicken manure, breeding pigs manure and synthetic fertilizer is weak because little or none reliable measurements are available. In cases where there are measurements (e.g. application of cow manure), it is questionable whether farmers in practice work as accurate as during the field experiments.

In a number of areas we identified uncertainty associated with the resolution of categorizations and with attribution-assumptions. In the traffic sector, the distinction in the statistics between heavy and light vehicles may need refinement to improve accuracy of emission calculations. Also, a difference was observed between vehicle counting with loops in the road outside the built-up area and results from questionnaires for heavy truck traffic. Here it should be noted that vehicle length (measured by the road loops) is not a perfect indicator for heavy truck traffic. Finally, the distribution of car kilometres over different road categories used in the emission calculations is partially based on assumptions, and the NO_x emissions are sensitive to these assumptions.
In sea ships, the patterns of switching between heavy and light fuels when ships enter the inland waterways (especially the Wester Schelde) is poorly known whereas

1 (young breeding cattle, dairy cattle, breeding pigs, calves)
2 (meat pigs, laying hens, meat cattle, chickens)

these fuels differ significantly in sulphur content. The assumptions presently used are based on old, outdated interviews that have never been updated.
For some small categories there are data problems. The number of car kilometres of old cars without catalytic converter is poorly known because this type of car is poorly represented in the used 'passenger car panel'. Regarding ship traffic on inland waterways, data are missing on towing services and ferries. For this category old (1994) data are used as a first approximation.

Averaging the pedigree scores for each quantity yields an aggregate measure for data strength (see *strength* column in appendix 2). A closer inspection of these results shows that 31% of the (number of) quantities elicited have a good strength (>2.6), 53% have a medium strength (1.4-2.6) and 16% has a poor strength (<1.4). The quantities with good strength belong to source-activity combinations that together cover 27% of the emissions (acidification equivalents).The ones with medium strength cover 68% and the poor strength scores cover about 3% of the emissions (acidification equivalents). Note that this measure is imperfect because not all PDFs for each source-activity combination were elicited: for some either activity data or emission factor is missing.

5.3 Uncertainty analysis

5.3.1 Tier-1

Table 5.3 shows the confidence intervals resulting from the Tier-1 analysis for each of the substances and acidification equivalents (AE). In totalising towards AE it is assumed that the emission uncertainties of the individual substances are mutually independent.

Table 5.3 Uncertainty intervals calculated with Tier-1

Substance	Tier-1			
	Emission level		Half 95% confidence intervals	
	(kton)	(AE)	based on expert data	based on defaults
NO_x	429	9323	14%	24%
SO_2	91	2860	6%	35%
NH_3	152	8951	12%	52%
AE (mln AE)		21134	8%	25%

These figures will be compared to the results of the Monte Carlo analysis in paragraph 5.3.2.

5.3.2 Monte Carlo analysis

By sampling each individual source-activity combination along with the respective probability distribution function, the probability distribution of the total emission was calculated. The most important source-activity combinations are included in appendix 4.

Figure 5.1 up to 5.4 show the resulting distributions for the total NO_x, SO_2, NH_3 and AE (acidification equivalents) emission in the Netherlands, for the base scenario.

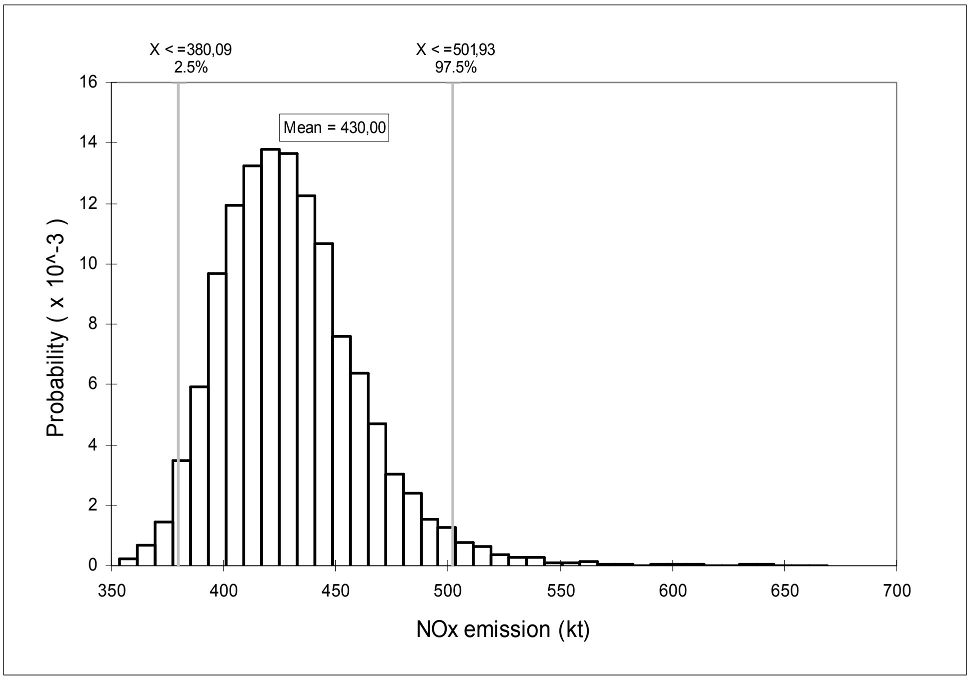

Figure 5.1 Probability distribution of total NO_x emission

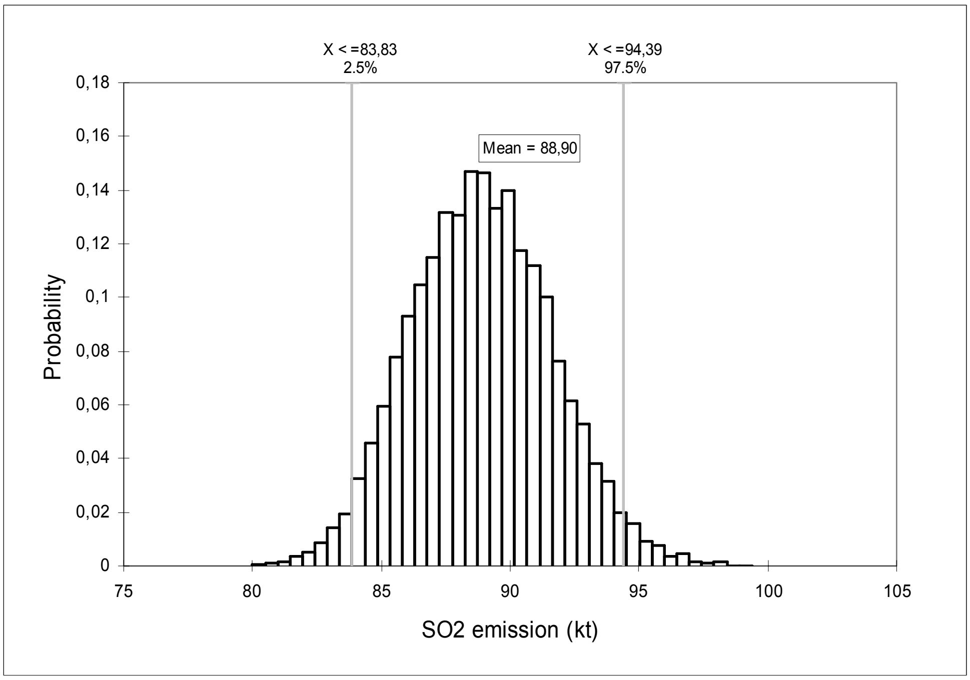

Figure 5.2 Probability distribution of total SO_2 emission

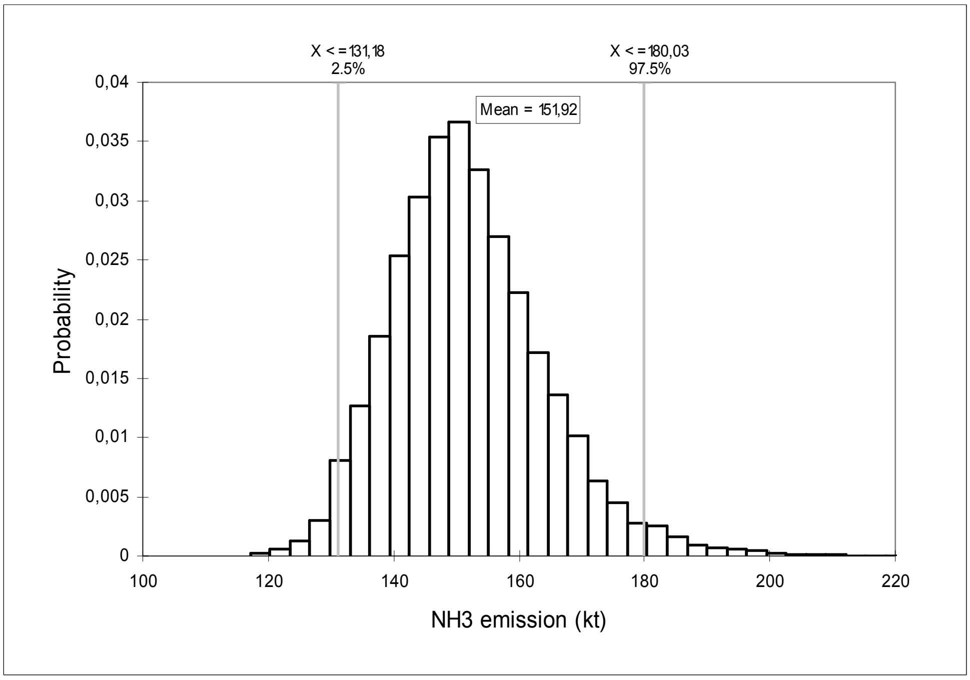

Figure 5.3 Probability distribution of total NH_3

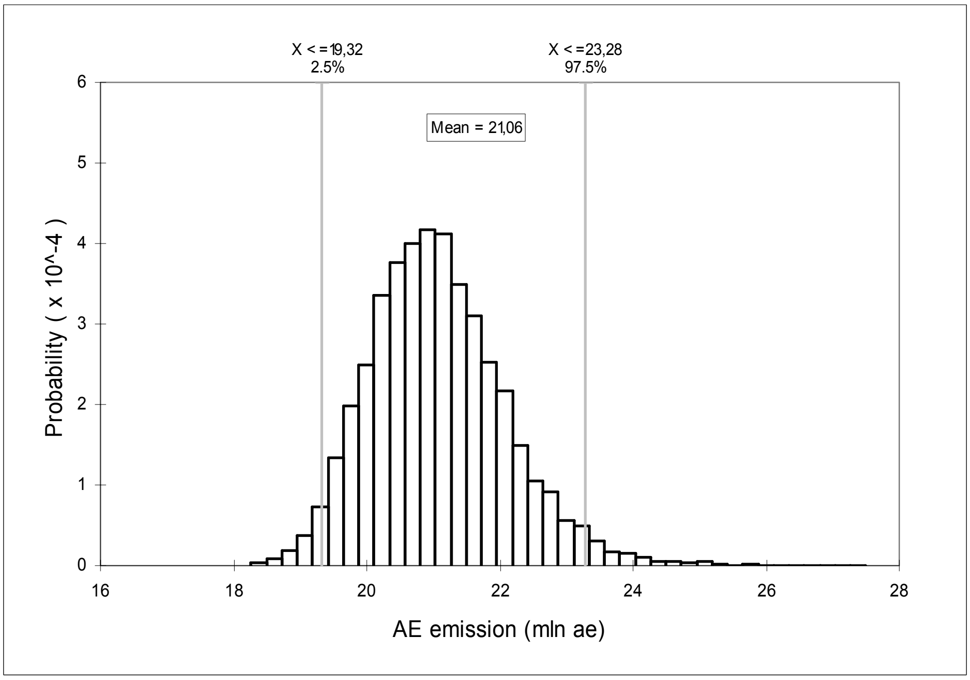

Figure 5.4 Probability distribution of total AE emission

The statistical data are summarized in the box plots of figure 5.5 – 5.8. The data for each substance are displayed in acidification equivalents. The line in the middle of the box denotes the median, and the top and bottom of the box indicate the first and third quartile thus indicating the asymmetry of the PDF. The vertical upper and lower line mark the 2.5% and the 97.5% point, thus confining the 95%-confidence interval.

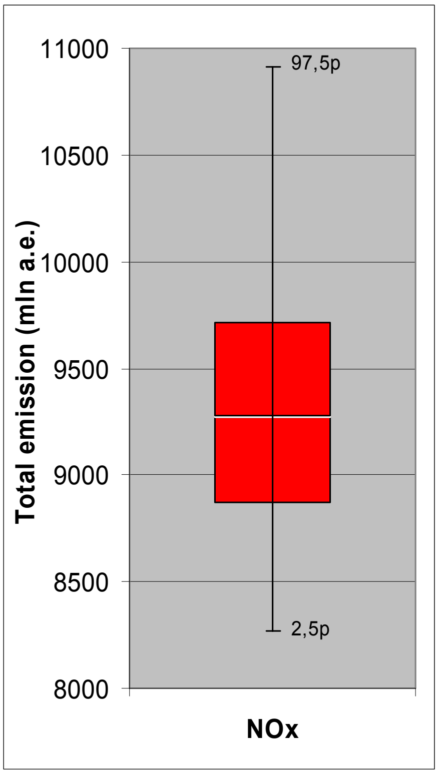

Figure 5.5 Box plot NO_x

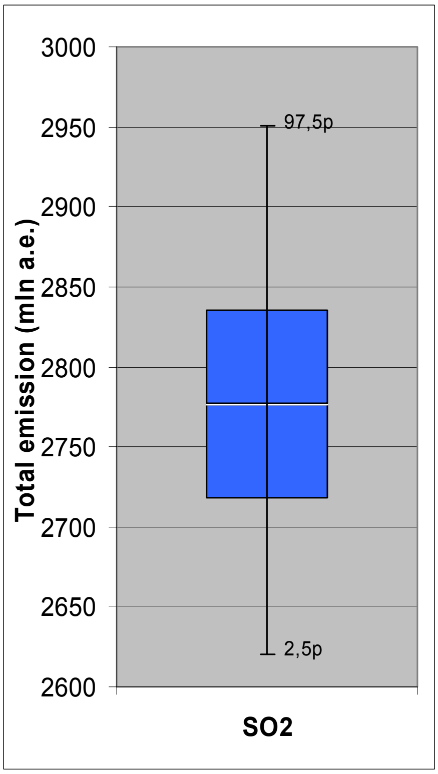

Figure 5.6 Box plot SO_2

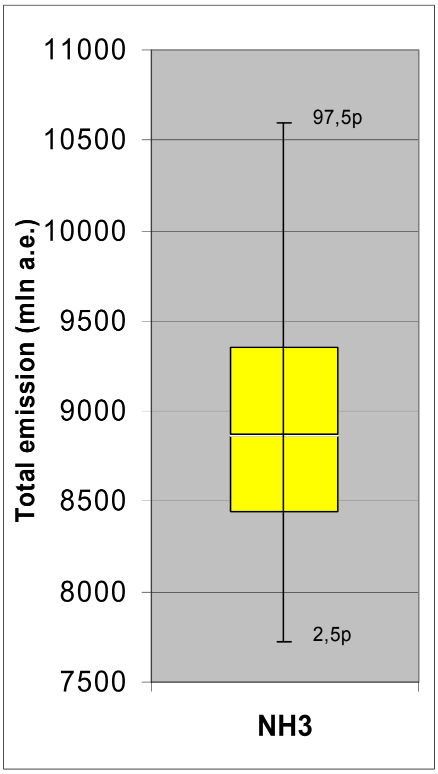

Figure 5.7 Box plot NH_3

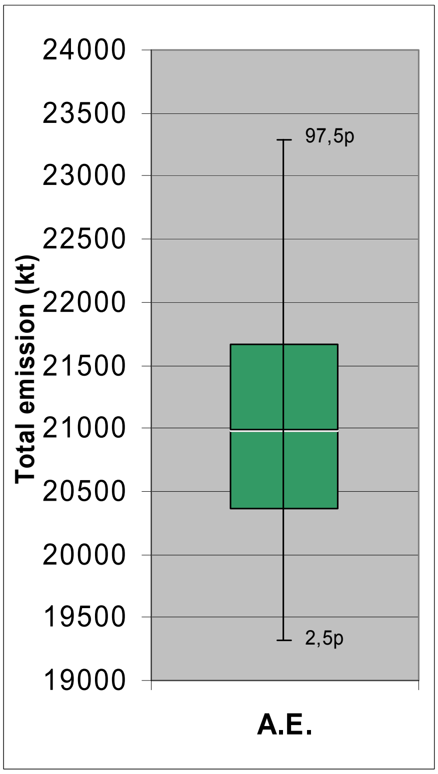

Figure 5.8 Box plot AE

A combination of figure 5.5 to 5.7 is given in figure 5.9 to illustrate the relative contribution of the different compounds to the total AE emissions.

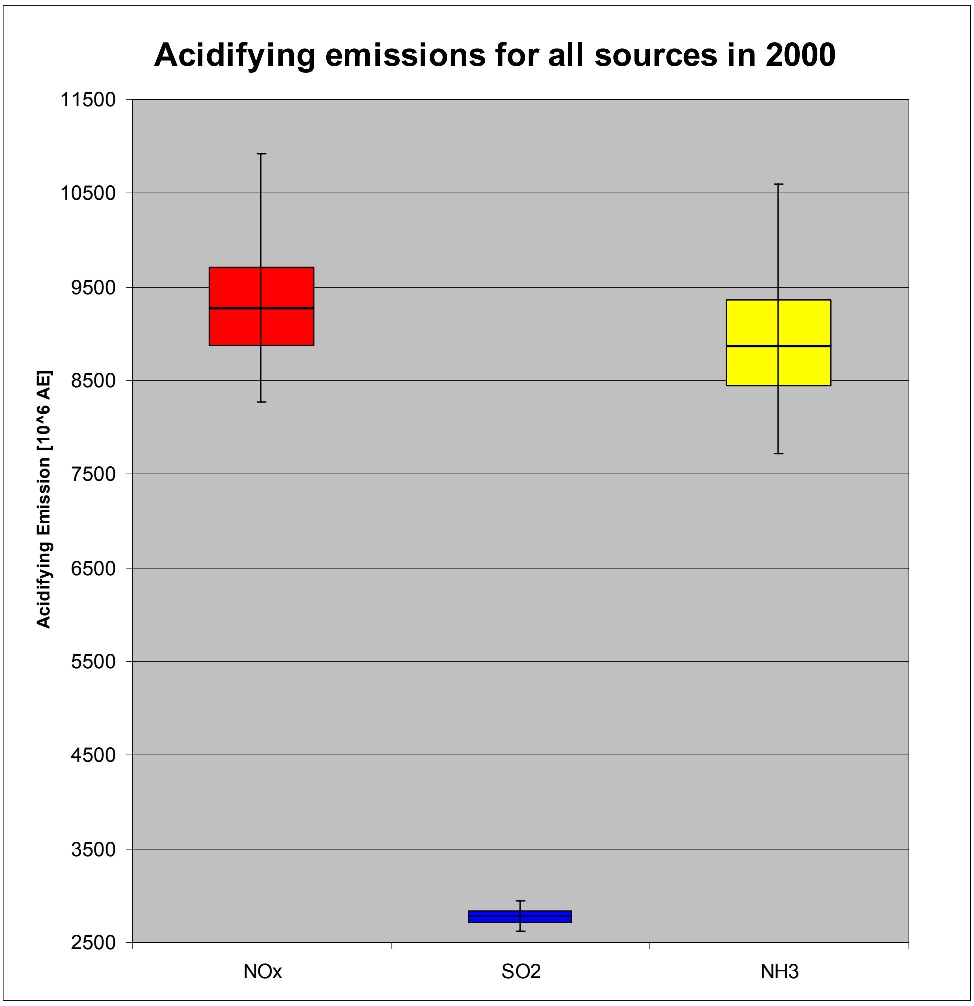

Figure 5.9 Combined Box plots

The key figures from the above mentioned graphical presentations for the base scenario are given in table 5.4, where the lower and upper bounds of the 95%-uncertainty interval are expressed relative to the median value. Please note that these results and the figure 5.1-5.8 illustrate some skewness of the resulting probability distributions.

Table 5.4 Key figures of base scenario

	NO_x	SO_2	NH_3		A.E.	
Mean	430,0	88,90	151,9	ktonnes	21,06	x 10^9
Median	426,7	88,86	150,7	ktonnes	20,99	x 10^9
95%-uncertainty interval: left	-10,9%	-5,7%	-13,0%		-7,9%	
95%-uncertainty interval: right	17,6%	6,2%	19,4%		10,9%	

The uncertainty in acidification equivalent is calculated by @RISK from the uncertainties of the emissions of the three substances.

Rank correlation analysis (C-square) indicates that NH_3, NO_x and SO_2, contribute 51.5%, 46.4% and 2.1% respectively to the AE uncertainty.

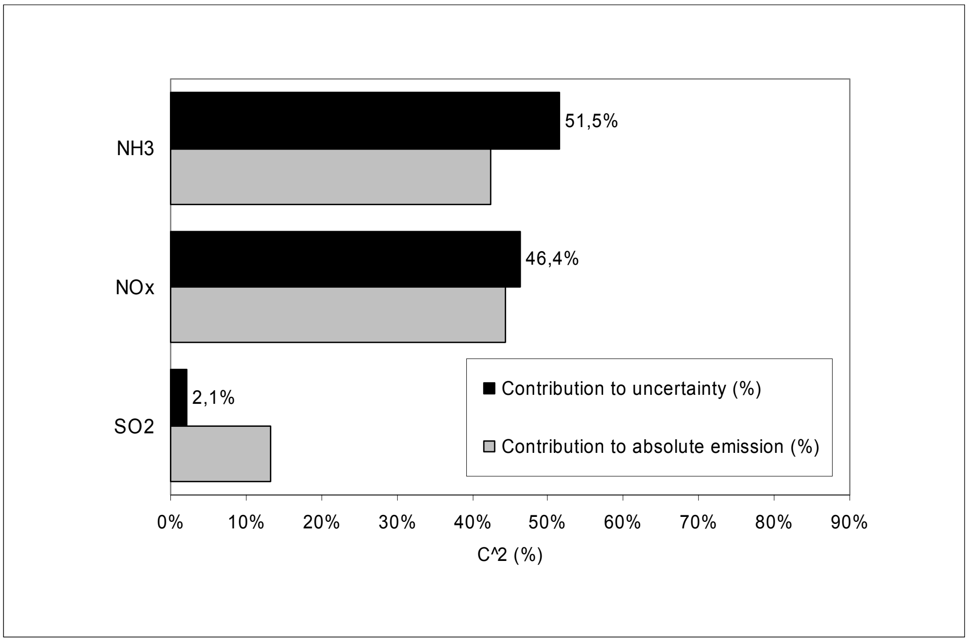

Figure 5.10 Correlation sensitivity of total emission of acidification equivalents: contribution of the substances

Furthermore a rank correlation analysis of individual source-activity combinations to the total AE emission was performed. In figure 5.11 the ten largest contributors to the uncertainty of the AE emission are displayed, as measured in terms of the correlation coefficients. Though this simple measure has its shortcomings as measure of uncertainty contribution (especially in case of strong non-linearities and dependencies) it gives a first indication of the impact that uncertainties in the various source-activities have on the uncertainty in the total emission.

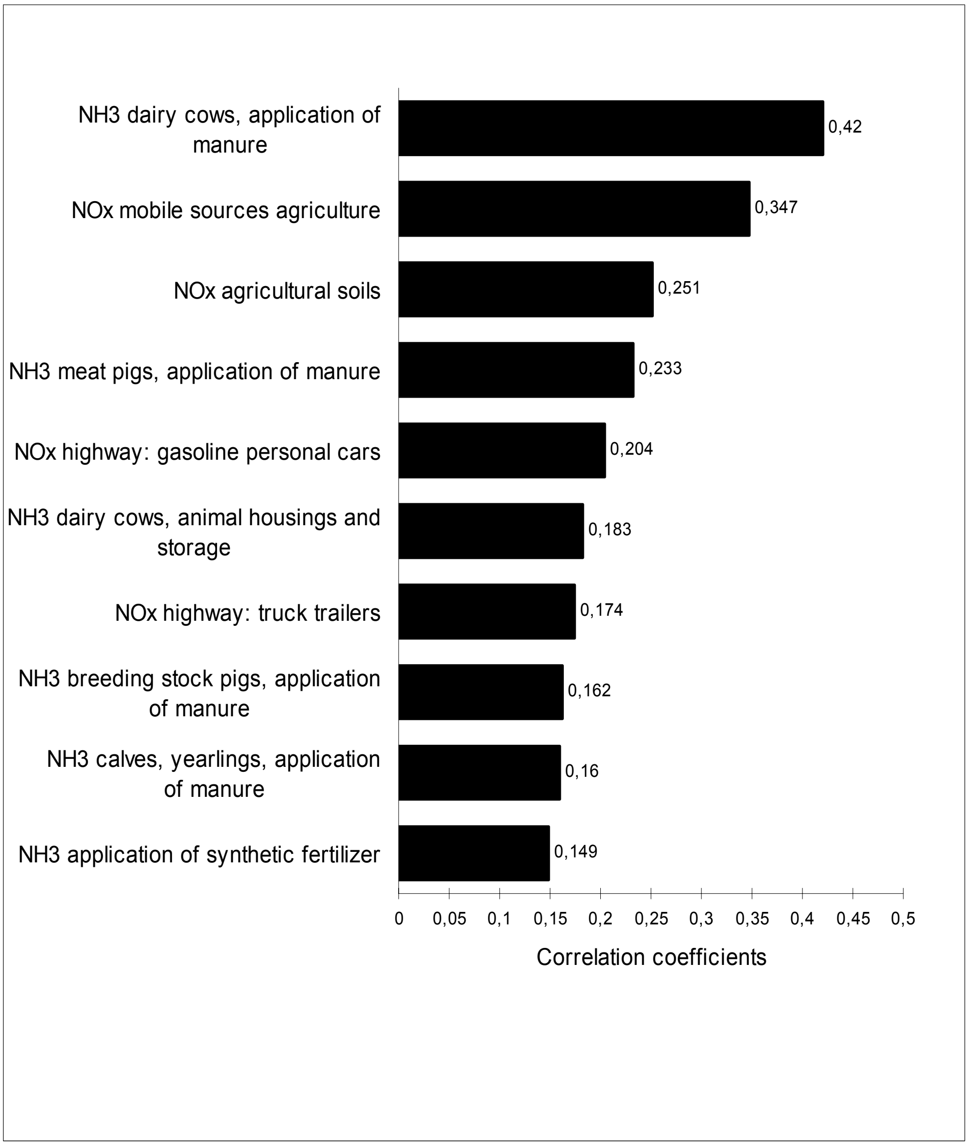

Figure 5.11 Relative contribution of individual source-activity combinations to the uncertainty in national total emission of acidification equivalents

Table 5.5 presents the largest contributors to the uncertainty for each of the individual substances. Note the consistency with figure 5.11; large contributors to one or more of the substances reappear in the uncertainty of the acidification equivalents.

A closer look at the correlation analysis of the individual substances points out that all but one contributors in figure 5.11 are based on expert data. Only “Agricultural Soils” (no. 3) was not included in the expert elicitation. However not all PDFs were provided by the experts. For the agricultural NH_3 emissions only the PDF for the emission aggregate was available initially (but PDFs for emission factors were supplied when the cascade dependency was implemented).

For the emissions from transport, the experts could only give the PDFs for the activity rate.

Table 5.5 Main contributors to the uncertainty of total NO_x, SO_2 and NH_3 emissions, as measured by correlation coefficients

rank	NO_x	C
1	Mobile sources agriculture	0,52
2	Agricultural soils	0,36
3	Highway: personal cars / vans	0,32
4	Highway: truck trailers	0,25
5	Other mobile sources	0,18
6	Highway: trucks	0,17
7	Mobile sources in building industry	0,17
8	Electricity distribution, combustion emissions	0,15
9	Country roads: trucks	0,13
10	Roads in towns: diesel personal cars	0,12
rank	**SO_2**	**C**
1	Crude oil refineries, combustion emissions	0,57
2	Sea ships, combustion emissions	0,48
3	Mobile sources in agriculture	0,40
4	Iron and steel production and processing, combustion emissions	0,27
5	Non-ferrous metals production, process emissions	0,24
6	Electricity distribution, combustion emissions from individual firms	0,23
7	Docked and anchored ships	0,17
8	WWTP emissions combustion	0,16
9	Production basic chemicals, combustion emissions	0,13
10	Electricity distribution, combustion emissions	0,12
rank	**NH_3**	**C**
1	Dairy cows, application of manure	0,58
2	Meat pigs, application of manure	0,32
3	Dairy cows, animal housings and storage	0,25
4	Application of synthetic fertilizer	0,22
5	Calves/yearlings, application of manure	0,22
6	Pigs breeding stock, application of manure	0,21
7	Transpiration and respiration	0,18
8	Meat pigs, animal housings and storage	0,17
9	Meat cattle, application of manure	0,15
10	Laying-hens, application of manure	0,14

5.3.3 Robustness of the methodological approach

As explained in chapter 2, the robustness of the results to several choices was assessed in this study. Four items were varied:
1. the use of expert data, compared with the use of default values only
2. the level of the default uncertainties for NO_x
3. the implementation of dependencies between source-activity combinations

Table 5.6 once more shows the calculation runs. The Tier-1 analysis scenarios are added as run 7 and 8.

Table 5.6 Calculation runs

Run no.	Uncertainty data	Valid Iterations	Dependencies	Reduced defaults for NO_x
1	expert data*	9299	yes	no
2	all defaults	4879	yes	no
3	expert data*	9984	yes	yes
4	expert data*	10000	no	no
5	all defaults	10000	no	no
6	expert data*	10000	no	yes
7	expert data	- (Tier-1)	no	no
8	all defaults	- (Tier-1)	no	no

* where available

Table 5.7 lists the mean values and standard deviations calculated for the total NO_x, SO_2 and NH_3 emissions for each scenario; moreover, the figures for acidification equivalents are included.

Table 5.7 Statistical results for all scenarios (in 10^6 AE)

Run no.	Mean value of the emission				Standard deviation			
	μ NO_x	μ SO_2	μ NH_3	μ total AE	σ NO_x	σ SO_2	σ NH_3	σ Total AE
1	9348	2778	8936	**21063**	688	85	727	**1010**
2	9330	2860	8955	**21144**	1091	506	2138	**2478**
3	9315	2777	8940	**21033**	373	84	782	**873**
4	9223	2777	8939	**20939**	645	84	770	**1006**
5	9312	2854	8914	**21080**	1157	496	2478	**2806**
6	9222	2777	8939	**20938**	353	84	770	**850**

The square of the standard deviation for AE almost equals the sum of the squared standard deviations for the individual compounds. This is an indication for the independency of the uncertainties in the National emission estimates for the different compounds.

Table 5.8 shows the relative standard deviations and half 95%-confidence intervals for the different scenarios.

Table 5.8 Statistic results for all scenarios (in %)

Run no.	Relative standard deviation				Half 95% confidence interval			
	σ NO_x	σ SO_2	σ NH_3	σ total AE	NO_x	SO_2	NH_3	Total AE
1	7.4%	3.1%	8.1%	**4.8%**	15%	6.1%	17%	**9.8%**
2	12%	18%	24%	**12%**	25%	39%	55%	**25%**
3	4.0%	3.0%	8.8%	**4.2%**	8.1%	6.1%	17%	**8.0%**
4	7.0%	3.0%	8.6%	**4.8%**	14%	6.1%	17%	**9.4%**
5	12%	17%	28%	**13%**	26%	39%	61%	**27%**
6	4.0%	3.0%	8.6%	**4.1%**	7.8%	6.1%	17%	**8.0%**
7	7.0%	3.1%	6.2%	**4%**	14%	6.1%	12%	**8%**
8	12%	18%	26%	**13%**	24%	35%	52%	**25%**

Interpretations:

1. **The use of expert data, compared to the use of default values only**
   (run 1 <> run 2; run 4<>5))
   The use of expert data reduces the standard deviation by a factor 1.6 for NO_x, 6 for SO_2 and 3 for NH_3 . For acidification equivalents this results in a reduction by a factor 2.5.

2. **The level of the default uncertainties for NO_x**
   (run 1 <> run 3; run 4 <> run 6)
   By reducing the default uncertainties for NO_x the s.d. decreases by a factor 1.8.

   Due to the Dutch abatement policy for NO_x , the emission factors in the Dutch emission inventory for the major stationary NO_x sources are to a large extent based on measurements. The use of the lowered default uncertainty is justified because the defaults from the ETC/ACC Good Practice Guidance for CLRTAP Emission Inventories [3] are only rough estimates (to a lesser extent based on measurements) . The result of the calculation run 3 (based on reduced NOx default uncertainties) is therefore assumed to be more representative for the Dutch situation than the base scenario.

3. **The implementation of dependencies between source-activity combinations**
   (run 1 <> run 4; run 3 <>run 6)
   The implementation of complementary dependencies in the calculations does not affect the standard deviation to a large extent.
   During the implementation of the dependencies for the agricultural NH_3 emissions in the calculations it became clear that errors in the dependencies structure may lead to underestimation of the uncertainties. Therefore the implementation of dependencies does require an in-depth analysis of the calculation method and interpretation of all parameters and related uncertainties.

4. **The use of Monte Carlo analysis versus Tier-1**
   (run 4 <> run 7; run 5 <> run 8)
   The effect of using Monte Carlo analysis rather than the simpler Tier-1 is marginal for NO_x and SO_2. However for NH_3 the confidence interval is increased by a factor 1.4 compared to Tier-1 if we use the expert data.

   The NH_3 emission from agriculture per RAPCODE in the Dutch inventory does not follow the generic rule of emission factor multiplied by activity rate. The emissions are calculated using a more complex algorithm using national N-excretion figures per animal type, which are allocated to the different sources of emission (pasture, application of manure, animal housing system and manure storage), each having different N- evaporating rates.
   In the Monte Carlo analysis the uncertainties in all three variables (including those with lognormal distributions) can be taken into account (cascade dependency). In the Tier-1 analysis only the uncertainty of the emission aggregate was used (normal distribution).

Diagnostic diagrams

With the results from the pedigree analysis and the Monte Carlo sensitivity analysis we have mapped two independent properties of uncertainties in the inputs of the emission monitoring of acidifying substances. The rank correlations from the Monte Carlo assessment express the sensitivity to inexactness in input data whereas strength (measured by averaged pedigree scores) expresses the quality of the underlying knowledge base of these data, in view of its empirical and methodological limitations. The two metrics can be combined in a so-called Diagnostic Diagram [9] mapping strength and sensitivity of key uncertain inputs. The Diagnostic Diagram is based on the notion that neither sensitivity alone nor strength alone is a sufficient measure for quality. Robustness of monitoring output to strength of the inputs could be good even if strength is low, provided that the uncertainty range in that input does not critically influence the outcome. In this situation our ignorance of the true value of that input has no immediate consequences because it has a negligible effect on the output. Alternatively, the output can be robust against spread in certain input data even if its relative contribution to the total spread in model is high provided that the strength of the knowledge base where it stems from is also high. In the latter case, the uncertainty in the outcome adequately reflects the inherent irreducible uncertainty in the emissions monitored. Uncertainty then is a property of the (best available practice) way in which monitoring takes place and does not stem from imperfect knowledge on the inputs used. Mapping the input data in a diagnostic diagram thus reveals the weakest critical links in the knowledge base of the emission monitoring system with respect to the overall emissions, and helps in the setting of priorities for improvement of the monitoring.

In figures 5.12 *a* through *d* we have plotted the squared rank correlations found with the Monte Carlo assessment against the averaged pedigree scores (as a metric for strength of the input) found in the expert elicitation interviews. This has been done for each of the inputs listed in figure 5.11 and table 5.5. We used the strength scores for the emission aggregates. Where pedigree scores were specified for activity data and emission factors, we determined the strength of the emission aggregate using the weakest link rule: when two quantities are multiplied, the pedigree score of the result equals the lowest pedigree score of the two quantities [12].
Some inputs were not included in the expert elicitation or pedigree scores were elicited for either only the activity data or only the emission factor. In these cases we searched among the inputs for similar quantities for which we did have results (e.g. NO_x emission factors of similar processes) and then assumed worst-case by using the lowest strength score of range of scores obtained for similar quantities.

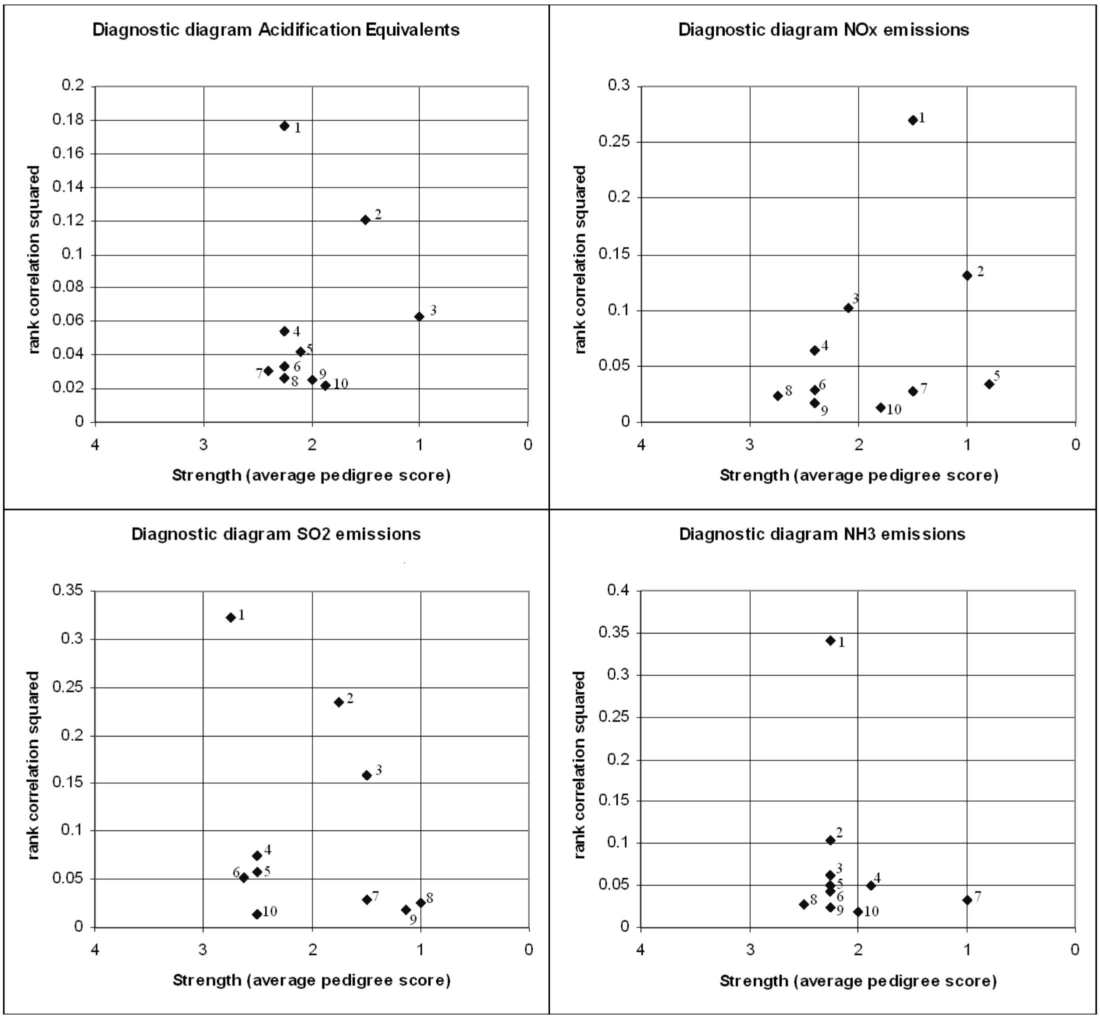

Figure 5.12 Diagnostic diagram for the 10 most sensitive source-activity combinations for total emission of acidification equivalents (a); for total NO_x emission (b), for total SO_2 emission (c) and for total NH_3 emission (d). The numbers in the diagrams correspond to the rank number of the source-activity combinations as given in figure 5.11 (a) respectively table 5.5 (b-d).

Looking at the diagram for the overall acidification emissions (fig 5.11a), the most problematic (that is: high contribution to overall uncertainty combined with a weak knowledge base, so the priority is from the top right corner to the bottom left corner of the diagram) source-activity combinations turn out to be "NH3 dairy cows, application of manure" (1), "NOx mobile sources agriculture" (2) and "NOx agricultural soils" (3). For the NO_x emission figures, the most problematic source-activity combinations are "Mobile sources agriculture" (1), "Agricultural soils" (2), "Other mobile sources" (5), "Highway: passenger cars / vans" (3) and "Mobile sources building industry" (7). For the SO_2 emission the most problematic source-activity combinations are "Sea vessels, combustion emissions" (2), "Crude oil refineries, combustion emissions" (1), "Mobile sources agriculture" (3), "WWTP emissions combustion" (8), "Production basic chemicals, combustion emissions" (9) and "Docked ships" (7). Finally for the NH_3 emission the most problematic source-activity combinations are: "Dairy cows, application of manure" (1), “Transpiration and respiration” (7) and “Meat pigs, application of manure” (2).

6. Conclusions and recommendations

Monte Carlo analysis is a more flexible way to quantify overall acidification uncertainties, because it allows for the use of specific non normal PDFs and the implementation of dependencies within the data. However, carrying out a complete Monte Carlo analysis, including the incorporation of dependencies, is more time-consuming than a Tier-1.

Table 6.1 shows the 95% confidence intervals according to the Monte Carlo analysis, compared to the Tier-1 in this study and an earlier Tier-1 study by the RIVM [9]. The figures are formatted as half 95% confidence intervals (NO_x = 430 kton +/- 14%).

Table 6.1 Uncertainty intervals

	Monte Carlo			Tier-1	
	Mean	**Standard deviation**	**half 95% confidence interval**	**half 95% confidence interval (This study)**	**half 95% confidence interval (RIVM)**
NO_x (kton)	430	31.7	15%	14%	11%
SO_2 (kton)	88.9	2.72	6.1%	6.1%	8%
NH_3 (kton)	152	12.4	17%	12%	17%
AE (10^9)	21.1	1.01	9.8%	8.0%	9%

The results from the Monte Carlo analysis do not differ significantly from the Tier-1 in this study, except for NH_3. This is due to the non-normal PDFs of some of the NH_3 agricultural key sources and their large uncertainties which can't be taken into account in the Tier-1 analysis.

The differences between the Monte Carlo analysis and the Tier-1 from the RIVM study are caused by differences in the uncertainties for the source activity combinations used in the two studies. In the Monte Carlo analysis expert data were used at the lowest possible level from the Dutch emission inventory for the year 2000. In the Tier-1 the RIVM used aggregations of source activity combinations for the year 1998. For NH_3 there is no difference between the Monte Carlo and the Tier-1 analysis because the RIVM used the same detailed uncertainty assessment for the agricultural sources in their Tier-1 approach.

The differences between the Tier-1 in this study and the former RIVM study are due to differences in the expert elicitations. In this study we interviewed the experts from different institutions involved in the annual emission inventory, in the RIVM study only RIVM experts (which are not all directly involved in the compilation of the emission inventory) were interviewed. Furthermore the elicitation was performed using different levels of aggregation when determining the PDFs. In the current study the most detailed source-activity combinations from the Dutch Emission inventory were used.

Correlation analysis shows that only a few source-activity combinations are responsible for the larger part of the uncertainty of NO_x, SO_2 and NH_3. When combined into acidification equivalents, we can conclude that one of the 10 largest contributors (NO_x from agricultural soils) depend on default uncertainties. For the other main contributors; NH_3 from agricultural sources and NO_x emissions from transport sources, expert data could be used for either the emission aggregate or the activity rate.

For NO_x 78% of the absolute emission was covered by expert data[1]; for SO_x and NH_3 this was about 81 and 94 %. The use of expert data substantially decreases the uncertainty, due to the fact that the uncertainty intervals as provided by the experts are small in comparison with the defaults given in the GPG CLRTAP report [3]. This was also illustrated in the scenario were we used reduced defaults for NO_x emulating the current situation in the Netherlands (NO_x emission factors based on measurements).

It is therefore recommended that the taskforces critically review the default uncertainties which were used in this study, as well as the coupling with SNAP categories. Furthermore the expert elicitation could be extended to cover all Key sources, even when an overestimation would be the result.

The standard deviation as calculated in the Monte Carlo analysis is increased for NH_3, compared to the Tier-1 analysis. The main reason for this is the fact that the emissions of NH_3 from agriculture (as reported per RAPCODE) are calculated using an elaborate algorithm with several parameters with different uncertainties and non-normal PDF. This as opposed to the emission calculations for the other substances, which in most cases follow the general rule: emission = AR * EF.

The introduction of the complementary dependencies had no significant effect on the outcome of the uncertainty analysis.

The main advance of Monte Carlo analysis (based on expert elicitation) compared to a Tier-1 approach lies in the possibility to introduce dependencies between sources, and the use of other than normal distributions. Experience from this study shows that the definition of the dependencies is very crucial for getting reliable results. Especially for those emission data which are calculated using an elaborate algorithm.

1 These figures include the sources-activity combinations for which only one PDF was provided either for AR or EF.

By combining the Monte Carlo sensitivity results with averaged scores for pedigree of source activity combinations we were able to identified the most problematic (that is: high contribution to overall uncertainty combined with weak knowledge base) source activity combinations.

There were not enough resources to include all source-activity combinations in the elicitation interviews. In this project, the key source analysis was used to determine the priority of source-activity combinations for which uncertainties and pedigree scores were elicited. Only after the Monte Carlo assessment it turned out that uncertainty in some of the source-activity combinations had significant influence on the overall uncertainty while these were not identified as important in the key source analysis and for which thus no elicitation of uncertainty and pedigree scores had taken place. In retrospect the "contribution to AE" from the key source analysis was not a good predictor for the importance of uncertainty in each source-activity combination. A better procedure could have been to start with a Monte Carlo assessment, assuming default uncertainties on all source-activity combination. The Monte Carlo correlation coefficients could then be used to determine the priority of source-activity combination for the elicitation interviews.

7. Literature

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8. Authentication

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2002-2003

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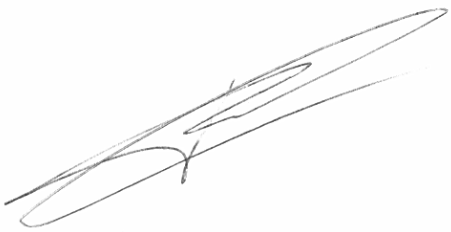

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Appendix 1 Clusters of key-sources

Rapcode	Procesomschrijving (in dutch)	Brandstof-Activiteit	Key sources (ranking) NOx level	NOx trend	SOx level	SOx trend	NH3 level	NH3 trend	AE level	AE trend	Experts	Contribution Cluster to AE	Cumulative Contribution to AE
0441121	VEESTAPEL, MELKKOEIEN, Stallen + opslag NH3	Dieren					1	2	1	2	1	11,3%	**11,3%**
0441221	VEESTAPEL, MELKKOEIEN, Aanwending mest - emissie NH3	Dieren					3	4	4	6	1	0,0%	
0441321	VEESTAPEL, MELKKOEIEN, Weiden - emissie NH3	Dieren					11	20	22	23	1	0,0%	
0445121	VEESTAPEL, VLEESVARKENS, Stallen + opslag NH3	Dieren					2	3	3	5	1	6,9%	**18,1%**
0445221	VEESTAPEL, VLEESVARKENS, Aanwending mest - emissie NH3	Dieren					7	12	12	13	1	0,0%	
T101001	ERI_SBI 23201: AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES, raffinaderijen, Raffinaderijen	AGFO	11	8	1	2			2	4	1	6,0%	**24,1%**
T100403	ERI_SBI 23201: AARDOLIERAFFINAGE, PROCESEMISSIES	_			4	18			30	57	1	0,0%	
T101001	ERI_SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES, raffinaderijen, Raffinaderijen	ZSO									1	0,0%	
T101001	ERI_SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES, raffinaderijen, Raffinaderijen	AG										0,0%	
8900801	SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES, raffinaderijen, Raffinaderijen	HBO									2	0,0%	
0102440	GEBRUIK TREKKERS VR. OPLEGGERS,AUTOSNELWEG OVERIG WEGVERKEER	DIESEL	3	11	31	24		34	11	53	1	5,6%	**29,7%**
0102450	GEBRUIK VRACHTAUTO,AUTOSNELWEG OVERIG WEGVERKEER	DIESEL	6	59	34	13		25	17	27	1	0,0%	
0102650	GEBRUIK VRACHTAUTO,LANDEL.WEG OVERIG WEGVERKEER	DIESEL	17	19		16		33	37	19	1	0,0%	
0102640	GEBRUIK TREKKERS VR. OPLEGGERS,LANDEL.WEG OVERIG WEGVERKEER	DIESEL	19	44		37		43	38	39	1	0,0%	
0442121	VEESTAPEL, JONGVEE FOKKERIJ, Stallen + opslag NH3	Dieren					8	14	15	16	1	4,2%	**33,9%**
0442221	VEESTAPEL, JONGVEE FOKKERIJ, Aanwending mest - emissie NH3	Dieren					10	18	21	20	1	0,0%	
0442321	VEESTAPEL, JONGVEE FOKKERIJ, Weiden - emissie NH3	Dieren					17	32	35	38	1	0,0%	
T103401	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	SK	18	10	3	3			13	15	1	4,0%	**38,0%**
T103401	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	SK steenkool	14	9	5	4			19	18	1	0,0%	
T103401	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	steenkool	40	1	12	1			58	1	1	0,0%	

Rapcode	Procesomschrijving (in dutch)	Brandstof-Activiteit	Key sources (ranking) NO_x level	NO_x trend	SO_x level	SO_x trend	NH_3 level	NH_3 trend	AE level	AE trend	Experts	Contribution Cluster to AE	Cumulative Contribution to AE
0230106	Binnenscheepvaart - verbranding	DIESEL	1	*7*	9	*20*		*22*	6	*66*	2	4,0%	**42,0%**
0230301	Binnenvaart duwvaart verbranding	DIESEL	29	*47*	33				52	*82*	2	0,0%	
0446121	VEESTAPEL, FOKVARKENS, Stallen + opslag NH3	Dieren					6	*10*	10	*12*	1	3,8%	**45,7%**
0446221	VEESTAPEL, FOKVARKENS, Aanwending mest - emissie NH3	Dieren					13	*23*	24	*25*	1	0,0%	
0259906	Zeescheepvaart - Varende zeeschepen, verbrandingsemissies	Zware stookolie	4	*14*	2	*6*		*1*	5	*7*	1	3,6%	**49,4%**
0447121	VEESTAPEL, LEGHENNEN, Stallen + opslag NH3	Dieren					5	*9*	9	*11*	1	3,5%	**52,9%**
0447221	VEESTAPEL, LEGHENNEN, Aanwending mest - emissie NH3	Dieren					16	*29*	32	*36*	1	0,0%	
0400701	Aanwending van kunstmest - NH3	N-gift					4	*6*	7	*9*	1	3,0%	**55,9%**
0100401	GEBRUIK PERS.AUTO BENZINE,AUTOSNELWEG PERSONEN/BEST.AUTO	BENZINE	5	*2*		*40*			14	*3*	1	2,9%	**58,7%**
0100601	GEBRUIK PERS.AUTO BENZINE,LANDEL.WEG PERSONEN/BEST.AUTO	BENZINE	13	*3*		*41*			36	*8*	1	0,0%	
0401101	Mobiele werktuigen landbouw - verbranding	DIESEL	2	*18*	10			*19*	8	*29*	1	2,8%	**61,6%**
8920401	SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	AARDGAS	9	*5*					25	*26*	2	2,6%	**64,2%**
T103401	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	AGFO	10	*6*	40				26	*28*	1	0,0%	
T103401	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	AG	53	*37*					82		1	0,0%	
0443221	VEESTAPEL, VLEESVEE, Aanwending mest - emissie NH3	Dieren					14	*26*	28	*33*	1	2,6%	**66,8%**
0443121	VEESTAPEL, VLEESVEE, Stallen + opslag NH3	Dieren					15	*28*	31	*35*	1	0,0%	
0443321	VEESTAPEL, VLEESVEE, Weiden - emissie NH3	Dieren					20	*39*	48	*48*	1	0,0%	
0448121	VEESTAPEL, VLEESKUIKENS, Stallen + opslag NH3	Dieren					9	*16*	16	*17*	1	2,3%	**69,1%**
0448221	VEESTAPEL, VLEESKUIKENS, Aanwending mest - emissie NH3	Dieren					19	*38*	46	*47*	1	0,0%	
0012107	Vuurhaarden consumenten (verbrandingsemissies), Hoofdverwarming woningen	AARDGAS	8	*53*					20	*52*	2	1,9%	**71,0%**
0800807	Vuurhaarden consumenten (verbrandingsemissies), warm water voorziening	AARDGAS	37	*58*					67		2	0,0%	
0800707	Vuurhaarden consumenten (verbrandingsemissies), koken	AARDGAS									2	0,0%	
0100402	GEBRUIK PERS.AUTO BENZINE KAT,AUTOSNELWEG PERSONEN/BEST.AUTO	BENZINE	15	*31*					27	*78*	1	1,7%	**72,7%**
0100602	GEBRUIK PERS.AUTO BENZINE KAT,LANDEL.WEG PERSONEN/BEST.AUTO	BENZINE	35	*35*					53	*80*	1	0,0%	

Rapcode	Procesomschrijving (in dutch)	Brandstof-Activiteit	Key sources (ranking) NOx level	NOx trend	SOx level	SOx trend	NH3 level	NH3 trend	AE level	AE trend	Experts	Contribution Cluster to AE	Cumulative Contribution to AE
0400301	Landbouwbodems	grondgebruik	7	33					18	60		1,6%	**74,3%**
0102240	GEBRUIK TREKKERS VR. OPLEGGERS,BEB. KOM OVERIG WEGVERKEER	DIESEL	12	40	43	33		41	29	50	1	1,4%	
0102250	GEBRUIK VRACHTAUTO,BEB. KOM OVERIG WEGVERKEER	DIESEL	34	15		15		36	63	22	1	0,0%	
0401261	Vuurhaarden Landbouw, glasbloemenbedrijven (Verbrandingsemissies)	AARDGAS	20	23					41		1	1,2%	**77,0%**
0401271	Vuurhaarden Landbouw, glasgroentebedrijven (Verbrandingsemissies)	AARDGAS	32	70					61		1	0,0%	
0401291	Vuurhaarden Landbouw, overige tuinbouwbedrijven (Verbrandingsemissies)	AARDGAS										0,0%	
0401232	Vuurhaarden Landbouw, hokdierbedrijven varkens (Verbrandingsemissies)	AARDGAS										0,0%	
0401242	Vuurhaarden Landbouw, hokdierbedrijven overige hokdieren (Verbrandingsemissies)	AARDGAS										0,0%	
0401221	Vuurhaarden Landbouw, bloem(bollen)bedrijven (Verbrandingsemissies)	AARDGAS										0,0%	
0401241	Vuurhaarden Landbouw, champignonbedrijven (Verbrandingsemissies)	AARDGAS										0,0%	
0401212	Vuurhaarden Landbouw, graasdierbedrijven (Verbrandingsemissies)	AARDGAS										0,0%	
0401251	Vuurhaarden Landbouw, combinatiebedrijven (Verbrandingsemissies)	AARDGAS										0,0%	
0401222	Vuurhaarden Landbouw, hokdierbedrijven legkippen (Verbrandingsemissies)	AARDGAS										0,0%	
0401231	Vuurhaarden Landbouw, boomkwekerijbedrijven (Verbrandingsemissies)	AARDGAS										0,0%	
0401211	Vuurhaarden Landbouw, akkerbouwbedrijven (Verbrandingsemissies)	AARDGAS										0,0%	
0401281	Vuurhaarden Landbouw, opengrondsgroentebedrijven (Verbrandingsemissies)	AARDGAS										0,0%	
0100404	GEBRUIK PERS.AUTOS DIESEL IDI,AUTOSNELWEG PERSONEN/BEST.AUTO	DIESEL	25	55	29	23		31	43	42	1	1,2%	**78,2%**
0100604	GEBRUIK PERS.AUTOS DIESEL IDI,LANDEL.WEG PERSONEN/BEST.AUTO	DIESEL	28	34	35	22		35	50	56	1	0,0%	
0444121	VEESTAPEL, VLEESKALVEREN, Stallen + opslag NH3	Dieren					18	37	44	43	1	1,2%	**79,4%**
0444221	VEESTAPEL, VLEESKALVEREN, Aanwending mest - emissie NH3	Dieren					21	40	51	49	1	0,0%	
8920601	SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	AARDGAS	30	45					57		2	1,2%	**80,6%**
0020416	SBI 85:GEZONDHEID/MAATSCH.WERK, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	AARDGAS	46	51					77		2	0,0%	
0020415	SBI 80:ONDERWIJS,NIET-IND. VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	AARDGAS	66	69							2	0,0%	

Rapcode	Procesomschrijving (in dutch)	Brandstof-Activiteit	Key sources (ranking)								Experts	Contribution Cluster to AE	Cumulative Contribution to AE
			NO_x		SO_x		NH_3		AE				
			level	trend	level	trend	level	trend	level	trend			
0020433	SBI 75:OVERHEIDSDIENSTEN, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	AARDGAS	72								2	0,0%	
T104201	ERI_SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	AGFO		*64*							2	0,0%	
0020432	SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	AARDGAS									2	0,0%	
0020412	SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	AARDGAS									2	0,0%	
0020418	SBI 92:CULTUUR,SPORT,RECREATIE, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	AARDGAS									2	0,0%	
0020405	SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	AARDGAS									2	0,0%	
0020413	SBI 65/67:FINANC.DIENSTVERLEN., VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	AARDGAS									2	0,0%	
8922301	SBI 93: PARTICULIERE DIENSTVERLENING W.O. WASSERIJEN, KAP- EN SCHOONHEIDSALONS, CREMATORIA, Verbrandingsemissies, rest overige bedrijfsgroepen, HDO	AARDGAS									2	0,0%	
T104201	ERI_SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	AG									2	0,0%	
0020417	SBI 91: MAATSCHAPPELIJKE, POLITIEKE EN BELANGENORGANISATIES, Verbrandingsemissies, rest overige bedrijfsgroepen, HDO	AARDGAS									2	0,0%	
T103901	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	AG									2	0,0%	
8922701	SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	AARDGAS									2	0,0%	
T100101	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	AGFO									2	0,0%	
T103901	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	AAG									2	0,0%	
T100101	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	AG									2	0,0%	
T103701	ERI_SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	AG									2	0,0%	

Rapcode	Procesomschrijving (in dutch)	Brandstof-Activiteit	Key sources (ranking) NOx level	NOx trend	SOx level	SOx trend	NH3 level	NH3 trend	AE level	AE trend	Experts	Contribution Cluster to AE	Cumulative Contribution to AE
8920501	SBI 41:WINNING EN DISTRIBUTIE VAN WATER, VERBRANDINGSEMISSIES, winning water, Drinkwaterbedrijven	AARDGAS									2	0,0%	
T104101	ERI_SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	AG									2	0,0%	
T103801	ERI_SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	AG									2	0,0%	
T151101	ERI_SBI 51/52:DETAIL- en GROOTHANDEL, VERBRANDINGSEMISSIES, groothandel, HDO	AGFO									2	0,0%	
T100703	ERI_SBI 241:OVERIGE CHEM.GRONDST., PROCESEMISSIES, vervaardiging basischemicalien, Chemische Industrie	_	39	*65*	42	*7*		*15*	59	*31*	1	1,2%	**81,8%**
8912903	SBI 24142: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van overige organische basischemicaliën, Chemische industrie	_							70	*73*	1	0,0%	
T102403	ERI_SBI 2413: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van overige anorganische basischemicaliën, Chemische industrie	_	71	*63*	13	*19*			72		1	0,0%	
8901101	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	RESTGAS			15	*17*			85		2	0,0%	
8912703	SBI 2413: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van overige anorganische basischemicaliën, Chemische industrie	_			28	*36*					1	0,0%	
8901101	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	RAFFGAS									1	0,0%	
T101101	ERI_SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	LMRG									1	0,0%	
8901101	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	HBO									1	0,0%	
T102703	ERI_SBI 2416: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van kunststof in primaire vorm, Chemische industrie	_									1	0,0%	
8912803	SBI 24141: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van petrochemische produkten, Chemische industrie	_									1	0,0%	
8913003	SBI 2416: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van kunststof in primaire vorm, Chemische industrie	_									1	0,0%	
8912603	SBI 2412: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van kleur- en verfstoffen, Chemische industrie	_									1	0,0%	

Rapcode	Procesomschrijving (in dutch)	Brandstof-Activiteit	Key sources (ranking) NOx level	NOx trend	SOx level	SOx trend	NH3 level	NH3 trend	AE level	AE trend	Experts	Contribution Cluster to AE	Cumulative Contribution to AE
8901101	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	BIOGAS									2	0,0%	
T104803	ERI_SBI 2417: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van synthetische rubber in primaire vorm, Chemische industrie	_									1	0,0%	
T101101	ERI_SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	OGB									1	0,0%	
T100903	ERI_SBI 27:VERVAARDIGEN VAN IJZER< STAAL EN FERRO-LEGERINGEN, PROCESEMISSIES, basismetaalindustrie, Overige industrie	_	23	*13*				*7*	45	*51*		1,1%	**82,9%**
T102201	ERI_SBI 271/273:BASISMETAALINDUSTRIE, VERWERKING EN VERVAARDIGING IJZER EN STAAL, VERBRANDINGSEMISSIES, Overige industrie	AGFO			6	*5*			55	*54*		0,0%	
T102201	ERI_SBI 271/273:BASISMETAALINDUSTRIE, VERWERKING EN VERVAARDIGING IJZER EN STAAL, VERBRANDINGSEMISSIES, Overige industrie	AG										0,0%	
8914603	SBI 272: BASISMETAALINDUSTRIE, PROCESEMISSIES Vervaardiging van stalen buizen Overige industrie	_										0,0%	
T104103	ERI_SBI 272: BASISMETAALINDUSTRIE, PROCESEMISSIES Vervaardiging van stalen buizen Overige industrie	_										0,0%	
0100214	GEBRUIK BESTELAUTO DIESEL IDI,BEB. KOM PERSONEN/BEST.AUTO	DIESEL	16	*50*	23	*11*		*24*	33	*37*	1	1,1%	**84,0%**
0100211	GEBRUIK BESTELAUTO BENZINE,BEB. KOM PERSONEN/BEST.AUTO	BENZINE	67	*20*						*46*	1	0,0%	
0100215	GEBRUIK BESTELAUTO LPG,BEB. KOM PERSONEN/BEST.AUTO	LPG		*66*							1	0,0%	
0100212	GEBRUIK BESTELAUTO BENZINE KAT,BEB. KOM PERSONEN/BEST.AUTO	BENZINE									1	0,0%	
0100614	GEBRUIK BESTELAUTO DIESEL IDI,LANDEL.WEG PERSONEN/BEST.AUTO	DIESEL	36	*25*					64	*75*	1	1,0%	**85,0%**
0100414	GEBRUIK BESTELAUTO DIESEL IDI,AUTOSNELWEG PERSONEN/BEST.AUTO	DIESEL	38	*28*					66		1	0,0%	
0100411	GEBRUIK BESTELAUTO BENZINE,AUTOSNELWEG PERSONEN/BEST.AUTO	BENZINE									1	0,0%	
0100611	GEBRUIK BESTELAUTO BENZINE,LANDEL.WEG PERSONEN/BEST.AUTO	BENZINE									1	0,0%	
0100415	GEBRUIK BESTELAUTO LPG,AUTOSNELWEG PERSONEN/BEST.AUTO	LPG									1	0,0%	
0100615	GEBRUIK BESTELAUTO LPG,LANDEL.WEG PERSONEN/BEST.AUTO	LPG									1	0,0%	
0100412	GEBRUIK BESTELAUTO BENZINE KAT,AUTOSNELWEG PERSONEN/BEST.AUTO	BENZINE									1	0,0%	
0100612	GEBRUIK BESTELAUTO BENZINE KAT,LANDEL.WEG PERSONEN/BEST.AUTO	BENZINE									1	0,0%	

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			NO_x		SO_x		NH_3		AE				
			level	trend	level	trend	level	trend	level	trend			
0340106	Stilliggende schepen	Marine diesel	33	*52*	7	*28*		*11*	34	*30*	1	0,9%	**85,9%**
T101101	ERI_SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	AGFO	22	*12*	19	*25*			40	*41*	1	0,8%	**86,7%**
8901101	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	AARDGAS	64								1	0,0%	
T102101	ERI_SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	AGFO	42	*26*					69	*70*	1	0,7%	**87,4%**
T103603	ERI_SBI 261: BOUWMAT.+GLASINDUSTRIE, PROCESEMISSIES Vervaardiging en bewerken van glas, Overige industrie	_		*68*	17	*10*		*17*	79	*34*	1	0,0%	
8901901	SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	AARDGAS		*17*	39					*44*	1	0,0%	
8901901	SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	STOOKOLIE			22	*39*					1	0,0%	
T103803	ERI_SBI 264: BOUWMAT.+GLASINDUSTRIE, PROCESEMISSIES Vervaardiging van produkten voor de bouw uit gebakken klei Overige industrie	_			37	*12*				*77*	1	0,0%	
T102101	ERI_SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	AG									1	0,0%	
8901901	SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	HBO									1	0,0%	
T104003	ERI_SBI 268: BOUWMAT.+GLASINDUSTRIE, PROCESEMISSIES Vervaardiging van overige niet-metaalhoudende minerale produkten n.e.g. Overige industrie	_						*8*		*32*	1	0,0%	
T102101	ERI_SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	LSO									1	0,0%	
T102101	ERI_SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	HBO1									1	0,0%	
8901901	SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	LPG									1	0,0%	
0401106	Mobiele werktuigen overig - verbranding	DIESEL	21		25			*44*	39	*59*		0,7%	**88,2%**
T101403	ERI_SBI 2415:KUNSTMESTSTOFFENIND., PROCESEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	_	44	*21*				*13*	56	*21*	1	0,7%	**88,9%**

Rapcode	Procesomschrijving (in dutch)	Brandstof-Activiteit	Key sources (ranking) NO$_x$ level	NO$_x$ trend	SO$_x$ level	SO$_x$ trend	NH$_3$ level	NH$_3$ trend	AE level	AE trend	Experts	Contribution Cluster to AE	Cumulative Contribution to AE
T101201	ERI_SBI 2415:KUNSTMESTSTOFFENIND., VERBRANDINGSEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	AGFO	54	*39*					88		1	0,0%	
8900901	SBI 2415:KUNSTMESTSTOFFENIND., VERBRANDINGSEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	AARDGAS		*38*						*72*	1	0,0%	
8900901	SBI 2415:KUNSTMESTSTOFFENIND., VERBRANDINGSEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	STOOKOLIE									1	0,0%	
8900901	SBI 2415:KUNSTMESTSTOFFENIND., VERBRANDINGSEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	HBO									1	0,0%	
0401108	MOBIELE WERKTUIGEN, BOUWSECTOR verbranding	DIESEL	24	*62*	27				42	*67*		0,7%	**89,5%**
0100405	GEBRUIK PERS.AUTOS LPG,AUTOSNELWEG PERSONEN/BEST.AUTO	LPG	41	*16*					62	*40*		0,7%	**90,2%**
0100605	GEBRUIK PERS.AUTOS LPG,LANDEL.WEG PERSONEN/BEST.AUTO	LPG	50	*22*					73	*58*		0,0%	**90,2%**
0100204	GEBRUIK PERS.AUTOS DIESEL IDI,BEB. KOM PERSONEN/BEST.AUTO	DIESEL	27	*29*	36	*14*		*27*	47	*55*		0,6%	**90,8%**
0100201	GEBRUIK PERS.AUTO BENZINE,BEB. KOM PERSONEN/BEST.AUTO	BENZINE	26	*4*		*35*			49	*10*		0,6%	**91,4%**
T104203	ERI_SBI 274: BASISMETAALINDUSTRIE, PROCESEMISSIES Vervaardiging van aluminium, lood, zink en tin, Overige industrie	_			8	*9*		*5*	60	*14*		0,6%	**92,0%**
8914703	SBI 274: BASISMETAALINDUSTRIE, PROCESEMISSIES Vervaardiging van aluminium, lood, zink en tin, Overige industrie	_			26							0,0%	
T102301	ERI_SBI 274/275:BASISMETAALINDUSTRIE, VERVAARDIGING VAN NON-FERRO METALEN EN GIETEN VAN METALEN, VERBRANDINGSEMISSIES, Overige industrie	AGFO										0,0%	
8914903	SBI 275: BASISMETAALINDUSTRIE, PROCESEMISSIES Gieten van ijzer en staal, Overige industrie	_										0,0%	
8920101	SBI 274/275:BASISMETAALINDUSTRIE, VERVAARDIGING VAN NON-FERRO METALEN EN GIETEN VAN METALEN, VERBRANDINGSEMISSIES, Overige industrie	HBO										0,0%	
T102301	ERI_SBI 274/275:BASISMETAALINDUSTRIE, VERVAARDIGING VAN NON-FERRO METALEN EN GIETEN VAN METALEN, VERBRANDINGSEMISSIES, Overige industrie	AG										0,0%	
8920101	SBI 274/275:BASISMETAALINDUSTRIE, VERVAARDIGING VAN NON-FERRO METALEN EN GIETEN VAN METALEN, VERBRANDINGSEMISSIES, Overige industrie	BIOGAS										0,0%	
T102301	ERI_SBI 274/275:BASISMETAALINDUSTRIE, VERVAARDIGING VAN NON-FERRO METALEN EN GIETEN VAN METALEN, VERBRANDINGSEMISSIES, Overige industrie	HBO1										0,0%	

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			NO_x		SO_x		NH_3		AE				
			level	trend	level	trend	level	trend	level	trend			
8920101	SBI 274/275:BASISMETAALINDUSTRIE, VERVAARDIGING VAN NON-FERRO METALEN EN GIETEN VAN METALEN, VERBRANDINGSEMISSIES, Overige industrie	AARDGAS										0,0%	
8920101	SBI 274/275:BASISMETAALINDUSTRIE, VERVAARDIGING VAN NON-FERRO METALEN EN GIETEN VAN METALEN, VERBRANDINGSEMISSIES, Overige industrie	LPG										0,0%	
0100202	GEBRUIK PERS.AUTO BENZINE KAT,BEB. KOM PERSONEN/BEST.AUTO	BENZINE	31	*24*					54	*74*		0,5%	**92,5%**
T100201	ERI_SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	AGFO	56	*42*								0,5%	**93,0%**
8900201	SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	AARDGAS	60	*41*						*71*		0,0%	
T100201	ERI_SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	AG	68	*54*								0,0%	
T100201	ERI_SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	SK			32	*38*						0,0%	
8900201	SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	BIOGAS			41							0,0%	
T105603	ERI_SBI 158: OVERIGE VOEDINGSMID., PROCESEMISSIES, voedings/genot industrie, Overige industrie	_										0,0%	
8900201	SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	HBO										0,0%	
T105303	ERI_SBI 155:ZUIVELINDUSTRIE, PROCESEMISSIES, voedings/genot industrie, Overige industrie	_										0,0%	
T100201	ERI_SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	BIOG										0,0%	
T100201	ERI_SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	ZSO										0,0%	
T100201	ERI_SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	HOUT										0,0%	
T100201	ERI_SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	OVB										0,0%	
8900201	SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	STOOKOLIE				*34*						0,0%	

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			level	trend	level	trend	level	trend	level	trend			
T100201	ERI_SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	HBO1										0,0%	
8900201	SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	PETROLEUM										0,0%	
8900201	SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	LPG										0,0%	
T100201	ERI_SBI 15/16:VOED.&GENOTMIDD.IND., VERBRANDINGSEMISSIES, voedings/genot industrie, Overige industrie	RHG										0,0%	
8920401	SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	RESTGAS	51	*36*	11	*8*			65	*62*		0,4%	**93,4%**
0102420	GEBRUIK AUTOBUS,AUTOSNELWEG OVERIG WEGVERKEER	DIESEL	47	*72*					76			0,3%	**93,7%**
0102620	GEBRUIK AUTOBUS,LANDEL.WEG OVERIG WEGVERKEER	DIESEL	57	*43*					89	*65*		0,0%	
0102234	GEBRUIK SPEC.VRTG.DIESEL DI,BEB. KOM OVERIG WEGVERKEER	DIESEL	48	*61*					78	*68*		0,3%	**94,0%**
0102634	GEBRUIK SPEC.VRTG.DIESEL DI,LANDEL.WEG OVERIG WEGVERKEER	DIESEL										0,0%	
0102434	GEBRUIK SPEC.VRTG.DIESEL DI,AUTOSNELWEG OVERIG WEGVERKEER	DIESEL										0,0%	
0102231	GEBRUIK SPEC.VRTG.BENZINE,BEB. KOM OVERIG WEGVERKEER	BENZINE										0,0%	
0102631	GEBRUIK SPEC.VRTG.BENZINE,LANDEL.WEG OVERIG WEGVERKEER	BENZINE										0,0%	
0102431	GEBRUIK SPEC.VRTG.BENZINE,AUTOSNELWEG OVERIG WEGVERKEER	BENZINE										0,0%	
8120002	OLIE- EN GASWINNING, WINNING OP ZEE:VERBRANDING, winning energiedragers, Energiesector	AARDGAS	45	*57*					74			0,3%	**94,3%**
0020402	SBI 11:OLIE- EN GASWINNING, VERBRANDINGSEMISSIES, winning energiedragers, Energiesector	AARDGAS	70									0,0%	
T104401	ERI_SBI 11: AARDOLIE EN GASWINNING EN DIENSTVERLENING, Verbrandingsemissies, Winning energiedragers, Energiesector	AG										0,0%	
E309911	Schiphol, Vliegverkeer-Climb Out	Kerosine	62	*67*								0,3%	**94,6%**
E309910	Schiphol, Vliegverkeer-Take Off	Kerosine										0,0%	
E309912	Schiphol, Vliegverkeer-Approach	Kerosine										0,0%	
E309913	Schiphol, Vliegverkeer-Idle	Kerosine										0,0%	

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			level	trend	level	trend	level	trend	level	trend			
E309914	Schiphol, Vliegverkeer-APU/GPU	Kerosine										0,0%	
T107103	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. PROCESEMISSIES, Bouw	_		*71*	30							0,3%	**94,9%**
0020405	SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	STEENKOOL			38							0,0%	
8921801	SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	BIOGAS										0,0%	
T107403	ERI_SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, PROCESEMISSIES, rest overige bedrijfsgroepen, HDO	_										0,0%	
0020405	SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	HBO										0,0%	
0020412	SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	HBO										0,0%	
0020432	SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	HBO										0,0%	
8922701	SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	HBO										0,0%	
0020416	SBI 85:GEZONDHEID/MAATSCH.WERK, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	STOOKOLIE				*43*						0,0%	
8920601	SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	HBO										0,0%	
0020416	SBI 85:GEZONDHEID/MAATSCH.WERK, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	HBO										0,0%	
8920601	SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	LPG										0,0%	
0020405	SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	LPG										0,0%	
T104201	ERI_SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	HBO1										0,0%	
T104101	ERI_SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	BIOG										0,0%	
0020433	SBI 75:OVERHEIDSDIENSTEN, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	HBO										0,0%	

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			NO_x		SO_x		NH_3		AE				
			level	trend	level	trend	level	trend	level	trend			
8920601	SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	STEENKOOL										0,0%	
T103901	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	SK										0,0%	
0020412	SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	STOOKOLIE										0,0%	
T100101	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	BK										0,0%	
0020415	SBI 80:ONDERWIJS,NIET-IND. VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	HBO										0,0%	
8921901	SBI 90004:SANERING MILIEUVERON, VERBRANDINGSEMISSIES, sanering milieuverontreiniging, Afvalverwijderingsbedrijven	LPG										0,0%	
T151301	ERI_SBI 90004: SANERING MILIEUVERONTREINIGING VERBRANDINGSEMISSIES, Overige industrie	PROG										0,0%	
8921801	SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	STOOKOLIE										0,0%	
8922701	SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	STEENKOOL										0,0%	
0020413	SBI 65/67:FINANC.DIENSTVERLEN., VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	HBO										0,0%	
0020412	SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	BIOGAS										0,0%	
0020412	SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	STEENKOOL										0,0%	
T103901	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	ZSO										0,0%	
0020412	SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	LPG										0,0%	
8922701	SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	LPG										0,0%	
0020413	SBI 65/67:FINANC.DIENSTVERLEN., VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	LPG										0,0%	

Rapcode	Procesomschrijving (in dutch)	Brandstof-Activiteit	Key sources (ranking)								Experts	Contribution Cluster to AE	Cumulative Contribution to AE
			NO_x		SO_x		NH_3		AE				
			level	trend	level	trend	level	trend	level	trend			
8921801	SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	LPG										0,0%	
0020433	SBI 75:OVERHEIDSDIENSTEN, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	LPG										0,0%	
0020432	SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	LPG										0,0%	
0020416	SBI 85:GEZONDHEID/MAATSCH.WERK, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	LPG										0,0%	
0020415	SBI 80:ONDERWIJS,NIET-IND. VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	LPG										0,0%	
8921801	SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	HBO										0,0%	
T103901	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	HBO1		*60*								0,0%	
T103901	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	CIRG										0,0%	
T103901	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	LPG										0,0%	
T100601	ERI_SBI 21:PAPIER EN PAPIERWAREN, VERBRANDINGSEMISSIES, papier industrie, Overige industrie	AG	49	*32*					80	*79*		0,3%	**95,1%**
T102103	ERI_SBI 211: PAPIER EN PAPIERWAREN, INDUSTRIE, PROCESEMISSIES Vervaardiging van papier en karton (incl. grafisch en voor verpakking), Overige industrie	_										0,0%	
T100601	ERI_SBI 21:PAPIER EN PAPIERWAREN, VERBRANDINGSEMISSIES, papier industrie, Overige industrie	AAG										0,0%	
T100601	ERI_SBI 21:PAPIER EN PAPIERWAREN, VERBRANDINGSEMISSIES, papier industrie, Overige industrie	BIOG										0,0%	
T100601	ERI_SBI 21:PAPIER EN PAPIERWAREN, VERBRANDINGSEMISSIES, papier industrie, Overige industrie	OVB										0,0%	
8900601	SBI 21:PAPIER EN PAPIERWAREN, VERBRANDINGSEMISSIES, papier industrie, Overige industrie	BIOGAS										0,0%	
8900601	SBI 21:PAPIER EN PAPIERWAREN, VERBRANDINGSEMISSIES, papier industrie, Overige industrie	HBO										0,0%	

Rapcode	Procesomschrijving (in dutch)	Brandstof-Activiteit	Key sources (ranking)								Experts	Contribution Cluster to AE	Cumulative Contribution to AE
			NO_x		SO_x		NH_3		AE				
			level	trend	level	trend	level	trend	level	trend			
8900601	SBI 21:PAPIER EN PAPIERWAREN, VERBRANDINGSEMISSIES, papier industrie, Overige industrie	LPG										0,0%	
REST	REST	_										4,9%	**100,0%**

Appendix 2 Results of expert elicitation

Quantity: EA=Emission Aggregate; AR=Activity Data; EF=Emission Factor
Colour coding in pedigree scores (*proxy, empirical, method, validation*, see table 3.2) <1.4 red, 1.4-2.6 amber; >2.6 green (traffic light analogy)
Strength=average pedigree score (proxy, empirical, method, and validation equally weighted)
Min (%) and *Max (%)*: For Uniform and Triangular distributions this represents the minimum and maximum of the uncertainty range. For normal distributions it gives the $\pm 2\sigma$ interval.
Shape of distribution: U=Uniform, T=Triangular, N=Normal, L=Lognormal
Expert number: 1= D. Heslinga; 2= K. vd Hoek; 3= J. Hulskotte, 4=J. Klein, 5=E. Zonneveld

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
0441121	Dieren	VEESTAPEL, MELKKOEIEN, Stallen + opslag NH3	1lb	EA NH3	3	1	3	2	2.25	-25%	25%	N		2
0441221	Dieren	VEESTAPEL, MELKKOEIEN, Aanwending mest - emissie NH3	1lb	EA NH3	3	2	2	2	2.25	-25%	100%	L		2
0441321	Dieren	VEESTAPEL, MELKKOEIEN, Weiden - emissie NH3	1lb	EA NH3	1	1	2	2	1.5	-50%	50%	N		2
0445121	Dieren	VEESTAPEL, VLEESVARKENS, Stallen + opslag NH3	2lb	EA NH3	3	2	3	2	2.5	-25%	25%	N		2
0445221	Dieren	VEESTAPEL, VLEESVARKENS, Aanwending mest - emissie NH3	2lb	EA NH3	3	2	2	2	2.25	-25%	100%	L		2
T101001	AGFO	ERI_SBI 23201: AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EA NOx	2.5	4	3.5	1	2.75	-5	5	U		1
T101001	AGFO	ERI_SBI 23201: AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EA NOx	4	2.5	3	2	2.88					5
T100403	_	ERI_SBI 23201: AARDOLIERAFFINAGE, PROCESEMISSIES	23201	EA NOx	2.5	4	3.5	1	2.75	-5	5	U		1
T100403	_	ERI_SBI 23201: AARDOLIERAFFINAGE, PROCESEMISSIES	23201	EA SO2	2.5	4	3.5	1	2.75	-5	5	U		1
T100403	_	ERI_SBI 23201: AARDOLIERAFFINAGE, PROCESEMISSIES	23201	EA NOx	4	2.5	3	2	2.88					5
T101001	ZSO	ERI_SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EA NOx	2.5	4	3.5	1	2.75	-5	5	U		1
T101001	ZSO	ERI_SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EA SO2	2.5	4	3.5	1	2.75	-5	5	U		1
T101001	ZSO	ERI_SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EA NOx	4	2.5	3	2	2.88					5
T101001	AG	ERI_SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EA NOx	2.5	4	3.5	1	2.75	-5	5	U		1
T101001	AG	ERI_SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EA NOx	4	2.5	3	2	2.88					5
8900801	HBO	SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	AR	4	2.5	3	2	2.88	-15	15	U		5
8900801	HBO	SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EF NOx	3	3	3	3	3	-20	20	U		5
8900801	HBO	SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EF SO2	4	4	3	3	3.5	-5	0	T	mode=0	5
8900801	HBO	SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EA NOx	2.5	4	3.5	1	2.75	-5	5	U		1
8900801	HBO	SBI 23201:AARDOLIERAFFINAGE, VERBRANDINGSEMISSIES	23201	EA SO2	2.5	4	3.5	1	2.75	-5	5	U		1
0102440	DIESEL	TREKKERS VR. OPLEGGERS,AUTOSNELWEG OVERIG WEGVERKEER	3	AR	3	2.5	3	1	2.38	-5	15	T	mode=+5	4
0102450	DIESEL	GEBRUIK VRACHTAUTO,AUTOSNELWEG OVERIG WEGVERKEER	3	AR	3	2.5	3	1	2.38	-5	15	T	mode=+5	4
0102650	DIESEL	GEBRUIK VRACHTAUTO,LANDEL.WEG OVERIG WEGVERKEER	3	AR	3	2.5	3	1	2.38	-5	15	T	mode=+5	4
0102640	DIESEL	TREKKERS VR. OPLEGGERS,LANDEL.WEG OVERIG WEGVERKEER	3	AR	3	2.5	3	1	2.38	-5	15	T	mode=+5	4

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
0442121	Dieren	VEESTAPEL, JONGVEE FOKKERIJ, Stallen + opslag NH3	4lb	EA NH3	3	0	2	2	1.75	-25%	25%	N		2
0442221	Dieren	VEESTAPEL, JONGVEE FOKKERIJ, Aanwending mest - emissie NH3	4lb	EA NH3	3	2	2	2	2.25	-25%	100%	L		2
0442321	Dieren	VEESTAPEL, JONGVEE FOKKERIJ, Weiden - emissie NH3	4lb	EA NH3	1	1	2	2	1.5	-50%	50%	N		2
T103401	SK	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40K	EA NOx	2.5	4	3	2.5	3	-10	10	U		1
T103401	SK	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40K	EA SO2	2	3	3	2.5	2.63	-10	10	U		1
T103401	SK steenkool	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40K	EA NOx	2.5	4	3	2.5	3	-10	10	U		1
T103401	SK steenkool	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40K	EA SO2	2	3	3	2.5	2.63	-10	10	U		1
T103401	steenkool	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40K	EA NOx	2.5	4	3	2.5	3	-10	10	U		1
T103401	steenkool	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40K	EA SO2	2	3	3	2.5	2.63	-10	10	U		1
0230106	DIESEL	Binnenscheepvaart - verbranding	1	AR	2	3	3	1	2.25	-15	15	U		4
0230106	DIESEL	Binnenscheepvaart - verbranding	1	EF NOx	4	3	3	3	3.25	-20	10	T	mode=0	4
0230106	DIESEL	Binnenscheepvaart - verbranding	1	AR	3	4	1.5	1.5	2.5	-15	5	T	mode=-10%	3
0230106	DIESEL	Binnenscheepvaart - verbranding	1	EF NOx	4	3	4	3	3.5	-10	5	T	mode=-2.5	3
0230106	DIESEL	Binnenscheepvaart - verbranding	1	EF SO2	4	2.5	1	0	1.88	-25	25	U		3
0230301	DIESEL	Binnenvaart duwvaart verbranding	1	AR	2	3	3	1	2.25	-15	15	U		4
0230301	DIESEL	Binnenvaart duwvaart verbranding	1	EF NOx	4	3	3	3	3.25	-20	10	T	mode=0	4
0230301	DIESEL	Binnenvaart duwvaart verbranding	1	AR	3	4	1.5	1.5	2.5	-15	5	T	mode=-10%	3
0230301	DIESEL	Binnenvaart duwvaart verbranding	1	EF NOx	4	3	4	3	3.5	-10	5	T	mode=-2.5	3
0230301	DIESEL	Binnenvaart duwvaart verbranding	1	EF SO2	4	2.5	1	0	1.88	-25	25	U		3
0446121	Dieren	VEESTAPEL, FOKVARKENS, Stallen + opslag NH3	3lb	EA NH3	3	1	3	2	2.25	-25%	25%	N		2
0446221	Dieren	VEESTAPEL, FOKVARKENS, Aanwending mest - emissie NH3	3lb	EA NH3	3	2	2	2	2.25	-25%	100%	L		2

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
0259906	Zware stookolie/ Diesel	Zeescheepvaart - Varende zeeschepen, verbrandingsemissies	2	AR	2	4	1	0	1.75	-30	30	O	Let op: trapezium-vorm: uniforme verdeling van -20 tot +20 met driehoe-kige staarten naar -30 en naar +30	3
0259906	Zware stookolie/ Diesel	Zeescheepvaart - Varende zeeschepen, verbrandingsemissies	2	EF NOx	4	3.5	4	2	3.38	-15	5	T	mode=0	3
0259906	Zware stookolie/ Diesel	Zeescheepvaart - Varende zeeschepen, verbrandingsemissies	2	EF SO2	2	2	2	2	2	-30	0	T	mode=-15	3
0447121	Dieren	VEESTAPEL, LEGHENNEN, Stallen + opslag NH3	5lb	EA NH3	3	2	3	2	2.5	-25%	25%	N		2
0447221	Dieren	VEESTAPEL, LEGHENNEN, Aanwending mest - emissie NH3	5lb	EA NH3	3	1	2	2	2	-25%	100%	L		2
0400701	N-gift	Aanwending van kunstmest - NH3	6lb	EA NH3	3	1	1.5	2	1.88	-50%	50%	N		2
0100401	BENZINE	GEBRUIK PERS.AUTO BENZINE,AUTOSNELWEG PERSONEN/BEST.AUTO	4	AR	3.5	2.5	2	0.5	2.13	-30	5	U		4
0100601	BENZINE	GEBRUIK PERS.AUTO BENZINE,LANDEL.WEG PERSONEN/BEST.AUTO	4	AR	3.5	2.5	2	0.5	2.13	-30	5	U		4
0401101	DIESEL	Mobiele werktuigen landbouw - verbranding	5	AR	3	3	3	1	2.5	-15	15	T	mode=0	4
8920401	AARDGAS	SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40A	AR	3.5	3.5	3	4	3.5	-1	1	U		5
8920401	AARDGAS	SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
8920401	AARDGAS	SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40A	EA NOx	2.5	4	3.5	1	2.75	-10	10	U		1
T103401	AGFO	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40A	EA NOx	2.5	4	3.5	1	2.75	-10	10	U		1
T103401	AG	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSIES, electriciteits producerende bedrijven, Energiesector	40A	EA NOx	2.5	4	3.5	1	2.75	-10	10	U		1

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodologiocal	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
0443221	Dieren	VEESTAPEL, VLEESVEE, Aanwending mest - emissie NH3	7lb	EA NH3	3	1	3	2	2.25	-25%	100%	L		2
0443121	Dieren	VEESTAPEL, VLEESVEE, Stallen + opslag NH3	7lb	EA NH3	3	2	2	2	2.25	-25%	25%	N		2
0443321	Dieren	VEESTAPEL, VLEESVEE, Weiden - emissie NH3	7lb	EA NH3	1	1	2	2	1.5	-50%	50%	N		2
0448121	Dieren	VEESTAPEL, VLEESKUIKENS, Stallen + opslag NH3	8lb	EA NH3	3	2	3	2	2.5	-25%	25%	N		2
0448221	Dieren	VEESTAPEL, VLEESKUIKENS, Aanwending mest - emissie NH3	8lb	EA NH3	3	1	2	2	2	-25%	100%	L		2
0012107	AARDGAS	Vuurhaarden consumenten (verbrandingsemissies), Hoofdverwarming woningen	3.3A	AR	3	3	3	3	3	-3	1	T	mode=-3	5
0012107	AARDGAS	Vuurhaarden consumenten (verbrandingsemissies), Hoofdverwarming woningen	3.3A	EF NOx	3	3	3	3	3	-20	20	U		5
0012107	AARDGAS	Vuurhaarden consumenten (verbrandingsemissies), Hoofdverwarming woningen	3.3A	AR	3.5	4	4	3	3.63	-2.5	2.5	U		3
0012107	AARDGAS	Vuurhaarden consumenten (verbrandingsemissies), Hoofdverwarming woningen	3.3A	EF NOx	4	3.5	4	3.5	3.75	-5	0	T	mode=0	3
0100402	BENZINE	PERS.AUTO BENZINE KAT,AUTOSNELWEG PERSONEN/BEST.AUTO	6	AR	3.5	3.5	3	1	2.75	-10	10	T	mode=0	4
0100602	BENZINE	GEBRUIK PERS.AUTO BENZINE KAT,LANDEL.WEG PERSONEN/BEST.AUTO	6	AR	3.5	3.5	3	1	2.75	-10	10	T	mode=0	4
0102240	DIESEL	GEBRUIK TREKKERS VR. OPLEGGERS,BEB. KOM OVERIG WEGVERKEER	7	AR	2	2	2	0	1.5	-50	50	U		4
0102250	DIESEL	GEBRUIK VRACHTAUTO,BEB. KOM OVERIG WEGVERKEER	7	AR	2	2	2	0	1.5	-50	50	U		4
0401261	AARDGAS	Vuurhaarden Landbouw, glasbloemenbedrijven (Verbrandingsemissies)	1A	AR	2.5	2	2	2	2.13	-5	5	U		5
0401261	AARDGAS	Vuurhaarden Landbouw, glasbloemenbedrijven (Verbrandingsemissies)	1A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0401271	AARDGAS	Vuurhaarden Landbouw, glasgroentebedrijven (Verbrandingsemissies)	1A	AR	2.5	2	2	2	2.13	-5	5	U		5
0401271	AARDGAS	Vuurhaarden Landbouw, glasgroentebedrijven (Verbrandingsemissies)	1A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0100404	DIESEL	GEBRUIK PERS.AUTOS DIESEL IDI,AUTOSNELWEG PERSONEN/BEST.AUTO	8	AR	3.5	3.5	3	0	2.5	-10	10	T	mode=0	4
0100604	DIESEL	GEBRUIK PERS.AUTOS DIESEL IDI,LANDEL.WEG PERSONEN/BEST.AUTO	8	AR	3.5	3.5	3	0	2.5	-10	10	T	mode=0	4
0444121	Dieren	VEESTAPEL, VLEESKALVEREN, Stallen + opslag NH3	10lb	EA NH3	3	1	3	2	2.25	-25%	25%	N		2
0444221	Dieren	VEESTAPEL, VLEESKALVEREN, Aanwending mest - emissie NH3	10lb	EA NH3	3	1	2	2	2	-25%	100%	L		2
8920601	AARDGAS	SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
8920601	AARDGAS	SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
8920601	AARDGAS	SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
0020416	AARDGAS	SBI 85:GEZONDHEID/MAATSCH.WERK, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
0020416	AARDGAS	SBI 85:GEZONDHEID/MAATSCH.WERK, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
0020416	AARDGAS	SBI 85:GEZONDHEID/MAATSCH.WERK, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0020415	AARDGAS	SBI 80:ONDERWIJS,NIET-IND. VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
0020415	AARDGAS	SBI 80:ONDERWIJS,NIET-IND. VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
0020415	AARDGAS	SBI 80:ONDERWIJS,NIET-IND. VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0020433	AARDGAS	SBI 75:OVERHEIDSDIENSTEN, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
0020433	AARDGAS	SBI 75:OVERHEIDSDIENSTEN, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
0020433	AARDGAS	SBI 75:OVERHEIDSDIENSTEN, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T104201	AGFO	ERI_SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T104201	AGFO	ERI_SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
T104201	AGFO	ERI_SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0020432	AARDGAS	SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
0020432	AARDGAS	SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
0020432	AARDGAS	SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0020412	AARDGAS	SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
0020412	AARDGAS	SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
0020412	AARDGAS	SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0020418	AARDGAS	SBI 92:CULTUUR,SPORT,RECREATIE, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
0020418	AARDGAS	SBI 92:CULTUUR,SPORT,RECREATIE, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
0020418	AARDGAS	SBI 92:CULTUUR,SPORT,RECREATIE, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0020405	AARDGAS	SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
0020405	AARDGAS	SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
0020405	AARDGAS	SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0020413	AARDGAS	SBI 65/67:FINANC.DIENSTVERLEN., VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
0020413	AARDGAS	SBI 65/67:FINANC.DIENSTVERLEN., VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
0020413	AARDGAS	SBI 65/67:FINANC.DIENSTVERLEN., VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
8922301	AARDGAS	SBI 93: PARTICULIERE DIENSTVERLENING W.O. WASSERIJEN, KAP- EN SCHOONHEIDSALONS, CREMATORIA, Verbrandingsemissies, HDO	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
8922301	AARDGAS	SBI 93: PARTICULIERE DIENSTVERLENING W.O. WASSERIJEN, KAP- EN SCHOONHEIDSALONS, CREMATORIA, Verbrandingsemissies, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
8922301	AARDGAS	SBI 93: PARTICULIERE DIENSTVERLENING W.O. WASSERIJEN, KAP- EN SCHOONHEIDSALONS, CREMATORIA, Verbrandingsemissies, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T104201	AG	ERI_SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T104201	AG	ERI_SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
T104201	AG	ERI_SBI 90003:AFVALINZAMELING/BEH, VERBRANDINGSEMISSIES, afvalbehandeling, Afvalverwijderingsbedrijven	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
0020417	AARDGAS	SBI 91: MAATSCHAPPELIJKE, POLITIEKE EN BELANGENORGANISATIES, Verbrandingsemissies, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
0020417	AARDGAS	SBI 91: MAATSCHAPPELIJKE, POLITIEKE EN BELANGENORGANISATIES, Verbrandingsemissies, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
0020417	AARDGAS	SBI 91: MAATSCHAPPELIJKE, POLITIEKE EN BELANGENORGANISATIES, Verbrandingsemissies, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T103901	AG	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T103901	AG	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
T103901	AG	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
8922701	AARDGAS	SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
8922701	AARDGAS	SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
8922701	AARDGAS	SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T100101	AGFO	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T100101	AGFO	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
T100101	AGFO	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T103901	AAG	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T103901	AAG	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
T103901	AAG	ERI_SBI 60/64:TRANSPORT/COMMUNICAT, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
T100101	AG	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T100101	AG	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
T100101	AG	ERI_SBI 14:WINNING VAN ZAND, GRIND, KLEI, ZOUT E.D. VERBRANDINGSEMISSIES, Bouw	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T103701	AG	ERI_SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T103701	AG	ERI_SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
T103701	AG	ERI_SBI 45:BOUWNIJVERHEID, VERBRANDINGSEMISSIES, bouwnijverheid en bouwinstallatiebedrijven, Bouw	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
8920501	AARDGAS	SBI 41:WINNING EN DISTRIBUTIE VAN WATER, VERBRANDINGSEMISSIES, winning water, Drinkwaterbedrijven	3.4A	EF NOx	1	1.5	2	0	1.13	-50	50	U		1
8920501	AARDGAS	SBI 41:WINNING EN DISTRIBUTIE VAN WATER, VERBRANDINGSEMISSIES, winning water, Drinkwaterbedrijven	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
8920501	AARDGAS	SBI 41:WINNING EN DISTRIBUTIE VAN WATER, VERBRANDINGSEMISSIES, winning water, Drinkwaterbedrijven	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T104101	AG	ERI_SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T104101	AG	ERI_SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
T104101	AG	ERI_SBI 70/74:VERHUUR, HANDEL EN DIENSTVERLENING, VERBRANDINGSEMISSIES, rest overige bedrijfsgroepen, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T103801	AG	ERI_SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T103801	AG	ERI_SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
T103801	AG	ERI_SBI 5: HANDEL EN REPARATIE VAN AUTO'S EN MOTORFIETSEN; BENZINESTATIONS, VERBRANDINGSEMISSIES, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T151101	AGFO	ERI_SBI 51/52:DETAIL- en GROOTHANDEL, VERBRANDINGSEMISSIES, groothandel, HDO	3.4A	EA NOx	2	2	2	0	1.5	-50	50	U		1

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
T151101	AGFO	ERI_SBI 51/52:DETAIL- en GROOTHANDEL, VERBRANDINGSEMISSIES, groothandel, HDO	3.4A	AR	2.5	2	3	1.5	2.25	-5	5	U		5
T151101	AGFO	ERI_SBI 51/52:DETAIL- en GROOTHANDEL, VERBRANDINGSEMISSIES, groothandel, HDO	3.4A	EF NOx	3	2.5	3	2.5	2.75	-30	30	U		5
T100703	_	ERI_SBI 241:OVERIGE CHEM.GRONDST., PROCESEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EA NOx	2	2	2	0	1.5	-50	50	U		1
8912903	-	SBI 24142: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van overige organische basischemicaliën, Chemische industrie	241B	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
T102403	_	ERI_SBI 2413: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van overige anorganische basischemicaliën, Chemische industrie	241B	EA NOx	2	2	2	0	1.5	-50	50	U		1
8901101	RESTGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
8901101	RESTGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	AR	2.5	3	2	1	2.13	-25	25	U		5
8901101	RESTGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EF NOx	2	2.5	2.5	2	2.25	-30	30	U	kan ook plus of min 50% zijn	5
8901101	RESTGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EF SO2	1	1.5	1.5	0.5	1.13	-75	75	U		5
8912703	-	SBI 2413: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van overige anorganische basischemicaliën, Chemische industrie	241B	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
8901101	RAFFGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
T101101	LMRG	ERI_SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EA NOx	2	2	2	0	1.5	-50	50	U		1
8901101	HBO	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
T102703	_	ERI_SBI 2416: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van kunststof in primaire vorm, Chemische industrie	241B	EA NOx	2	2	2	0	1.5	-50	50	U		1
8912803	-	SBI 24141: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van petrochemische produkten, Chemische industrie	241B	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
8913003	-	SBI 2416: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES	241B	EF NOx	1	1.5	1.5	0	1	-50	50	U		1

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
		Vervaardiging van kunststof in primaire vorm, Chemische industrie												
8912603	-	SBI 2412: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van kleur- en verfstoffen, Chemische industrie	241B	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
8901101	BIOGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
8901101	BIOGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	AR	2.5	3	2	1	2.13	-25	25	U		5
8901101	BIOGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EF NOx	2	2.5	2.5	2	2.25	-30	30	U	kan ook plus of min 50% zijn	5
8901101	BIOGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EF SO2	1	1.5	1.5	0.5	1.13	-75	75	U		5
T104803	_	ERI_SBI 2417: OVERIGE CHEM.GRONDST.,INDUSTRIE, PROCESEMISSIES Vervaardiging van synthetische rubber in primaire vorm, Chemische industrie	241B	EA NOx	2	2	2	0	1.5	-50	50	U		1
T101101	OGB	ERI_SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241B	EA NOx	2	2	2	0	1.5	-50	50	U		1
0100214	DIESEL	GEBRUIK BESTELAUTO DIESEL IDI,BEB. KOM PERSONEN/BEST.AUTO	9	AR	3	2	2	0	1.75	-30	10	T	mode=-10	4
0100211	BENZINE	GEBRUIK BESTELAUTO BENZINE,BEB. KOM PERSONEN/BEST.AUTO	9	AR	3	2	2	0	1.75	-30	10	T	mode=-10	4
0100215	LPG	GEBRUIK BESTELAUTO LPG,BEB. KOM PERSONEN/BEST.AUTO	9	AR	3	2	2	0	1.75	-30	10	T	mode=-10	4
0100212	BENZINE	GEBRUIK BESTELAUTO BENZINE KAT,BEB. KOM PERSONEN/BEST.AUTO	9	AR	3	2	2	0	1.75	-30	10	T	mode=-10	4
0100614	DIESEL	GEBRUIK BESTELAUTO DIESEL IDI,LANDEL.WEG PERSONEN/BEST.AUTO	10	AR	3	2	2	0	1.75	-10	30	T	mode=+10	4
0100414	DIESEL	GEBRUIK BESTELAUTO DIESEL IDI,AUTOSNELWEG PERSONEN/BEST.AUTO	10	AR	3	2	2	0	1.75	-10	30	T	mode=+10	4
0100411	BENZINE	GEBRUIK BESTELAUTO BENZINE,AUTOSNELWEG PERSONEN/BEST.AUTO	10	AR	3	2	2	0	1.75	-10	30	T	mode=+10	4
0100611	BENZINE	GEBRUIK BESTELAUTO BENZINE,LANDEL.WEG PERSONEN/BEST.AUTO	10	AR	3	2	2	0	1.75	-10	30	T	mode=+10	4
0100415	LPG	GEBRUIK BESTELAUTO LPG,AUTOSNELWEG PERSONEN/BEST.AUTO	10	AR	3	2	2	0	1.75	-10	30	T	mode=+10	4
0100615	LPG	GEBRUIK BESTELAUTO LPG,LANDEL.WEG PERSONEN/BEST.AUTO	10	AR	3	2	2	0	1.75	-10	30	T	mode=+10	4
0100412	BENZINE	GEBRUIK BESTELAUTO BENZINE KAT,AUTOSNELWEG PERSONEN/BEST.AUTO	10	AR	3	2	2	0	1.75	-10	30	T	mode=+10	4
0100612	BENZINE	GEBRUIK BESTELAUTO BENZINE KAT,LANDEL.WEG PERSONEN/BEST.AUTO	10	AR	3	2	2	0	1.75	-10	30	T	mode=+10	4

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
0340106	Marine diesel	Stilliggende schepen	11	AR	1	4	1	0	1.5	-50	20	T	mode=0	3
0340106	Marine diesel	Stilliggende schepen	11	EF NOx	4	2.5	4	2	3.13	-20	10	T	mode=0	3
0340106	Marine diesel	Stilliggende schepen	11	EF SO2	2	2	2	2	2	-40	0	U		3
T101101	AGFO	ERI_SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241A	EA NOx	2	2	2	0	1.5	-50	50	U		1
8901101	AARDGAS	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIES, vervaardiging basischemicalien, Chemische Industrie	241A	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
T102101	AGFO	ERI_SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	26A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T103603	_	ERI_SBI 261: BOUWMAT.+GLASINDUSTRIE, PROCESEMISSIES Vervaardiging en bewerken van glas, Overige industrie	26A	EA NOx	2	2	2	0	1.5	-50	50	U		1
8901901	AARDGAS	SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	26A	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
8901901	STOOKOLIE	SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	26A	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
T103803	_	ERI_SBI 264: BOUWMAT.+GLASINDUSTRIE, PROCESEMISSIES Vervaardiging van produkten voor de bouw uit gebakken klei Overige industrie	26A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T102101	AG	ERI_SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	26A	EA NOx	2	2	2	0	1.5	-50	50	U		1
8901901	HBO	SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	26A	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
T104003	_	ERI_SBI 268: BOUWMAT.+GLASINDUSTRIE, PROCESEMISSIES Vervaardiging van overige niet-metaalhoudende minerale produkten n.e.g. Overige industrie	26A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T102101	LSO	ERI_SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	26A	EA NOx	2	2	2	0	1.5	-50	50	U		1
T102101	HBO1	ERI_SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	26A	EA NOx	2	2	2	0	1.5	-50	50	U		1
8901901	LPG	SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIES, bouwmaterialen-, aardewerk- en glasindustrie, Overige industrie	26A	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
0401106	DIESEL	Mobiele werktuigen overig - verbranding	13	AR	1	1	1	0	0.75					4

Activity code	Fuel/activity	Process description (Dutch)	Cluster	Quantity	proxy	Empirical	methodological	validation	Strength	min (%)	max (%)	Shape of distribution	Further specification of distribution	Expert number
T101403	_	ERI_SBI 2415:KUNSTMESTSTOFFENIND., PROCESEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	2415	EA NH3	2	3	3	1	2.25	-10	10	U		1
T101201	AGFO	ERI_SBI 2415:KUNSTMESTSTOFFENIND., VERBRANDINGSEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	2415	EA NOx	2	2	2	0	1.5	-50	50	U		1
8900901	AARDGAS	SBI 2415:KUNSTMESTSTOFFENIND., VERBRANDINGSEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	2415	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
8900901	STOOKOLIE	SBI 2415:KUNSTMESTSTOFFENIND., VERBRANDINGSEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	2415	EF NOx	1	1.5	1.5	0	1	-50	50	U		1
8900901	HBO	SBI 2415:KUNSTMESTSTOFFENIND., VERBRANDINGSEMISSIES, kunstmeststoffenindustrie, Chemische Industrie	2415	EF NOx	1	1.5	1.5	0	1	-50	50	U		1

Appendix 3 Dependencies (in Dutch)

Cluster	Expert	Dependency (Dutch)	Comments
23201	EZ	Als alles op basis van crude oil input is berekend, dan zijn in deze cluster de NO_x en SO_2 emissies gecorreleerd. Dat geldt niet voor aardgas. Wel kan de crude oil input mede bepalend zijn voor hoeveel aardgas er in het proces wordt gebruikt.	Not applicable
40A	EZ	De hoeveelheid emissie kan beïnvloed worden door verschuivingen in de toedeling tussen papierindustrie, basis chemie en voedingsmiddelen. Deze drie categorieën hebben verschillende emissiefactoren.	Complementary correlation
3.3A	EZ, JH	De clusters 3.3A, 3.4A en 1A zijn gecorreleerd. De totale omvang van deze 3 clusters samen is maatgevend. De som moet kloppen met tabel 3.4 uit de NEH. 3.3a en 1a worden afzonderlijk bepaald . 3.4a is hierbij de sluitpost. Hierbij dient te worden opgemerkt dat het NEH getal nog gecorrigeerd wordt (4.3.1.2) voor mobiele werktuigen. Er wordt een post HBO en landbouw afgetrokken van het NEH totaal voordat dit gebruikt wordt om de emissies in cluster 3.4a te bepalen.	Very complicated; not implemented
241B	EZ	Rapcode 8901101(restgas en biogas): er is hier een correlatie met de totale brandstofinzet	Contribution to the total very small; neglected
3	JK	Er is een negatieve correlatie met bestelauto's (cluster 10). Een deel van de zware bedrijfsvoertuigen zou bij bestelauto's buiten de bebouwde kom gerekend moeten worden (sensor in weg meet voertuiglengte en telt deel van bestelauto's tenorechte als vrachtwagens). Er vind een procentuele verdeling plaats over drie wegcategorieën: autosnelweg, landelijke wegen en bebouwde kom. Daardoor is er een negatieve correlatie met cluster 7 (bebouwde kom) Er is een correlatie denkbaar met autobussen (cluster 19) en speciale voertuigen (cluster 18) maar deze lijkt verwaarloosbaar.	Complementary correlation (see table 4.2 – C2, C3, C4). Busses are not taken into consideration.
4	JK	Er is een indirecte correlatie met metingen van bestelauto's buiten de bebouwde kom (cluster 10). De lichte voertuigen en totaal bestelauto's worden met een vast percentage verdeeld over bebouwde kom, landelijke wegen en autosnelwegen. Je weet het totaal buiten de bebouwde kom voor lichte voertuigen (verdeeld naar landelijke wegen en autosnelweg). Daarvan trek je de bestelauto's af en dat levert personenautokilometers op. Echter, het aantal kilometers bestelauto's is veel kleiner dan personenauto's. Bovendien heeft dit verhaal betrekking op alle personenauto's en cluster 4 betreft de auto's zonder katalysator.	Very complicated; not implemented
5	JK	Er is een correlatie met cluster 12 (bouw). Deze correlatie loopt via het gedeelte verhuurbedrijven. Verhuurbedrijven verhuren zowel aan bouw als aan landbouw. De landbouwcijfers worden wel afgeleid uit verhuurcijfers, de bouwcijfers niet. Dit is omdat de verhuur al zit in de wijze waarop bouwcijfers worden bepaald. Er is een correlatie tussen cluster 5 (landbouw), cluster 12 (bouw) en cluster 13 (overig). Cluster 13 wordt bepaald door het totaal uit de NEH te nemen en daar clusters 5 en 12 van af te trekken.	Complementary correlation; C5
6	JK	Net als bij cluster 4 is hier een relatie met de bestelauto's en met de verdeling binnen en buiten bebouwde kom. Cluster 6 is negatief gecorreleerd met cluster 4.	Complementary correlation; C2, C3, C4

Cluster	Expert	Dependency (Dutch)	Comments
19	JK	Er is een correlatie met buiten de bebouwde kom Er is een indirecte zwakke correlatie met bestelauto's buiten de bebouwde kom (via miscategorisering van bestelwagens door de klassengrenzen bij meetlussen).	Not quantifiable
8 beb kom = alles – buiten de 2e kunnen we niets van zeggen (niet getalsmatig gecorreleerd)	JK	- Ook hier speelt de correlatie met bestelauto's alsmede de correlatie door de procentuele verdeling over de drie wegtypen. - Ook is er sprake van een correlatie met benzine en LPG auto's (clusters 6,4,8 en 14). Het totaal is bekend en wordt op basis van aannames verdeeld over brandstoffen.	Complementary correlation; C2, C3, C4 Not numerically correlated
9	JK	Er is een correlatie met cluster 10. Het totaal bestelauto's wordt met percentages verdeeld over 3 wegtypen. Het totaal moet 100% blijven.	Complementary correlation; C2, C3, C4
13	JK	Er is een correlatie met clusters 5 en 12. Het totaal moet in balans zijn.	See cluster 5
40A	DH	Er is een correlatie tussen de 2 ERI rapcodes en de SBI rapcode in dit cluster: Als bijvoorbeeld in de ERI te weinig brandstof wordt gerapporteerd dan wordt de emissiefactor te hoog en wordt dus de emissie in de bijschatting te hoog.	Correlation can only be applied when the underlying calculations are available (calculation of emission factors); not applied here.
241B	DH	Er is een correlatie tussen de groep ERI rapcodes en de groep SBI rapcodes in dit cluster: Als bijvoorbeeld in de ERI te weinig brandstof wordt gerapporteerd dan wordt de emissiefactor te hoog en wordt dus de emissie in de bijschatting te hoog.	Same as above
2415 idem	DH	Er is een correlatie tussen de groep ERI rapcodes en de groep SBI rapcodes in dit cluster: Als bijvoorbeeld in de ERI te weinig brandstof wordt gerapporteerd dan wordt de emissiefactor te hoog en wordt dus de emissie in de bijschatting te hoog.	Same as above
1lb, 2lb, 3lb, 4lb, 5lb, 6lb, 7lb, 8lb, 10lb	KvdH	De NH3 emissies worden bepaald met het MAM (Mest en Ammoniak) model. Door de wijze van berekenen ontstaan enkele correlaties. Elk veetype (koeien, varkens, pluimvee) wordt verdeeld over een aantal staltypen. Bijvoorbeeld varkens over gangbaar en emissiearm en bij pluimvee zijn er 5 staltypen. De verdeling over de staltypen moet opgeteld altijd op 100% uitkomen. Bij trekkingen uit verdelingsfuncties kun je dit oplossen door voor het hoogste percentage geen onafhankelijke trekking te doen maar deze als sluitpost te gebruiken om op 100% te komen. (commentaar JvdS: het lijkt mij dat deze correlatie niet speelt bij een analyse op rapcode nivo omdat rapcodes niet uitgesplitst zijn naar staltype). Het MAM model beschrijft een stikstofstroom. De volgorde is stallen -> opslag -> aanwending -> beweiding. Hierdoor ontstaat een correlatie: als er meer stikstof geemiteerd wordt bij de stallen dan is er bij de aanwending minder stikstof beschikbaar en dus minder emissie. Dit speelt in cluster 1lb (tussen rapcodes 0441121 en 0441221), in cluster 2lb (tussen 0445121 en 0445221), cluster 3lb (tussen 0446121 en 0446221), cluster 4lb (tussen 0442121 en 0442221), cluster 5lb (tussen 0447121 en 0447221), 7lb (tussen 0443121 en 0443221), 8lb (tussen 0448121 en 0448221) 10lb (tussen 0444121 en 0444221)	Correlation cannot be applied, because this refers to relations within an activity. Cascade correlation; C6

Cluster	Expert	Dependency (Dutch)	Comments
		Bij dieren die een weidegang kennen zijn emissies in weide en stal gecorreleerd. Meer emissie in de stal betekent minder emissies in de wei. In het traject Stal->opslag->aanwending wordt ca. 20% van de stikstof in de stroom NH3, in het traject Wei wordt ca 8% van de stikstofstroom omgezet in NH3. De fractie van de dieren in de stal en die van de dieren in de wei moet samen 100% zijn. Dit speelt in clusters 4lb, 7lb	
		Er is een correlatie tussen alle NH3 emissies uit aanwending. Deze loopt via het weer. Als er een jaar veel regen is dan gaan alle NH3 emissies uit aanwending omlaag. Bij weinig regen gaan ze omhoog. Dit geldt dus voor clusters (rapcode): 1lb (0441221), 2lb (0445221), 3lb (0446221), 4lb (0442221), 5lb (0447221), 7lb (0443221), 8lb (0448221) en 10lb (0444221)	Cascade correlation; C6
		Er is een correlatie tussen kunstmestaanwending en mestaanwending. Als mestaanwending minder emissies geeft blijft er meer stikstof in de grond waardoor er bij het bemestingsadvies minder kunstmest wordt voorgeschreven dus minder kunstmest wordt aangewend. Dit betekent een correlatie tussen enerzijds cluster 6lb en anderzijds alle aanwendingsrapcodes samen, namelijk: clusters (rapcode): 1lb (0441221), 2lb (0445221), 3lb (0446221), 4lb (0442221), 5lb (0447221), 7lb (0443221), 8lb (0448221) en 10lb (0444221)	Not quantifiable. Not related in calculations.

Appendix 4 Input data

The tables below contain the most important uncertainty data in a condensed presentation. The source-activity combinations are sorted by absolute contribution to the total annual emission. Only the top 20 is displayed. The item "Others" shows the remaining emission, due to all other source-activity combinations.

NO_x

Cluster code	Source category	NO_x emission kg	PDF type[1]	half 95%-unc. intervals[2]		
				AR unc.	EF unc.	EM unc.
1	Binnenscheepvaart - verbranding	30730000	T / T	5%	5%	
5	Mobiele werktuigen landbouw - verbranding	25109850	T / L	15%	141%	
3	GEBRUIK TREKKERS VR. OPLEGGERS,AUTOSNELWEG OVERIG	22474306	T / L	15%	71%	
2	Zeescheepvaart - Varende zeeschepen, verbrandingse	19323405	T / T	30%	5%	
4	GEBRUIK PERS.AUTO BENZINE,AUTOSNELWEG PERSONEN/BES	19301379	U / L	5%	71%	
3	GEBRUIK VRACHTAUTO,AUTOSNELWEG OVERIG WEGVERKEER	15272055	T / L	15%	71%	
9lb	Landbouwbodems	15176864	L			200%
3.3A	Vuurhaarden consumenten (verbrandingsemissies), Ho	14356077	T / U	1%	20%	
40A	SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSI	12630000	U / U	1%	30%	
40A	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEM	11190451	U			10%
23201	ERI_SBI 23201: AARDOLIERAFFINAGE, VERBRANDINGSEMIS	10002198	U			5%
7	GEBRUIK TREKKERS VR. OPLEGGERS,BEB. KOM OVERIG WEG	9288160	U / L	50%	71%	
4	GEBRUIK PERS.AUTO BENZINE,LANDEL.WEG PERSONEN/BEST	8504564	U / L	5%	71%	
40K	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEM	8436000	U			10%
6	GEBRUIK PERS.AUTO BENZINE KAT,AUTOSNELWEG PERSONEN	8215980	T / L	10%	71%	
9	GEBRUIK BESTELAUTO DIESEL IDI,BEB. KOM PERSONEN/BE	8187177	T / L	10%	71%	
3	GEBRUIK VRACHTAUTO,LANDEL.WEG OVERIG WEGVERKEER	7844343	T / L	15%	71%	
40K	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEM	7214196	U			10%
3	GEBRUIK TREKKERS VR. OPLEGGERS,LANDEL.WEG OVERIG W	6961183	T / L	15%	71%	

[1]) Format: [AR] / [EF] or [EM]. N = normal distribution, L = lognormal, U = uniform, T = triangular

[2]) Valid only for normal or lognormal distribution. For uniform: upper limit (lower limit is omitted; usually symmetric). For triangular: upper limit (lower limit and most likely value are omitted).

SO_2

Cluster code	Source category	SO_2 emission kg	PDF type[1]	half 95%-unc. intervals[2]		
				AC unc.	EF unc.	EM unc.
23201	ERI_SBI 23201: AARDOLIERAFFINAGE, VERBRANDINGSEMIS	26668872	U			10%
2	Zeescheepvaart - Varende zeeschepen, verbrandingse	11108838	T / T	30%	0%	
40K	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEM	8878946	U			10%
23201	ERI_SBI 23201: AARDOLIERAFFINAGE, PROCESEMISSIES	6399054	U			5%
40K	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEM	4353000	U			10%
271	ERI_SBI 271/273:BASISMETAALINDUSTRIE, VERWERKING E	3374268	L			40%
11	Stilliggende schepen	3171374	T / U	20%	0%	
274	ERI_SBI 274: BASISMETAALINDUSTRIE, PROCESEMISSIES	3115077	L			40%
1	Binnenscheepvaart - verbranding	2093040	T / U	5%	25%	
5	Mobiele werktuigen landbouw - verbranding	1717514	T / L	15%	71%	
40R	SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEMISSI	1578332	L			20%
40K	ERI_SBI 40:ELECTRICITEITSDISTRIBUT, VERBRANDINGSEM	981180	U			10%
241B	ERI_SBI 2413: OVERIGE CHEM.GRONDST.,INDUSTRIE, PRO	947398	L			40%
241B	SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMISSIE	721750	U / U	25%	75%	
26A	ERI_SBI 261: BOUWMAT.+GLASINDUSTRIE, PROCESEMISSIE	594652	L			40%
241A	ERI_SBI 241:OVERIGE CHEM.GRONDST., VERBRANDINGSEMI	560014	L			20%
26A	SBI 26:BOUWMAT.+GLASINDUSTRIE, VERBRANDINGSEMISSIE	481500	L			20%
9	GEBRUIK BESTELAUTO DIESEL IDI,BEB. KOM PERSONEN/BE	481270	T / L	10%	71%	
13	Mobiele werktuigen overig - verbranding	445016	L			100%

NH_3

Cluster code	Source category	NH_3 emission kg	PDF type[1]	half 95%-unc. intervals[2]		
				AR unc.	EF unc.	EM unc.
1lb	VEESTAPEL, MELKKOEIEN, Stallen + opslag NH3	20275000	N			25%
2lb	VEESTAPEL, VLEESVARKENS, Stallen + opslag NH3	16300000	N			25%
1lb	VEESTAPEL, MELKKOEIEN, Aanwending mest - emissie	15181000	L			100%
6lb	Aanwending van kunstmest - NH3	10700000	N			50%
5lb	VEESTAPEL, LEGHENNEN, Stallen + opslag NH3	9061000	N			25%
3lb	VEESTAPEL, FOKVARKENS, Stallen + opslag NH3	8817000	N			25%
2lb	VEESTAPEL, VLEESVARKENS, Aanwending mest - emissi	8320000	L			100%
4lb	VEESTAPEL, JONGVEE FOKKERIJ, Stallen + opslag NH3	6822000	N			25%
8lb	VEESTAPEL, VLEESKUIKENS, Stallen + opslag NH3	6071000	N			25%
4lb	VEESTAPEL, JONGVEE FOKKERIJ, Aanwending mest - em	5189000	L			100%
1lb	VEESTAPEL, MELKKOEIEN, Weiden - emissie NH3	4935000	N			50%
3lb	VEESTAPEL, FOKVARKENS, Aanwending mest - emissie	4718000	L			100%
7lb	VEESTAPEL, VLEESVEE, Aanwending mest - emissie NH	3679000	L			100%
7lb	VEESTAPEL, VLEESVEE, Stallen + opslag NH3	3459000	N			25%
5lb	VEESTAPEL, LEGHENNEN, Aanwending mest - emissie N	3447000	L			100%
4lb	VEESTAPEL, JONGVEE FOKKERIJ, Weiden - emissie NH3	3215000	N			50%
10lb	VEESTAPEL, VLEESKALVEREN, Stallen + opslag NH3	2334000	N			25%
8lb	VEESTAPEL, VLEESKUIKENS, Aanwending mest - emissi	2193000	L			100%
7lb	VEESTAPEL, VLEESVEE, Weiden - emissie NH3	2145000	N			50%

Appendix 5 Uncertainty assessment in the 2000 emissions of NO_x, SO_2 and NH_3 in the Netherlands (according to “Dutch sector” split)

Introduction

This document contains the results of the uncertainty assessment in the 2000 emission figures for NO_x, SO_2 and NH_3, and split up according to the main Dutch sectors. The results are obtained using the methods and the results of the expert elicitation as reported in the TNO report **“Uncertainty assessment of NO_x, SO_2 and NH_3 emissions in the Netherlands”**. A detailed description of the Tier 2 method used for the uncertainty assessments can be found in the main report.

The results in this document are only indicative, because of the following reasons:

- The calculations were performed with the data as submitted in the 2002 emission inventory round. The emissions therefore may slightly differ from the most recent emission inventory round.
- A new emission source was added: emissions from fishery (this source was included in the Dutch emission inventory after completion of the major report);
- No expert elicitation was performed yet for this source, we used a default uncertainty;
- This holds also for several other sources. Because the default uncertainty (which we used for the sources for which no expert elicitation took place) is expected to be higher than the opinion of the experts, we expect that further input from experts will decrease the calculated uncertainties.
- The results are aggregated to the sector split as required for the Dutch policy development.

Results

In this section the results of the uncertainty assessment are presented in the form of tables. The tables indicate for the different components the emissions in 2000 and the uncertainty in the emissions for the different policy sectors. The uncertainty is expressed as 95% confidence interval (notation +/- …%). For each component the major contributing sectors (or sources) to the uncertainty in the total national emission are elaborated in general terms.

SO_2		Emissions 2000 (KTon)		95 % Confidence interval (+/- %)	
Industry, energy sector and waste management		**65,4**		**6%**	
Energy sector		*16,9*		*8%*	
Industry total		*48,2*		*8%*	
	Refineries		33,1		8%
	Iron and steel		7,0		26%
	Chemical industry		4,1		25%
	Other industry		3,9		21%
Waste Management		*0,3*		*35%*	
Transport		**21,0**		**16%**	
Road traffic total		*3,9*		*19%*	
	Passenger cars		2,4		26%
	Trucks [a)]		1,5		27%
	Bikes		0,0		49%
Other transport total		*17,1*		*20%*	
	Trains (diesel)		0,1		68%
	Inland shipping (freight)		2,3		23%
	Recreational shipping		0,1		97%
	Fishery		0,0		176%
	Aviation		0,3		42%
	Other mobile sources		2,6		65%
	Other sea shipping		11,7		24%
Consumers		**0,5**		**46%**	
Institutional, services and building industry [b)]		**1,7**		**42%**	
Agriculture		**0,3**		**58%**	
EU-NEC-TOTAL		**88,9**		**6%**	

In the following table the most contributing (sub)sectors to the total uncertainty in SO_2 emissions are presented. The uncertainty (95 % Confidence interval) is expressed in absolute quantities (+/- kton). Note that the separate sector contributions cannot be simply added to arrive at the uncertainty per substance (because of their independency).

SO_2

Contribution of sectors to the uncertainty in the national emissions	95% Confidence (+/- kton)	Contribution of subsectors to the uncertainty in the sector emissions	95% Confidence (+/- kton)
Industry, energy sector en waste management	3,9	ERI refineries	2,5
		Iron and steel	1,8
		ERI energy	1,1
Transport	3,4	Other sea shipping	2,8
		Other mobile sources	1,7
		Passenger cars	0,6
Consumers	0,2	Combustion of fuel oil , heating houses	0,2
		Combustion of wood in stoves and fireplaces	0,1
		Combustion of coal, heating of houses	0,1
Institutional, services and building industry	0,7	WWTP	0,7
		Building industry	0,2
Agriculture	0,1	Combustion	0,1
SO_2 National Total	**5,3**		

NO_x	Emissions 2000 (KTon)	95 % Confidence interval (+/-%)
Industry, energy sector and waste management	**99,8**	**11%**
large plants >= 20 MWth [a]	*42,1*	*5%*
small plants <= 20 MWth	*57,7*	*19%*
Transport	**268,5**	**20%**
Road traffic total	*168,8*	*20%*
Passenger cars	91,7	27%
Trucks	76,6	29%
Bikes	0,5	53%
Other transport total	*99,7*	*41%*
Trains (diesel)	1,8	71%
Inland shipping (freight)	33,5	9%
Recreational shipping	1,3	96%
Fishery	0,0	172%
Aviation [b)]	3,1	87%
Other mobile sources	37,5	102%
Other sea shipping [b)]	22,5	21%
Consumers	**19,6**	**20%**
Institutional, services and building industry	**12,1**	**15%**
Agriculture	**12,2**	**23%**
EU-NEC-TOTAL	**412,2**	**13%**

[a]: Because this sector split can not be exactly retrieved from the database we made the arbitrary choice to include here all the combustion emissions from individual registered plants in the energy and refinery sector. All other sources in the target group were allocated under "small plants"

[b]: Definitions may differ from the exact NEC definitions

In the following table the most contributing (sub)sectors to the total uncertainty in NO_x emissions are presented. The uncertainty (95 % Confidence interval) is expressed in absolute quantities (+/- kton). Note that the separate sector contributions cannot be simply added to arrive at the uncertainty per substance (because of their dependency).

NO_x

Contribution of sectors to the uncertainty in the national emissions	95% Confidence interval (+/- kton)	Contribution of subsectors to the uncertainty in the sector emissions	95% Confidence interval (+/- kton)
Industry, energy sector en waste management	10,9	Non ERI energy	7,4
		Iron and steel	5,7
		Chemical industry	4,6
Transport	54,0	Other Mobile sources	39,2
		Passenger cars	24,9
		Trucks and busses	22,3
Consumers	4,0	Combustion natural gas, heating of houses	3,3
		Combustion natural gas, warm water supply	2,5
		Combustion of wood in stoves and fireplaces	1,1
Institutional, services and building industry	1,8	Institutional, services	1,8
		Building industry	0,5
		WWTP	0,3
Agriculture	2,8	Combustion	2, 8
NOx National Total	**53,8**		

NH_3		Emissions 2000 (KTon)	95 % Confidence Interval (+/- %)
Industry		**3,0**	**124%**
Transport		**2,6**	**163%**
Consumers		**2,1**	**71%**
Institutional, services and building industry [a)]		**0,5**	**93%**
Agriculture		**138,8**	**16%**
Manure total		*128,1*	*16%*
	Cattle	69,2	26%
	Pigs	38,2	28%
	Poultry	20,8	23%
Synthetic fertilizer		*10,7*	*48%*
EU-NEC-TOTAAL		**147,1**	**16%**

The next table represents the most contributing (sub)sectors to the total uncertainty in NH_3 emissions. The uncertainty (95 % Confidence interval) is expressed in absolute quantities (+/- kton). Note that the separate sector contributions cannot be simply added to arrive at the uncertainty per substance (because of their dependency).

NH_3

Contribution of sectors to the Confidence in the national emissions	95% Confidence interval (+/- kton)	Contribution of subsectors to the Confidence in the sector emissions	95% Confidence interval (+/- kton)
Agriculture	21,9	Synthetic fertilizer	5,1
		Cattle	17,8
		Pigs	10,8
		Poultry	4,8
Transport	4,2	Passenger cars	4,2
Industry	3,7	Chemical industry	3,4
		Other industry	0,7
Consumers	1,5	Pets, manure	1,3
		Cleaning products	0,5
		Smoking of cigarettes	0,3
Institutional, services and building industry	0,5	Institutional, services	0,5
NH_3 National Total	**23,1**		

Appendix 6 Quick-Scan Onzekerheidsanalyse verzurende stoffen (in Dutch)

- **QS-1. Hoe is de opdracht/probleemdefinitie afgebakend (welke context-factoren worden wel/niet meegenomen)?**

1a. Probleemvisie

✓ Wat is de visie van de opdrachtgever op het probleem (in twee zinnen)?
EmissieRegistratie (WEM): Om verbeteringen in de monitoring beter te kunnen sturen en prioriteren, is inzicht nodig in de kwaliteit en onzekerheid van emissiecijfers. Echter, kennis omtrent onzekerheden en methodieken voor in beeld brengen daarvan zijn maar beperkt aanwezig in het ER circuit.

✓ Zijn er andere visies op het probleem dan die van de opdrachtgever? Welke (twee zinnen per visie)?

MNP: Inzicht in kwaliteit emissiecijfer is nodig bij de evaluatie van overheidsbeleid, gericht op het voldoen aan emissie-doelen. Bij het formuleren van conclusies over effectiviteit van genomen maatregelen, of noodzaak voor aanvullende maatregelen moet je goed weten of uitspraken voldoende gesteund kunnen worden gezien de kwaliteit van de beschikbare gegevens.
MNP: Om ketenberekeningen voor verzuring (bron-verspreiding-effect) te kunnen doen, is het nodig de marges van de emissie-data te kennen. Dit heeft effect op de mogelijke uitkomsten van de berekeningen.
VROM (KvI): In het verleden is veel commotie geweest over het ontbreken van marges rondom RIVM-cijfers (Affaire deKwaadsteniet). Naast het aanpakken van deze kritiek, is het ook zinnig om onzekerheden te kennen voor het formuleren van nieuwe doelen en de noodzaak voor aanvullend beleid.

(Het gaat hier om visies van de betrokken MNP'ers en derden; belicht zowel politiek-maatschappelijke als wetenschappelijke aspecten.)

⇨ *1a-H1,1a-H2*

✓ Hoe sterk is het probleem verweven met andere problemen? Met welke?

⇨ *1a-H3*

Verwevenheid bestaat tussen beleidsvelden klimaatverandering, ozonproblematiek en verzuring. Beleid voor klimaatverandering (BKG-beleid) heeft ook gevolg voor thema verzuring en andersom.

Dus ook verweving met onzekerheidsanalyse van broeikasgassen voor het National Inventory Report voor IPCC, en de vervolgstudie van NOVEM (ICIS, IVM). Het gaat hierbij om dezelfde emissiebronnen voor verbrandingsgassen (vuurhaarden, verkeer). De onzekerheid in de basisdata voor deze activiteitenniveau's zou hetzelfde moeten zijn in deze studies. Uitwisseling is waarschijnlijk lastig omdat aggregatieniveaus verschillend zijn. Hopelijk heeft de studie een voorbeeldfunctie, zodat andere stofgroepen en thema's in de toekomst worden opgepakt.

Actiepunt: Vergelijken uitkomsten BKG studie met deze studie.

1b. Gerelateerde kennis- en onderzoeksvragen

✓ Wat is de *kennisvraag* van de opdrachtgever in relatie tot het probleem (in twee zinnen)?
Emissieregistratie: Wat is de kwaliteit van emissies van verzurende stoffen in termen van onzekerheid en betrouwbaarheid? Welke methoden en kennis is nodig om uitspraken over onzekerheden te kunnen doen?
VROM (KvI, verkeer?): Is de kwaliteit van emissiecijfers voldoende voor het formuleren van nieuwe doelen en de noodzaak voor aanvullend beleid?

✓ In welke onderzoeksvragen is deze kennisvraag vertaald door het MNP (een zin per onderzoeksvraag)?
MNP: Is de kwaliteit van emissiecijfers voldoende voor evaluatie van overheidsbeleid op het gebied van verzuring?
MNP: Wat is de kwantitatieve onzekerheid in emissies van verzurende stoffen, die input zijn voor de rekenketen van bron naar milieu-effect?

✓ Welke mogelijkerwijs relevante aspecten van het probleem zijn buiten beschouwing gelaten? Waarom (een zin per aspect)?
⇨ *1b-H1, 1b-H2*
Niet alle relevante experts zijn betrokken in het onderzoek, vanwege de beschikbare capaciteit en tijd.

1c. Beleidscontext en probleemhistorie

✓ Wat voor rol speelt de studie in het beleidsproces? (meerdere keuzes zijn mogelijk)
- ❑ ad-hoc beleidsadvies
- ❑ evalueren van bestaand beleid
- ❑ evalueren van voorgesteld beleid
- ❑ signaleren van mogelijke problemen
- ❑ identificeren en/of evalueren van mogelijke oplossingen
- ❑ uitvoeren van contra-expertise
- ❑ anders (licht toe)

⇨ *1c-H1*
Evaluatie van bestaand en voorgesteld beleid; signaleren mogelijke problemen (zwakke kennis)

- ✓ Wat is er in het verleden over dit probleem gezegd?

  ⇨ *1c-H2*

  In 2001 is een vergelijkbare studie uitgevoerd bij het RIVM. Daarbij waren enkel RIVM-experts betrokken, en het aggregatieniveau van processen was anders (Bedrijfsgroepen-niveau en categorieën volgens KEMA-studie). De resultaten daarvan zijn in de Bijlage van MB2001 opgenomen, maar in de tekst is er niets over opgemerkt. Dus geen communicatie en conclusies mbt onzekerheden verzuring.
  De huidige studie neemt emissie-oorzaken (RAP-codes) als uitgangspunt, wat beter aansluit op de werkwijze en kennis binnen de ER-werkgroepen. Hiermee wordt de studie beter bruikbaar in het gewenste verbeterproces van de emissie-monitoring. Beleidsevaluatie kan ook beter gedaan worden, omdat bijdragen per doelgroep beter herkenbaar zijn.

- ❑ **QS-2. Wat zijn de voornaamste betrokkenen (stakeholders/actoren) en hun rollen en visies ten aanzien van het probleem, en welke consequenties heeft dit voor de uiteindelijke probleemdefinitie en aanpak?**

2a. Inventarisatie betrokkenen en hun probleemvisie

- ✓ Wat zijn de voornaamste betrokkenen (stakeholders/actoren) rond het probleem en in hoeverre wordt het probleem door de betrokkenen reeds onderkend (bijvoorbeeld vanuit hun mogelijk verschillende probleemvisies en rollen)?
  (Vul de eerste twee hoofdkolommen van de tabel 1 in.)

  ⇨ 2a-H1, 2a-H2, 2a-H3

  ⇨

  WEM: Werkgroepleden, noodzaak wordt erkend en kennis wordt expliciet gebruikt.
  RIVM: Thema verantwoordelijke verzuring (LED) en Milieubalans (NMD), Winand Smeets en Bart Wesselink. Zijn zich bewust van het probleem
  VROM: KvI Johan Sliggers. Is niet betrokken bij deze studie, maar vermoedelijk wel op de hoogte van de problematiek.

2b. Probleemkarakteristieken

- ✓ Zijn de volgende karakteristieken van toepassing op het probleem (meerdere keuzes mogelijk)?
  - ❑ er is dissensus over beleidsdoelen met betrekking tot het probleem en/of oplossingsrichtingen
    Voor wat betreft kennisopbouw rondom onzekerheden is er geen dissensus. De manier waarop je met deze kennis in beleidsevaluatie en formulering omgaat kan verschillen. Zou in de toekomst sterker kunnen spelen, als het beleidsdoel in zicht komt.

    ⇨ *2b-H1*

- ❑ er staat maatschappelijk veel op het spel
  Formuleren van aanvullend beleid betreft specifieke doelgroepen.
  ⇨ *2b-H2*
- ❑ er is dissensus over het soort kennis dat nodig is om het beleidsprobleem op te lossen
  De uitkomst van het onderzoek is zo goed als de beschikbare kennis. Naast kwantitatieve onzekerheid proberen we ook ene inschatting te geven van de kwaliteit van cijfers. De NUSAP scores zijn niet algemeen geaccepteerd, de CLRTAP good practice guide wordt wel gevolgd. Een externe review op de studie zou wenselijk zijn.
  ⇨ *2b-H3*
- ❑ er is grote onzekerheid over het (natuurlijke en sociale) gedrag van het systeem dat relevant is voor het probleem en zijn oplossing
  Dat is juist het onderwerp van de studie.
  ⇨ *2b-H4*

2c. Gewenste stakeholder-betrokkenheid.

✓ Welke rol en inzet van de betrokkenen valt te overwegen, en gedurende welke fase van de studie (begin, tijdens, na afloop)?
(Vul de laatste hoofdkolom van tabel 1 in.)
⇨ *2c-H1*

❑ **QS-3. Wat zijn de belangrijkste indicatoren/graadmeters die gebruikt worden in de studie en wat is hun relatie tot de probleemdefinitie?**

✓ Wat zijn de belangrijkste indicatoren/graadmeters die in deze studie gebruikt worden, en hoe goed weerspiegelen deze indicatoren/graadmeters de essentiële aspecten van het afgebakende probleem?
Kwantitatieve onzekerheden: 95% ranges en hun verdeling
Kwalitatieve onderbouwing: NUSAP pedigree scores.
⇨ *3a-H1, 3a-H2, 3a-H3*

✓ Hoe groot is het draagvlak voor het gebruik van deze indicatoren/graadmeters bij beleidsanalyses in de wetenschap en in de maatschappij, inclusief besluitvormers, politici, etc.?
Kwantitatief groot (IPCC, CLRTAP)
Kwalitatief (nog) laag. Recente methode die zich nog moet bewijzen.
⇨ *3b-H1, 3b-H2*

- **QS-4. Hoe toereikend is de beschikbare kennisbasis om de opdracht succesvol uit te voeren?**

  ✓ Welke kwaliteitseisen zijn relevant voor het antwoord?
  Voldoende experts per kennisveld.
  Inzicht in onderbouwing cijfermateriaal.
  NUSAP pedigree: proxys, empirie, methodes, onafhankelijke toetsing.
  ⇨ *4a-H1*

  ✓ Welke beleidsrelevante controverses spelen er t.a.v. de kennisbasis?
  Er zijn veel verschillende methodologieën in omloop (UU, TU-Delft, ICIS etc) over expert-bevraging, kwaliteitsaspecten en typologieën. De experts kunnen zeer verschillende antwoorden geven, en deze zijn lastig te beoordelen en combineren. Dit is methodisch zeer omstreden. Of deze controverses relevant voor beleid zijn? Verder is er nog discussie over het belang van afhankelijkheden in dit soort analyses, waarbij een groot aantal bronnen wordt gecombineerd en geaggregeerd. De studie geeft hier hopelijk ook antwoord op.
  ⇨ *4b-H1*

  ✓ Wat zijn de belangrijkste knelpunten in de kennisbasis om de gewenste kwaliteit te leveren, mede in het licht van bestaande controverses en de sterkte en zwakte van kennis in de betreffende domeinen?
  Is juist het onderwerp van studie.
  ⇨ *4c-H1*

  ✓ Wat betekenen deze knelpunten voor de reikwijdte, kwaliteit en acceptatie van de resultaten van deze studie?
  Is een erkend probleem. Daarom een externe review nodig.
  ⇨ *4d-H1, 4d-H2,4d-H3,4d-H4*

  ✓ Hoe kunnen deze knelpunten in de toekomst het beste worden aangepakt?
  Wetenschappelijk onderzoek over methodieken en case-studies doen.
  ⇨ *4e-H1*

- **QS-5. Wat zijn de meest relevante onzekerheden in het licht van het probleem en wat is hun aard en locatie?**

  ✓ Op welke wijze dienen onzekerheden in het beleidsadvies meegenomen te worden (meerdere keuzes zijn mogelijk; kan per indicator/graadmeter verschillen)?
  (Motiveer de gemaakte keuzes kort.)

  - Onzekerheden spelen geen noemenswaardige rol.
  - De *robuustheid* van beleidsrelevante conclusies ten aanzien van onderliggende onzekerheden is bepaald, en wordt expliciet vermeld.
    Dit moet uit deze studie worden afgeleid. Daar moeten de thema-experts nog wel uitspraken over doen. Of zij de kennis juist kunnen interpreteren is dan de vraag.

- De meest *beleidsrelevante onzekerheden* zijn geïdentificeerd.
  - De *mogelijke consequenties* van deze onzekerheden voor de beleidsrelevante conclusies worden besproken, bijv. wat zijn de gevolgen t.a.v. het wel/niet halen van beleidsdoelstellingen etc.
    Is wenselijk voor MB2004.
  - Informatie wordt gegeven over de *aard* van de beleidsrelevante onzekerheden, bijv. heeft onzekerheid primair te maken met gebrekkige c.q. beperkte kennis[1] en/of is ze het principieel gevolg van het onvoorspelbare en variabele karakter van het systeem[2]?
    Typologie is geen onderdeel van de studie, maar de sterkte van de onderbouwing is dat wel.
  - Informatie wordt gegeven over de (on)mogelijkheid tot *reductie en controle* van deze onzekerheden en van hun mogelijke effecten, bijv. is het mogelijk om kennis-onzekerheid op termijn te verkleinen door meer kennis te verzamelen, kan het effect van intrinsieke onzekerheid beperkt worden door gerichte beleidsmaatregelen te nemen?
    Valt af te leiden uit de resultaten, en met name uit kwalitatieve scores.
    De meest *beleidsrelevante onzekerheden* zijn geïdentificeerd.
  - Er wordt besproken wat de *mogelijke consequenties* van deze onzekerheden zijn voor de beleidsrelevante conclusies, bijv. wat zijn de gevolgen t.a.v. het wel/niet halen van beleidsdoelstellingen etc.
  - Ook wordt informatie gegeven over de *aard* van de beleidsrelevante onzekerheden, bijv. heeft onzekerheid primair te maken heeft met gebrekkige c.q. beperkte kennis (bijv. controverses; gebrek aan inzicht; onderzoek in ontwikkeling; beperkte empirische basis (weinig metingen beschikbaar of mogelijk)) en/of is ze het principieel gevolg van het onvoorspelbare en variabele karakter van het systeem (vb. beperkte voorspelbaarheid van menselijk gedrag; sociaal-economische ontwikkelingen; mate waarin maatregelen en regels/afspraken wel/niet geïmplementeerd nageleefd worden; mate van controle /handhaafbaarheid van maatregelen etc.)?
  - Bovendien wordt informatie gegeven over de (on)mogelijkheid tot *reductie en controle* van deze onzekerheden en van hun mogelijke effecten, bijv. is kennis-onzekerheid op termijn te verkleinen door meer kennis te verzamelen, kan het effect van intrinsieke onzekerheid beperkt worden door gerichte beleidsmaatregelen te nemen?
- Onzekerheden in de belangrijkste *eindresultaten* worden expliciet weergegeven.
  - Een kwantitatieve beschrijving van beleidsrelevante onzekerheden is vereist (bijv. bandbreedtes, uitkomsten uit scenario-studies). Ja.

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[1] Bijv. controverses; gebrek aan inzicht; onderzoek in ontwikkeling; beperkte empirische basis (weinig metingen beschikbaar of mogelijk).

[2] Bijv. beperkte voorspelbaarheid van menselijk gedrag; sociaal-economische ontwikkelingen; mate waarin maatregelen en regels/afspraken wel/niet geïmplementeerd nageleefd worden; mate van controle /handhaafbaarheid van maatregelen etc.

- ❍ Een kwalitatieve beschrijving van de beleidsrelevante onzekerheden is voldoende. Ja.
- ❑ De belangrijkste *'bronnen van onzekerheid'* worden opgespoord en hun bijdrage tot de onzekerheid van het eindresultaat wordt ingeschat.
  - ❍ Een kwantitatieve analyse is vereist (bijv. kwantitatieve gevoeligheidsanalyse). Ja
  - ❍ Een kwalitatieve analyse is voldoende. Ja
    ⇒ 5a-H1, 5a-H2

✓ Welke onzekerheidsaspecten verdienen extra aandacht, te bepalen aan de hand van onderstaande probleemkarakteristieken (meerdere keuzes zijn mogelijk; kan per indicator/graadmeter verschillen)?

- ❑ diverse aannames zijn kritisch
  Gebruik key-sources en defaults is een top-down keuze, waardoor je onzekere bronnen over het hoofd kunt zien.
  => *5b-H1*
- ❑ schatting van indicator zit dicht bij norm- of doelstelling voor die indicator
  NVT
  ⇒ 5b-H2
- ❑ een kleine verandering van de indicatorschatting heeft mogelijk grote gevolgen voor geschatte kosten, impacts of risico's
  NVT
  ⇒ 5b-H2
- ❑ er is dissensus over beleidsdoelen
  NVT
  =>*5b-H3*
- ❑ er staat maatschappelijk veel op het spel
  NVT
  => *5b-H4*
- ❑ er is dissensus over het soort kennis dat nodig is om het probleem op te lossen
  NVT
  => *5b-H5*
- ❑ er is grote onzekerheid over het (natuurlijke en sociale) gedrag van het systeem dat relevant is voor het probleem en zijn oplossing
  Onderwerp van studie
  => *5b-H6*
- ❑ de gebruikte assessment methode kent haar eigen typische onzekerheden die extra aandacht behoeven (bijvoorbeeld modelstructuur onzekerheden)
  Gebruik key-sources en defaults is een top-down keuze, waardoor je onzekere bronnen over het hoofd kunt zien. Combinatie van expertantwoorden is ook omstreden.

=> *5b-H7*

- ✓ Op welke 'lokaties' (onderdelen) verwacht je de belangrijkste onzekerheden, en wat weet je over hun aard?
  Zie uitkomsten eerder uitgevoerde Tier-1 studie.
  => *5c-H1*

- ✓ Welke acties/methoden zijn vereist om de belangrijkste onzekerheden beter in kaart te brengen en wat is de haalbaarheid daarvan binnen de gegeven capaciteit? Welke onzekerheidsassessment besluit je uit te voeren?
  Verbeteren monitoringsproces naar emissiebronnen; aanvullend methodisch onderzoek.
  ⇒ *5d-H1*

❑ **QS-6. Hoe wordt onzekerheidsinformatie gerapporteerd?**
In de MB2004 willen we de resultaten gebruiken. Hiervoor is nodig dat de boodschappen juist en helder worden gecommuniceerd.

a. Identificeer je publiek en je hoofdboodschappen, en zorg voor goede afstemming van beide.

- ✓ Wat zijn de voornaamste boodschappen die je wilt overbrengen en hoe sluit dat aan op de interesse/behoefte van de ontvanger(s) en op datgene wat de ontvanger(s) met de informatie zal/wil doen?
  WEM: Wordt bediend met (technisch) rapport. Welke emissiebronnen vergen meer aandacht en wil je beter in kaart brengen.
  VROM en 2e Kamer via MB2004. Aangeven wat de onzekerheid is van het landelijk totaal verzurende stoffen. Is het beleidsdoel bereikt, gezien deze onzekerheden? Op welke doelgroepen moet je aanvullend beleid richten, gezien de grootte en onzekerheid van emissies.
  => *6a-H1, ..., 6a-H5*

b. Identificeer de robuustheid van de hoofdboodschappen.

- ✓ Wat zijn de voornaamste aannames waarop de hoofdboodschappen van het beleidsadvies/rapport zijn gebaseerd en hoe robuust zijn de hoofdconclusies voor aannames en voor onzekerheden in gebruikte kennis en informatie?
  Robuustheid wordt expliciet onderzocht, maar communicatie hiervan is nog niet eerder gedaan.
  => *6b-H1,...,6b-H3*

c. Identificeer beleidsrelevante onzekerheidsaspecten.

- ✓ Welke onzekerheidsaspecten verdienen extra aandacht in het licht van de beleidsrelevantie?
  =>*6c-H1*

d. Rapporteer onzekerheid op een transparante wijze.

Extra inspanning nodig, samen met onzekerheids-experts.
=>6d-H1,…,6d-H4

e. Zorg voor een afgewogen en consistente rapportage over onzekerheid.

Extra inspanning nodig, samen met onzekerheids-experts.
=>6e-H1,…,6e-H9

f. Zorg voor traceerbaarheid en onderbouwing bij schriftelijke rapportage.

Zit in rapport verwerkt.
=>6f-H1,…,6f-H3

Tabel 1 *De voornaamste betrokkenen bij de studie*

Identificeer de belangrijkste betrokkenen rond dit probleem: ↓	Wordt het probleem reeds onderkend door de betrokkenen? (vraag 2a)				Welke betrokkenheid in de studie is gewenst? (vraag 2c) (licht kort toe; geef ook aan in welke fase van de studie)		
	Nau-we-lijks	**Ge-deel-telijk**	**Volle-dig**	**Toelichting** (b.v. afwijkende probleem-visie t.o.v. opdrachtgever)	**Probleem definitie**	**Inbreng van kennis en/of informatie**	**Evalueren van proces en/of resultaten**
– Kabinet en ministeries (nationaal)	❑	✓	❑	Specifieke vragen van vaste kamercommissie.			
– Parlement (nationaal)	❑	✓	❑	Idem			
– Andere gouvernementele actoren (lokale/regionale/internationale overheden)	❑	✓	❑	VROM Inspectie; CLRTAP	VROM/KvI	VROM/KvI	VROM/KvI
– Andere planbureaus (CPB, SCP, RPB)	✓	❑	❑				
– Onderzoeksinstellingen/ adviesbureaus	❑	✓	❑	TNO/MEP			
– Wetenschappers/universiteiten	❑	✓	❑	UU, TU-Delft, Max Planck			Max Planck/ John v Aardenne
– Sectorspecifieke actoren/stakeholders – (landbouw, verkeer, industrie)	✓	❑	❑				
– Sectoroverstijgende belangen-organisaties (bijv. VNO)	✓	❑	❑				
– Milieu- en consumenten-organisaties	✓	❑	❑				
– Ongeorganiseerde belanghebbenden; Burger	✓	❑	❑				
– Media	❑	✓	❑	Kranten hebben affaire DeK gepubliceerd			
– Anderen	❑	❑	✓	CCDM/WEM	CCDM/WEM	CCDM/WEM	CCDM/WEM