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The Eco-indicator 99
A damage oriented method for Life Cycle Impact Assessment

Methodology Annex

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Third edition

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CONTENTS

1. Introduction

This report is the annex to the Eco-indicator 99 methodology report. It contains background data on all calculations and the uncertainties in the results. The structure and the paragraph numbering of this annex are identical to the main report.

No attempts have been made to produce a “readable” book. The main contents are tables and some explanatory text. Only in chapter 3 a relatively detailed discussion on the EUSES model settings and assumptions is given. The fate analysis with EUSES for carcinogenic substances that contribute to damage to human health and for ecotoxic substances that contribute to damage to ecosystems is described in detail.

Chapter 4, 5 and 6 provide the background data for the calculation of the damage to Human Health, Ecosystem Quality and Resources respectively.

In chapter 7 the data for damage assessment, including normalisation and weighting, are presented.

2. Backgrounds

The data in this annex are meant to be used as a reference source. Parts of the data originate from other publications. These publications contain much more details than we can present here. The most important publications that contain data, which have been used directly are:

- Human health, cultural perspectives and uncertainties: [HOFSTETTER 1998]
- Radiation: [FRISCHKNECHT ET AL 1999]
- Resources: [MÜLLER-WENK 1998-2]
- Land-use: [KÖLLNER 1999] and [MÜLLER-WENK 1998-1]
- Panel Assessment: [METTIER 1999]
- Normalisation [BLONK ET AL 1996]

On other subjects special calculations have been made, that have not (yet) appeared in published papers. Such calculations have been described in more detail, although the texts in this annex must still be considered as summaries.

3. Fate analysis for mass loads

3.1. Starting points

Fate analysis with EUSES has been carried out for substances that contribute to the damage to Human Health (carcinogenic substances) and substances that contribute to damage to Ecosystem Quality (ecotoxic substances). For all other elementary flows fate analysis has been carried out in a different way, using the most suitable models. The fate factors calculated with EUSES for the two damage categories are included in the tables 4.1 and 5.1. In these tables the whole effect chain from emission to damage is calculated.

The purpose of the EUSES calculations for the Eco-indicator 99 is to calculate the fate analysis of relevant substances in the environment in Europe. A steady state concentration (Predicted Environmental Concentration or PEC) of a substance in different compartments is calculated using a standard flow.

The emission flow can be situated in five compartments:
- An emission to air.
- An emission to waste water.
- An emission to surface water.
- An emission to industrial soil.
- An emission agricultural soil.

The Predicted Environmental Concentration is calculated by the model for:
- Air
- Surface water (total concentration)
- Surface water (dissolved concentration)
- Agricultural soil
- Pore water of agricultural soil
- Industrial soil
- Natural soil
- Sediment
- Food (meat, milk, vegetables)
- Drinking water

Fate analysis has been calculated with EUSES for emissions in 4 environmental compartments: emissions to air, water, industrial soil and agricultural soil. For carcinogenic substances resulting concentrations in air and drinking water and the human dose through food have been used to assess the damage to Human Health. For ecotoxic substances the resulting concentrations in water and three types of soil (agricultural, industrial and natural soil) have been used to assess the damage to Ecosystem Quality.

3.2. Determining the model settings for the EUSES calculations

3.2.1. Area size, population and scale

In the European continental system the number of inhabitants and the total surface area are based on the countries from the EU and the EFTA without Iceland. Iceland is excluded because it is too different from the rest of the countries and the continental system is supposed to be a homogenous system, with only the surface water included. This means that 17 countries are included: Norway, Sweden, Finland, Denmark, Ireland, Great Britain, the Netherlands, Belgium, Germany, Austria, France, Switzerland, Portugal, Spain, Italy, Greece and Luxembourg. The data for area size and total number of inhabitants are derived from the OECD environmental data 1995 [OECD 1995].

For the fate analysis calculations in EUSES the regional scale is used. The regional and continental models are in fact identical, with equal parameter settings and emission input, the results of the model calculations will be exactly the same. However, the advantage of the regional model is the possibility of directly calculating the exposure of humans through food and drinking water. The standard EUSES settings, based on the consensus of international expert groups for the European continental model will be the basis for the calculations. However, some of these standard defaults have to be adjusted to meet the requirements of the Eco-indicator methodology.

3.2.2. Simulating a "Closed Europe"

To be able to determine the total effect of an emission the effects of transboundary pollution should be excluded, the leaching of emissions to areas outside Europe will cause an underestimation of the concentrations. Consequently, flows of emissions into the system must also be excluded. Some of the model parameters are adjusted to isolate the system from the surrounding compartment. However, the adjustment of the parameters must not influence the stability of the model and the reliability of the resulting concentrations. Too large modifications would cause unrealistic results.

- Residence time of air in the system: the **wind speed** can be minimised (1E-30 m/s), causing substances in the air compartment to spread only within Europe. The resulting residence time of air in the system is $1.95*10^{31}$ days and the concentration of substances in the air is determined mainly by dry and wet deposition, diffusion- en degradation processes.
- Residence time of water in the system: the residence time of water in the system is determined by the inflow of water (rain) and the outflow (mainly run-off from soil) en becomes higher when the **rainfall** and **run-off** become smaller. Decreasing the rainfall to increase the residence time of the water in the system is not a very good option, because the rainfall has a very large influence on many processes in the model. Minimising the rainfall would cause a large decrease in the transport of substances from air to soil and water. The resulting concentrations in air would become unrealistically high whereas the concentrations in soil and water become unrealistically low. De run-off from soil to (ground)water causes transport of substances from the soil to the water compartment. Reducing the run-off reduces the transport of substances to the area outside the system via the water and causes higher concentrations in the soil compartments and lower concentrations in the water compartments. In this way the concentrations that would occur in a closed system, where evaporation and rainfall can form an internal equilibrium, are approximated in the best possible way. Minimising the run-off will increase the residence time of water in the system from 166 days to 1560 days (4.27 years). This is the maximum residence time that can be realised with the standard rainfall, larger residence times would cause model instability because water will accumulate in the system. In the regional model the **fraction of water flowing from the continent** is also set to minimum, isolating the chosen region from the rest of the continent.
- **Waste water**. In EUSES all calculations are carried out with direct emissions to surface water. Emissions to the sewer system have no meaning in LCA because the wastewater treatment is considered part of the technosphere. The flow of treated wastewater is therefore set to minimum ($1E^{-30}$ litres per person per day).

3.2.3. Fate analysis for metals

EUSES is originally designed for organic substances and is suited for lipophilic(non-polar) and non-dissipating compounds. The fate of metals in the environment is much less predictable and the fate modelling is very complex. It is possible to use EUSES for fate modelling, but different input data are required [EUSES 1996]:

- For water solubility estimates have been made using average circumstances in natural waters (pH, concentrations of suspended solids etc.) [RIVM 1998].
- The Octanol-water partition coefficient is not relevant for metals. Measured partition coefficients have been used for the calculations.
- Most of the metals present in the atmosphere will be associated with aerosols. Therefore a low value for vapour pressure (e.g. 10^{-10} Pa) should be used to make the model estimate the fraction bound to aerosol close to 1.

- Volatilisation can be ignored for metals, except for mercury. The Henry-constant should be set to a very low value.
- Measured partition coefficients must be used for partitioning of metals between water-soil, water-sediment and water-suspended matter.

Biotic and abiotic degradation is not relevant for metals. Theoretically within a "closed Europe" without any sinks an emission flow will cause an infinite accumulation of metals. In the EUES model there are two sinks:

- Deep groundwater: via vertical transport of substances (leaching) through the soil the substances will eventually end up in the deeper groundwater.
- Burial: Through sedimentation, substances associated with suspended solids can be buried into sediments permanently.

For substances that do not degrade in any way like metals, steady state concentrations will be reached when the removal of substances by the leaching and burial processes is just as fast as the emission flow in a closed Europe. For metals the residence time in the system with the settings mentioned above is 20.000 to 200.000 years with a degradation rate constant of 0.

3.2.4. Settings

De settings in EUSES for the regional and continental system are demonstrated in the tables below. The regional model is set to the scale of Europe, with the default European settings. The area and population size of the continental scale are chosen a factor of 10 larger so the regional calculations will not be influenced by the continental scale in any way.

Parameter	Value	Remarks
wind speed	1E-30	set to minimum
run-off	1E-04	set to minimum
wastewater	1E-30	set to minimum

Table 3.1: General settings

Parameter	Value	Remarks
Area regional system	3.6E+06 km2	European continental system 1993*
Number of inhabitants	3.8E+08	1994*
Area fraction of water	0.03	standard European default
Area fraction of natural soil	0.6	standard European default
Area fraction of agricultural soil	0.27	standard European default
Area fraction of industrial soil	0.1	standard European default
Fraction of water flow from continent	1.0E-30	set to minimum
Water depth	3 m	standard European default
Suspended solids concentration	25 mg/ml	standard European default
Residence time of water	1.56E+03 days	calculation output
Residence time of air	1.95E+31 days	calculation output
Net sedimentation rate	2.87 mm/yr	calculation output

*Table 3.2: Settings of the European model, *)Data from [OECD 1995]*

3.3. Influence of the settings on the model calculations

3.3.1. Minimal run-off

The purpose of minimising the run-off is to avoid "leaking" of substances via the water compartment to the area's outside Europe, which causes an underestimation of the environmental impacts caused by emissions in Europe. The influence of minimising the run-off on the concentrations in different compartments depends mainly on the initial emission compartment and the type of substance. Because transports from soil to water are minimised with minimum run-off, for emissions to soil and air, the concentrations in the soil become higher, whereas the concentration in the water becomes slightly lower for most substances.

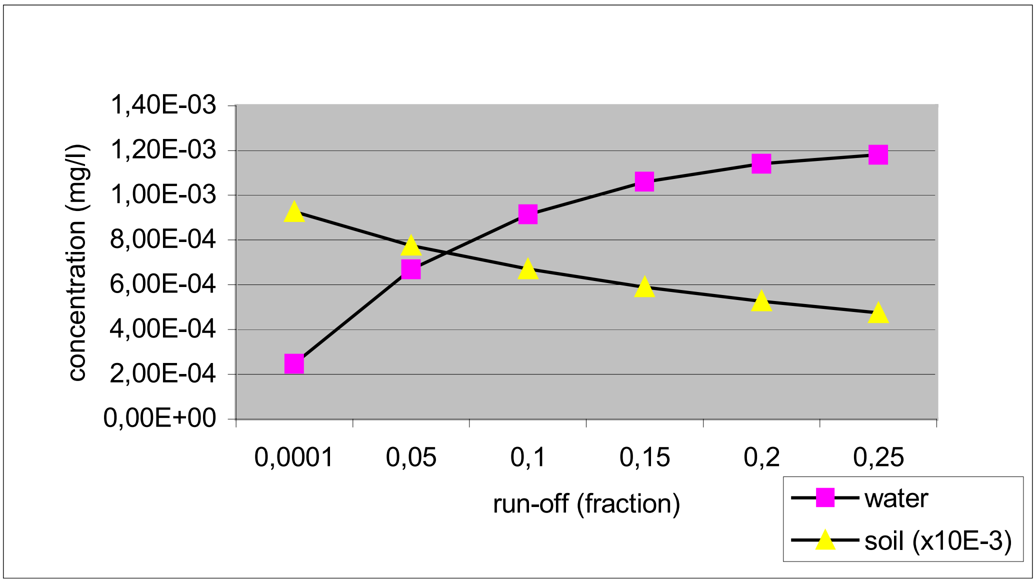

Figure 3.1: Concentration change for emissions of Cadmium to air

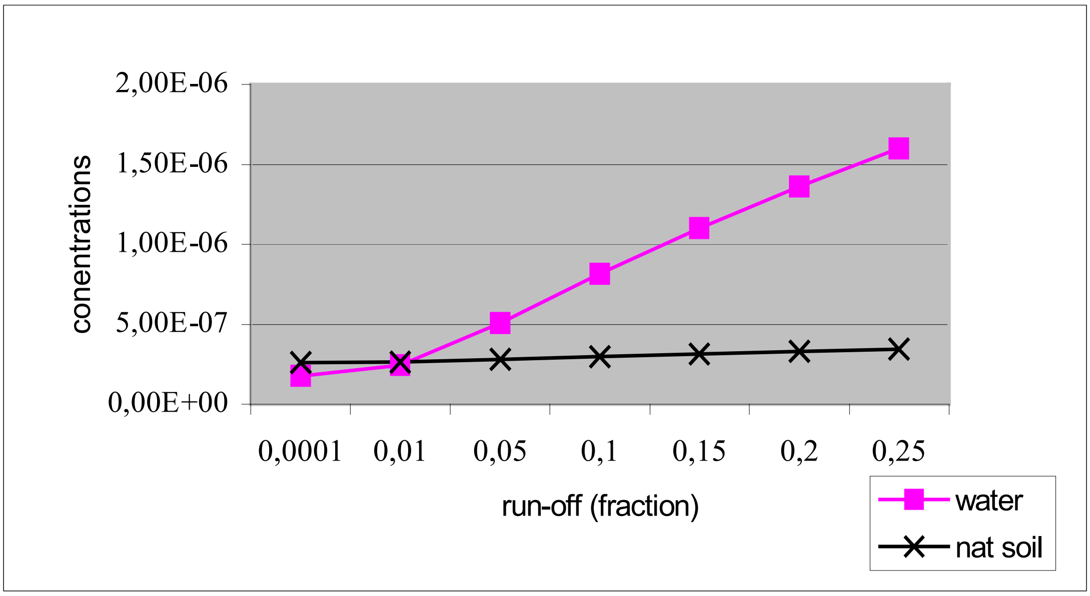

Figure 3.2: Concentration change for emissions of PCP to industrial soil

Most emissions listed in LCA inventories are emissions to air and emissions to water. The overall effect of minimising the run-off for emissions to air and water is an increase in the concentrations. For emissions to water, all concentrations increase with minimum run-off, which is demonstrated in figure 3.3.

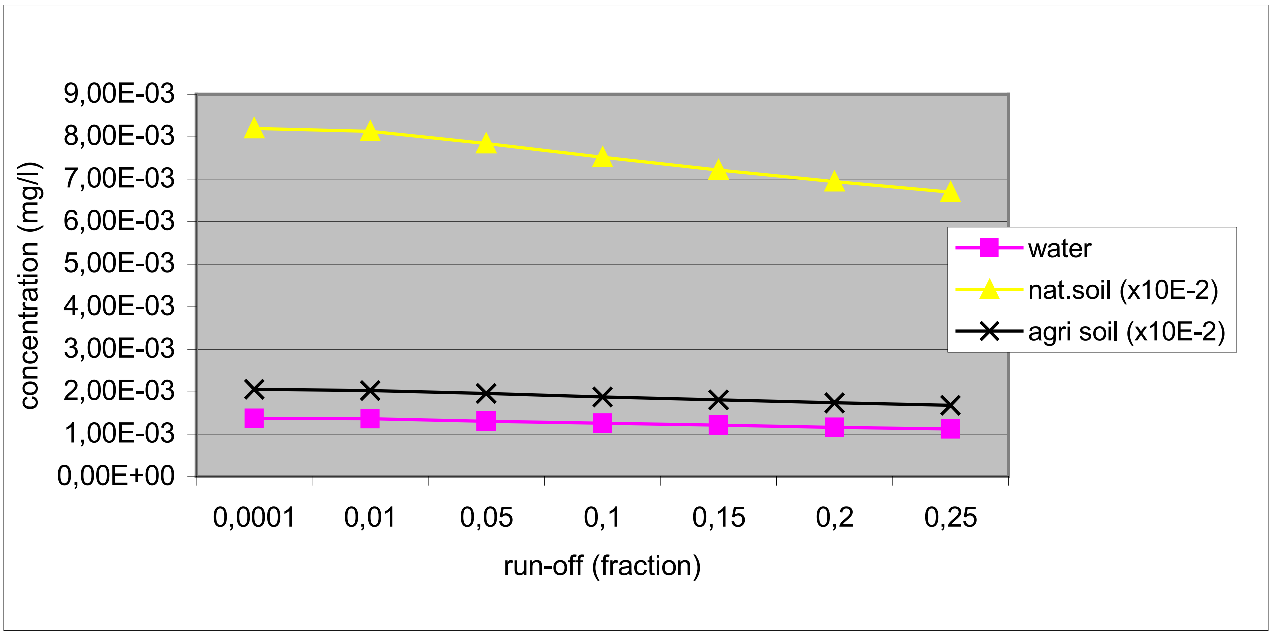

Figure 3.3: Concentration change for emissions of PCP to water

In table 3.3 the effect of minimising the run off is demonstrated for standard emissions in each compartment.

Emissions of lead (10.000 kg/d)	Concentration in compartment:	normal run-off	minimal run-off	Difference with normal run-off
to air	water (mg/l)	3.91E-04	2.51E-04	- 36%
	air (mg/m3)	2.53E-11	2.53E-11	0
	agricultural soil (mg/kg)	4.69	7.59	+ 62%
	natural soil (mg/kg)	4.69	7.59	+ 62%
	industrial soil (mg/kg)	4.69	7.59	+ 62%
to water	water (mg/l)	6.22E-04	6.27E-04	+ 1%
	air (mg/m3)	2.65E-22	2.67E-22	+ 1%
	agricultural soil (mg/kg)	4.9E-11	7.99E-11	+ 63%
	natural soil (mg/kg)	4.9E-11	7.99E-11	+ 63%
	industrial soil (mg/kg)	4.9E-11	7.99E-11	+ 63%
to industrial soil	water (mg/l)	3.84E-04	2.39E-04	- 38%
	air (mg/m3)	4.24E-19	6.86E-19	+ 62%
	agricultural soil (mg/kg)	7.85E-08	2.06E-07	+162%
	natural soil (mg/kg)	7.85E-08	2.06E-07	+162%
	industrial soil (mg/kg)	46.9	75.9	+ 62%
to agricultural soil	water (mg/l)	3.84E-04	2.39E-04	- 38%
	air (mg/m3)	4.24E-19	6.86E-19	+ 62%
	agricultural soil (mg/kg)	17.4	28.1	+ 62%
	natural soil (mg/kg)	7.85E-08	2.06E-07	+162%
	industrial soil (mg/kg)	7.85E-08	2.06E-07	+162%

Table 3.3 Influence of run-off on the concentrations of lead in the environment

From the steady state concentration in the water, the residence time of water in the system and the total volume of water in Europe, the total loss of substances to the areas outside Europe can be calculated. Since the model can not be closed entirely, even with minimised run-off part of the emission is "lost".

With the Simple Box 2.0 model, which can be closed entirely a check was made on the leaking of substances [JAGER 1998]. The EUSES model is based on the Simple Box 2.0 model and with identical settings, the resulting concentrations will be identical too. With an entirely closed model, the concentrations calculated with the Simple Box model for most substances where up to 1% higher. For Cadmium the concentration in water and sediment were 6% higher. This means that the losses caused by the fact that the model is not entirely closed are less than 6% in most cases.

For lead the loss of substance is less than 1% of the emission in case of minimal run off. From the table 3.3 it can be calculated that with normal run-off up to 25% of the emission flows out of the system, causing an underestimate of the effects of lead. For substances that are more soluble and degrade faster, like pentachlorophenol (PCP), the steady state concentrations are much lower. However, the loss of emissions to areas outside the system with normal run-off is still 22% in case of an emission to water.

It can be concluded that the overall effect of minimising the run off on the concentrations is a minimal loss of emissions to areas outside Europe, which means concentration increases in most compartments. The loss of emissions to areas outside Europe is less than 1% for most substances, while with normal run-off the losses can be up to 25%, depending on the type of substance. The relatively small concentration decrease in the water compartment that occurs with emissions to air, agricultural soil and industrial soil is acceptable, since this compartment comprises only 3% of the total area of Europe and this effect is amply compensated by higher concentrations in the soil.

3.3.2. Degradation time

The influence of degradation time of substances on the concentrations is linear in EUSES. This means that increasing the degradation with a factor of 10 will lower the concentration with the same factor as long as this is the main influencing parameter. In the EUSES model it is possible to choose a degradation of 0. Within an almost entirely closed system and a degradation of 0 the retention time of persistent substances like metals depends on slow processes e.g. the transport to deep groundwater and the burial of the material in sediments. Therefore the residence times of metals and other non-degradable substances are very long and the resulting steady state concentrations are high. Since it is normal for these substances to accumulate in the environment, this scenario is not unrealistic. However, the time necessary to reach steady state for this persistent substances under this circumstances is a few hundred until a few thousand years.

A time period of a few hundred until a few thousand years to reach steady state means that the present emission level has to be maintained for the same period of time in order to reach this steady state concentration. It also means that the total effect of a present emission will occur in the far future. Choosing to calculate concentrations with 0 degradation thus implies that all the future generations over the next 1,000 years are considered equally important as the present population (egalitarian principle). An other option, which was used in the CML project "Impact assessment of toxic releases" is to choose a time horizon. In the CML project a half-life of 10,000 days, which is 27.4 years was chosen, resulting in a total degradation time of about 180 years. The reason for this was the fact that the 10,000 days was the maximum for the USES model, used in this project. The difference between the long term and short term concentrations is between 1 and 2 orders of magnitude.
No choice has been made on the time horizon for metal accumulation. The problem has been solved by assigning the different choices to different cultural perspectives (see section 3.5).

3.4. Input data and substance list

With the settings presented in section 3.2, the minimum data set for a substance to calculate concentrations in air, water, soil and sediments must contain:

- the molecular weight
- the vapour pressure

- the octanol/water partition coefficient or for metals measured soil-water, sediment-water and suspended solids-water partition coefficients must be used.
- solubility in water
- emission in Europe to air, water or soil

For organic substances with these data also the human exposure through food and drinking water can be calculated. For metals the human exposure through air and drinking water can be calculated but the exposure through food (fish, meat milk and crops) can not be calculated without specific Bioconcentration factors (BCF) for this substance. Specific values for bioconcentration factors and transfer coefficients for metals are derived from [SLOOFF ET AL1990A/B][ROS & SLOOFF 1987][HUIJBREGTS 1999-1/2].

Since the model uses defaults, which represent "European Averages", for most substances only the most important physical/chemical properties are required to carry out the fate analysis. The substance data used in this project originate mainly from [Bakker & van de Meent 1997] and data from [HOFSTETTER 1998]. Hofstetter used data from the CML project "Impact assessment of toxic releases" [GUINÉE ET AL 1996] for 50% of the carcinogenic substances. For calculations of metals through food intake several sources for bioconcentration factors and experimental data on accumulation of metals in the food chain were used together with data from [HUIJBREGTS 1999-2].

Whether or not a substance is included in the fate analysis is determined by both practical and fundamental reasons. For ecotoxicity data-availability was the limiting factor. Damage information is only available for the 43 substances that are considered the most harmful to ecosystems in the Netherlands. The most recent substance data necessary for calculation of environmental concentrations and PAF in the Netherlands were collected in the report by [Bakker & van de Meent 1997].
For carcinogenics the IARC list of substances as used by [HOFSTETTER 1998] is used, but inclusion of the substance in the damage assessment depends on the cultural perspective (see section 3.5). However only a small selection of the substances analysed by IARC is used. Many substances could not be included because of lack of data on substance characteristics or Unit Risk information. New damage factors should be added when sufficient data becomes available.

3.5. The role of cultural perspectives

The role of cultural perspectives is expressed in fate analysis in two aspects:

1. Long term or short term accumulation of heavy metals. For the egalitarian and hierarchist perspectives the accumulation of heavy metals is calculated until a steady state situation is reached within the closed model. This means that for some metals the emission flow must remain the same for several thousands of years to reach steady state. In the EUSES model a degradation of 0 was assumed for this. Individualists consider this unrealistic and choose a time horizon of about 100 to 200 years, depending on the type of metal. In the EUSES model this is realised by simulating a half-life (DT50) of 10^4 days. This is similar to the former USES default value, which was used in the CML project "Impact assessment of toxic releases" [GUINÉE ET AL 1996]

3.6. Sources of uncertainty

In [HOFSTETTER 1998] the uncertainty in multimedia fate models is discussed in detail.

A quantitative estimate of the fate factors has been undertaken based on

- the experts' judgement in SETAC (1995),
- the experience gained with the validation exercises undertaken here,
- the insights from discussions on the accuracy of the model and model parameters that had been chosen, and
- the distribution and intake behaviour of the substances.

According to [HOFSTETTER 1998]several experts state explicitly based on their experience that the distribution of the values that they assume to be stochastically spread can be approximated by a lognormal distribution. Van de Meent (1995) calculated probability distributions with a Monte Carlo

Simulation, which could for most substances be approximated with a lognormal distribution. SETAC (1995) makes this assumption implicitly. The fate factors are always positive and the distribution can be assumed to be oblique. Therefore the fate factors in appendix tables 4.1 and 5.1 are assumed to be the mean value of a lognormal distribution with a geometric standard deviation σ_g. The estimates of σ_g^2 for the fate factors considered by [HOFSTETTER 1998] are listed in table 3.4. The mean value multiplied and divided by σ_g^2 covers the confident interval of 95%.

Criteria	**Substances concerned** **(for emission to air)**	σ_g^2 F"air, air	σ_g^2 F"air, water	σ_g^2 F"air, food
• More than 95% of the total intake is inhaled, i.e., the substance shows only minor partitioning • The properties are well known • the substance is well suited for the chosen model	Methyl chloride, 1,1,1,2-Tetrachloroethane, 1,2-Dichloroethane, Chloroform, Dichloromethane, 1,2-Dibromoethane, Hexachloroethane, 1,1,2-Trichloroethane, Perchloroethylene, Bromodichloromethane, Ethylene Oxide, Benzene, Benzyl-chloride, Trichlorethylene, Vinyl chloride, Acrylonitrile, Epichlorhydrin, Diesel soot particles, 1,1 Dichlorethylene, Carbon-tetrachloride, Styrene, BCEE, BCME, Acetaldehyde, 1,3-Butadiene	2	4	8
• The substance partitions • The properties are well known • The substance is well suited for the chosen model	Trifluralin, Hexachlorobenzene, alpha-HCH, Dichlorvos, DEHP, Dibutyl-phthalate, beta-HCH, Formaldehyde, Aldrin, gamma-HCH, 1,4-Dioxane, PCBs, Benz[a]anthracene, BaP, Dieldrin, 3-Methylchloanthrene, TCDD, Dibenz[a,h]anthracene, Pentachlorphenol	3	6	12
• The properties are uncertain or unknown, or • The substance is not well suited for the chosen model	Arsenic, Cadmium, Nickel, Nickel-ref.-dust, Nickel-subsulfide, Chromium(VI), Propylene-oxide, 1,1,2,2-Tetrachloroethane, Benzotrichloride, Hexachlorobutadiene, 2,4,6-Trichlorphenol,	20	40	80
Criteria	**Substances concerned** **(for emission to water)**	σ_g^2 F"water, air	σ_g^2 F"water, water	σ_g^2 F"water, food
• More than 95% of the total intake is by drinking water, i.e., the substance shows only minor partitioning • The properties are well known • The substance is well suited for the chosen model	Acetaldehyde, Dichlorvos, 1,4-Dioxane, Formaldehyde	4	2	8
• The substance partitions • The properties are well known • The substance is well suited for the chosen model	Trifluralin, Hexachlorobenzene, alpha-HCH, DEHP, Dibutyl-phthalate, beta-HCH, Aldrin, gamma-HCH, PCBs, Benz[a]anthracene, BaP, Dieldrin, 3-Methylchloanthrene, TCDD, Dibenz[a,h]anthracene, Methyl chloride, 1,1,1,2-Tetrachloroethane, 1,2-Dichloroethane, Chloroform, Dichloromethane, 1,2-Dibromoethane, Hexachloroethane, 1,1,2-Trichloroethane, Perchloroethylene, Bromodichloromethane, Ethylene Oxide, Benzene, Benzyl-chloride, Trichlorethylene, Vinyl chloride, Acrylonitrile, Epichlorhydrin, Diesel soot particles, 1,1 Dichlorethylene, Carbon-tetrachloride, Styrene, BCEE, BCME, 1,3-Butadiene, Pentachlorphenol	6	3	12
• The properties are uncertain or unknown, or • The substance is not well suited for the chosen model	Arsenic, Cadmium, Nickel, Nickel-ref.-dust, Nickel-subsulfide, Chromium(VI), Propylene-oxide, 1,1,2,2-Tetrachloroethane, Benzotrichloride, Hexachlorobutadiene, 2,4,6-Trichlorphenol,	40	20	80

Table 3.4: Estimated geometric standard deviations for the calculated fate factors. For some substances a different category is chosen in this study because more data were available Derived from [HOFSTETTER 1998]

The criteria used for assigning the substances to one of three uncertainty classes for emission to air and water each is given in the first column in table 3.4. The metals and phenols both are placed into class with the highest uncertainty because they do not or do only partly fit with the model restrictions. Other substances belong to the most uncertain class because they either showed poor accordance with the results from [JOLLIET 1997] (i.e., Tetrachloroethane) or were calculated with default degradation rates for relevant compartments. In contradiction to [SETAC 1995] we assumed in the case of the most uncertain class the same additional uncertainty factors for the first and second change of media as we did for the first two classes. We chose this procedure because most of the substances in this class with the largest geometric standard deviations have their main intake path via food; but this path is assumed to have a better quality than is suggested by the $\sigma_g^2 = 500$ proposed by [SETAC 1995]. All other σ_g^2 in table 3.4 are directly taken from [SETAC 1995].

The estimated geometric standard deviations in table 3.4 include both stochastic and systematic errors. The stochastic errors alone, relevant if the fate relative to a reference substance is determined, would result in smaller standard deviations. However, we do stay with the assessment of the absolute fate factors because our aim is the modelling of absolute potential damages. Further work on the validation of multimedia fate models is necessary to improve the expert-based estimates made here. Comparisons of model outcomes are currently carried out by [JOLLIET 1998][HOFSTETTER 1998].

4. Human Health

4.1. p.m.
4.2. p.m.
4.3. p.m.

4.4. Damage to Human Health caused by carcinogenic substances

For the damage to Human Health from carcinogenic substances the calculation covers 3 separate steps:
1. Fate analysis: from emission to concentration.
2. Effect analysis: from concentration to cancer cases per kg emission.
3. Damage analysis: from cancer cases per kg to DALYs per kg emission.

The separate steps are demonstrated in the annex table 4.1.

The list of substances included for calculation of damage to human health (carcinogenic substances) is determined by cultural perspectives: Individualists only include substances with sufficient proof on carcinogenicity to humans. Hierarchists include substances that are considered carcinogenic based in international scientific consensus. Egalitarians include all substances that could possibly be carcinogenic.[HOFSTETTER 1998]

Fate analysis
Fate analysis for emissions to air, water, urban soil and industrial soil is carried out for 53 substances in EUSES. The three exposure pathways air (inhalation), drinking water (oral uptake) and food (oral uptake) are considered. For exposure from metals through food specific transfer coefficients have been used to calculate the exposure (see chapter 3 of the annex report).

Fate factors are calculated from the concentration in air, the concentration in drinking water and the dose by food resulting from the EUSES output, based on an emission of 10.000 kg/d and an emission area of $3.6*10^6$ square kilometres.

Fate factors are used to transform an emission into a concentration. For the calculation of the fate factors the following formulas are used:

F,air→air: Emission $(mg.y^{-1})/m^2$ * Fate factor $(m^2.y)/m^3$ = Concentration in air(mg/m^3)
F,air→drinking water: Emission $(mg.y^{-1})/m^2$ * Fate factor $(m^2.y)/l$ = Conc. in drinking water (mg/l)
F,air→food: Emission $(mg.y^{-1})/m^2$ * Fate factor $(m^2.y)/(kg.d)$ = Dose by food (mg/kg/d)

Example for arsenic from emission to air to (steady state) concentration in air:
The long term (steady state) concentration of arsenic in air resulting from an emission to air of 10.000 kg/d is $7.93*10^{-6}$ mg/m^3.
The emission is 10,000 kg * 365 = $3,650,000*10^6$ mg/yr per $3.6*10^{12}$ m^2 =1.0139 $(mg.y^{-1})/m^2$.
The fate factor in $(m^2.y)/m^3$ = Concentration / Emission = $7.93*10^{-6}$ / 1.0139 = $7.82*10^{-6}$ $(m^2.y)/m^3$

With the calculated fate factors the resulting concentration in air, drinking water or dose by food from any emission to air, water, industrial soil and agricultural soil in Europe can be calculated for all 53 substances.

Effect analysis
For the effect analysis the list of unit risk (UR) factors compiled by [HOFSTETTER 1998] is used.
The unit-risk concept (WHO 1987) is used for estimation of the dose response relationship.

The definition of the unit risk factor is:
The unit risk factor for inhalation is an estimate of the probability that an average individual will develop cancer when exposed to a pollution at an ambient concentration of one microgram per cubic meter for the individual's life (70 years) [UR in cases per µg/m3]

Unit risk factors are derived from IRIS (US EPA) , WHO Europe and Germany. In case more unit risk factors are available the most recent factors are preferred. Bold printed factors are extrapolated by [HOFSTETTER 1998].

For the fate analysis in EUSES it had to be assumed that the substance is emitted in Europe in a diffuse way and will spread evenly over the compartments. In reality some substances will cause high local concentrations in specific areas where high population densities occur.
The high local concentrations cannot be modelled for the whole of Europe, causing an underestimation of effects for substances that occur in high concentrations in densely populated areas. However, the high population densities can be modelled per substance, so another underestimation can be avoided. The population density per substance for emissions to air and water is calculated by [HOFSTETTER 1998] based on the distribution patterns of the substances in the compartments considered.

For emissions to industrial soil and agricultural soil it is assumed here that the maximum population density is exposed. For emissions to industrial soil the exposure is mainly through air and food. For emissions to agricultural soil the exposure is mainly through food. For exposure through air in industrial areas, resulting from emissions to industrial soil, a high population density can be assumed. For exposure through food, resulting from emissions to urban soil and agricultural soil, it is also logical to assume a high population density, since most of the carcinogenic substances in food will be consumed by humans. This means that most of the substance present in the food will be consumed.

The Formula used for calculation of the Effect factor for exposure through air is:
Effect = Unit Risk (per year)* population density
E (cases.$\mu g^{-1}.m^3$ / (m^2. y)) = UR (cases.$\mu g^{-1}.m^3$) / lifetime (70 years) * pop. density (persons/m^2)

A correction is made for the unit risk per year by dividing by 70 years.

The Incidence factors in cancer cases per kg emission in Europe can be calculated by multiplying the Effect factor with the Fate factor:
Incidence (cases/kg) = Effect (cases.$\mu g^{-1}.m^3$ / (m^2. y)) * 10^9 * Fate (m^2.y)/m^3

Example for arsenic from emission to air to (steady state) Incidence :
Effect in (cases.$\mu g^{-1}.m^3$ / (m^2. y)) = $1.5*10^{-3}$ / 70 * 9.44e*10^{-5} = 2.02 *10^{-9}
Incidence (I) in cases per kg emission to air in Europe = 2.02 *10^{-9} * 10^9 * 7.82*10^{-6} = 1.58*10^{-5}

<u>*Damage analysis*</u>
The estimation of DALYs per incidence case is copied from [HOFSTETTER 1998]. For this estimation information on the seriousness of the illness, the duration, the death rate and age of the people affected are used. For the individualist age weighting is used, resulting in lower estimates. The total DALYs per kg emission to a specific compartment for a specific perspective are calculated by adding the different exposure pathways. In formula:

Egalitarian DALYs per kg emission to air = Incidence, air-air (cases/kg) * DALYs (E, inhalation) + Incidence, air-drw (cases/kg) * DALYs (E, oral uptake) + Incidence, air- food (cases/kg) * DALYs (E, oral uptake)

Example for arsenic from emission to air to (steady state) DALYs per kg emission to air :
I, air-air (cases/kg) * DALYs (E, inhalation) + I, air-drw (cases/kg) * DALYs (E, oral uptake) + I, air- food (cases/kg) * DALYs (E, oral uptake) = 1.58*10^{-5} * 16.1 + 3.03*10^{-4} * 13.1 + 1.56*10^{-3} * 13.1 = 0.0246 DALYs.

For the overall calculation results, for egalitarians the long term steady state concentrations for metals, resulting from a continuous emission flow is used (long term) and all 4 substance groups of the IARC classification are included [HOFSTETTER 1998]. For Hierarchists also the long term steady state is used and a selection of substance groups depending on the required evidence of the effects for the hierarchist perspective is used. For Individualists the concentrations resulting from short term emission flows (during 100-200 years, short term) are used and only substances with sufficient evidence on the carcinogenicity for humans are included (IARC group 1).

Emissions to air 10.000 kg/d - Resulting concentrations and human intake									
		Concentr. in	Dose by	Dose by	Concentr. in	Dose by	Contributions to pathway:		
		Drinking water	Drinking water	Food	Air	Inhalation	D	F	A
Substance	CAS-number	[mg/l]	[mg/kg/d]	[mg/kg/d]	[mg/m3]	[mg/kg/d]	%	%	%
Arsenic (long term)	7440-38-2	4.55E-03	1.30E-04	7.81E-04	7.93E-06	1.70E-06	14	86	0
Arsenic (short term)	7440-38-2	1.33E-04	3.80E-06	4.48E-05	7.93E-06	1.70E-06	8	89	3
Benzene	71-43-2	1.32E-07	3.77E-09	6.23E-09	3.21E-05	6.87E-06	0	0	100
Bis(chloromethyl)ether	542-88-1	6.30E-08	1.80E-09	1.20E-09	4.01E-06	8.60E-07	0	0	100
Cadmium (long term)	7440-43-9	5.60E-03	1.60E-04	1.70E-03	1.59E-05	3.40E-06	9	91	0
Cadmium (short term)	7440-43-9	6.30E-04	1.80E-05	1.98E-04	5.60E-06	1.20E-06	8	91	1
Chromium VI (long term)	7440-47-3	1.23E-03	3.50E-05	5.88E-04	5.60E-06	1.20E-06	6	94	0
Chromium VI (short term)	7440-47-3	9.10E-06	2.60E-07	5.82E-06	5.60E-06	1.20E-06	4	80	16
Nickel (long term)	7440-02-0	5.25E-03	1.50E-04	8.60E-04	4.48E-06	9.60E-07	15	85	0
Nickel-refinery-dust (long term)	7440-02-0	5.25E-03	1.50E-04	8.60E-04	4.48E-06	9.60E-07	6	94	0
Nickel-subsulfide (long term)	7440-02-0	5.25E-03	1.50E-04	8.60E-04	4.48E-06	9.60E-07	6	94	0
Nickel (short term)	7440-02-0	2.28E-04	6.50E-06	3.82E-04	4.48E-06	9.60E-07	2	98	0
Nickel-refinery-dust (short term)	7440-02-0	2.28E-04	6.50E-06	3.82E-04	4.48E-06	9.60E-07	4	96	1
Nickel-subsulfide (short term)	7440-02-0	2.28E-04	6.50E-06	3.82E-04	4.48E-06	9.60E-07	4	96	1
Vinylchloride	75-56-9	1.37E-09	3.90E-11	1.90E-10	1.12E-05	2.40E-06	0	0	100
1,2-dibromoethane	106-93-4	3.03E-06	8.65E-08	1.13E-07	2.00E-04	4.29E-05	0	0	100
1,3-butadiene	106-99-0	1.48E-07	4.22E-09	8.80E-09	1.28E-06	2.75E-07	1	3	95
Acrylonitril	107-13-1	3.85E-07	1.10E-08	9.00E-09	1.56E-05	3.35E-06	0	0	99
Benzo(a)pyreen	50-32-8	4.90E-08	1.40E-09	2.30E-05	1.96E-07	4.20E-08	0	100	0
Benzo(a)anthracene	56-55-3	2.73E-05	7.80E-07	9.90E-04	2.66E-05	5.70E-06	0	99	1
Dibenz(a)anthracene	53-70-3	1.44E-04	4.10E-06	3.00E-02	3.92E-06	8.40E-07	0	100	0
Diesel soot particles (no calculations in EUSES)									
Epichloorhydrin	106-89-8	2.38E-07	6.80E-09	5.80E-09	1.59E-05	3.40E-06	0	0	100
Ethylene oxide	75-21-8	3.85E-04	1.10E-05	5.70E-06	6.07E-04	1.30E-04	7	4	89
Formaldehyde	50-00-0	4.20E-08	1.20E-09	9.00E-10	2.80E-06	6.00E-07	0	0	100
Polychlorobiphenyls	1336-36-3	1.12E-06	3.20E-08	2.60E-04	2.75E-04	5.90E-05	0	81	18
Propylene oxide	75-56-9	1.51E-04	4.30E-06	3.20E-06	4.67E-04	1.00E-04	4	3	93
1,2-dichloroethane	107-06-2	1.79E-06	5.10E-08	1.00E-07	3.22E-04	6.90E-05	0	0	100
1,4-dioxane	123-91-1	6.20E-08	1.77E-09	1.23E-09	4.01E-06	8.59E-07	0	0	100
2,3,7,8, -TCDD-dioxin	1746-01-6	1.65E-06	4.70E-08	2.20E-03	1.73E-05	3.70E-06	0	100	0
2,4,6-trichlorophenol	88-06-2	1.64E-05	4.68E-07	4.43E-06	8.26E-05	1.77E-05	2	20	78
Acetaldehyde	75-07-0	5.95E-08	1.70E-09	1.30E-09	4.01E-06	8.59E-07	0	0	100
alpha-hexachlorocyclohexan	319-84-6	9.45E-08	2.70E-09	1.77E-07	6.39E-06	1.37E-06	0	11	88
Benzotrichloride	98-07-7	2.00E-08	5.70E-10	2.50E-07	6.39E-04	1.37E-04	0	0	100
Benzylchloride	100-44-7	1.86E-07	5.30E-09	2.50E-08	1.73E-05	3.70E-06	0	1	99
beta-hexachlorocyclohexan	319-85-17	1.58E-07	4.50E-09	2.30E-07	6.53E-06	1.40E-06	0	14	86
Bromodichloromethane	75-27-4	1.19E-06	3.40E-08	1.70E-07	7.93E-05	1.70E-05	0	1	99
Carbontetrachloride	56-23-5	3.99E-05	1.14E-06	1.00E-05	3.87E-02	8.30E-03	0	0	100
Chloroform	67-66-3	4.90E-06	1.40E-07	3.60E-07	3.22E-04	6.90E-05	0	1	99
Diethylhexylphthalate	117-81-7	2.98E-09	8.50E-11	1.00E-04	2.66E-06	5.70E-07	0	99	1
Dichloromethane	75-09-2	1.86E-06	5.30E-08	4.70E-08	2.29E-04	4.90E-05	0	0	100
Dichlorvos	62-73-7	4.90E-06	1.40E-07	8.00E-06	3.78E-06	8.10E-07	2	89	9
Lindane (gamma HCH)	58-89-9	5.95E-07	1.70E-08	1.00E-06	3.17E-05	6.80E-06	0	13	87
Hexachlorobenzene	118-74-1	1.23E-05	3.50E-07	5.90E-03	2.10E-03	4.50E-04	0	93	7
Pentachlorophenol	87-86-5	1.82E-05	5.20E-07	4.30E-03	2.89E-05	6.20E-06	0	100	0
Perchloroethylene	127-18-4	2.21E-07	6.30E-09	1.97E-07	1.91E-04	4.10E-05	0	0	100
Styrene	100-42-5	3.43E-09	9.80E-11	2.30E-09	7.93E-07	1.70E-07	0	1	99
1,1,1,2-Tetrachlorethane	630-20-6	2.49E-05	7.10E-07	1.00E-05	2.71E-03	5.80E-04	0	2	98
1,1,2,2-Tetrachlorethane	79-34-5	1.30E-04	3.70E-06	1.50E-05	2.52E-03	5.40E-04	1	3	97
1,1,2-Trichlorethane	79-00-5	2.24E-07	6.40E-09	3.20E-08	1.40E-04	3.00E-05	0	0	100
1,1 - dichloroethene	75-35-4	2.03E-09	5.80E-11	1.90E-10	2.01E-06	4.30E-07	0	0	100
3 - methylcholanthrene	56-49-5	3.50E-06	1.00E-07	8.30E-04	1.07E-06	2.30E-07	0	100	0
Aldrin	309-00-2	5.60E-07	1.60E-08	2.60E-04	1.21E-06	2.60E-07	0	100	0
Bis (2-chloretyl)ether	111-44-4	4.31E-07	1.23E-08	8.10E-09	4.01E-06	8.60E-07	1	1	98
Dibutylphthalate	84-74-2	1.61E-06	4.60E-08	3.00E-04	2.71E-06	5.80E-07	0	100	0
Dieldrin	60-57-1	1.12E-03	3.20E-05	8.70E-02	3.17E-06	6.80E-07	0	100	0
Hexachlorobutadiene	87-68-3	9.45E-07	2.70E-08	1.40E-05	6.53E-04	1.40E-04	0	9	91
Hexachloroethane	67-72-1	1.68E-05	4.80E-07	5.60E-05	2.52E-03	5.40E-04	0	9	91
Methylchloride	74-87-3	7.00E-07	2.00E-08	5.50E-08	2.80E-03	6.00E-04	0	0	100
Trichlorethylene	79-01-6	3.36E-10	9.60E-12	2.90E-10	1.35E-05	2.90E-06	0	0	100
Trifluralin	1582-09-8	1.09E-07	3.10E-09	4.10E-06	1.45E-06	3.10E-07	0	93	7

Table 4.1: Damage to Human Health (carcinogenics) EUSES output

Emissions to water 10.000 kg/d – Resulting concentrations and human intake									
		Concentr. in	Dose by	Dose by	Concentr. in	Dose by	Contributions to pathway:		
		Drinking water	Drinking water	Food	Air	Inhalation	D	F	A
Substance	CAS-number	[mg/l]	[mg/kg/d]	[mg/kg/d]	[mg/m3]	[mg/kg/d]	%	%	%
Arsenic (long term)	7440-38-2	2.28E-03	6.50E-05	7.15E-04	4.01E-12	8.60E-13	8	92	0
Arsenic (short term)	7440-38-2	1.86E-03	5.30E-05	5.72E-04	3.22E-12	6.90E-13	8	92	0
Benzene	71-43-2	3.71E-05	1.06E-06	1.61E-06	2.96E-05	6.34E-06	12	18	70
Bis(chloromethyl)ether	542-88-1	3.85E-05	1.10E-06	1.90E-07	3.59E-06	7.70E-07	53	9	37
Cadmium (long term)	7440-43-9	2.63E-03	7.50E-05	2.04E-04	9.80E-12	2.10E-12	27	73	0
Cadmium (short term)	7440-43-9	2.10E-03	6.00E-05	1.65E-04	7.93E-12	1.70E-12	27	73	0
Chromium VI (long term)	7440-47-3	9.45E-05	2.70E-06	4.42E-05	3.03E-13	6.50E-14	6	94	0
Chromium VI (short term)	7440-47-3	7.35E-05	2.10E-06	3.56E-05	2.43E-13	5.20E-14	6	94	0
Nickel (long term)	7440-02-0	2.73E-03	7.80E-05	4.72E-04	2.99E-12	6.40E-13	14	86	0
Nickel-refinery-dust (long term)	7440-02-0	2.73E-03	7.80E-05	4.72E-04	2.99E-12	6.40E-13	42	58	0
Nickel-subsulfide (long term)	7440-02-0	2.73E-03	7.80E-05	4.72E-04	2.99E-12	6.40E-13	42	58	0
Nickel (short term)	7440-02-0	2.21E-03	6.30E-05	3.82E-04	2.43E-12	5.20E-13	14	86	0
Nickel-refinery-dust (short term)	7440-02-0	2.21E-03	6.30E-05	3.82E-04	2.43E-12	5.20E-13	7	93	0
Nickel-subsulfide (short term)	7440-02-0	2.21E-03	6.30E-05	3.82E-04	2.43E-12	5.20E-13	7	93	0
Vinylchloride	75-56-9	3.85E-05	1.10E-06	1.80E-07	1.07E-05	2.30E-06	31	5	64
1,2-dibromoethane	106-93-4	4.48E-05	1.28E-06	1.60E-06	1.96E-04	4.21E-05	3	4	94
1,3-butadiene	106-99-0	1.56E-04	4.45E-06	2.51E-06	1.12E-06	2.40E-07	62	35	3
Acrylonitril	107-13-1	8.40E-05	2.40E-06	2.20E-07	1.35E-05	2.90E-06	43	4	53
Benzo(a)pyreen	50-32-8	3.26E-05	9.30E-07	7.40E-03	7.00E-10	1.50E-10	0	100	0
Benzo(a)anthracene	56-55-3	2.52E-05	7.20E-07	3.80E-03	2.43E-05	5.20E-06	0	100	0
Dibenz(a)anthracene	53-70-3	4.55E-05	1.30E-06	1.50E-02	8.40E-06	1.80E-06	0	100	0
Diesel soot particles (no calculations in EUSES)									
Epichloorhydrin	106-89-8	3.22E-05	9.20E-07	1.50E-07	1.17E-05	2.50E-06	26	4	70
Ethylene oxide	75-21-8	3.01E-04	8.60E-06	3.60E-06	3.59E-04	7.70E-05	10	4	86
Formaldehyde	50-00-0	3.92E-05	1.12E-06	1.80E-07	2.47E-06	5.30E-07	61	10	29
Polychlorobiphenyls	1336-36-3	8.40E-06	2.40E-07	4.20E-03	2.29E-04	4.90E-05	0	99	1
Propylene oxide	75-56-9	2.28E-04	6.50E-06	2.30E-06	2.89E-04	6.20E-05	9	3	88
1,2-dichloroethane	107-06-2	4.20E-05	1.20E-06	1.20E-06	3.13E-04	6.70E-05	2	2	97
1,4-dioxane	123-91-1	3.41E-05	9.74E-07	1.58E-07	3.08E-06	6.61E-07	54	9	37
2,3,7,8, -TCDD-dioxin	1746-01-6	2.80E-05	8.00E-07	8.60E-03	7.47E-06	1.60E-06	0	100	0
2,4,6-trichlorophenol	88-06-2	2.16E-04	6.18E-06	1.96E-05	5.65E-05	1.21E-05	16	52	32
Acetaldehyde	75-07-0	3.92E-05	1.12E-06	1.83E-07	3.53E-06	7.57E-07	54	9	37
alpha-hexachlorocyclohexan	319-84-6	4.38E-05	1.25E-06	4.59E-05	6.30E-06	1.35E-06	3	95	3
Benzotrichloride	98-07-7	1.90E-05	5.44E-07	8.00E-05	6.30E-04	1.35E-04	0	37	63
Benzylchloride	100-44-7	3.85E-05	1.10E-06	2.30E-06	1.49E-05	3.20E-06	17	35	48
beta-hexachlorocyclohexan	319-85-17	4.55E-05	1.30E-06	5.40E-05	6.53E-06	1.40E-06	2	95	2
Bromodichloromethane	75-27-4	4.20E-05	1.20E-06	1.70E-06	7.00E-05	1.50E-05	7	9	84
Carbontetrachloride	56-23-5	5.78E-05	1.65E-06	1.60E-05	3.83E-02	8.20E-03	0	0	100
Chloroform	67-66-3	4.55E-05	1.30E-06	1.50E-06	3.17E-04	6.80E-05	2	2	96
Diethylhexylphthalate	117-81-7	1.93E-06	5.50E-08	1.00E-03	5.13E-07	1.10E-07	0	100	0
Dichloromethane	75-09-2	4.20E-05	1.20E-06	3.00E-07	2.29E-04	4.90E-05	2	1	97
Dichlorvos	62-73-7	5.25E-05	1.50E-06	7.30E-07	3.92E-09	8.40E-10	67	33	0
Lindane (gamma HCH)	58-89-9	4.20E-05	1.20E-06	5.10E-05	2.89E-05	6.20E-06	2	87	11
Hexachlorobenzene	118-74-1	3.50E-05	1.00E-06	8.20E-03	2.01E-03	4.30E-04	0	95	5
Pentachlorophenol	87-86-5	3.26E-04	9.30E-06	9.80E-03	1.63E-06	3.50E-07	0	100	0
Perchloroethylene	127-18-4	3.85E-05	1.10E-06	2.00E-05	1.87E-04	4.00E-05	2	33	65
Styrene	100-42-5	3.85E-05	1.10E-06	9.70E-06	7.47E-07	1.60E-07	10	89	1
1,1,1,2-Tetrachlorethane	630-20-6	5.25E-05	1.50E-06	2.00E-05	2.57E-03	5.50E-04	0	3	96
1,1,2,2-Tetrachlorethane	79-34-5	2.31E-04	6.60E-06	1.80E-05	2.38E-03	5.10E-04	1	3	95
1,1,2-Trichlorethane	79-00-5	3.85E-05	1.10E-06	3.40E-06	1.40E-04	3.00E-05	3	10	87
1,1 - dichloroethene	75-35-4	3.85E-05	1.10E-06	1.60E-06	2.01E-06	4.30E-07	35	51	14
3 - methylcholanthrene	56-49-5	2.56E-04	7.30E-06	0.071	8.40E-08	1.80E-08	0	100	0
Aldrin	309-00-2	2.52E-05	7.20E-07	7.20E-03	5.13E-07	1.10E-07	0	100	0
Bis (2-chloretyl)ether	111-44-4	1.26E-04	3.60E-06	3.00E-07	3.45E-06	7.40E-07	78	6	16
Dibutylphthalate	84-74-2	2.35E-04	6.70E-06	1.60E-03	3.27E-08	7.00E-09	0	100	0
Dieldrin	60-57-1	4.20E-04	1.20E-05	1.10E-01	2.66E-08	5.70E-09	0	100	0
Hexachlorobutadiene	87-68-3	1.96E-05	5.60E-07	3.00E-04	6.53E-04	1.40E-04	0	68	32
Hexachloroethane	67-72-1	5.25E-05	1.50E-06	1.20E-04	2.43E-03	5.20E-04	0	19	81
Methylchloride	74-87-3	3.50E-05	1.00E-06	8.50E-08	2.66E-03	5.70E-04	0	0	100
Trichlorethylene	79-01-6	6.65E-05	1.90E-06	2.80E-06	1.35E-05	2.90E-06	25	37	38
Trifluralin	1582-09-8	8.05E-05	2.30E-06	6.80E-04	8.87E-07	1.90E-07	0	100	0

Table 4.1(continued): Damage to Human Health (carcinogenics) EUSES output

Emissions to industrial soil 10.000 kg/d - Resulting concentrations and human intake									
		Concentr. in	Dose by	Dose by	Concentr. in	Dose by	Contributions to pathway:		
		Drinking water	Drinking water	Food	Air	Inhalation	D	F	A
Substance	CAS-number	[mg/l]	[mg/kg/d]	[mg/kg/d]	[mg/m3]	[mg/kg/d]	%	%	%
Arsenic (long term)	7440-38-2	4.62E-04	1.32E-05	1.43E-04	2.66E-12	5.70E-13	8	92	0
Arsenic (short term)	7440-38-2	3.92E-05	1.12E-06	1.22E-05	2.80E-11	6.00E-12	8	92	0
Benzene	71-43-2	1.30E-07	3.72E-09	1.63E-08	3.16E-05	6.77E-06	0	0	100
Bis(chloromethyl)ether	542-88-1	5.95E-08	1.70E-09	2.30E-09	3.97E-06	8.50E-07	0	0	100
Cadmium (long term)	7440-43-9	1.23E-04	3.50E-06	1.14E-05	7.00E-10	1.50E-10	23	77	0
Cadmium (short term)	7440-43-9	3.36E-05	9.60E-07	2.69E-06	2.33E-10	5.00E-11	26	74	0
Chromium VI (long term)	7440-47-3	7.35E-05	2.10E-06	3.50E-05	1.35E-10	2.90E-11	6	94	0
Chromium VI (short term)	7440-47-3	1.72E-06	4.90E-08	8.21E-07	3.87E-12	8.30E-13	6	94	0
Nickel (long term)	7440-02-0	3.47E-04	9.90E-06	5.98E-05	1.82E-10	3.90E-11	14	86	0
Nickel-refinery-dust (long term)	7440-02-0	3.47E-04	9.90E-06	5.98E-05	1.82E-10	3.90E-11	7	93	0
Nickel-subsulfide (long term)	7440-02-0	3.47E-04	9.90E-06	5.98E-05	1.82E-10	3.90E-11	7	93	0
Nickel (short term)	7440-02-0	4.55E-05	1.30E-06	7.64E-06	2.89E-11	6.20E-12	15	85	0
Nickel-refinery-dust (short term)	7440-02-0	4.55E-05	1.30E-06	7.64E-06	2.89E-11	6.20E-12	7	93	0
Nickel-subsulfide (short term)	7440-02-0	4.55E-05	1.30E-06	7.64E-06	2.89E-11	6.20E-12	7	93	0
Vinylchloride	75-56-9	1.37E-09	3.90E-11	2.00E-10	1.12E-05	2.40E-06	0	0	100
1,2-dibromoethane	106-93-4	2.96E-06	8.47E-08	2.15E-07	1.96E-04	4.20E-05	0	1	99
1,3-butadiene	106-99-0	9.42E-08	2.69E-09	5.31E-09	7.47E-07	1.60E-07	2	3	95
Acrylonitril	107-13-1	3.71E-07	1.06E-08	9.40E-09	1.50E-05	3.22E-06	0	0	99
Benzo(a)pyreen	50-32-8	2.24E-08	6.40E-10	5.10E-06	3.08E-11	6.60E-12	0	100	0
Benzo(a)anthracene	56-55-3	2.49E-05	7.10E-07	9.20E-04	2.43E-05	5.20E-06	0	99	1
Dibenz(a)anthracene	53-70-3	3.85E-05	1.10E-06	9.00E-03	7.00E-06	1.50E-06	0	100	0
Diesel soot particles (no calculations in EUSES)									
Epichloorhydrin	106-89-8	2.35E-07	6.70E-09	6.00E-09	1.59E-05	3.40E-06	0	0	100
Ethylene oxide	75-21-8	2.66E-04	7.60E-06	6.20E-06	4.29E-04	9.20E-05	7	6	87
Formaldehyde	50-00-0	4.10E-08	1.17E-09	1.00E-09	2.66E-06	5.70E-07	0	0	100
Polychlorobiphenyls	1336-36-3	1.12E-06	3.20E-08	2.60E-04	2.75E-04	5.90E-05	0	81	18
Propylene oxide	75-56-9	1.05E-04	3.00E-06	2.30E-06	3.41E-04	7.30E-05	4	3	93
1,2-dichloroethane	107-06-2	1.75E-06	5.00E-08	1.40E-07	3.17E-04	6.80E-05	0	0	100
1,4-dioxane	123-91-1	6.09E-08	1.74E-09	5.00E-09	3.94E-06	8.45E-07	0	1	99
2,3,7,8, -TCDD-dioxin	1746-01-6	4.55E-08	1.30E-09	2.60E-05	1.21E-07	2.60E-08	0	100	0
2,4,6-trichlorophenol	88-06-2	2.65E-06	7.56E-08	7.24E-07	1.33E-05	2.84E-06	2	20	78
Acetaldehyde	75-07-0	5.81E-08	1.66E-09	1.34E-09	3.91E-06	8.37E-07	0	0	100
alpha-hexachlorocyclohexan	319-84-6	8.09E-08	2.31E-09	1.60E-07	5.46E-06	1.17E-06	0	12	88
Benzotrichloride	98-07-7	2.00E-08	5.70E-10	2.50E-07	6.39E-04	1.37E-04	0	0	100
Benzylchloride	100-44-7	1.68E-07	4.80E-09	1.50E-08	1.54E-05	3.30E-06	0	0	99
beta-hexachlorocyclohexan	319-85-17	1.33E-07	3.80E-09	2.00E-07	5.60E-06	1.20E-06	0	14	85
Bromodichloromethane	75-27-4	1.19E-06	3.40E-08	8.30E-08	7.93E-05	1.70E-05	0	0	99
Carbontetrachloride	56-23-5	3.96E-05	1.13E-06	1.00E-05	3.87E-02	8.30E-03	0	0	100
Chloroform	67-66-3	4.90E-06	1.40E-07	2.60E-07	3.13E-06	6.70E-07	13	24	63
Diethylhexylphthalate	117-81-7	2.10E-10	6.00E-12	4.10E-07	7.93E-09	1.70E-09	0	100	0
Dichloromethane	75-09-2	1.82E-06	5.20E-08	4.80E-08	2.29E-04	4.90E-05	0	0	100
Dichlorvos	62-73-7	9.45E-09	2.70E-10	1.60E-08	7.47E-09	1.60E-09	2	90	9
Lindane (gamma HCH)	58-89-9	5.60E-07	1.60E-08	9.90E-07	2.99E-05	6.40E-06	0	13	86
Hexachlorobenzene	118-74-1	3.19E-06	9.10E-08	1.50E-03	5.60E-04	1.20E-04	0	93	7
Pentachlorophenol	87-86-5	4.20E-08	1.20E-09	1.90E-06	5.13E-09	1.10E-09	0	100	0
Perchloroethylene	127-18-4	2.21E-07	6.30E-09	1.94E-07	1.87E-04	4.00E-05	0	0	100
Styrene	100-42-5	2.91E-09	8.30E-11	2.00E-09	6.53E-07	1.40E-07	0	1	99
1,1,1,2-Tetrachlorethane	630-20-6	2.38E-05	6.80E-07	9.70E-06	2.61E-03	5.60E-04	0	2	98
1,1,2,2-Tetrachlorethane	79-34-5	1.19E-04	3.40E-06	1.40E-05	2.29E-03	4.90E-04	1	3	97
1,1,2-Trichlorethane	79-00-5	2.24E-07	6.40E-09	3.30E-08	1.40E-04	3.00E-05	0	0	100
1,1 - dichloroethene	75-35-4	2.03E-09	5.80E-11	2.40E-10	2.01E-06	4.30E-07	0	0	100
3 - methylcholanthrene	56-49-5	5.25E-06	1.50E-07	1.50E-03	5.13E-09	1.10E-09	0	100	0
Aldrin	309-00-2	1.26E-06	3.60E-08	4.20E-04	2.66E-07	5.70E-08	0	100	0
Bis (2-chloretyl)ether	111-44-4	3.85E-07	1.10E-08	7.30E-09	3.64E-06	7.80E-07	1	1	98
Dibutylphthalate	84-74-2	1.82E-08	5.20E-10	1.80E-07	5.60E-10	1.20E-10	0	100	0
Dieldrin	60-57-1	1.44E-04	4.10E-06	3.90E-02	1.54E-07	3.30E-08	0	100	0
Hexachlorobutadiene	87-68-3	9.45E-07	2.70E-08	1.40E-05	6.53E-04	1.40E-04	0	9	91
Hexachloroethane	67-72-1	1.47E-05	4.20E-07	5.10E-05	2.19E-03	4.70E-04	0	10	90
Methylchloride	74-87-3	7.00E-07	2.00E-08	5.50E-08	2.80E-03	6.00E-04	0	0	100
Trichlorethylene	79-01-6	3.36E-10	9.60E-12	2.90E-10	1.35E-05	2.90E-06	0	0	100
Trifluralin	1582-09-8	4.55E-08	1.30E-09	5.10E-07	6.07E-08	1.30E-08	0	97	2

Table 4.1(continued): Damage to Human Health (carcinogenics) EUSES output

Emissions to agricultural soil 10.000 kg/d - Resulting concentrations and human intake									
		Concentr. in	Dose by	Dose by	Concentr. in	Dose by	Contributions to pathway:		
		Drinking water	Drinking water	Food	Air	Inhalation	D	F	A
Substance	CAS-number	[mg/l]	[mg/kg/d]	[mg/kg/d]	[mg/m3]	[mg/kg/d]	%	%	%
Arsenic (long term)	7440-38-2	1.72E-02	4.90E-04	2.44E-03	2.66E-10	5.70E-11	17	83	0
Arsenic (short term)	7440-38-2	4.90E-04	1.40E-05	9.78E-05	7.47E-12	1.60E-12	13	87	0
Benzene	71-43-2	8.72E-05	2.49E-06	1.23E-06	3.07E-05	6.58E-06	24	12	64
Bis(chloromethyl)ether	542-88-1	3.15E-03	9.00E-05	1.60E-06	3.92E-06	8.40E-07	97	2	1
Cadmium (long term)	7440-43-9	2.03E-02	5.80E-04	6.23E-03	7.00E-10	1.50E-10	9	91	0
Cadmium (short term)	7440-43-9	2.31E-03	6.60E-05	7.03E-04	7.93E-11	1.70E-11	9	91	0
Chromium VI (long term)	7440-47-3	4.55E-03	1.30E-04	2.08E-03	1.35E-10	2.90E-11	6	94	0
Chromium VI (short term)	7440-47-3	3.40E-05	9.70E-07	1.55E-05	9.80E-13	2.10E-13	6	94	0
Nickel (long term)	7440-02-0	1.89E-02	5.40E-04	2.98E-03	1.82E-10	3.90E-11	15	85	0
Nickel-refinery-dust (long term)	7440-02-0	1.89E-02	5.40E-04	2.98E-03	1.82E-10	3.90E-11	15	77	0
Nickel-subsulfide (long term)	7440-02-0	1.89E-02	5.40E-04	2.98E-03	1.82E-10	3.90E-11	15	77	0
Nickel (short term)	7440-02-0	8.40E-04	2.40E-05	1.34E-04	8.40E-12	1.80E-12	15	85	0
Nickel-refinery-dust (short term)	7440-02-0	8.40E-04	2.40E-05	1.34E-04	8.40E-12	1.80E-12	15	77	0
Nickel-subsulfide (short term)	7440-02-0	8.40E-04	2.40E-05	1.34E-04	8.40E-12	1.80E-12	15	77	0
Vinylchloride	75-56-9	2.70E-06	7.70E-08	1.50E-08	1.12E-05	2.40E-06	3	1	96
1,2-dibromoethane	106-93-4	3.10E-04	8.85E-06	3.60E-06	1.91E-04	4.10E-05	17	7	77
1,3-butadiene	106-99-0	8.02E-04	2.29E-05	9.00E-06	3.69E-07	7.90E-08	72	28	0
Acrylonitril	107-13-1	4.83E-04	1.38E-05	2.52E-06	1.44E-05	3.08E-06	71	13	16
Benzo(a)pyreen	50-32-8	7.00E-06	2.00E-07	3.20E-04	7.93E-12	1.70E-12	0	100	0
Benzo(a)anthracene	56-55-3	2.56E-04	7.30E-06	8.40E-03	1.96E-05	4.20E-06	0	100	0
Dibenz(a)anthracene	53-70-3	1.44E-04	4.10E-06	3.00E-02	3.92E-06	8.40E-07	0	100	0
Diesel soot particles (no calculations in EUSES)									
Epichloorhydrin	106-89-8	3.05E-04	8.70E-06	1.60E-06	1.54E-05	3.30E-06	64	12	24
Ethylene oxide	75-21-8	5.60E-03	1.60E-04	3.10E-05	4.11E-04	8.80E-05	57	11	32
Formaldehyde	50-00-0	3.01E-04	8.60E-06	1.60E-06	2.66E-06	5.70E-07	80	15	5
Polychlorobiphenyls	1336-36-3	3.85E-05	1.10E-06	2.30E-03	2.75E-04	5.90E-05	0	97	2
Propylene oxide	75-56-9	3.22E-03	9.20E-05	1.80E-05	2.57E-04	5.50E-05	56	11	33
1,2-dichloroethane	107-06-2	1.19E-04	3.40E-06	1.30E-06	3.17E-04	6.80E-05	5	2	94
1,4-dioxane	123-91-1	3.14E-04	8.96E-06	1.61E-06	3.93E-06	8.43E-07	79	14	7
2,3,7,8, -TCDD-dioxin	1746-01-6	7.70E-06	2.20E-07	7.60E-04	3.03E-08	6.50E-09	0	100	0
2,4,6-trichlorophenol	88-06-2	2.85E-04	8.14E-06	1.21E-05	3.92E-06	8.39E-07	39	57	4
Acetaldehyde	75-07-0	3.01E-04	8.61E-06	1.60E-06	3.78E-06	8.11E-07	78	15	7
alpha-hexachlorocyclohexan	319-84-6	1.96E-04	5.59E-06	5.96E-05	3.93E-06	8.42E-07	8	90	1
Benzotrichloride	98-07-7	2.00E-08	5.70E-10	2.50E-07	6.39E-04	1.37E-04	0	0	100
Benzylchloride	100-44-7	2.21E-04	6.30E-06	3.80E-06	1.17E-05	2.50E-06	50	30	20
beta-hexachlorocyclohexan	319-85-17	1.86E-04	5.30E-06	6.70E-05	3.69E-06	7.90E-07	7	92	1
Bromodichloromethane	75-27-4	3.08E-04	8.80E-06	4.00E-06	7.47E-05	1.60E-05	31	14	56
Carbontetrachloride	56-23-5	6.30E-05	1.80E-06	1.10E-05	3.83E-02	8.20E-03	0	0	100
Chloroform	67-66-3	3.12E-04	8.90E-06	3.70E-06	3.08E-04	6.60E-05	11	5	84
Diethylhexylphthalate	117-81-7	8.05E-08	2.30E-09	7.50E-05	1.96E-09	4.20E-10	0	100	0
Dichloromethane	75-09-2	1.72E-04	4.90E-06	6.00E-07	2.29E-04	4.90E-05	9	1	90
Dichlorvos	62-73-7	9.80E-05	2.80E-06	1.40E-06	1.91E-09	4.10E-10	67	33	0
Lindane (gamma HCH)	58-89-9	2.73E-04	7.80E-06	1.00E-04	2.71E-05	5.80E-06	7	88	5
Hexachlorobenzene	118-74-1	4.20E-05	1.20E-06	1.40E-03	1.68E-04	3.60E-05	0	97	3
Pentachlorophenol	87-86-5	7.00E-06	2.00E-07	4.00E-05	9.33E-10	2.00E-10	0	100	0
Perchloroethylene	127-18-4	2.52E-05	7.20E-07	3.50E-06	1.87E-04	4.00E-05	2	8	90
Styrene	100-42-5	9.10E-05	2.60E-06	6.00E-06	4.29E-07	9.20E-08	30	69	1
1,1,1,2-Tetrachlorethane	630-20-6	2.14E-04	6.10E-06	2.10E-05	2.43E-03	5.20E-04	1	4	95
1,1,2,2-Tetrachlorethane	79-34-5	3.47E-05	9.90E-07	8.30E-07	1.40E-04	3.00E-05	3	3	94
1,1,2-Trichlorethane	79-00-5	3.47E-05	9.90E-07	8.30E-07	1.40E-04	3.00E-05	3	3	94
1,1 - dichloroethene	75-35-4	2.17E-05	6.20E-07	2.90E-07	2.01E-06	4.30E-07	46	22	32
3 - methylcholanthrene	56-49-5	1.12E-04	3.20E-06	1.10E-02	1.31E-09	2.80E-10	0	100	0
Aldrin	309-00-2	2.91E-04	8.30E-06	3.40E-02	8.40E-08	1.80E-08	0	100	0
Bis (2-chloretyl)ether	111-44-4	1.68E-03	4.80E-05	8.60E-06	3.45E-06	7.40E-07	84	15	1
Dibutylphthalate	84-74-2	9.45E-06	2.70E-07	2.30E-05	1.40E-10	3.00E-11	1	99	0
Dieldrin	60-57-1	7.35E-03	2.10E-04	4.70E-01	1.07E-07	2.30E-08	0	100	0
Hexachlorobutadiene	87-68-3	3.22E-05	9.20E-07	9.90E-05	6.53E-04	1.40E-04	0	41	58
Hexachloroethane	67-72-1	1.47E-04	4.20E-06	9.60E-05	2.10E-03	4.50E-04	1	17	82
Methylchloride	74-87-3	5.95E-06	1.70E-07	9.00E-08	2.80E-03	6.00E-04	0	0	100
Trichlorethylene	79-01-6	5.25E-07	1.50E-08	1.10E-08	1.35E-05	2.90E-06	1	0	99
Trifluralin	1582-09-8	5.25E-05	1.50E-06	1.60E-04	1.49E-08	3.20E-09	1	99	0

Table 4.1(continued): Damage to Human Health (carcinogenics) EUSES output

Fate Factors	Fate factors air			Fate factors water		
	air-air	air-drw	air-food	water-air	water-drw	water-food
	m2y/m3	m2y/l	ım2y/(kg.d)	m2y/m3	m2y/l	m2y/(kg.d)
Substance						
Arsenic (long term)	7.82E-06	4.49E-03	7.70E-04	3.96E-12	2.24E-03	7.05E-04
Arsenic (short term)	7.82E-06	1.31E-04	4.42E-05	3.18E-12	1.83E-03	5.64E-04
Benzene	3.16E-05	1.30E-07	6.14E-09	2.92E-05	3.66E-05	1.59E-06
Bis(chloromethyl)ether	3.96E-06	6.21E-08	1.18E-09	3.54E-06	3.80E-05	1.87E-07
Cadmium (long term)	1.56E-05	5.52E-03	1.68E-03	9.67E-12	2.59E-03	2.01E-04
Cadmium (short term)	5.52E-06	6.21E-04	1.95E-04	7.82E-12	2.07E-03	1.63E-04
Chromium VI (long term)	5.52E-06	1.21E-03	5.80E-04	2.99E-13	9.32E-05	4.36E-05
Chromium VI (short term)	5.52E-06	8.98E-06	5.74E-06	2.39E-13	7.25E-05	3.51E-05
Nickel (long term)	4.42E-06	5.18E-03	8.48E-04	2.95E-12	2.69E-03	4.66E-04
Nickel-refinery-dust (long term)	4.42E-06	4.23E-06	2.43E-03	2.95E-12	1.78E-06	1.07E-04
Nickel-subsulfide (long term)	4.42E-06	4.23E-06	2.43E-03	2.95E-12	1.78E-06	1.07E-04
Nickel (short term)	4.42E-06	2.24E-04	3.77E-04	2.39E-12	2.17E-03	3.77E-04
Nickel-refinery-dust (short term)	4.42E-06	1.83E-07	1.74E-04	2.39E-12	2.62E-07	8.65E-04
Nickel-subsulfide (short term)	4.42E-06	1.83E-07	1.74E-04	2.39E-12	2.62E-07	8.65E-04
Vinylchloride	1.10E-05	1.35E-09	1.87E-10	1.06E-05	3.80E-05	1.78E-07
1,2-dibromoethane	1.97E-04	2.99E-06	1.11E-07	1.94E-04	4.42E-05	1.58E-06
1,3-butadiene	1.27E-06	1.46E-07	8.68E-09	1.10E-06	1.54E-04	2.48E-06
Acrylonitril	1.54E-05	3.80E-07	8.88E-09	1.33E-05	8.28E-05	2.17E-07
Benzo(a)pyreen	1.93E-07	4.83E-08	2.27E-05	6.90E-10	3.21E-05	7.30E-03
Benzo(a)anthracene	2.62E-05	2.69E-05	9.76E-04	2.39E-05	2.49E-05	3.75E-03
Dibenz(a)anthracene	3.87E-06	1.42E-04	2.96E-02	8.28E-06	4.49E-05	1.48E-02
Diesel soot particles	1.70E-05					
Epichloorhydrin	1.56E-05	2.35E-07	5.72E-09	1.15E-05	3.18E-05	1.48E-07
Ethylene oxide	5.98E-04	3.80E-04	5.62E-06	3.54E-04	2.97E-04	3.55E-06
Formaldehyde	2.76E-06	4.14E-08	8.88E-10	2.44E-06	3.87E-05	1.78E-07
Polychlorobiphenyls	2.72E-04	1.10E-06	2.56E-04	2.26E-04	8.28E-06	4.14E-03
Propylene oxide	4.60E-04	1.48E-04	3.16E-06	2.85E-04	2.24E-04	2.27E-06
1,2-dichloroethane	3.18E-04	1.76E-06	9.86E-08	3.08E-04	4.14E-05	1.18E-06
1,4-dioxane	3.95E-06	6.11E-08	1.21E-09	3.04E-06	3.36E-05	1.56E-07
2,3,7,8, -TCDD-dioxin	1.70E-05	1.62E-06	2.17E-03	7.36E-06	2.76E-05	8.48E-03
2,4,6-trichlorophenol	8.15E-05	1.62E-05	4.37E-06	5.57E-05	2.13E-04	1.93E-05
Acetaldehyde	3.95E-06	5.87E-08	1.28E-09	3.48E-06	3.87E-05	1.80E-07
alpha-hexachlorocyclohexan	6.31E-06	9.32E-08	1.75E-07	6.21E-06	4.32E-05	4.53E-05
Benzotrichloride	6.31E-04	1.97E-08	2.47E-07	6.21E-04	1.88E-05	7.89E-05
Benzylchloride	1.70E-05	1.83E-07	2.47E-08	1.47E-05	3.80E-05	2.27E-06
beta-hexachlorocyclohexan	6.44E-06	1.55E-07	2.27E-07	6.44E-06	4.49E-05	5.33E-05
Bromodichloromethane	7.82E-05	1.17E-06	1.68E-07	6.90E-05	4.14E-05	1.68E-06
Carbontetrachloride	3.82E-02	3.94E-05	9.86E-06	3.77E-02	5.70E-05	1.58E-05
Chloroform	3.18E-04	4.83E-06	3.55E-07	3.13E-04	4.49E-05	1.48E-06
Diethylhexylphthalate	2.62E-06	2.93E-09	9.86E-05	5.06E-07	1.90E-06	9.86E-04
Dichloromethane	2.26E-04	1.83E-06	4.64E-08	2.26E-04	4.14E-05	2.96E-07
Dichlorvos	3.73E-06	4.83E-06	7.89E-06	3.87E-09	5.18E-05	7.20E-07
Lindane (gamma HCH)	3.13E-05	5.87E-07	9.86E-07	2.85E-05	4.14E-05	5.03E-05
Hexachlorobenzene	2.07E-03	1.21E-05	5.82E-03	1.98E-03	3.45E-05	8.09E-03
Pentachlorophenol	2.85E-05	1.80E-05	4.24E-03	1.61E-06	3.21E-04	9.67E-03
Perchloroethylene	1.89E-04	2.17E-07	1.94E-07	1.84E-04	3.80E-05	1.97E-05
Styrene	7.82E-07	3.38E-09	2.27E-09	7.36E-07	3.80E-05	9.57E-06
1,1,1,2-Tetrachlorethane	2.67E-03	2.45E-05	9.86E-06	2.53E-03	5.18E-05	1.97E-05
1,1,2,2-Tetrachlorethane	2.49E-03	1.28E-04	1.48E-05	2.35E-03	2.28E-04	1.78E-05
1,1,2-Trichlorethane	1.38E-04	2.21E-07	3.16E-08	1.38E-04	3.80E-05	3.35E-06
1,1 - dichloroethene	1.98E-06	2.00E-09	1.87E-10	1.98E-06	3.80E-05	1.58E-06
3 - methylcholanthrene	1.06E-06	3.45E-06	8.19E-04	8.28E-08	2.52E-04	7.00E-02
Aldrin	1.20E-06	5.52E-07	2.56E-04	5.06E-07	2.49E-05	7.10E-03
Bis (2-chloretyl)ether	3.96E-06	4.25E-07	7.99E-09	3.41E-06	1.24E-04	2.96E-07
Dibutylphthalate	2.67E-06	1.59E-06	2.96E-04	3.22E-08	2.31E-04	1.58E-03
Dieldrin	3.13E-06	1.10E-03	8.58E-02	2.62E-08	4.14E-04	1.08E-01
Hexachlorobutadiene	6.44E-04	9.32E-07	1.38E-05	6.44E-04	1.93E-05	2.96E-04
Hexachloroethane	2.49E-03	1.66E-05	5.52E-05	2.39E-03	5.18E-05	1.18E-04
Methylchloride	2.76E-03	6.90E-07	5.42E-08	2.62E-03	3.45E-05	8.38E-08
Trichlorethylene	1.33E-05	3.31E-10	2.86E-10	1.33E-05	6.56E-05	2.76E-06
Trifluralin	1.43E-06	1.07E-07	4.04E-06	8.75E-07	7.94E-05	6.71E-04

Table 4.1(continued): Damage to Human Health (carcinogenics)

Fate factors	Fate factors industrial soil			Fate factors agricultural soil		
	ind. soil-air	ind. soil-drw	ind. soil-food	agri. soil-air	agri.soil-drw	agri. soil-food
Substance	m2y/m3	m2y/l	m2y/(kg.d)	m2y/m3	m2y/l	m2y/(kg.d)
Arsenic (long term)	2.62E-12	4.56E-04	1.41E-04	2.62E-10	1.69E-02	2.41E-03
Arsenic (short term)	2.76E-11	3.87E-05	1.20E-05	7.36E-12	4.83E-04	9.65E-05
Benzene	3.12E-05	1.28E-07	1.61E-08	3.03E-05	8.60E-05	1.21E-06
Bis(chloromethyl)ether	3.91E-06	5.87E-08	2.27E-09	3.87E-06	3.11E-03	1.58E-06
Cadmium (long term)	6.90E-10	1.21E-04	1.12E-05	6.90E-10	2.00E-02	6.14E-03
Cadmium (short term)	2.30E-10	3.31E-05	2.65E-06	7.82E-11	2.28E-03	6.93E-04
Chromium VI (long term)	1.33E-10	7.25E-05	3.45E-05	1.33E-10	4.49E-03	2.05E-03
Chromium VI (short term)	3.82E-12	1.69E-06	8.10E-07	9.67E-13	3.35E-05	1.53E-05
Nickel (long term)	1.80E-10	3.42E-04	5.90E-05	1.80E-10	1.86E-02	2.94E-03
Nickel-refinery-dust (long term)	1.80E-10	2.79E-07	1.35E-04	1.80E-10	1.52E-05	1.74E-03
Nickel-subsulfide (long term)	1.80E-10	2.79E-07	1.35E-04	1.80E-10	1.52E-05	1.74E-03
Nickel (short term)	2.85E-11	4.49E-05	7.54E-06	8.28E-12	8.28E-04	1.32E-04
Nickel-refinery-dust (short term)	2.85E-11	3.66E-08	1.74E-05	8.28E-12	6.76E-07	7.71E-05
Nickel-subsulfide (short term)	2.85E-11	3.66E-08	1.74E-05	8.28E-12	6.76E-07	7.71E-05
Vinylchloride	1.10E-05	1.35E-09	1.97E-10	1.10E-05	2.66E-06	1.48E-08
1,2-dibromoethane	1.93E-04	2.92E-06	2.12E-07	1.89E-04	3.06E-04	3.55E-06
1,3-butadiene	7.36E-07	9.29E-08	5.24E-09	3.64E-07	7.91E-04	8.88E-06
Acrylonitril	1.48E-05	3.66E-07	9.27E-09	1.42E-05	4.76E-04	2.49E-06
Benzo(a)pyreen	3.04E-11	2.21E-08	5.03E-06	7.82E-12	6.90E-06	3.16E-04
Benzo(a)anthracene	2.39E-05	2.45E-05	9.07E-04	1.93E-05	2.52E-04	8.28E-03
Dibenz(a)anthracene	6.90E-06	3.80E-05	8.88E-03	3.87E-06	1.42E-04	2.96E-02
Diesel soot particles						
Epichloorhydrin	1.56E-05	2.31E-07	5.92E-09	1.52E-05	3.00E-04	1.58E-06
Ethylene oxide	4.23E-04	2.62E-04	6.12E-06	4.05E-04	5.52E-03	3.06E-05
Formaldehyde	2.62E-06	4.04E-08	9.86E-10	2.62E-06	2.97E-04	1.58E-06
Polychlorobiphenyls	2.72E-04	1.10E-06	2.56E-04	2.72E-04	3.80E-05	2.27E-03
Propylene oxide	3.36E-04	1.04E-04	2.27E-06	2.53E-04	3.18E-03	1.78E-05
1,2-dichloroethane	3.13E-04	1.73E-06	1.38E-07	3.13E-04	1.17E-04	1.28E-06
1,4-dioxane	3.89E-06	6.01E-08	4.93E-09	3.88E-06	3.09E-04	1.59E-06
2,3,7,8, -TCDD-dioxin	1.20E-07	4.49E-08	2.56E-05	2.99E-08	7.59E-06	7.50E-04
2,4,6-trichlorophenol	1.31E-05	2.61E-06	7.14E-07	3.86E-06	2.81E-04	1.19E-05
Acetaldehyde	3.85E-06	5.73E-08	1.32E-09	3.73E-06	2.97E-04	1.58E-06
alpha-hexachlorocyclohexan	5.39E-06	7.97E-08	1.58E-07	3.88E-06	1.93E-04	5.88E-05
Benzotrichloride	6.31E-04	1.97E-08	2.47E-07	6.31E-04	1.97E-08	2.47E-07
Benzylchloride	1.52E-05	1.66E-07	1.48E-08	1.15E-05	2.17E-04	3.75E-06
beta-hexachlorocyclohexan	5.52E-06	1.31E-07	1.97E-07	3.64E-06	1.83E-04	6.61E-05
Bromodichloromethane	7.82E-05	1.17E-06	8.19E-08	7.36E-05	3.04E-04	3.95E-06
Carbontetrachloride	3.82E-02	3.90E-05	9.86E-06	3.77E-02	6.21E-05	1.08E-05
Chloroform	3.08E-06	4.83E-06	2.56E-07	3.04E-04	3.07E-04	3.65E-06
Diethylhexylphthalate	7.82E-09	2.07E-10	4.04E-07	1.93E-09	7.94E-08	7.40E-05
Dichloromethane	2.26E-04	1.80E-06	4.73E-08	2.26E-04	1.69E-04	5.92E-07
Dichlorvos	7.36E-09	9.32E-09	1.58E-08	1.89E-09	9.67E-05	1.38E-06
Lindane (gamma HCH)	2.95E-05	5.52E-07	9.76E-07	2.67E-05	2.69E-04	9.86E-05
Hexachlorobenzene	5.52E-04	3.14E-06	1.48E-03	1.66E-04	4.14E-05	1.38E-03
Pentachlorophenol	5.06E-09	4.14E-08	1.87E-06	9.21E-10	6.90E-06	3.95E-05
Perchloroethylene	1.84E-04	2.17E-07	1.91E-07	1.84E-04	2.49E-05	3.45E-06
Styrene	6.44E-07	2.87E-09	1.97E-09	4.23E-07	8.98E-05	5.92E-06
1,1,1,2-Tetrachlorethane	2.58E-03	2.35E-05	9.57E-06	2.39E-03	2.11E-04	2.07E-05
1,1,2,2-Tetrachlorethane	2.26E-03	1.17E-04	1.38E-05	1.38E-04	3.42E-05	8.19E-07
1,1,2-Trichlorethane	1.38E-04	2.21E-07	3.25E-08	1.38E-04	3.42E-05	8.19E-07
1,1 - dichloroethene	1.98E-06	2.00E-09	2.37E-10	1.98E-06	2.14E-05	2.86E-07
3 - methylcholanthrene	5.06E-09	5.18E-06	1.48E-03	1.29E-09	1.10E-04	1.08E-02
Aldrin	2.62E-07	1.24E-06	4.14E-04	8.28E-08	2.87E-04	3.35E-02
Bis (2-chloretyl)ether	3.59E-06	3.80E-07	7.20E-09	3.41E-06	1.66E-03	8.48E-06
Dibutylphthalate	5.52E-10	1.80E-08	1.78E-07	1.38E-10	9.32E-06	2.27E-05
Dieldrin	1.52E-07	1.42E-04	3.85E-02	1.06E-07	7.25E-03	4.64E-01
Hexachlorobutadiene	6.44E-04	9.32E-07	1.38E-05	6.44E-04	3.18E-05	9.76E-05
Hexachloroethane	2.16E-03	1.45E-05	5.03E-05	2.07E-03	1.45E-04	9.47E-05
Methylchloride	2.76E-03	6.90E-07	5.42E-08	2.76E-03	5.87E-06	8.88E-08
Trichlorethylene	1.33E-05	3.31E-10	2.86E-10	1.33E-05	5.18E-07	1.08E-08
Trifluralin	5.98E-08	4.49E-08	5.03E-07	1.47E-08	5.18E-05	1.58E-04

Table 4.1(continued): Damage to Human Health (carcinogenics)

Effect analysis	Unit risk factors			Population density			
	Oral	Inhalation	Drinking water				
	Slope factor	Unit Risk	Unit Risk	(via air)	(via water)	(via ind.soil)	(via agri soil)
Substance	(mg/kg/d)-1	(µg/m3)-1	(µg/l)-1	P/m2	P/m2	P/m2	P/m2
Arsenic (long term)	1.50E+00	1.50E-03	5.00E-05	9.44E-05	3.00E-04	3.00E-04	3.00E-04
Arsenic (short term)	1.50E+00	1.50E-03	5.00E-05	9.44E-05	3.00E-04	3.00E-04	3.00E-04
Benzene	2.90E-02	6.00E-06	8.30E-07	5.59E-05	6.95E-05	3.00E-04	3.00E-04
Bis(chloromethyl)ether	2.20E+02	6.20E-02	6.20E-03	1.32E-04	1.50E-04	3.00E-04	3.00E-04
Cadmium (long term)	6.30E+00	1.80E-03		6.82E-05	3.00E-04	3.00E-04	3.00E-04
Cadmium (short term)	6.30E+00	1.80E-03		6.82E-05	3.00E-04	3.00E-04	3.00E-04
Chromium VI (long term)	1.40E+02	4.00E-02		1.15E-04	3.00E-04	3.00E-04	3.00E-04
Chromium VI (short term)	1.40E+02	4.00E-02		1.15E-04	3.00E-04	3.00E-04	3.00E-04
Nickel (long term)	1.19E+00	3.40E-04		1.24E-04	3.00E-04	3.00E-04	3.00E-04
Nickel-refinery-dust (long term)	8.40E-01	2.40E-04		1.24E-04	3.00E-04	3.00E-04	3.00E-04
Nickel-subsulfide (long term)	1.68E+00	4.80E-04		1.24E-04	3.00E-04	3.00E-04	3.00E-04
Nickel (short term)	1.19E+00	3.40E-04		1.24E-04	3.00E-04	3.00E-04	3.00E-04
Nickel-refinery-dust (short term)	8.40E-01	2.40E-04		1.24E-04	3.00E-04	3.00E-04	3.00E-04
Nickel-subsulfide (short term)	1.68E+00	4.80E-04		1.24E-04	3.00E-04	3.00E-04	3.00E-04
Vinylchloride	3.50E-03	1.00E-06	1.00E-07	8.17E-05	8.19E-05	3.00E-04	3.00E-04
1,2-dibromoethane	8.50E+01	2.20E-04	2.50E-03	2.30E-05	2.31E-05	3.00E-04	3.00E-04
1,3-butadiene	9.80E-01	2.80E-04	2.80E-05	2.30E-04	2.56E-04	3.00E-04	3.00E-04
Acrylonitril	5.40E-01	6.80E-05	1.50E-05	6.96E-05	8.97E-05	3.00E-04	3.00E-04
Benzo(a)pyreen	7.30E+00	8.70E-02	2.10E-04	1.14E-04	3.00E-04	3.00E-04	3.00E-04
Benzo(a)anthracene	3.12E+00	8.90E-04		1.02E-04	3.00E-04	3.00E-04	3.00E-04
Dibenz(a)anthracene	4.90E+01	1.40E-02		1.14E-04	3.00E-04	3.00E-04	3.00E-04
Diesel soot particles		3.40E-05		7.36E-05			
Epichloorhydrin	9.90E-03	1.20E-06	2.80E-07	6.95E-05	1.93E-04	3.00E-04	3.00E-04
Ethylene oxide		1.00E-04		1.63E-05	2.10E-05	3.00E-04	3.00E-04
Formaldehyde	4.55E-02	1.30E-05	1.30E-06	1.54E-04	3.00E-04	3.00E-04	3.00E-04
Polychlorobiphenyls	4.20E+00	1.20E-03		2.89E-05	4.55E-05	3.00E-04	3.00E-04
Propylene oxide	2.40E-01	3.70E-06	6.80E-06	1.81E-05	2.98E-05	3.00E-04	3.00E-04
1,2-dichloroethane	9.10E-02	2.60E-05	2.60E-06	1.92E-05	1.93E-05	3.00E-04	3.00E-04
1,4-dioxane	1.10E-02	1.40E-06	3.10E-07	1.34E-04	3.00E-04	3.00E-04	3.00E-04
2,3,7,8, -TCDD-dioxin	4.90E+03	1.40E+00		8.95E-05	2.60E-04	3.00E-04	3.00E-04
2,4,6-trichlorophenol	1.10E-02	3.10E-06	3.10E-07	3.59E-05	1.25E-04	3.00E-04	3.00E-04
Acetaldehyde	7.70E-03	2.20E-06	2.20E-07	1.33E-04	2.81E-04	3.00E-04	3.00E-04
alpha-hexachlorocyclohexan	6.30E+00	1.80E-03	1.80E-04	1.06E-04	1.19E-04	3.00E-04	3.00E-04
Benzotrichloride	1.30E+01	3.71E-03	3.60E-04	1.51E-05	1.51E-05	3.00E-04	3.00E-04
Benzylchloride	1.70E-01	4.86E-05	4.90E-06	6.66E-05	8.24E-05	3.00E-04	3.00E-04
beta-hexachlorocyclohexan	1.80E+00	5.30E-04	5.30E-05	1.16E-04	3.00E-04	3.00E-04	3.00E-04
Bromodichloromethane	6.20E-02	1.77E-05	1.80E-06	3.35E-05	3.57E-05	3.00E-04	3.00E-04
Carbontetrachloride	1.30E-01	1.50E-05	3.70E-06	6.30E-06	6.30E-06	3.00E-04	3.00E-04
Chloroform	6.10E-03	2.30E-05	1.70E-07	1.92E-05	1.93E-05	3.00E-04	3.00E-04
Diethylhexylphthalate	1.40E-02	2.40E-07	4.00E-07	1.31E-04	2.57E-04	3.00E-04	3.00E-04
Dichloromethane	7.50E-03	4.70E-07	2.10E-07	2.18E-05	2.19E-05	3.00E-04	3.00E-04
Dichlorvos	2.90E-01	8.29E-05		6.48E-05	3.00E-04	3.00E-04	3.00E-04
Lindane (gamma HCH)	1.33E+00	3.80E-04	3.80E-05	1.17E-04	2.71E-04	3.00E-04	3.00E-04
Hexachlorobenzene	1.60E+00	4.60E-04	4.60E-05	4.29E-05	4.82E-05	3.00E-04	3.00E-04
Pentachlorophenol	1.20E-01		3.00E-06	7.57E-05	1.05E-04	3.00E-04	3.00E-04
Perchloroethylene		5.80E-07		2.35E-05	2.36E-05	3.00E-04	3.00E-04
Styrene	2.00E-03	5.70E-07	5.70E-08	2.90E-04	3.00E-04	3.00E-04	3.00E-04
1,1,1,2-Tetrachlorethane	2.60E-02	7.40E-06	7.40E-07	9.93E-06	1.01E-05	3.00E-04	3.00E-04
1,1,2,2-Tetrachlorethane	2.00E-01	5.80E-05	5.80E-06	1.03E-05	1.05E-05	3.00E-04	3.00E-04
1,1,2-Trichlorethane	5.70E-02	1.60E-05	1.60E-06	2.65E-05	2.67E-05	3.00E-04	3.00E-04
1,1 - dichloroethene	6.00E-01	5.00E-05	1.70E-05	1.85E-04	1.86E-04	3.00E-04	3.00E-04
3 - methylcholanthrene	9.45E+00	2.70E-03		1.15E-04	3.00E-04	3.00E-04	3.00E-04
Aldrin	1.70E+01	4.90E-03	4.90E-03	2.36E-04	3.00E-04	3.00E-04	3.00E-04
Bis (2-chloretyl)ether	1.10E+00	3.30E-04	3.30E-05	1.32E-04	1.49E-04	3.00E-04	3.00E-04
Dibutylphthalate	6.00E-01	5.00E-05	1.70E-05	1.03E-04	3.00E-04	3.00E-04	3.00E-04
Dieldrin	1.60E+01	4.60E-03	4.60E-04	1.05E-04	3.00E-04	3.00E-04	3.00E-04
Hexachlorobutadiene	7.80E-02	2.20E-05	2.20E-06	1.51E-05	1.55E-05	3.00E-04	3.00E-04
Hexachloroethane	1.40E-02	4.00E-06	4.00E-07	9.92E-06	1.01E-05	3.00E-04	3.00E-04
Methylchloride		3.60E-06		9.81E-06	1.01E-05	3.00E-04	3.00E-04
Trichlorethylene		4.30E-07		7.40E-05	7.42E-05	3.00E-04	3.00E-04
Trifluralin	7.70E-03	2.20E-06	2.20E-07	1.71E-05	8.17E-05	3.00E-04	3.00E-04

Table 4.1(continued): Damage to Human Health (carcinogenics)

Effect analysis	Emissions to air			Emissions to water		
Incidence factors (cases/kg)	air, air	air, dr.water	air, food	water,air	water, dr.water	water, food
Substance	cases/kg	cases/kg	cases/kg	cases/kg	cases/kg	cases/kg
Arsenic (long term)	1.58E-05	3.03E-04	1.56E-03	2.54E-11	4.81E-04	4.53E-03
Arsenic (short term)	1.58E-05	8.85E-06	8.94E-05	2.04E-11	3.92E-04	3.63E-03
Benzene	1.52E-07	8.63E-11	1.42E-10	1.74E-07	3.01E-08	4.57E-08
Bis(chloromethyl)ether	4.64E-04	7.28E-07	4.92E-07	4.72E-04	5.06E-04	8.86E-05
Cadmium (long term)	2.75E-05	0.00E+00	1.03E-02	7.46E-11	0.00E+00	5.43E-03
Cadmium (short term)	9.69E-06	0.00E+00	1.20E-03	6.04E-11	0.00E+00	4.39E-03
Chromium VI (long term)	3.63E-04	0.00E+00	1.33E-01	5.13E-11	0.00E+00	2.62E-02
Chromium VI (short term)	3.63E-04	0.00E+00	1.32E-03	4.10E-11	0.00E+00	2.11E-02
Nickel (long term)	2.67E-06	0.00E+00	1.79E-03	4.29E-12	0.00E+00	2.37E-03
Nickel-refinery-dust (long term)	1.88E-06	0.00E+00	3.62E-03	3.03E-12	0.00E+00	3.83E-04
Nickel-subsulfide (long term)	3.76E-06	0.00E+00	7.24E-03	6.06E-12	0.00E+00	7.67E-04
Nickel (short term)	2.67E-06	0.00E+00	7.96E-04	3.49E-12	0.00E+00	1.92E-03
Nickel-refinery-dust (short term)	1.88E-06	0.00E+00	2.59E-04	2.46E-12	0.00E+00	3.11E-03
Nickel-subsulfide (short term)	3.76E-06	0.00E+00	5.18E-04	4.92E-12	0.00E+00	6.23E-03
Vinylchloride	1.29E-08	1.57E-13	7.66E-13	1.24E-08	4.44E-09	7.27E-10
1,2-dibromoethane	1.43E-05	2.45E-06	3.11E-06	1.41E-05	3.64E-05	4.43E-05
1,3-butadiene	1.17E-06	1.34E-08	2.80E-08	1.13E-06	1.57E-05	8.87E-06
Acrylonitril	1.04E-06	5.66E-09	4.76E-09	1.16E-06	1.59E-06	1.50E-07
Benzo(a)pyreen	2.74E-05	1.65E-08	2.70E-04	2.57E-07	2.89E-05	2.28E-01
Benzo(a)anthracene	3.40E-05	0.00E+00	4.44E-03	9.13E-05	0.00E+00	5.01E-02
Dibenz(a)anthracene	8.83E-05	0.00E+00	2.36E+00	4.97E-04	0.00E+00	3.11E+00
Diesel soot particles	6.08E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epichloorhydrin	1.86E-08	6.53E-11	5.62E-11	3.82E-08	2.46E-08	4.05E-09
Ethylene oxide	1.40E-05	0.00E+00	0.00E+00	1.06E-05	0.00E+00	0.00E+00
Formaldehyde	7.91E-08	1.19E-10	8.90E-11	1.36E-07	2.15E-07	3.46E-08
Polychlorobiphenyls	1.35E-04	0.00E+00	4.45E-04	1.76E-04	0.00E+00	1.13E-02
Propylene oxide	4.40E-07	2.61E-07	1.96E-07	4.49E-07	6.49E-07	2.31E-07
1,2-dichloroethane	2.27E-06	1.26E-09	2.46E-09	2.21E-06	2.97E-08	2.97E-08
1,4-dioxane	1.06E-08	3.62E-11	2.55E-11	1.83E-08	4.47E-08	7.35E-09
2,3,7,8, -TCDD-dioxin	3.05E-02	0.00E+00	1.36E+01	3.82E-02	0.00E+00	1.54E+02
2,4,6-trichlorophenol	1.29E-07	2.57E-09	2.46E-08	3.08E-07	1.18E-07	3.79E-07
Acetaldehyde	1.65E-08	2.45E-11	1.87E-11	3.08E-08	3.41E-08	5.58E-09
alpha-hexachlorocyclohexan	1.72E-05	2.55E-08	1.67E-06	1.91E-05	1.32E-05	4.86E-04
Benzotrichloride	5.03E-04	1.52E-09	6.90E-07	4.99E-04	1.46E-06	2.22E-04
Benzylchloride	7.87E-07	8.53E-10	3.99E-09	8.42E-07	2.19E-07	4.54E-07
beta-hexachlorocyclohexan	5.64E-06	1.36E-08	6.75E-07	1.46E-05	1.02E-05	4.11E-04
Bromodichloromethane	6.62E-07	1.01E-09	4.97E-09	6.24E-07	3.81E-08	5.31E-08
Carbontetrachloride	5.16E-05	1.31E-08	1.15E-07	5.10E-05	1.90E-08	1.85E-07
Chloroform	2.01E-06	2.26E-10	5.95E-10	1.98E-06	2.10E-09	2.48E-09
Diethylhexylphthalate	1.18E-09	2.19E-12	2.58E-06	4.46E-10	2.79E-09	5.07E-05
Dichloromethane	3.31E-08	1.20E-10	1.08E-10	3.31E-08	2.72E-09	6.93E-10
Dichlorvos	2.86E-07	0.00E+00	2.12E-06	1.37E-09	0.00E+00	8.95E-07
Lindane (gamma HCH)	1.99E-05	3.72E-08	2.19E-06	4.21E-05	6.10E-06	2.59E-04
Hexachlorobenzene	5.84E-04	3.41E-07	5.71E-03	6.27E-04	1.09E-06	8.91E-03
Pentachlorophenol	0.00E+00	5.82E-08	5.50E-04	0.00E+00	1.45E-06	1.75E-03
Perchloroethylene	3.68E-08	0.00E+00	0.00E+00	3.60E-08	0.00E+00	0.00E+00
Styrene	1.85E-09	7.98E-13	1.88E-11	1.80E-09	9.28E-09	8.20E-08
1,1,1,2-Tetrachlorethane	2.80E-06	2.57E-09	3.64E-08	2.71E-06	5.55E-09	7.43E-08
1,1,2,2-Tetrachlorethane	2.13E-05	1.09E-07	4.36E-07	2.05E-05	1.99E-07	5.34E-07
1,1,2-Trichlorethane	8.37E-07	1.34E-10	6.81E-10	8.41E-07	2.31E-08	7.28E-08
1,1 - dichloroethene	2.62E-07	9.00E-11	2.97E-10	2.63E-07	1.71E-06	2.51E-06
3 - methylcholanthrene	4.71E-06	0.00E+00	1.28E-02	9.59E-07	0.00E+00	2.84E+00
Aldrin	1.98E-05	9.13E-06	1.47E-02	1.06E-05	5.22E-04	5.17E-01
Bis (2-chloretyl)ether	2.47E-06	2.65E-08	1.66E-08	2.39E-06	8.70E-06	6.91E-07
Dibutylphthalate	1.97E-07	3.98E-08	2.61E-04	6.90E-09	1.69E-05	4.06E-03
Dieldrin	2.16E-05	7.63E-04	2.06E+00	5.17E-07	8.17E-04	7.44E+00
Hexachlorobutadiene	3.05E-06	4.41E-10	2.32E-07	3.13E-06	9.40E-09	5.10E-06
Hexachloroethane	1.41E-06	9.40E-10	1.10E-07	1.38E-06	2.98E-09	2.39E-07
Methylchloride	1.39E-06	0.00E+00	0.00E+00	1.36E-06	0.00E+00	0.00E+00
Trichlorethylene	6.07E-09	0.00E+00	0.00E+00	6.08E-09	0.00E+00	0.00E+00
Trifluralin	7.66E-10	5.74E-12	7.60E-09	2.25E-09	2.04E-08	6.03E-06

Table 4.1(continued): Damage to Human Health (carcinogenics)

Effect analysis	Emissions to industrial soil			Emissions to agricultural soil		
Incidence factors (cases/kg)	ind. soil, air	ind. soil, dr.water	ind. soil, food	agri. soil, air	agri. soil, dr.water	agri soil, food
Substance	cases/kg	cases/kg	cases/kg	cases/kg	cases/kg	cases/kg
Arsenic (long term)	1.69E-11	9.76E-05	9.07E-04	1.69E-09	3.62E-03	1.55E-02
Arsenic (short term)	1.78E-10	8.28E-06	7.74E-05	4.73E-11	1.04E-04	6.20E-04
Benzene	8.01E-07	4.57E-10	2.00E-09	7.79E-07	3.06E-07	1.51E-07
Bis(chloromethyl)ether	1.04E-03	1.56E-06	2.14E-06	1.03E-03	8.26E-02	1.49E-03
Cadmium (long term)	5.33E-09	0.00E+00	3.04E-04	5.33E-09	0.00E+00	1.66E-01
Cadmium (short term)	1.78E-09	0.00E+00	7.16E-05	6.04E-10	0.00E+00	1.87E-02
Chromium VI (long term)	2.29E-08	0.00E+00	2.07E-02	2.29E-08	0.00E+00	1.23E+00
Chromium VI (short term)	6.55E-10	0.00E+00	4.86E-04	1.66E-10	0.00E+00	9.17E-03
Nickel (long term)	2.62E-10	0.00E+00	3.01E-04	2.62E-10	0.00E+00	1.50E-02
Nickel-refinery-dust (long term)	1.85E-10	0.00E+00	4.86E-04	1.85E-10	0.00E+00	6.25E-03
Nickel-subsulfide (long term)	3.69E-10	0.00E+00	9.73E-04	3.69E-10	0.00E+00	1.25E-02
Nickel (short term)	4.16E-11	0.00E+00	3.84E-05	1.21E-11	0.00E+00	6.74E-04
Nickel-refinery-dust (short term)	2.94E-11	0.00E+00	6.25E-05	8.52E-12	0.00E+00	2.78E-04
Nickel-subsulfide (short term)	5.87E-11	0.00E+00	1.25E-04	1.70E-11	0.00E+00	5.55E-04
Vinylchloride	4.73E-08	5.77E-13	2.96E-12	4.73E-08	1.14E-09	2.22E-10
1,2-dibromoethane	1.82E-04	3.13E-05	7.72E-05	1.78E-04	3.27E-03	1.29E-03
1,3-butadiene	8.84E-07	1.11E-08	2.20E-08	4.36E-07	9.49E-05	3.73E-05
Acrylonitril	4.32E-06	2.35E-08	2.15E-08	4.13E-06	3.06E-05	5.75E-06
Benzo(a)pyreen	1.13E-08	1.99E-08	1.57E-04	2.92E-09	6.21E-06	9.87E-03
Benzo(a)anthracene	9.13E-05	0.00E+00	1.21E-02	7.37E-05	0.00E+00	1.11E-01
Dibenz(a)anthracene	4.14E-04	0.00E+00	1.86E+00	2.32E-04	0.00E+00	6.21E+00
Diesel soot particles	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Epichloorhydrin	8.05E-08	2.78E-10	2.51E-10	7.81E-08	3.60E-07	6.70E-08
Ethylene oxide	1.81E-04	0.00E+00	0.00E+00	1.74E-04	0.00E+00	0.00E+00
Formaldehyde	1.46E-07	2.25E-10	1.92E-10	1.46E-07	1.65E-06	3.08E-07
Polychlorobiphenyls	1.40E-03	0.00E+00	4.62E-03	1.40E-03	0.00E+00	4.08E-02
Propylene oxide	5.33E-06	3.02E-06	2.33E-06	4.01E-06	9.26E-05	1.83E-05
1,2-dichloroethane	3.49E-05	1.92E-08	5.39E-08	3.49E-05	1.31E-06	5.00E-07
1,4-dioxane	2.33E-08	7.98E-11	2.32E-10	2.33E-08	4.11E-07	7.49E-08
2,3,7,8, -TCDD-dioxin	7.18E-04	0.00E+00	5.39E-01	1.80E-04	0.00E+00	1.57E+01
2,4,6-trichlorophenol	1.74E-07	3.47E-09	3.37E-08	5.13E-08	3.73E-07	5.63E-07
Acetaldehyde	3.63E-08	5.40E-11	4.36E-11	3.52E-08	2.80E-07	5.21E-08
alpha-hexachlorocyclohexan	4.15E-05	6.15E-08	4.26E-06	2.99E-05	1.49E-04	1.59E-03
Benzotrichloride	1.00E-02	3.04E-08	1.37E-05	1.00E-02	3.04E-08	1.37E-05
Benzylchloride	3.16E-06	3.48E-09	1.08E-08	2.40E-06	4.57E-06	2.73E-06
beta-hexachlorocyclohexan	1.25E-05	2.98E-08	1.52E-06	8.26E-06	4.16E-05	5.10E-04
Bromodichloromethane	5.94E-06	9.05E-09	2.18E-08	5.59E-06	2.34E-06	1.05E-06
Carbontetrachloride	2.46E-03	6.19E-07	5.50E-06	2.43E-03	9.85E-07	6.04E-06
Chloroform	3.04E-07	3.52E-09	6.70E-09	2.99E-05	2.24E-07	9.54E-08
Diethylhexylphthalate	8.05E-12	3.55E-13	2.43E-08	1.99E-12	1.36E-10	4.44E-06
Dichloromethane	4.54E-07	1.62E-09	1.52E-09	4.54E-07	1.52E-07	1.90E-08
Dichlorvos	2.62E-09	0.00E+00	1.96E-08	6.70E-10	0.00E+00	1.72E-06
Lindane (gamma HCH)	4.80E-05	9.00E-08	5.57E-06	4.35E-05	4.39E-05	5.62E-04
Hexachlorobenzene	1.09E-03	6.19E-07	1.01E-02	3.27E-04	8.17E-06	9.47E-03
Pentachlorophenol	0.00E+00	5.33E-10	9.64E-07	0.00E+00	8.88E-08	2.03E-05
Perchloroethylene	4.58E-07	0.00E+00	0.00E+00	4.58E-07	0.00E+00	0.00E+00
Styrene	1.57E-09	7.00E-13	1.69E-11	1.03E-09	2.19E-08	5.07E-08
1,1,1,2-Tetrachlorethane	8.17E-05	7.44E-08	1.07E-06	7.59E-05	6.68E-07	2.31E-06
1,1,2,2-Tetrachlorethane	5.61E-04	2.92E-06	1.18E-05	3.43E-05	8.50E-07	7.02E-07
1,1,2-Trichlorethane	9.47E-06	1.51E-09	7.95E-09	9.47E-06	2.34E-07	2.00E-07
1,1 - dichloroethene	4.24E-07	1.46E-10	6.09E-10	4.24E-07	1.56E-06	7.35E-07
3 - methylcholanthrene	5.86E-08	0.00E+00	5.99E-02	1.49E-08	0.00E+00	4.39E-01
Aldrin	5.51E-06	2.61E-05	3.02E-02	1.74E-06	6.02E-03	2.44E+00
Bis (2-chloretyl)ether	5.08E-06	5.37E-08	3.39E-08	4.82E-06	2.34E-04	4.00E-05
Dibutylphthalate	1.18E-10	1.31E-09	4.57E-07	2.96E-11	6.79E-07	5.83E-05
Dieldrin	2.99E-06	2.79E-04	2.64E+00	2.09E-06	1.43E-02	3.18E+01
Hexachlorobutadiene	6.08E-05	8.79E-09	4.62E-06	6.08E-05	2.99E-07	3.26E-05
Hexachloroethane	3.71E-05	2.49E-08	3.02E-06	3.55E-05	2.49E-07	5.68E-06
Methylchloride	4.26E-05	0.00E+00	0.00E+00	4.26E-05	0.00E+00	0.00E+00
Trichlorethylene	2.46E-08	0.00E+00	0.00E+00	2.46E-08	0.00E+00	0.00E+00
Trifluralin	5.64E-10	4.23E-11	1.66E-08	1.39E-10	4.88E-08	5.21E-06

Table 4.1(continued): Damage to Human Health (carcinogenics)

Damage analysis: DALYs per Incidence case				
	DALYs	DALYs	DALYs	DALYs
	Inhalation	drw & food	Inhalation	drw & food
	E, H	E,H	Individualist	Individualist
Substance			(age weight.)	(age weight.)
Arsenic (long term)	16.1	13.1	10.4	8.5
Arsenic (short term)	16.1	13.1	10.4	8.5
Benzene	16.5	16.5	10.4	8.5
Bis(chloromethyl)ether	16.1	13.1	10.4	8.5
Cadmium (long term)	16.1	13.1	10.4	8.5
Cadmium (short term)	16.1	13.1	10.4	8.5
Chromium VI (long term)	16.1	13.1	10.4	8.5
Chromium VI (short term)	16.1	13.1	10.4	8.5
Nickel (long term)	16.1	13.1	10.4	8.5
Nickel-refinery-dust (long term)	12.5	13.1	10.4	8.5
Nickel-subsulfide (long term)	12.5	13.1	10.4	8.5
Nickel (short term)	16.1	13.1	10.4	8.5
Nickel-refinery-dust (short term)	12.5	13.1	10.4	8.5
Nickel-subsulfide (short term)	12.5	13.1	10.4	8.5
Vinylchloride	16.2	16.2	10.4	8.5
1,2-dibromoethane	13.1	13.1	10.4	8.5
1,3-butadiene	13.1	13.1	10.4	8.5
Acrylonitril	16.1	13.1	10.4	8.5
Benzo(a)pyreen	16.1	13.1	10.4	8.5
Benzo(a)anthracene	13.1	13.1	10.4	8.5
Dibenz(a)anthracene	13.1	13.1	10.4	8.5
Diesel soot particles	16.1		10.4	
Epichloorhydrin	16.1	13.1	10.4	8.5
Ethylene oxide	13.1	13.1	10.4	8.5
Formaldehyde	12.5	13.1	10.4	8.5
Polychlorobiphenyls	3.4	3.4	10.4	8.5
Propylene oxide	13.1	13.1	10.4	8.5
1,2-dichloroethane	13.1	13.1	10.4	8.5
1,4-dioxane	13.1	13.1	10.4	8.5
2,3,7,8, -TCDD-dioxin	13.1	13.1	10.4	8.5
2,4,6-trichlorophenol	13.1	13.1	10.4	8.5
Acetaldehyde	13.1	13.1	10.4	8.5
alpha-hexachlorocyclohexan	16.1	13.1	10.4	8.5
Benzotrichloride	13.1	13.1	10.4	8.5
Benzylchloride	13.1	13.1	10.4	8.5
beta-hexachlorocyclohexan	16.1	13.1	10.4	8.5
Bromodichloromethane	13.1	13.1	10.4	8.5
Carbontetrachloride	16.2	16.2	10.4	8.5
Chloroform	13.1	13.1	10.4	8.5
Diethylhexylphthalate	13.1	13.1	10.4	8.5
Dichloromethane	13.1	13.1	10.4	8.5
Dichlorvos	13.1	13.1	10.4	8.5
Lindane (gamma HCH)	16.1	13.1	10.4	8.5
Hexachlorobenzene	13.1	13.1	10.4	8.5
Pentachlorophenol	13.1	13.1	10.4	8.5
Perchloroethylene	13.1	13.1	10.4	8.5
Styrene	13.1	13.1	10.4	8.5
1,1,1,2-Tetrachlorethane	13.1	13.1	10.4	8.5
1,1,2,2-Tetrachlorethane	13.1	13.1	10.4	8.5
1,1,2-Trichlorethane	13.1	13.1	10.4	8.5
1,1 - dichloroethene	13.1	13.1	10.4	8.5
3 - methylcholanthrene	13.1	13.1	10.4	8.5
Aldrin	13.1	13.1	10.4	8.5
Bis (2-chloretyl)ether	16.1	13.1	10.4	8.5
Dibutylphthalate	13.1	13.1	10.4	8.5
Dieldrin	13.1	13.1	10.4	8.5
Hexachlorobutadiene	13.1	13.1	10.4	8.5
Hexachloroethane	13.1	13.1	10.4	8.5
Methylchloride	13.1	13.1	10.4	8.5
Trichlorethylene	13.1	13.1	10.4	8.5
Trifluralin	13.1	13.1	10.4	8.5

Table 4.1(continued): Damage to Human Health (carcinogenics)

Damage analysis: Egalitarian DALYs per kg emission in Europe				
Emissions to:	Air	Water	Ind. soil	Agri soil
	total	total	total	total
Substance	DALYs	DALYs	DALYs	DALYs
Arsenic (long term)	2.46E-02	6.57E-02	1.32E-02	2.50E-01
Arsenic (short term)				
Benzene	2.50E-06	4.12E-06	1.33E-05	2.04E-05
Bis(chloromethyl)ether	7.48E-03	1.54E-02	1.68E-02	1.12E+00
Cadmium (long term)	1.35E-01	7.12E-02	3.98E-03	2.17E+00
Cadmium (short term)				
Chromium VI (long term)	1.75E+00	3.43E-01	2.71E-01	1.61E+01
Chromium VI (short term)				
Nickel (long term)	2.35E-02	3.11E-02	3.94E-03	1.96E-01
Nickel-refinery-dust (long term)	4.74E-02	5.02E-03	6.37E-03	8.19E-02
Nickel-subsulfide (long term)	9.48E-02	1.00E-02	1.27E-02	1.64E-01
Nickel (short term)				
Nickel-refinery-dust (short term)				
Nickel-subsulfide (short term)				
Vinylchloride	2.09E-07	2.84E-07	7.67E-07	7.89E-07
1,2-dibromoethane	2.60E-04	1.24E-03	3.81E-03	6.22E-02
1,3-butadiene	1.58E-05	3.37E-04	1.20E-05	1.74E-03
Acrylonitril	1.69E-05	4.16E-05	7.01E-05	5.43E-04
Benzo(a)pyreen	3.98E-03	2.99E+00	2.06E-03	1.29E-01
Benzo(a)anthracene	5.86E-02	6.58E-01	1.60E-01	1.45E+00
Dibenz(a)anthracene	3.10E+01	4.07E+01	2.44E+01	8.14E+01
Diesel soot particles	9.78E-06	0.00E+00	0.00E+00	0.00E+00
Epichloorhydrin	3.02E-07	9.90E-07	1.30E-06	6.86E-06
Ethylene oxide	1.83E-04	1.39E-04	2.38E-03	2.27E-03
Formaldehyde	9.91E-07	4.97E-06	1.83E-06	2.75E-05
Polychlorobiphenyls	1.97E-03	3.91E-02	2.04E-02	1.44E-01
Propylene oxide	1.17E-05	1.74E-05	1.40E-04	1.50E-03
1,2-dichloroethane	2.98E-05	2.98E-05	4.58E-04	4.81E-04
1,4-dioxane	1.39E-07	9.21E-07	3.10E-07	6.67E-06
2,3,7,8, -TCDD-dioxin	1.79E+02	2.02E+03	7.06E+00	2.06E+02
2,4,6-trichlorophenol	2.05E-06	1.05E-05	2.76E-06	1.29E-05
Acetaldehyde	2.16E-07	9.23E-07	4.77E-07	4.81E-06
alpha-hexachlorocyclohexan	3.00E-04	6.85E-03	7.25E-04	2.32E-02
Benzotrichloride	6.60E-03	9.46E-03	1.32E-01	1.32E-01
Benzylchloride	1.04E-05	1.98E-05	4.16E-05	1.27E-04
beta-hexachlorocyclohexan	9.99E-05	5.75E-03	2.22E-04	7.36E-03
Bromodichloromethane	8.76E-06	9.36E-06	7.82E-05	1.18E-04
Carbontetrachloride	8.38E-04	8.29E-04	3.99E-02	3.94E-02
Chloroform	2.63E-05	2.60E-05	4.12E-06	3.96E-04
Diethylhexylphthalate	3.38E-05	6.64E-04	3.18E-07	5.81E-05
Dichloromethane	4.36E-07	4.79E-07	5.99E-06	8.19E-06
Dichlorvos	3.15E-05	1.17E-05	2.91E-07	2.25E-05
Lindane (gamma HCH)	3.49E-04	4.16E-03	8.46E-04	8.64E-03
Hexachlorobenzene	8.25E-02	1.25E-01	1.47E-01	1.28E-01
Pentachlorophenol	7.21E-03	2.29E-02	1.26E-05	2.67E-04
Perchloroethylene	4.82E-07	4.72E-07	6.00E-06	6.00E-06
Styrene	2.44E-08	1.22E-06	2.09E-08	9.65E-07
1,1,1,2-Tetrachlorethane	3.72E-05	3.66E-05	1.09E-03	1.03E-03
1,1,2,2-Tetrachlorethane	2.86E-04	2.78E-04	7.54E-03	4.70E-04
1,1,2-Trichlorethane	1.10E-05	1.23E-05	1.24E-04	1.30E-04
1,1 - dichloroethene	3.43E-06	5.88E-05	5.57E-06	3.56E-05
3 - methylcholanthrene	1.67E-01	3.72E+01	7.85E-01	5.76E+00
Aldrin	1.93E-01	6.78E+00	3.96E-01	3.21E+01
Bis (2-chloretyl)ether	4.03E-05	1.61E-04	8.29E-05	3.67E-03
Dibutylphthalate	3.43E-03	5.34E-02	6.00E-06	7.73E-04
Dieldrin	2.70E+01	9.75E+01	3.46E+01	4.17E+02
Hexachlorobutadiene	4.30E-05	1.08E-04	8.56E-04	1.23E-03
Hexachloroethane	1.99E-05	2.12E-05	5.26E-04	5.43E-04
Methylchloride	1.83E-05	1.78E-05	5.58E-04	5.58E-04
Trichlorethylene	7.95E-08	7.97E-08	3.22E-07	3.22E-07
Trifluralin	1.10E-07	7.93E-05	2.25E-07	6.89E-05

Table 4.1(continued): Damage to Human Health (carcinogenics)

Damage analysis: Hierarchist DALYs per kg emission in Europe				
Emissions to:	Air	Water	Ind. soil	Agri soil
	total	total	total	total
Substance	DALYs	DALYs	DALYs	DALYs
Arsenic (long term)	2.46E-02	6.57E-02	1.32E-02	2.50E-01
Arsenic (short term)				
Benzene	2.50E-06	4.12E-06	1.33E-05	2.04E-05
Bis(chloromethyl)ether	7.48E-03	1.54E-02	1.68E-02	1.12E+00
Cadmium (long term)	1.35E-01	7.12E-02	3.98E-03	2.17E+00
Cadmium (short term)				
Chromium VI (long term)	1.75E+00	3.43E-01	2.71E-01	1.61E+01
Chromium VI (short term)				
Nickel (long term)	2.35E-02	3.11E-02	3.94E-03	1.96E-01
Nickel-refinery-dust (long term)	4.74E-02	5.02E-03	6.37E-03	8.19E-02
Nickel-subsulfide (long term)	9.48E-02	1.00E-02	1.27E-02	1.64E-01
Nickel (short term)				
Nickel-refinery-dust (short term)				
Nickel-subsulfide (short term)				
Vinylchloride	2.09E-07	2.84E-07	7.67E-07	7.89E-07
1,2-dibromoethane	2.60E-04	1.24E-03	3.81E-03	6.22E-02
1,3-butadiene	1.58E-05	3.37E-04	1.20E-05	1.74E-03
Acrylonitril	1.69E-05	4.16E-05	7.01E-05	5.43E-04
Benzo(a)pyreen	3.98E-03	2.99E+00	2.06E-03	1.29E-01
Benzo(a)anthracene	5.86E-02	6.58E-01	1.60E-01	1.45E+00
Dibenz(a)anthracene	3.10E+01	4.07E+01	2.44E+01	8.14E+01
Diesel soot particles	9.78E-06	0.00E+00	0.00E+00	0.00E+00
Epichloorhydrin	3.02E-07	9.90E-07	1.30E-06	6.86E-06
Ethylene oxide	1.83E-04	1.39E-04	2.38E-03	2.27E-03
Formaldehyde	9.91E-07	4.97E-06	1.83E-06	2.75E-05
Polychlorobiphenyls	1.97E-03	3.91E-02	2.04E-02	1.44E-01
Propylene oxide	1.17E-05	1.74E-05	1.40E-04	1.50E-03
1,2-dichloroethane	2.98E-05	2.98E-05	4.58E-04	4.81E-04
1,4-dioxane	1.39E-07	9.21E-07	3.10E-07	6.67E-06
2,3,7,8, -TCDD-dioxin	1.79E+02	2.02E+03	7.06E+00	2.06E+02
2,4,6-trichlorophenol	2.05E-06	1.05E-05	2.76E-06	1.29E-05
Acetaldehyde	2.16E-07	9.23E-07	4.77E-07	4.81E-06
alpha-hexachlorocyclohexan	3.00E-04	6.85E-03	7.25E-04	2.32E-02
Benzotrichloride	6.60E-03	9.46E-03	1.32E-01	1.32E-01
Benzylchloride	1.04E-05	1.98E-05	4.16E-05	1.27E-04
beta-hexachlorocyclohexan	9.99E-05	5.75E-03	2.22E-04	7.36E-03
Bromodichloromethane	8.76E-06	9.36E-06	7.82E-05	1.18E-04
Carbontetrachloride	8.38E-04	8.29E-04	3.99E-02	3.94E-02
Chloroform	2.63E-05	2.60E-05	4.12E-06	3.96E-04
Diethylhexylphthalate	3.38E-05	6.64E-04	3.18E-07	5.81E-05
Dichloromethane	4.36E-07	4.79E-07	5.99E-06	8.19E-06
Dichlorvos	3.15E-05	1.17E-05	2.91E-07	2.25E-05
Lindane (gamma HCH)	3.49E-04	4.16E-03	8.46E-04	8.64E-03
Hexachlorobenzene	8.25E-02	1.25E-01	1.47E-01	1.28E-01
Pentachlorophenol	7.21E-03	2.29E-02	1.26E-05	2.67E-04
Perchloroethylene	4.82E-07	4.72E-07	6.00E-06	6.00E-06
Styrene	2.44E-08	1.22E-06	2.09E-08	9.65E-07

Table 4.1(continued): Damage to Human Health (carcinogenics)

Damage analysis: Individualist DALYs per kg emission in Europe				
Emissions to:	Air	Water	Ind. soil	Agri soil
	total	total	total	total
Substance	DALYs	DALYs	DALYs	DALYs
Arsenic (long term)				
Arsenic (short term)	1.00E-03	3.42E-02	7.28E-04	6.15E-03
Benzene	1.58E-06	2.45E-06	8.35E-06	1.20E-05
Bis(chloromethyl)ether	4.83E-03	9.96E-03	1.08E-02	7.25E-01
Cadmium (long term)				
Cadmium (short term)	1.03E-02	3.73E-02	6.09E-04	1.59E-01
Chromium VI (long term)				
Chromium VI (short term)	1.50E-02	1.79E-01	4.13E-03	7.80E-02
Nickel (long term)				
Nickel-refinery-dust (long term)				
Nickel-subsulfide (long term)				
Nickel (short term)	6.79E-03	1.63E-02	3.27E-04	5.73E-03
Nickel-refinery-dust (short term)	2.22E-03	2.65E-02	5.31E-04	2.36E-03
Nickel-subsulfide (short term)	4.44E-03	5.29E-02	1.06E-03	4.72E-03
Vinylchloride	1.34E-07	1.73E-07	4.92E-07	5.04E-07

Table 4.1(continued): Damage to Human Health (carcinogenics)

4.5. Damage to Human Health caused by respiratory effects

For respiratory effects from air pollutants the fate analysis, effect analysis and damage analysis is copied from [HOFSTETTER 1998] without making any changes to the original data.

In the annex tables (table 4.2 and 4.3) part of the data used are specified. The calculation procedure is similar to the calculation of damage from carcinogenics, but cannot be demonstrated completely. For each individual substance the estimate of DALYs is very specific, since the health effects are very variable. Descriptions of the health effects from different pollutants can be found in [HOFSTETTER 1998].

In the table are listed:

- the primary pollutants, which are emitted into air.
- the secondary pollutants, which are formed in the environment from the primary pollutants.
- the fate factors
- the contribution to the three perspectives (cultural bias), indicating which substance is included in which perspective.
- the resulting DALYs per kg emission to air in Europe are listed respectively.

DALYs from inorganic macropollutants are listed in table 4.2. For organic substances which form Ozone, the DALYs are listed in table 4.3.

The concept of Photochemical Ozone Creation Potential is used for organic emissions. The POCP expresses the incremental ozone concentration per incremental emissions for a specific VOC normalised by the ratio for ethylene. Ethylene serves as the reference substance and is one of the most reactive VOCs. The POCP values for single substances are derived from [JENKIN 1997]
The calculation of fate factors for ozone creation through emissions of VOC is done according to the "umbrella principle". The fate factor is calculated for only one sum parameter (here NMVOC). The relative activity of all individual substances to the sum parameter is the POCP. The average POCP value of NMVOC is 59.2%. with this information fate factors for all individual VOCs can be calculated.[HOFSTETTER 1998]

Emissions to air							
Primary Pollutant	Secondary Pollutant	fate factor m2a/m3	Cultural perspective	Egalitarian Dalys/kg	Hierarchist Dalys/kg	Individualist Dalys/kg	standard deviation σ_g^2
CO	CO	1.00E-04	E	7.31E-07			64
TSP	PM10	4.40E-06	E,H,I	1.10E-04	1.10E-04	8.03E-05	19
PM10	PM10	1.50E-05	E,H,I	3.75E-04	3.75E-04	2.74E-04	19
PM2.5	PM2.5	1.70E-05	E,H,I	7.00E-04	7.00E-04	5.10E-04	19
SOx (as SO2)	SO2	3.00E-06	E,H	1.09E-06	1.09E-06		27
SOx (as SO2)	Sulphates	1.30E-06	E,H,I	5.35E-05	5.35E-05	3.90E-05	16
NH3	Sulphates	1.70E-06	E,H,I	7.00E-05	7.00E-05	5.10E-05	16
NH3	Nitrates	6.00E-07	E,H	1.50E-05	1.50E-05		36
NOx (as NO2)	NO2	2.50E-06	E	4.31E-07			54
NOx (as NO2)	Nitrates	3.50E-06	E,H	8.74E-05	8.74E-05		36
NOx (as NO2)	O3	1.50E-06	E,H,I	1.28E-06	1.28E-06	1.19E-06	21

Table 4.2: Damage to Human Health (respiratory effects, inorganic substances)

Emissions to air							
POCP = Photochemical Ozone Creation Potential (secondary pollutant is Ozone)							
Primary Pollutant	POCP [%]	fate factor m2a/m3	Cultural perspective	Egalitarian Dalys/kg	Hierarchist Dalys/kg	Individualist Dalys/kg	standard deviation σ_g^2
alkanes							
methane	0.6	1.50E-08	E,H,I	1.28E-08	1.28E-08	1.19E-08	23
ethane	12.3	3.10E-07	E,H,I	2.64E-07	2.64E-07	2.45E-07	23
propane	17.6	4.50E-07	E,H,I	3.83E-07	3.83E-07	3.56E-07	23
butane	35.2	8.90E-07	E,H,I	7.57E-07	7.57E-07	7.04E-07	23
i-butane	30.7	7.80E-07	E,H,I	6.64E-07	6.64E-07	6.17E-07	23
pentane	39.5	1.00E-06	E,H,I	8.51E-07	8.51E-07	7.91E-07	23
i-pentane	40.5	1.00E-06	E,H,I	8.51E-07	8.51E-07	7.91E-07	23
neopentane	17.3	4.40E-07	E,H,I	3.74E-07	3.74E-07	3.48E-07	23
hexane	48.2	1.20E-06	E,H,I	1.02E-06	1.02E-06	9.50E-07	23
2-methyl pentane	42	1.10E-06	E,H,I	9.36E-07	9.36E-07	8.70E-07	23
3-methyl pentane	47.9	1.20E-06	E,H,I	1.02E-06	1.02E-06	9.50E-07	23
2,2-dimethyl butane	24.1	6.10E-07	E,H,I	5.19E-07	5.19E-07	4.83E-07	23
2,3-dimethyl butane	54.1	1.40E-06	E,H,I	1.19E-06	1.19E-06	1.11E-06	23
heptane	49.4	1.30E-06	E,H,I	1.11E-06	1.11E-06	1.03E-06	23
2-methyl hexane	41.1	1.00E-06	E,H,I	8.51E-07	8.51E-07	7.91E-07	23
3-methyl hexane	36.4	9.20E-07	E,H,I	7.83E-07	7.83E-07	7.28E-07	23
octane	45.3	1.10E-06	E,H,I	9.36E-07	9.36E-07	8.70E-07	23
nonane	41.4	1.00E-06	E,H,I	8.51E-07	8.51E-07	7.91E-07	23
decane	38.4	9.70E-07	E,H,I	8.26E-07	8.26E-07	7.68E-07	23
undecane	38.4	9.70E-07	E,H,I	8.26E-07	8.26E-07	7.68E-07	23
dodecane	35.7	9.00E-07	E,H,I	7.66E-07	7.66E-07	7.12E-07	23
cyclohexane	29	7.30E-07	E,H,I	6.21E-07	6.21E-07	5.78E-07	23
alkenes/dienes							
ethene	100	2.50E-06	E,H,I	2.13E-06	2.13E-06	1.98E-06	23
propene	112	2.80E-06	E,H,I	2.38E-06	2.38E-06	2.22E-06	23
1-butene	108	2.70E-06	E,H,I	2.30E-06	2.30E-06	2.14E-06	23
cis 2-butene	115	2.90E-06	E,H,I	2.47E-06	2.47E-06	2.29E-06	23
trans 2-butene	113	2.90E-06	E,H,I	2.47E-06	2.47E-06	2.29E-06	23
methyl propene	62.7	1.60E-06	E,H,I	1.36E-06	1.36E-06	1.27E-06	23
1-pentene	97.7	2.50E-06	E,H,I	2.13E-06	2.13E-06	1.98E-06	23
cis 2-pentene	112	2.80E-06	E,H,I	2.38E-06	2.38E-06	2.22E-06	23
trans 2-pentene	112	2.80E-06	E,H,I	2.38E-06	2.38E-06	2.22E-06	23
2-methyl 1-butene	77.1	2.00E-06	E,H,I	1.70E-06	1.70E-06	1.58E-06	23
2-methyl 2-butene	84.2	2.10E-06	E,H,I	1.79E-06	1.79E-06	1.66E-06	23
3-methyl 1-butene	67.1	1.70E-06	E,H,I	1.45E-06	1.45E-06	1.35E-06	23
1-hexene	87.4	2.20E-06	E,H,I	1.87E-06	1.87E-06	1.74E-06	23
cis 2-hexene	107	2.70E-06	E,H,I	2.30E-06	2.30E-06	2.14E-06	23
trans 2-hexene	107	2.70E-06	E,H,I	2.30E-06	2.30E-06	2.14E-06	23
1,3-butadiene	85.1	2.20E-06	E,H,I	1.87E-06	1.87E-06	1.74E-06	23
isoprene	109	2.80E-06	E,H,I	2.38E-06	2.38E-06	2.22E-06	23
alkynes							
acetylene	8.5	2.20E-07	E,H,I	1.87E-07	1.87E-07	1.74E-07	23
aromatics							
benzene	21.8	5.50E-07	E,H,I	4.68E-07	4.68E-07	4.35E-07	23
toluene	63.7	1.60E-06	E,H,I	1.36E-06	1.36E-06	1.27E-06	23
o-xylene	105	2.70E-06	E,H,I	2.30E-06	2.30E-06	2.14E-06	23
m-xylene	111	2.80E-06	E,H,I	2.38E-06	2.38E-06	2.22E-06	23
p-xylene	101	2.60E-06	E,H,I	2.21E-06	2.21E-06	2.06E-06	23
ethyl benzene	73	1.80E-06	E,H,I	1.53E-06	1.53E-06	1.42E-06	23
n-propyl benzene	63.6	1.60E-06	E,H,I	1.36E-06	1.36E-06	1.27E-06	23
i-propyl benzene	50	1.30E-06	E,H,I	1.11E-06	1.11E-06	1.03E-06	23

Table 4.3: Damage to Human Health (respiratory effects, organic substances)

Emissions to air							
POCP = Photochemical Ozone Creation Potential (secondary pollutant is Ozone)							
Primary Pollutant	POCP [%]	fate factor m2a/m3	Cultural perspective	Egalitarian Dalys/kg	Hierarchist Dalys/kg	Individualist Dalys/kg	standard deviation σ_g^2
Aromatics (continued)							
1,2,3-trimethyl benzene	127	3.20E-06	E,H,I	2.72E-06	2.72E-06	2.53E-06	23
1,2,4-trimethyl benzene	128	3.20E-06	E,H,I	2.72E-06	2.72E-06	2.53E-06	23
1,3,5-trimethyl benzene	138	3.50E-06	E,H,I	2.98E-06	2.98E-06	2.77E-06	23
o-ethyl toluene	89.8	2.30E-06	E,H,I	1.96E-06	1.96E-06	1.82E-06	23
m-ethyl toluene	102	2.60E-06	E,H,I	2.21E-06	2.21E-06	2.06E-06	23
p-ethyl toluene	90.6	2.30E-06	E,H,I	1.96E-06	1.96E-06	1.82E-06	23
3,5-dimethyl ethyl benzene	132	3.30E-06	E,H,I	2.81E-06	2.81E-06	2.61E-06	23
3,5-diethyl toluene	130	3.30E-06	E,H,I	2.81E-06	2.81E-06	2.61E-06	23
aldehydes							
formaldehyde	51.9	1.30E-06	E,H,I	1.11E-06	1.11E-06	1.03E-06	23
acetaldehyde	64.1	1.60E-06	E,H,I	1.36E-06	1.36E-06	1.27E-06	23
propionaldehyde	79.8	2.00E-06	E,H,I	1.70E-06	1.70E-06	1.58E-06	23
n-butyraldehyde	79.5	2.00E-06	E,H,I	1.70E-06	1.70E-06	1.58E-06	23
i-butyraldehyde	51.4	1.30E-06	E,H,I	1.11E-06	1.11E-06	1.03E-06	23
pentanal	76.5	1.90E-06	E,H,I	1.62E-06	1.62E-06	1.50E-06	23
ketones							
acetone	9.4	2.40E-07	E,H,I	2.04E-07	2.04E-07	1.90E-07	23
methyl ethyl ketone	37.3	9.50E-07	E,H,I	8.09E-07	8.09E-07	7.52E-07	23
2-pentanone	54.8	1.40E-06	E,H,I	1.19E-06	1.19E-06	1.11E-06	23
3-pentanone	41.4	1.00E-06	E,H,I	8.51E-07	8.51E-07	7.91E-07	23
methyl i-propyl ketone	36.4	9.20E-07	E,H,I	7.83E-07	7.83E-07	7.28E-07	23
2-hexanone	57.2	1.40E-06	E,H,I	1.19E-06	1.19E-06	1.11E-06	23
3-hexanone	59.9	1.50E-06	E,H,I	1.28E-06	1.28E-06	1.19E-06	23
methyl i-butyl ketone	49	1.20E-06	E,H,I	1.02E-06	1.02E-06	9.50E-07	23
methyl t-butyl ketone	32.3	8.20E-07	E,H,I	6.98E-07	6.98E-07	6.49E-07	23
cyclohexanone	29.9	7.60E-07	E,H,I	6.47E-07	6.47E-07	6.01E-07	23
alcohols							
methanol	13.1	3.30E-07	E,H,I	2.81E-07	2.81E-07	2.61E-07	23
ethanol	38.6	9.80E-07	E,H,I	8.34E-07	8.34E-07	7.75E-07	23
n-propanol	54.3	1.40E-06	E,H,I	1.19E-06	1.19E-06	1.11E-06	23
i-propanol	14	3.50E-07	E,H,I	2.98E-07	2.98E-07	2.77E-07	23
n-butanol	61.2	1.60E-06	E,H,I	1.36E-06	1.36E-06	1.27E-06	23
s-butanol	40	1.00E-06	E,H,I	8.51E-07	8.51E-07	7.91E-07	23
i-butanol	37.5	9.50E-07	E,H,I	8.09E-07	8.09E-07	7.52E-07	23
t-butanol	12.3	3.10E-07	E,H,I	2.64E-07	2.64E-07	2.45E-07	23
2-methyl 1-butanol	40.7	1.00E-06	E,H,I	8.51E-07	8.51E-07	7.91E-07	23
2-methyl 2-butanol	14.2	3.60E-07	E,H,I	3.06E-07	3.06E-07	2.85E-07	23
3-methyl 1-butanol	41.2	1.00E-06	E,H,I	8.51E-07	8.51E-07	7.91E-07	23
3-methyl 2-butanol	36.6	9.30E-07	E,H,I	7.91E-07	7.91E-07	7.36E-07	23
3-pentanol	42.2	1.10E-06	E,H,I	9.36E-07	9.36E-07	8.70E-07	23
diacetone alcohol	26.2	6.60E-07	E,H,I	5.62E-07	5.62E-07	5.22E-07	23
cyclohexanol	44.6	1.10E-06	E,H,I	9.36E-07	9.36E-07	8.70E-07	23
ethane diol	38.2	9.70E-07	E,H,I	8.26E-07	8.26E-07	7.68E-07	23
propane diol	45.7	1.20E-06	E,H,I	1.02E-06	1.02E-06	9.50E-07	23

Table 4.3 (continued): Damage to Human Health (respiratory effects, organic substances)

Emissions to air							
POCP = Photochemical Ozone Creation Potential (secondary pollutant is Ozone)							
Primary Pollutant	POCP [%]	fate factor m2a/m3	Cultural perspective	Egalitarian Dalys/kg	Hierarchist Dalys/kg	Individualist Dalys/kg	standard deviation σ_g^2
esters							
methyl formate	3.3	8.40E-08	E,H,I	7.15E-08	7.15E-08	6.65E-08	23
methyl acetate	4.6	1.20E-07	E,H,I	1.02E-07	1.02E-07	9.50E-08	23
ethyl acetate	21.3	5.40E-07	E,H,I	4.60E-07	4.60E-07	4.27E-07	23
n-propyl acetate	29	7.30E-07	E,H,I	6.21E-07	6.21E-07	5.78E-07	23
i-propyl acetate	21.3	5.40E-07	E,H,I	4.60E-07	4.60E-07	4.27E-07	23
n-butyl acetate	24.1	6.10E-07	E,H,I	5.19E-07	5.19E-07	4.83E-07	23
s-butyl acetate	26.7	6.80E-07	E,H,I	5.79E-07	5.79E-07	5.38E-07	23
t-butyl acetate	6.5	1.60E-07	E,H,I	1.36E-07	1.36E-07	1.27E-07	23
carboxylic acids							
formic acid	3.2	8.10E-08	E,H,I	6.89E-08	6.89E-08	6.41E-08	23
acetic acid	9.7	2.50E-07	E,H,I	2.13E-07	2.13E-07	1.98E-07	23
propanoic acid	15	3.80E-07	E,H,I	3.23E-07	3.23E-07	3.01E-07	23
ethers and glycol ethers							
dimethyl ether	17.4	4.40E-07	E,H,I	3.74E-07	3.74E-07	3.48E-07	23
diethyl ether	46.7	1.20E-06	E,H,I	1.02E-06	1.02E-06	9.50E-07	23
di i-propyl ether	47.6	1.20E-06	E,H,I	1.02E-06	1.02E-06	9.50E-07	23
methyl t-butyl ether	15.2	3.90E-07	E,H,I	3.32E-07	3.32E-07	3.09E-07	23
ethyl t-butyl ether	21.4	5.40E-07	E,H,I	4.60E-07	4.60E-07	4.27E-07	23
2-methoxy ethanol	30	7.60E-07	E,H,I	6.47E-07	6.47E-07	6.01E-07	23
2-ethoxy ethanol	38.7	9.80E-07	E,H,I	8.34E-07	8.34E-07	7.75E-07	23
1-methoxy 2-propanol	36.8	9.30E-07	E,H,I	7.91E-07	7.91E-07	7.36E-07	23
2-butoxy ethanol	43.8	1.10E-06	E,H,I	9.36E-07	9.36E-07	8.70E-07	23
1-butoxy propanol	43.6	1.10E-06	E,H,I	9.36E-07	9.36E-07	8.70E-07	23
halocarbons							
chloromethane (methylchloride)	0.5	1.30E-08	E,H,I	1.11E-08	1.11E-08	1.03E-08	23
dichloromethane (methylene chloride)	6.8	1.70E-07	E,H,I	1.45E-07	1.45E-07	1.35E-07	23
trichloromethane	2.3	5.80E-08	E,H,I	4.94E-08	4.94E-08	4.59E-08	23
methyl chloroform (1,1,1 Trichlororethane)	0.9	2.30E-08	E,H,I	1.96E-08	1.96E-08	1.82E-08	23
cis 1,2-dichloroethene	44.7	1.10E-06	E,H,I	9.36E-07	9.36E-07	8.70E-07	23
trans 1,2-dichloroethene	39.2	9.90E-07	E,H,I	8.43E-07	8.43E-07	7.83E-07	23
trichloroethene	32.5	8.20E-07	E,H,I	6.98E-07	6.98E-07	6.49E-07	23
tetrachloroethene	2.9	7.30E-08	E,H,I	6.21E-08	6.21E-08	5.78E-08	23
NMVOC [Derwent 1996]	59.2	1.50E-06	E,H,I	1.28E-06	1.28E-06	1.19E-06	23

Table 4.3(continued): Damage to Human Health (respiratory effects, organic substances)

4.6. Damage to Human Health caused by climate change

Table 4.4 presents the results of the calculations by Tol [TOL 1999B/C]. We added the damages in all 9 world regions to a world total. Only net damages and not net benefits per world region and year are added. Next to that we added the damages for two different time frames: short term from 2000 to 2100 and long term from 2000 to 2200.

		Malaria	Schistosomiasis	Dengue fever	Cardiovascular disorders	Respiratory disorders	People displaced (sea level)	Total death
		death	death	death	death	death	number	death
CO2 up to 2100	per tC	1.4E-05	0	3.3E-07	1.6E-05	2.3E-06	7.8E-07	3.3E-05
CO2 up to 2200	per tC	1.4E-05	0	3.3E-07	2.5E-05	3.0E-06	1.0E-06	4.2E-05
CH4 up to 2100	per tCH4	8.3E-05	0	2.7E-06	7.1E-05	1.7E-05	4.4E-06	1.7E-04
CH4 up to 2200	per tCH4	8.3E-05	0	2.7E-06	8.1E-05	1.9E-05	5.0E-06	1.9E-04
N2O up to 2100	per tN2O	1.3E-03	0	3.0E-05	1.4E-03	2.0E-04	7.4E-05	2.9E-03
N2O up to 2200	per tN2O	1.3E-03	0	3.0E-05	2.5E-03	2.7E-04	1.0E-04	4.1E-03

Table 4.4a: Aggregated results for damages from FUND 2.0, personal communication of Richard Tol, IVM, Amsterdam, described in [TOL 1999B/C]

		Malaria	Schistosomiasis	Dengue fever	Cardiovascular disorders	Respiratory disorders	People displaced (sea level)	Total death
		death	death	death	death	death	number	death
CO2 up to 2100	per tC	0	-1.8E-10	0	-2.6E-5	-9.1E-08	0	-2.6E-05
CO2 up to 2200	per tC	0	-1.8E-10	0	-2.6E-5	-5.9E-7	-7.8E-08	-2.6E-05
CH4 up to 2100	per tCH4	0	-8.3E-10	0	-2.2E-4	-5.0E-07	-2.2E-07	-2.2E-04
CH4 up to 2200	per tCH4	0	-8.3E-10	0	-2.2E-4	-2.5E-06	-8.7E-07	-2.3E-04
N2O up to 2100	per tN2O	0	-1.8E-8	0	-2.0E-3	-8.4E-06	0	-2.0E-03
N2O up to 2200	per tN2O	0	-1.8E-8	0	-2.0E-3	-6E-05	-4.7E-06	-2.1E-03

Table 4.4.b: Aggregated results for benefits from FUND 2.0, personal communication of Richard Tol, IVM, Amsterdam, described in [TOL 1999B/C]

4.6.1. Calculation of DALYs

Vector-borne diseases occur so far mainly in areas where the population shows a high immunity. This immunity develops only after the first years of life. Therefore, many young children are victims of this disease and only few people of the other age-classes are concerned which results in a very high number of YLL per death. However, if the regions at risk move to places where people are not immune, the death will be distributed more evenly among the different age-classes.
Thermal stress by more extreme heat or cold episodes will show a completely different effect. Epidemiologists speak from a harvesting effect, which means that mainly very old people or people already weakened by other illnesses will die. Their life expectancy at the time of death is assumed to be low. Some of the people may have died anyway some days or weeks later, some may have died at the next extreme weather event in the same or the next year. For consistency reasons one may assume the same years of life lost as assumed for acute respiratory effects [HOFSTETTER 1998:333] leading to 0.75 YLL(0,0), with a σ_g^2 of 5.
Table 4.5 is a compilation of data from [MURRAY ET AL 1996] for endpoints relevant for this paper[1]. The years of life lost calculated from the estimated world-wide death distribution in 2000 among different age-classes and the standard life expectancy table adapted from the one found for Japanese women confirms the statements made above.
The number of years of life lost is very high for Malaria and Dengue and somewhat lower for Schistosomiasis. Heart and cerebrovascular diseases show even in this average pattern (with many other causes than thermal stress) much lower YLL than the vector-borne diseases. However, all numbers for YLL per death are overestimates when applied to future health damages due to climate change because vector-borne diseases will concern in future more non-immune adults and because thermal stress, as suggested above, will cause much less years of life lost.

[1][KALKSTEIN 1997] mentions that weather influences so many causes of death that a separation does not make any sense. The Eurowinter Group [EWG 1997] identifies ischaematic heart disease (IHD), cerebrovascular disease (CVD) and respiratory disease (RD) (COPD, Asthma and respiratory infections) as main endpoints concerned. [MARTENS 1998A] finds CVD and RD to be strongly associated with temperature.

	Disability weights		World 1990							World 2000	
	untreated	treated	Mio Death	YLL (1,1) death	YLD (1,1) death	DALYs (0,0) death	1000 death	avg. age at onset	avg. duration	YLL (0,1) death	YLL (0,0) death
Diarrhoea diseases-episodes	0.086-0.119	0.086-0.119	2.95	32.0	1.8	76.9	2946	13.9	0.02	78.1	72.4
Malaria			0.856	32.7	4.3	79.4					
Episodes	0.172-0.211	0.172-0.211					856	13.5	0.01	79.1	73.3
Anaemia	0.012-0.013	0.012-0.013					0				
Neurological sequelae	0.473	0.435					0	2.4	52.2		
Schistosomiasis – Infection	0.005-0.006	0.005-0.006	0.008	19.5	170.0	175.0				27.6	31.0
Dengue	0.172-0.211	0.172-0.211	0.021	35.4	0.3	71.4	21	9.9	0.08	81.7	73.5
Ischaematic heart disease			6.26	6.6	0.8	14.7					
Acute myocardial inf	0.491	0.395					6260	64	0.06	9.4	14.7
Angina pectoris	0.227	0.095					0				
Congestive heart failure	0.323	0.171						62.9	2.8		
Cerebrovascular disease	0.262-0.301	0.224-0.258	4.38	7.3	1.5	16.9	4381	64.5	5.2	10.5	15.7

Table 4.5: Compilation of data taken from [MURRAY ET AL 1996] or calculated based on their data.

To summarise we use the following data:

- For malaria we use 50 DALYs per death with a σg^2 of 2 for all three perspectives. This number takes into account that mostly children are victims of malaria but some non-immune individuals will be affected as well (from which the rich ones will survive).
- For dengue fever we can assume with same reasoning as well 50 DALYs per death with a σg^2 of 2 for all three perspectives.
- For Schistosomiasis Table 7 suggest a value of about 30 DALYs per death with a σg^2 of 2 (for I, E, and H).
- For so-called acute mortality due to respiratory effects [HOFSTETTER 1998:333] estimated 0.75 DALYs(0,0) and 0.48 DALYs(0,1) per case with a σg^2 of 5.
- [MURRAY 1996] specifies the following disabilities that may be related to sea-level rise:

Disability:	**DALYs:**
Infertility (heavy stressed people are often infertile)	0.18 (only people in fertile period)
Stress incontinence	<60: 0.025, >60: 0.033
Unipolar major depression	0.6 (treated 0.302)
Post-traumatic stress disorders	0.105
Panic disorder	0.173 (treated 0.091)

Table 4.6: Disabilities related to sea level rise

- Due to the slow increase of sea levels and planability of the movement we assume that stress and panic are less important than mental problems. Children will suffer less than aged people. The full period may well be longer than 5 years because the people suffer already before they finally move.
- Taking about 5 years before and 5 years after movement as relevant period and assuming that few persons will suffer very hard while others very little we start with 1 DALY per people displaced with a σg^2 of 5.
- Hierarchists may argue that such a displacement is not a real problem but a matter of good organisation. Egalitarians will judge it as a serious impact because of the social structure, which is destroyed by such displacement and Individualists will judge this problematic due to the serious limitations of the individual freedom (all are forced to move).
- As a result only egalitarians and individualists consider displacement.
- Based on these assumptions Table 4.7 shows the damage estimates in DALYs for the three cultural perspectives.

		Malaria	Schistoso-miasis	Dengue fever	Cardiovas-cular disorders	Respiratory disorders	People displaced (sea level)	Total E-attitude	Total H-attitude
		DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)
	DALYs/case	50	30	50	0.75	0.75	1		
CO2 up to 2100	per tC	7.2E-4	0.0E+0	1.7E-5	1.2E-5	1.7E-6	7.8E-7	7.5E-4	7.5E-4
CO2 up to 2200	per tC	7.2E-4	0.0E+0	1.7E-5	1.9E-5	2.2E-6	1.0E-6	7.5E-4	7.5E-4
CH4 up to 2100	per tCH4	4.2E-3	0.0E+0	1.3E-4	5.3E-5	1.3E-5	4.4E-6	4.4E-3	4.4E-3
CH4 up to 2200	per tCH4	4.2E-3	0.0E+0	1.3E-4	6.1E-5	1.4E-5	5.0E-6	4.4E-3	4.4E-3
N2O up to 2100	per tN2O	6.5E-2	0.0E+0	1.5E-3	1.1E-3	1.5E-4	7.4E-5	6.8E-2	6.8E-2
N2O up to 2200	per tN2O	6.5E-2	0.0E+0	1.5E-3	1.9E-3	2.0E-4	1.0E-4	6.9E-2	6.9E-2

		Malaria	Schistoso-miasis	Dengue fever	Cardiovas-cular disorders	Respiratory disorders	People displaced (sea level)	Total I-attitude
		DALYs(0,1)	DALYs(0,1)	DALYs(0,1)	DALYs(0,1)	DALYs(0,1)	DALYs(0,1)	DALYs(0,1)
	DALYs/case	50	30	50	0.48	0.48	1	
CO2 up to 2100	per tC	7.2E-4	0.0E+0	1.7E-5	7.7E-6	1.1E-6	7.8E-7	7.4E-4
CO2 up to 2200	per tC	7.2E-4	0.0E+0	1.7E-5	1.2E-5	1.4E-6	1.0E-6	7.5E-4
CH4 up to 2100	per tCH4	4.2E-3	0.0E+0	1.3E-4	3.4E-5	8.3E-6	4.4E-6	4.4E-3
CH4 up to 2200	per tCH4	4.2E-3	0.0E+0	1.3E-4	3.9E-5	9.2E-6	5.0E-6	4.4E-3
N2O up to 2100	per tN2O	6.5E-2	0.0E+0	1.5E-3	6.8E-4	9.6E-5	7.4E-5	6.7E-2
N2O up to 2200	per tN2O	6.5E-2	0.0E+0	1.5E-3	1.2E-3	1.3E-4	1.0E-4	6.8E-2

Table. 4.7a:Positive human health damages expressed in DALYs, based on the model results of table 4.4, for three cultural perspectives.

		Malaria	Schistoso-miasis	Dengue fever	Cardiovas-cular disorders	Respiratory disorders	People displaced (sea level)	Total E-attitude	Total H-attitude
		DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)	DALYs(0,0)
	DALYs/ case	50	30	50	0.75	0.75	1		
CO2 up to 2100	per tC	0.0E+0	-5.4E-6	0.0E+0	-1.9E-5	-6.8E-8	0.0E+0	-2.5E-5	-2.5E-5
CO2 up to 2200	per tC	0.0E+0	-5.4E-6	0.0E+0	-1.9E-5	-4.4E-7	-7.8E-8	-2.5E-5	-2.5E-5
CH4 up to 2100	per tCH4	0.0E+0	-2.5E-5	0.0E+0	-1.7E-4	-3.8E-7	-2.2E-7	-1.9E-4	-1.9E-4
CH4 up to 2200	per tCH4	0.0E+0	-2.5E-5	0.0E+0	-1.7E-4	-1.8E-6	-8.7E-7	-2.0E-4	-1.9E-4
N2O up to 2100	per tN2O	0.0E+0	-5.4E-4	0.0E+0	-1.5E-3	-6.3E-6	0.0E+0	-2.0E-3	-2.0E-3
N2O up to 2200	per tN2O	0.0E+0	-5.4E-4	0.0E+0	-1.5E-3	-4.5E-5	-4.7E-6	-2.1E-3	-2.1E-3

		Malaria	Schistoso-miasis	Dengue fever	Cardiovas-cular disorders	Respiratory disorders	People displaced (sea level)	Total I-attitude
		DALYs(0,1)	DALYs(0,1)	DALYs(0,1)	DALYs(0,1)	DALYs(0,1)	DALYs(0,1)	DALYs(0,1)
	DALYs/ case	50	30	50	0.48	0.48	1	
CO2 up to 2100	per tC	0.0E+0	-5.4E-6	0.0E+0	-1.2E-5	-4.3E-8	0.0E+0	-1.8E-5
CO2 up to 2200	per tC	0.0E+0	-5.4E-6	0.0E+0	-1.2E-5	-2.8E-7	-7.8E-8	-1.8E-5
CH4 up to 2100	per tCH4	0.0E+0	-2.5E-5	0.0E+0	-1.1E-4	-2.4E-7	-2.2E-7	-1.3E-4
CH4 up to 2200	per tCH4	0.0E+0	-2.5E-5	0.0E+0	-1.1E-4	-1.2E-6	-8.7E-7	-1.3E-4
N2O up to 2100	per tN2O	0.0E+0	-5.4E-4	0.0E+0	-9.6E-4	-4.0E-6	0.0E+0	-1.5E-3
N2O up to 2200	per tN2O	0.0E+0	-5.4E-4	0.0E+0	-9.8E-4	-2.9E-5	-4.7E-6	-1.5E-3

Table 4.7b:Human health benefits expressed in DALYs, based on the model results of Table 4.5, for three cultural perspectives.

4.6.2 Extrapolation to other substances

The table below specifies the equivalency factors from [SCHIMEL ET AL 1996]

		Lifetime		20a			100a		Un-certainty
		a	Min	Max	Average	Min	Max	Average	in %
Carbon Dioxide	CO2	~100(iii)			1			1	
Methane (ii)	CH4	12.2			56			21	65
Nitrous Oxide	N2O	120			280			310	40
HFC-23	CHF3	264			9100			11700	40
HFC-32	CH2F2	5.6			2100			650	65
HFC-41	CH3F	3.7			490			150	65
HFC-43-10mee	C5H2F10	17.1			3000			1300	65
HFC-125	C2HF5	32.6			4600			2800	40
HFC-134	C2H2F4	10.6			2900			1000	65
HFC-134a	CH2FCF3	14.6			3400			1300	65
HFC-152a	CH2FCF3	1.5			460			140	65
HFC-143	C2H3F3	3.8			1000			300	65
HFC-143a	C2H3F3	48.3			5000			3800	40
HFC-227ea	C3HF7	36.5			4300			2900	40
HFC-236fa	C3H2F6	209			5100			6300	40
HFC-245ca	C3H3F5	6.6			1800			560	65
Chloroform	CHCl3	0.51			14			4	90
Methylene chloride	CH2Cl2	0.46			31			9	90
Sulphur hexafluoride	SF6	3200			16300			23900	40
Perfluormethane	CF4	50000			4400			6500	40
Perfluorethane	C2F6	10000			6200			9200	40
Perfluorpropane	C3F8	2600			4800			7000	40
Perfluorbutane	C4F10	2600			4800			7000	40
Perfluorpentane	C5F12	4100			5100			7500	40
Perfluorhexane	C6F14	3200			5000			7400	40
Perfluorcyclobutane	c-C4F8	3200			6000			8700	40
Trifluoroiodo-methane	CF3I	<0.005			<3			<1	90
CFC-11 (i)	CFCl3	50	1200	2900		540	2100	1065§	65
CFC-12 (i)	CF2Cl2	102	6000	6800		6200	7100	6635§	40
CFC-113 (i)	CF3Cl3	85	2800	3800		2600	3600	3059§	40
HCFC-22 (i)	CF2HCl	12.1	3500	3700		1300	1400	1349§	40
HCFC-142b (i)	C2F2H3Cl	18.4	3600	3800		1600	1700	1649§	40
H1301 (i)	CF3Br	65	-97600	-14100		-85400	-14100	-34701§	90
HCFC-141b (i)	CFH3Cl2	9.4	660	1200		170	370	251§	90
Methyl chloroform	CH3CCl3	4.9	-1000	-400		-320	-130	-204§	90
Carbon Tetrachloride (i)	CCl4	42	-2600	-500		-2400	-650	-1249§	90
HCFC-123 (i)	C2F3HCl2	1.4	60	170		20	50	32§	90
HCFC-124 (i)	C2F4HCl	6.1	1300	1400		390	430	410§	65

Table 4.8: Global Warming Potential (mass basis) with future CO2 levels held constant at current levels [SCHIMEL ET AL 1996]
(i) includes direct and indirect effects from stratospheric ozone depletion
(ii) includes direct and indirect effects from stratospheric water vapour production and tropospheric ozone production
(iii) this is an average adjustment time, the turnover time would be only about 4 years [SCHIMEL 1996:76]
§ own geometric averaging

[SCHIMEL 1996] reports a general uncertainty range of the GWPs of 30% and a range of 50% for the gases where the ozone depletion was considered as well. Due to the poorer agreement between GWP and global damage factors for gases with low atmospheric life-time the uncertainty range was estimated as a combination of the uncertainty reported by [SCHIMEL ET AL 1996] and the one introduced by the umbrella principle.

4.6.3. Results

The table below describes the ultimate results for the three perspectives, using the extrapolation based on CO2, CH4 and N2O, as described in the main report.

		100 years		Total E	Total H	Total I	Total
		GWP	σ_g^2	DALYs(0,0)/t	DALYs(0,0)/t	DALYs(0,1)/t	σ_g^2
Carbon Dioxide	CO2	1	1.7	0.00021	0.00021	0.0002	2.4
Methane (ii)	CH4	n.u.	2.9	0.0044	0.0044	0.0044	3.6
Nitrous Oxide	N2O	n.u.	1.7	0.069	0.069	0.067	2.4
HFC-23	CHF3	11700	1.7	2.6	2.6	2.5	2.4
HFC-32	CH2F2	650	2.9	0.14	0.14	0.13	3.6
HFC-41	CH3F	150	2.9	0.031	0.031	0.031	3.6
HFC-43-10mee	C5H2F10	1300	2.9	0.27	0.27	0.27	3.6
HFC-125	C2HF5	2800	1.7	0.58	0.57	0.057	2.4
HFC-134	C2H2F4	1000	2.9	0.21	0.21	0.21	3.6
HFC-134a	CH2FCF3	1300	2.9	0.27	0.27	0.27	3.6
HFC-152a	CH2FCF3	140	2.9	0.029	0.029	0.029	3.6
HFC-143	C2H3F3	300	2.9	0.063	0.063	0.062	3.6
HFC-143a	C2H3F3	3800	1.7	0.78	0.78	0.77	2.4
HFC-227ea	C3HF7	2900	1.7	0.6	0.59	0.59	2.4
HFC-236fa	C3H2F6	6300	1.7	1.4	1.4	1.4	2.4
HFC-245ca	C3H3F5	560	2.9	0.12	0.12	0.12	3.6
Chloroform	CHCl3	4	10.0	0.00083	0.00084	0.00083	11.1
Methylene chloride	CH2Cl2	9	10.0	0.0019	0.0019	0.0019	11.1
Sulphur hexafluoride	SF6	23900	1.7	5.3	5.3	5.2	2.4
Perfluormethane	CF4	6500	1.7	1.4	1.4	1.4	2.4
Perfluorethane	C2F6	9200	1.7	2	2	2	2.4
Perfluorpropane	C3F8	7000	1.7	1.5	1.6	1.5	2.4
Perfluorbutane	C4F10	7000	1.7	1.5	1.6	1.5	2.4
Perfluorpentane	C5F12	7500	1.7	1.7	1.7	1.6	2.4
Perfluorhexane	C6F14	7400	1.7	1.6	1.6	1.6	2.4
Perfluorcyclobutane	c-C4F8	8700	1.7	1.9	1.9	1.9	2.4
Trifluoroiodomethane	CF3I	1	10.0	0.00021	0.00021	0.00021	11.1
CFC-11 (i)	CFCl3	1065	2.9	0.22	0.22	0.22	3.6
CFC-12 (i)	CF2Cl2	6635	1.7	1.4	1.4	1.3	2.4
CFC-113 (i)	CF3Cl3	3059	1.7	0.63	0.63	0.63	2.4
HCFC-22 (i)	CF2HCl	1349	1.7	0.28	0.28	0.28	2.4
HCFC-142b (i)	C2F2H3Cl	1649	1.7	0.34	0.34	0.34	2.4
H1301 (i)	CF3Br	-34701	10.0	-7.1	-7.1	-7	11.1
HCFC-141b (i)	CFH3Cl2	251	10.0	0.052	0.052	0.052	11.1
Methyl chloroform (i)	CH3CCl3	-204	10.0	-0.043	-0.043	-0.042	11.1
Carbon Tetrachloride (i)	CCl4	-1249	10.0	-0.26	-0.26	-0.25	11.1
HCFC-123 (i)	C2F3HCl2	32	10.0	0.0066	0.0066	0.0066	11.1
HCFC-124 (i)	C2F4HCl	410	2.9	0.085	0.085	0.085	3.6

Table 4.9:Positive human health damages due to global warming for the three cultural perspectives hierarchists (H), egalitarians (E), and individualists (I) initially extrapolated from table 4.7a with the GWP's from table 4.8
(i) includes direct and indirect effects from stratospheric ozone depletion

4.7. Damage to Human Health caused by ionising radiation

The data used in this section can all be found in [FRISHKNECHT ET AL 1999]

4.7.1. Fate and exposure factors

The exposure and fate modelling is different for regional and globally dispersed substances. Table 4.10 presents the regional dispersed substances.

Exposure factor [man.Sv/kBq]	Atmospheric releases	Liquid releases into rivers	Liquid releases into the ocean	Reference
Silver-110 (Ag-110m)	-	3.30E-10	-	[DREICER 1995]
Americium-241 (Am-241)	-	-	2.10E-08	[DREICER 1995]
Carbon-14 (C-14)	-	-	7.80E-10	[DREICER 1995]
Curium alpha (Cm alpha)	-	-	3.80E-08	[DREICER 1995]
Cobalt-58 (Co-58)	2.80E-10	2.70E-11	-	[DREICER 1995]
Cobalt-60 (Co-60)	1.10E-08	2.90E-08	2.60E-10	[DREICER 1995]
Cesium-134 (Cs-134)	7.90E-09	9.50E-08	5.20E-11	[DREICER 1995]
Cesium-137 (Cs-137)	8.90E-09	1.10E-07	5.20E-11	[DREICER 1995]
Iodine-131 (I-131)	1.00E-10	3.30E-10	-	[DREICER 1995]
Iodine-133 (I-133)	6.20E-12	-	-	[DREICER 1995]
Manganese-54 (Mn-54)	-	2.10E-10	-	[DREICER 1995]
Lead-210 (Pb-210)	1.00E-09	-	-	[UNSCEAR 1993]
Polonium-210 (Po-210)	1.00E-09	-	-	[UNSCEAR 1993]
Plutonium alpha (Pu alpha)	5.50E-08	-	4.90E-09	[DREICER 1995]
Plutonium-238 (Pu-238)	4.40E-08	-	-	[DREICER 1995]
Radium-226 (Ra-226)	6.0E-10 1)	8.5E-11 2)	-	
Radon-222 (Rn-222)	1.60E-11	-	-	[DREICER 1995]
Ruthenium-106 (Ru-106)	-	-	9.50E-11	[DREICER 1995]
Antimony-124 (Sb-124)	-	5.40E-10	-	[DREICER 1995]
Antimony-125 (Sb-125)	-	-	9.80E-12	[DREICER 1995]
Strontium-90 (Sr-90)	-	-	2.70E-12	[DREICER 1995]
Thorium-230 (Th-230)	3.00E-08	-	-	[UNSCEAR 1993]
Uranium-234 (U-234)	6.40E-08	1.60E-09	1.50E-11	[DREICER 1995]
Uranium-235 (U-235)	1.40E-08	1.50E-09	1.60E-11	[DREICER 1995]
Uranium-238 (U-238)	5.40E-09	1.50E-09	1.50E-11	[DREICER 1995]
Xenon-133 (Xe-133)	9.40E-14	-	-	[DREICER 1995]

Table 4.10: Exposure factors (collective dose per activity released) of radionuclides. The squared geometric standard deviation σ_g^2 for each exposure factor is 10 (Assumption based on qualitative information). Dividing and multiplying the best estimate by σ_g^2 spans the 95% confidence interval.[1]): [UNSCEAR 1993]
[2]): based on the assumption that the ^{226}Ra-emission of 2 kBq/kg natural uranium released during mining and milling [ESU 1996:VII:56] leads to the ^{226}Ra concentration in rivers of 40 Bq/m^3 used in [DREICER 1995:109].

	Local and regional exposure and exposure from global dispersion during 100'000 years		**Local and regional exposure and exposure from global dispersion during 100 years**		**Local and regional exposure only**	
	Exposure factor [man.Sv/kBq]	assumed standard deviation σ_g^2	Exposure factor [man.Sv/kBq]	assumed standard deviation σ_g^2	Exposure factor [man.Sv/kBq]	assumed standard deviation σ_g^2
Atmospheric releases:						
Carbon-14 (C-14)	1.40E-07	10	1.30E-08	10	1.40E-11	10
Tritium (H-3)	9.50E-12	20	9.50E-12	20	3.30E-14	10
Iodine-129 (I-129)	6.20E-07	50	1.90E-07	20	7.20E-08	10
Krypton-85 (Kr-85)	9.30E-14	20	9.30E-14	20	1.00E-14	10
Liquid releases:						
Tritium (H-3) into river	3.00E-13	20	3.00E-13	20	2.50E-13	10
Tritium (H-3) into the sea	4.60E-14	20	4.60E-14	20	8.30E-16	10
Iodine-129 (I-129)	6.60E-08	50	1.50E-08	20	2.10E-10	10

Table. 4.11: Exposure factors (collective dose per activity released) of radionuclides based on Dreicer et al. (1995) considering local and regional effects, excluding and including global collective doses with different time horizons. Dividing and multiplying the best estimate by σ_g^2 spans the 95% confidence interval.

4.7.2. Calculation of DALYs

The following table 4.12 summarises the number of fatal and non-fatal cases. This information is then combined with the calculated DALYs per case in table 4.13 and table 4.14.

Tissue or organ	Lethality fraction	Fatal cancers	Non-fatal cancers	Level of association
	[-]	[10^{-2} cases per man.Sv]	[10^{-2} cases per man.Sv]	
Bladder	0.5	0.3	0.3	Probable
Bone marrow	0.99	0.5	0.005	Definite
Bone surface	0.7	0.05	0.021	[1])
Breast	0.5	0.2	0.2	Definite [2])
Colon	0.55	0.85	0.695	Probable
Liver	0.95	0.15	0.008	Possible
Lung	0.95	0.85	0.045	Definite
Oesophagus	0.95	0.3	0.016	Possible
Ovary	0.7	0.1	0.043	Probable
Skin	0.002	0.02	9.98	Probable
Stomach	0.9	1.1	0.122	Probable
Thyroid	0.1	0.08	0.72	Definite
Remainder	0.71	0.5	0.204	[1])
Total		5	12.36	

Table 4.12. Lethality fractions and probabilities of occurrence for the different cancers considered [ICRP 1990], and level of association based on epidemiological studies (atomic bomb survivors and medical radiation) reported in [RON & MUIRHEAD 1998:170]. The squared geometric standard deviation (lognormal distribution) is estimated to be a factor of 3 for all tumour types.
[1]): no information available in the respective reference
[2]): female breast

Tissue or organ	Average Disability weights D_m	Average age of onset a_m	Average duration of disease L_m	$YLD_m(0,0)$	$YLD_m(0,1)$
	[-]	[a]	[a]	[a]	[a]
Bladder	0.087	67.2	4.7	0.41	0.29
Bone marrow [1])	0.060	58.5	3.8	0.23	0.20
Bone surface [2])	0.136	62.6	3.4	0.47	0.38
Breast	0.084	60.3	4.3	0.36	0.31
Colon	0.217	67.5	3.9	0.85	0.61
Liver	0.239	64.3	1.77	0.42	0.34
Lung	0.146	66.7	2.0	0.29	0.22
Oesophagus	0.217	66.2	1.8	0.39	0.30
Ovary	0.095	59.0	3.3	0.31	0.28
Skin	0.045	55.4	4.4	0.20	0.19
Stomach	0.217	66.6	3.0	0.65	0.48
Thyroid [2])	0.136	62.6	3.4	0.47	0.38
Remainder [2])	0.136	62.6	3.4	0.47	0.38

Table. 4.13:Years lived disabled before death or recovery for different cancer sites with and without age weighting. Disability weights from [MURRAY 1996:414FF], age of onset and duration from [Murray 1996:541ff].
[1]): approximated by lymphomas and multiple myleoma,
[2]): due to missing data the average of all cancer sites was chosen

Tissue or organ	$YLD_m(0,0)$ [a/fatal cancer]	$YLL_m(0,0)$ [a/fatal cancer]	$DALYs_m(0,0)$ [a/fatal cancer]	$YLD_m(0,1)$ [a/fatal cancer]	$YLL_m(0,1)$ [a/fatal cancer]	$DALYs_m(0,1)$ [a/fatal cancer]
Bladder	0.41	12.1	12.5	0.29	7.0	7.3
Bone marrow [1])	0.23	16.8/30.9 [3])	17.0/31.1 [3])	0.20	11.7/25 [4])	11.9/25.2 [4])
Bone surface [2])	0.47	17.0	17.5	0.38	11.7	12.1
Breast	0.36	20.2	20.6	0.31	14.3	14.6
Colon	0.85	14.5	15.3	0.61	9.1	9.7
Liver	0.42	15.8	16.2	0.34	10.6	10.9
Lung	0.29	15.6	15.9	0.22	10.4	10.6
Oesophagus	0.39	15.5	15.9	0.30	10.3	10.6
Ovary	0.31	18.2	18.5	0.28	12.2	12.5
Skin	0.20	20.0	20.2	0.19	15.2	15.4
Stomach	0.65	18.1	18.8	0.48	12.7	13.2
Thyroid [2])	0.47	17.0	17.5	0.38	11.7	12.1
Remainder [2])	0.47	17.0	17.5	0.38	11.7	12.1

Table. 4.14: Years lived disabled, years life lost, and disability adjusted life years for different cancer sites with and without age weighting per case of fatal cancer.
[1]): approximated by lymphomas and multiple myleoma.
[2]): due to missing data the average of all cancer sites was chosen.
[3]): more specific data from [LAND & SINCLAIR 1991:55].
[4]): estimated from more specific data in [LAND & SINCLAIR 1991:55].

4.7.3. Results

Table 4.15 summarises the damage factors per pollutant (expressed as kBq)

	Damage factor per pollutant						
	Egalitarian	σ_g^2	Hierarchist	σ_g^2	Individualist	σ_g^2	
	DALYs(0,0)/kBq		DALYs(0,0)/Kbq		DALYs(0,1)/kBq		
Emitted to air:							
C-14	2.10E-07	15	2.10E-07	15	1.60E-08	15	
Co-58	4.30E-10	15	4.30E-10	15	3.60E-10	15	
Co-60	1.60E-08	15	1.60E-08	15	1.40E-08	15	
Cs-134	1.20E-08	15	1.20E-08	15	1.00E-08	15	
Cs-137	1.30E-08	15	1.30E-08	15	1.10E-08	15	
H-3	1.40E-11	28	1.40E-11	28	1.20E-11	28	
I-129	9.40E-07	65	9.40E-07	28	2.50E-07	28	
I-131	1.60E-10	15	1.60E-10	15	1.30E-10	15	
I-133	9.40E-12	15	9.40E-12	15	7.90E-12	15	
Kr-85	1.40E-13	28	1.40E-13	28	1.20E-13	28	
Pb-210	1.50E-09	15	1.50E-09	15	1.30E-09	15	
Po-210	1.50E-09	15	1.50E-09	15	1.30E-09	15	
Pu alpha	8.30E-08	15	8.30E-08	15	7.00E-08	15	
Pu-238	6.70E-08	15	6.70E-08	15	5.70E-08	15	
Ra-226	9.10E-10	15	9.10E-10	15	7.60E-10	15	
Rn-222	2.40E-11	15	2.40E-11	15	2.00E-11	15	
Th-230	4.50E-08	15	4.50E-08	15	3.80E-08	15	
U-234	9.70E-08	15	9.70E-08	15	8.20E-08	15	
U-235	2.10E-08	15	2.10E-08	15	1.70E-08	15	
U-238	8.20E-09	15	8.20E-09	15	6.90E-09	15	
Xe-133	1.40E-13	15	1.40E-13	15	1.20E-13	15	
Emitted to rivers and lakes:							
Ag-110m	5.10E-10	15	5.10E-10	15	4.20E-10	15	
Co-58	4.10E-11	15	4.10E-11	15	3.40E-11	15	
Co-60	4.40E-08	15	4.40E-08	15	3.70E-08	15	
Cs-134	1.40E-07	15	1.40E-07	15	1.20E-07	15	
Cs-137	1.70E-07	15	1.70E-07	15	1.40E-07	15	
H-3	4.50E-13	28	4.50E-13	28	3.80E-13	28	
I-131	5.00E-10	15	5.00E-10	15	4.20E-10	15	
Mn-54	3.10E-10	15	3.10E-10	15	2.60E-10	15	
Ra-226	1.30E-10	15	1.30E-10	15	1.10E-10	15	
Sb-124	8.20E-10	15	8.20E-10	15	6.90E-10	15	
U-234	2.40E-09	15	2.40E-09	15	2.00E-09	15	
U-235	2.30E-09	15	2.30E-09	15	2.00E-09	15	
U-238	2.30E-09	15	2.30E-09	15	1.90E-09	15	
Emitted to the Ocean:							
Am-241	3.10E-08	15	3.10E-08	15	2.60E-08	15	
C-14	1.20E-09	15	1.20E-09	15	9.90E-10	15	
Cm alpha	5.70E-08	15	5.70E-08	15	4.80E-08	15	
Co-60	3.90E-10	15	3.90E-10	15	3.30E-10	15	
Cs-134	7.90E-11	15	7.90E-11	15	6.60E-11	15	
Cs-137	7.90E-11	15	7.90E-11	15	6.70E-11	15	
H-3	6.90E-14	28	6.90E-14	28	5.80E-14	28	
I-129	1.00E-07	65	1.00E-07	28	1.90E-08	28	
Pu alpha	7.40E-09	15	7.40E-09	15	6.20E-09	15	
Ru-106	1.40E-10	15	1.40E-10	15	1.20E-10	15	
Sb-125	1.50E-11	15	1.50E-11	15	1.20E-11	15	
Sr-90	4.00E-12	15	4.00E-12	15	3.40E-12	15	
U-234	2.30E-11	15	2.30E-11	15	1.90E-11	15	
U-235	2.50E-11	15	2.50E-11	15	2.10E-11	15	
U-238	2.30E-11	15	2.30E-11	15	2.00E-11	15	

Table. 4.15: Damage factors and characterisation factors for three scenarios following three world views combining the data given in Tables 3 to 7. The σ_g^2 stands for the geometric standard deviation. Dividing and multiplying the best estimate by σ_g^2 spans the 95% confidence interval.

4.8. Damage to Human Health caused by ozone layer depletion

In the main report sufficient data for the calculation of the fate factor and the estimation of DALYs per % ozone layer depletion is shown. These figures are repeated at the top of the table. The damage per kg CFC-11 is calculated by multiplying the fate factor and the DALYs per % depletion.
The equivalency factors are taken from [HAUSSCHILD 1998] They are based on a time frame of 100 years.

		Egalitarian	Hierarchist	Individualist
% ozone layer depl. per kg CFC11		1.68E-08	1.68E-08	1.68E-08
DALYs per percentage ozone layer depletion		6.25E+04	6.25E+04	5.05E+04
	ODP_{100}			
CFC-11	1	1.05E-03	1.05E-03	8.50E-04
CFC-113	0.9	9.48E-04	9.48E-04	7.65E-04
CFC-114	0.85	8.95E-04	8.95E-04	7.23E-04
CFC-115	0.4	4.21E-04	4.21E-04	3.40E-04
CFC-12	0.82	8.63E-04	8.63E-04	6.97E-04
CFC-13		0.00E+00	0.00E+00	0.00E+00
tetrachloromethane	1.2	1.26E-03	1.26E-03	1.02E-03
HALON-1201	1.4	1.47E-03	1.47E-03	1.19E-03
HALON-1202	1.25	1.32E-03	1.32E-03	1.06E-03
HALON-1211	5.1	5.37E-03	5.37E-03	4.34E-03
HALON-1301	12	1.26E-02	1.26E-02	1.02E-02
HALON-2311	0.14	1.47E-04	1.47E-04	1.19E-04
HALON-2401	0.25	2.63E-04	2.63E-04	2.13E-04
HALON-2402	7	7.37E-03	7.37E-03	5.95E-03
methyl bromide	0.64	6.74E-04	6.74E-04	5.44E-04
HCFC-123	0.014	1.47E-05	1.47E-05	1.19E-05
HCFC-124	0.03	3.16E-05	3.16E-05	2.55E-05
HCFC-141b	0.1	1.05E-04	1.05E-04	8.50E-05
HCFC-142b	0.05	5.26E-05	5.26E-05	4.25E-05
HCFC-22	0.04	4.21E-05	4.21E-05	3.40E-05
HCFC-225ca	0.02	2.11E-05	2.11E-05	1.70E-05
HCFC-225cb	0.02	2.11E-05	2.11E-05	1.70E-05
1,1,1-trichloroethane	0.114	1.20E-04	1.20E-04	9.69E-05
methyl chloride	0.02	2.11E-05	2.11E-05	1.70E-05

Table 4.16: Extrapolation of damages caused by CFC11 to other substances, using ODB equivalence factors collected by [HAUSCHILD & WENZEL 1998]

5. Ecosystem Quality

5.1. p.m.

5.2. Damage to Ecosystem Quality caused by ecotoxic substances

For the damage to Ecosystem Quality caused by toxic effects the calculation is demonstrated in annex table 5.1.

Three steps are considered:
1. Fate analysis: from emission to concentration.
2. Effect analysis: from concentration to hazard units.
3. Damage analysis: from hazard units to damage: $PAFm^2$.

The separate steps are demonstrated in the annex tables.

5.2.1. Fate analysis

The Potential Affected Fraction of species can be calculated for aquatic and terrestrial ecosystems. For aquatic ecosystems the concentration in water is the starting point for the calculation of the damage. For the terrestrial ecosystems the concentration in the pore water of the soil compartment is used.
In EUSES four emission compartments air, water, agricultural soil an industrial soil are taken into account. The resulting concentrations in the receiving compartments, water compartment and the pore water of agricultural soil, industrial soil and natural soil, the so-called receiving compartment, determine the damage to ecosystems.

With transfer factors for the transfer of substances from soil to pore water (Ksoil/water) and the density of the soil (1700 kg/ m^3 wwt) the pore water concentrations are calculated according to the following formula:

Cporewater (mg/l) = Csoil (mg/kg) * ρ soil (kg/m^3) / Ksoil/pw (m^3/m^3)* 10^{-3}

Example for the pore water concentration of 1,2,3-trichlorobenzene in agricultural soil resulting from an emission to air: ρ soil = 1700 kg/m^3, Ksoil/pw = 85.5 m^3/m^3 Cporewater (mg/l) = $((2.2*10^{-5}*1700) / 85.5)*10^{-3} = 4.37*10^{-7}$

Fate factors are calculated for four emission compartments and the relevant four receiving compartments according to the principles explained in chapter 3.
In EUSES fate analysis has been carried out on a total of 71 substances. For 43 of these substances sufficient data (in the form of a statistical calculation for the average NEC) was available to assess the damage to Ecosystem Quality.

5.2.2. Effect analysis

The toxicity of the substances is characterised by standardised concentrations : Hazard Units. Hazard Units are similar to PEC/NEC ratio's : the Predicted Environmental Concentration divided by the No Effect Concentration. The no-effect concentration is assumed to represent the average NEC for the whole ecosystem. The values for the average NEC for aquatic and terrestrial ecosystems are derived from [Bakker & van de Meent 1997]. Bold printed figures mean that for lack of data for aquatic ecosystems the value for pore water in soil is used. The Hazard Units for an emission of 1 kg in Europe are calculated with the following formula:

HU (air,water) = (E (mg.y^{-1})/m^2 * Fate factor (m^2.y)/l) / A (mg/l)

HU: Hazard Units (dimensionless, standardised concentration)
E = emission in Europe

A = Average NEC for all species for a specific substance

> Example for the Hazard units for 1,2,3-trichlorobenzene in water resulting from an emission in Europe of 1kg per year to air:
> HU (air,water) = $(1*10^6/3.6*10^{12} * 7.39*10^{-7})/1.04 = 1.96*10^{-13}$

To avoid double counting, the HU for agricultural soil, resulting from an emission to agricultural soil is excluded. When an emission occurs on agricultural soil, the damage from leaching to water and other soil compartments and evaporation to air is included. The damage to the agricultural soil is already included in the damage from land-use. Therefore the hazard units (agri, agri) are set to 0.

5.2.3. Damage analysis

The height of the standardised concentration relates to a certain PAF. The damage depends on the slope of the PAF curve in the workpoint. The workpoint is determined by the present damage: the present combi-PAF in Europe. According to [ZWART 1998] the average combi-PAF for Europe lies between 10 and 50%. On a linear scale, at combi-PAF 10% the slope is quite steep while at 50% the slope has decreased almost a factor of 3.

The choice of the slope is related to the cultural perspective. Egalitarians choose for the precautionary principle and use the steepest slope, a small increase in HU gives a high increase in PAF, While individualists use the flattest slope. Hierarchists use the average.

Each receiving compartment has a specific concentration, resulting from a specific emission. Each receiving compartment in Europe has a specific size [EUSES 1996]. For each compartment the damage is assessed separately. The total damage is the sum of the damages of the separate receiving compartments. The total PAFm^2 resulting from an emission of 1 kg is calculated for a specific perspective with the following formula:

$$\begin{aligned} PAFm^2 \text{ (air)} = & \text{ HU (air,water)} * dPAF/dHU * \text{Areasize water } (m^2) \\ & + \text{HU (air,nat.soil)} * dPAF/dHU * \text{Areasize nat.soil } (m^2) \\ & + \text{HU (air,agr.soil)} * dPAF/dHU * \text{Areasize agr.soil } (m^2) \\ & + \text{HU (air,ind.soil)} * dPAF/dHU * \text{Areasize ind.soil } (m^2) \end{aligned}$$

> Example of the total damage tot ecosystem quality in the egalitarian perspective for an emission of 1 kg of 1,2,3- trichlorobenzene to air:
>
> - Area size water in Europe 3% of $3.6*10^6 = 1.08*10^5$ km^2
> - Area size natural soil in Europe 60% of $3.6*10^6 = 2.16*10^6$ km^2
> - Area size agricultural soil in Europe 27% of $3.6*10^6 = 0.97*10^6$ km^2
> - Area size industrial soil in Europe 10% of $3.6*10^6 = 0.36*10^6$ km^2
>
> $$\begin{aligned} PAFm^2 \text{ (air)} = & \ 1.96*10^{-13} * 0.739 * 1.08*10^5 * 10^6 \\ & + 1.82*10^{-13} * 0.739 * 2.16*10^6 * 10^6 \\ & + 1.15*10^{-13} * 0.739 * 0.97*10^6 * 10^6 \\ & + 1.82*10^{-13} * 0.739 * 0.36*10^6 * 10^6 = 4.38*10^{-1} \end{aligned}$$

Emissions to air 10.000 kg/d -- Resulting concentrations in :										
		K soil/water	Water	Air	Agricult. soil	Porewater AS	Natural soil	Porewater NS	Indust. soil	Porewater IS
Substance	CAS-number	[m3/m3]	[mg/l]	[mg/m3]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]
1,2- dichloroethane	107-06-2	1.59	1.73E-06	3.21E-04	1.66E-06	1.78E-06	1.68E-06	1.80E-06	1.68E-06	1.80E-06
1,2,3-trichlorobenzene	87-61-6	85.5	7.49E-07	9.16E-05	2.20E-05	4.37E-07	3.50E-05	6.96E-07	3.50E-05	6.96E-07
1,2,4-trichlorobenzene	120-82-1	68.4	9.19E-07	7.16E-05	1.15E-05	2.86E-07	2.50E-05	6.21E-07	2.50E-05	6.21E-07
1,2-dibromoethane	106-93-4	1.79	2.93E-06	2.00E-04	3.19E-06	3.03E-06	3.25E-06	3.09E-06	3.25E-06	3.09E-06
1,3,5-trichlorobenzene	108-70-3	93.9	1.79E-06	7.28E-04	8.35E-05	1.51E-06	1.02E-04	1.85E-06	1.02E-04	1.85E-06
1,3-butadiene	106-99-0	1.75	1.47E-07	1.28E-06	7.58E-08	7.37E-08	1.53E-07	1.49E-07	1.53E-07	1.49E-07
1,4-dioxane	123-91-1	0.236	4.59E-08	4.01E-06	8.61E-09	6.20E-08	8.63E-09	6.22E-08	8.63E-09	6.22E-08
2,4,6-trichlorophenol	88-06-2	7.34	1.64E-05	8.25E-05	1.04E-05	2.41E-06	3.51E-05	8.13E-06	3.51E-05	8.13E-06
2,4-D	94-75-7	7.34	3.24E-06	1.90E-07	9.14E-05	2.12E-05	3.61E-04	8.36E-05	3.61E-04	8.36E-05
Acetaldehyde	75-07-0	0.31	5.26E-08	4.01E-06	1.08E-08	5.96E-08	1.12E-08	6.14E-08	1.12E-08	6.14E-08
Acrolein	107-02-8	0.555	9.70E-05	5.00E-04	3.50E-05	1.10E-04	5.80E-05	1.78E-04	2.04E-09	6.25E-09
Acrylonitril	107-13-1	0.268	3.34E-07	1.56E-05	6.08E-08	3.85E-07	6.36E-08	4.03E-07	6.36E-08	4.03E-07
alpha-hexachlorocyclohexan	319-84-6	43	9.59E-08	6.41E-06	2.39E-06	9.44E-08	3.33E-06	1.32E-07	3.33E-06	1.32E-07
Arsenic (long term)	7440-38-2	1470	6.50E-04	4.30E-07	4	4.63E-03	4	4.63E-03	4	4.63E-03
Arsenic (short term)	7440-38-2	1470	1.10E-04	4.30E-07	0.114	1.32E-04	0.422	4.88E-04	0.422	4.88E-04
Atrazine	1912-24-9	5.02	4.99E-05	1.13E-07	3.50E-04	1.19E-04	1.27E-03	4.30E-04	1.27E-03	4.30E-04
Azinphos-methyl	86-50-0	6.58	1.48E-05	1.06E-07	3.83E-04	9.89E-05	1.42E-03	3.67E-04	1.42E-03	3.67E-04
Bentazon	25057-89-0	0.32	2.43E-05	4.97E-08	3.60E-04	1.91E-03	7.09E-04	3.77E-03	7.09E-04	3.77E-03
Benzene	71-43-2	2.29	1.25E-07	3.21E-05	1.78E-07	1.32E-07	1.83E-07	1.36E-07	1.83E-07	1.36E-07
Benzo(a)pyreen	50-32-8	3060	1.42E-07	1.95E-07	8.71E-05	4.84E-08	3.48E-04	1.93E-07	3.48E-04	1.93E-07
Benzo(a)anthracene	56-55-3	2320	1.87E-06	2.64E-05	0.0373	2.74E-05	0.0457	3.35E-05	0.0457	3.35E-05
Benzotrichloride	98-07-7	5.12E+07	8.00E-08	6.40E-04	9.90E-08	3.30E-15	9.90E-08	3.29E-15	9.90E-08	3.29E-15
Benzylchloride	100-44-7	2.97	2.24E-07	1.71E-05	3.27E-07	1.87E-07	4.20E-07	2.40E-07	4.20E-07	2.40E-07
beta-hexachlorocyclohexan	319-85-17	49.9	9.94E-08	6.41E-06	4.60E-06	1.57E-07	6.67E-06	2.27E-07	6.67E-06	2.27E-07
Bis(chloromethyl)ether	542-88-1	0.232	5.38E-08	4.01E-06	8.46E-09	6.20E-08	8.48E-09	6.21E-08	8.48E-09	6.21E-08
Bromodichloromethane	75-27-4	2.11	1.07E-06	8.00E-05	1.50E-06	1.21E-06	1.53E-06	1.23E-06	1.53E-06	1.23E-06
Cadmium (long term)	7440-43-9	285	2.47E-04	6.20E-07	0.926	5.52E-03	0.926	5.52E-03	0.926	5.52E-03
Cadmium (short term)	7440-43-9	285	1.12E-04	6.20E-07	0.105	6.23E-04	0.312	1.86E-03	0.312	1.86E-03
Carbendazim	10605-21-7	0.844	2.21E-04	1.57E-08	1.19E-03	2.39E-03	2.02E-03	4.07E-03	2.02E-03	4.07E-03
Carbontetrachloride	56-23-5	7.02	4.00E-05	3.90E-02	1.60E-04	4.00E-05	1.70E-04	4.12E-05	1.70E-04	4.12E-05
Chloroform	67-66-3	1.79	4.71E-06	3.21E-04	5.11E-06	4.85E-06	5.20E-06	4.94E-06	5.20E-06	4.94E-06
Chromium (long term)	7440-47-3	2.16E+04	5.34E-04	5.80E-07	15.7	1.23E-03	15.7	1.24E-03	15.7	1.24E-03
Chromium (short term)	7440-47-3	2.16E+04	2.59E-05	5.70E-07	0.117	9.21E-06	0.458	3.60E-05	0.458	3.60E-05
Copper (long term)	7440-50-8	810	1.64E-04	1.90E-07	2.42	5.09E-03	2.42	5.08E-03	2.42	5.08E-03
Copper (short term)	7440-50-8	810	4.05E-05	1.90E-07	0.112	2.36E-04	0.395	8.29E-04	0.395	8.29E-04
Dibenz(a)anthracene	53-70-3	1.11E+04	1.13E-05	1.01E-05	0.365	5.60E-05	0.667	1.02E-04	0.667	1.02E-04
Dibutylftalaat	84-74-2	252	3.26E-06	2.72E-06	4.40E-05	2.97E-07	1.76E-04	1.19E-06	1.76E-04	1.19E-06
Dichloromethane	75-09-2	0.614	1.79E-06	2.29E-04	6.69E-07	1.85E-06	6.71E-07	1.86E-06	6.71E-07	1.86E-06

Table 5.1: Damage to Ecosystem Quality (ecotoxicity) EUSES output

Emissions to air 10.000 kg/d -- Resulting concentrations in :										
		K soil/water	Water	Air	Agricult. soil	Porewater AS	Natural soil	Porewater NS	Indust. soil	Porewater IS
Substance	CAS-number	[m3/m3]	[mg/l]	[mg/m3]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]
Dichlorvos	62-73-7	1.51	5.41E-07	3.79E-06	4.22E-06	4.76E-06	1.66E-05	1.87E-05	1.66E-05	1.87E-05
Diethylhexylphthalate	117-81-7	4.09E+04	1.06E-07	2.64E-06	2.43E-05	1.01E-09	9.69E-05	4.03E-09	9.69E-05	4.03E-09
Dioxins		5.99E+03	6.18E-06	1.75E-05	5.77E-03	1.64E-06	0.0229	6.50E-06	0.0229	6.50E-06
Diquat-dibromide	85-00-7	43	5.74E-05	2.96E-12	0.0109	4.31E-04	0.0356	1.41E-03	0.0356	1.41E-03
Diuron	330-54-1	7.47	3.45E-05	1.24E-08	1.05E-03	2.39E-04	3.74E-03	8.51E-04	3.74E-03	8.51E-04
DNOC		3.46	1.41E-05	7.56E-06	9.50E-05	4.66E-05	3.70E-04	1.82E-04	3.70E-04	1.82E-04
Epichloorhydrin	106-89-8	0.28	1.72E-07	1.60E-05	3.93E-08	2.39E-07	4.05E-08	2.46E-07	4.05E-08	2.46E-07
Ethylene oxide	75-21-8	0.222	1.33E-04	5.87E-04	4.79E-05	3.67E-04	4.99E-05	3.82E-04	4.99E-05	3.82E-04
Fentin-acetate		22.9	6.54E-07	1.87E-07	3.51E-05	2.60E-06	1.37E-04	1.02E-05	1.37E-04	1.02E-05
Fluoranthene	206-44-0	639	5.61E-07	1.83E-06	7.41E-06	1.97E-08	2.96E-05	7.87E-08	2.96E-05	7.87E-08
Formaldehyde	50-00-0	0.286	3.70E-08	2.80E-06	7.00E-09	4.20E-08	7.25E-09	4.31E-08	7.25E-09	4.31E-08
Hexachlorobenzene	118-74-1	1.66E+03	5.64E-05	2.08E-03	5.32E-03	5.47E-06	0.0171	1.75E-05	0.0171	1.75E-05
Lead (long term)	7439-92-1	3.60E+06	2.51E-04	2.40E-07	7.58	3.58E-03	7.58	3.58E-06	7.58	3.58E-06
Lead (short term)	7439-92-1	3.60E+06	2.38E-05	2.40E-07	0.116	5.48E-05	0.444	2.10E-07	0.444	2.10E-07
Lindane (gamma HCH)	58-89-9	49.9	4.40E-07	3.16E-05	1.73E-05	5.90E-07	1.92E-05	6.54E-07	1.92E-05	6.54E-07
Malathion	121-75-5	6.58	7.29E-06	2.11E-06	1.73E-05	4.47E-06	6.86E-05	1.77E-05	6.86E-05	1.77E-05
Maneb	12427-38-2	5.12	9.94E-07	3.12E-06	3.09E-04	1.03E-04	1.09E-03	3.62E-04	1.09E-03	3.62E-04
Mecoprop	7085-19-0	10.2	1.08E-05	6.65E-08	1.26E-04	2.10E-05	4.97E-04	8.28E-05	4.97E-04	8.28E-05
Mercury (long term)	7439-97-6	4.95E+03	6.42E-04	7.07E-04	3.61	1.24E-03	3.61	1.24E-03	3.61	1.24E-03
Mercury (short term)	7439-97-6	4.95E+03	3.46E-04	5.40E-04	0.0566	1.94E-05	0.213	7.32E-05	0.213	7.32E-05
Metabenzthiazuron		1.72	1.07E-04	4.90E-08	1.21E-03	1.19E-03	2.93E-03	2.90E-03	2.93E-03	2.90E-03
Metamitron		0.378	2.47E-05	3.06E-10	2.77E-04	1.25E-03	6.74E-04	3.03E-03	6.74E-04	3.03E-03
Metribuzin	21087-64-4	1.02	9.25E-06	7.01E-09	3.57E-04	5.95E-04	1.09E-03	1.82E-03	1.09E-03	1.82E-03
Mevinphos	7786-34-7	0.305	6.04E-06	4.60E-08	1.27E-05	7.06E-05	4.88E-05	2.72E-04	4.88E-05	2.72E-04
Monolinuron		2.49	2.06E-05	6.25E-07	2.52E-04	1.72E-04	8.35E-04	5.70E-04	8.35E-04	5.70E-04
Nickel (long term)	7440-02-0	840	5.02E-04	3.40E-07	2.5	5.06E-03	2.5	5.06E-03	2.5	5.06E-03
Nickel (short term)	7440-02-0	840	1.22E-04	3.40E-07	0.113	2.28E-04	0.397	8.03E-04	0.397	8.03E-04
Parathion	56-38-2	46.3	1.28E-07	4.70E-07	8.26E-06	3.03E-07	3.26E-05	1.20E-06	3.26E-05	1.20E-06
Pentachlorophenol	87-86-5	531	7.58E-05	2.90E-05	3.66E-04	1.17E-06	1.46E-03	4.67E-06	1.46E-03	4.67E-06
Perchloroethylene	127-18-4	21.8	2.24E-07	1.89E-04	2.84E-06	2.21E-07	2.90E-06	2.26E-07	2.90E-06	2.26E-07
Phenol	108-95-2	0.82	1.24E-06	7.80E-07	9.60E-06	1.99E-05	2.80E-05	5.80E-05	2.80E-05	5.80E-05
Polychlorobiphenyls		3.56E+03	7.17E-07	2.76E-04	2.34E-03	1.12E-06	2.34E-03	1.12E-06	2.34E-03	1.12E-06
Propylene oxide	75-56-9	0.23	8.22E-05	4.83E-04	2.05E-05	1.52E-04	2.71E-05	2.00E-04	2.71E-05	2.00E-04
Simazine	122-34-9	2.4	3.74E-05	3.61E-08	5.58E-04	3.95E-04	1.81E-03	1.28E-03	1.81E-03	1.28E-03
Styrene	100-42-5	11.4	5.69E-09	8.01E-07	2.31E-08	3.45E-09	3.52E-08	5.25E-09	3.52E-08	5.25E-09
Thiram	137-26-8	1.33	3.26E-07	1.31E-07	1.73E-06	2.22E-06	6.04E-06	7.72E-06	6.04E-06	7.72E-06
Toluene	108-88-3	6.41	5.73E-08	1.72E-05	1.89E-07	5.00E-08	2.19E-07	5.81E-08	2.19E-07	5.81E-08
Trifluralin	1582-09-8	309	2.26E-07	1.43E-06	3.95E-06	2.17E-08	1.52E-05	8.36E-08	1.52E-05	8.36E-08
Vinylchloride	75-56-9	1.91	1.36E-09	1.10E-05	1.55E-09	1.38E-09	1.55E-09	1.38E-09	1.55E-09	1.38E-09
Zinc (long term)	7440-66-6	375	7.18E-05	3.80E-07	1.2	5.44E-03	1.2	5.44E-03	1.2	5.44E-03
Zinc (short term)	7440-66-6	375	2.83E-05	3.80E-07	0.107	4.86E-04	0.339	1.54E-03	0.339	1.54E-03

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity) EUSES output

Emissions to water 10.000 kg/d - Resulting concentrations in :											
		K soil/water	Water	Air	Agricult. soil	Porewater AS	Natural soil	Porewater NS	Indust. soil	Porewater IS
Substance	CAS-number	[m3/m3]	[mg/l]	[mg/m3]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]
1,2- dichloroethane	107-06-2	1.59	8.16E-05	3.15E-04	1.63E-06	1.74E-06	1.65E-06	1.76E-06	1.65E-06	1.76E-06
1,2,3-trichloorbenzeen	87-61-6	85.5	7.53E-05	8.06E-05	1.93-5	3.85E-07	3.08E-05	6.12E-07	3.08E-05	6.12E-07
1,2,4-trichloorbenzeen	120-82-1	68.4	8.28E-05	6.65E-05	1.07E-05	2.66E-07	2.33E-05	5.79E-07	2.33E-05	5.79E-07
1,2-dibromoethane	106-93-4	1.79	8.99E-05	1.97E-04	3.13E-06	2.97E-06	3.19E-06	3.03E-06	3.19E-06	3.03E-06
1,3,5-trichloorbenzeen	108-70-3	93.9	7.31E-05	6.52E-04	7.47E-05	1.35E-06	9.14E-05	1.65E-06	9.14E-05	1.65E-06
1,3-butadiene	106-99-0	1.75	1.56E-04	1.12E-06	6.61E-08	6.42E-08	1.34E-07	1.30E-07	1.34E-07	1.30E-07
1,4-dioxane	123-91-1	0.236	6.82E-05	3.08E-06	6.63E-09	4.77E-08	6.65E-09	4.79E-08	6.65E-09	4.79E-08
2,4,6-trichlorophenol	88-06-2	7.34	2.17E-04	5.67E-05	7.14E-06	1.65E-06	2.41E-05	5.58E-06	2.41E-05	5.58E-06
2,4-D	94-75-7	7.34	1.11E-04	3.67E-12	1.77E-09	4.10E-10	6.99E-09	1.62E-09	6.99E-09	1.62E-09
Acetaldehyde	75-07-0	0.31	7.81E-05	3.53E-06	9.56E-09	5.25E-08	9.87E-09	5.41E-08	9.87E-09	5.41E-08
Acrolein	107-02-8	0.555	2.70E-04	3.40E-04	2.40E-05	7.40E-05	4.00E-05	1.23E-04	4.00E-05	1.23E-04
Acrylonitril	107-13-1	0.268	8.40E-05	1.36E-05	5.31E-08	3.36E-07	5.55E-08	3.52E-07	5.55E-08	3.52E-07
alpha-hexachlorocyclohexan	319-84-6	43	8.76E-05	6.31E-06	2.35E-06	9.29E-08	3.28E-06	1.30E-07	3.28E-06	1.30E-07
Arsenic (long term)	7440-38-2	1470	2.90E-03	4.00E-12	3.80E-05	4.30E-08	3.80E-05	4.39E-08	3.80E-05	4.39E-08
Arsenic (short term)	7440-38-2	1470	2.32E-03	3.20E-12	8.70E-07	1.00E-09	3.20E-06	3.70E-09	3.20E-06	3.70E-09
Atrazine	1912-24-9	5.02	2.69E-03	4.78E-11	1.48E-07	5.02E-08	5.38E-07	1.82E-07	5.38E-07	1.82E-07
Azinphos-methyl	86-50-0	6.58	7.65E-04	5.13E-13	1.85E-09	4.78E-10	6.85E-09	1.77E-09	6.85E-09	1.77E-09
Bentazon	25057-89-0	0.32	8.29E-04	1.84E-12	1.33E-08	7.08E-08	2.63E-08	1.40E-07	2.63E-08	1.40E-07
Benzene	71-43-2	2.29	7.43E-05	2.96E-05	1.64E-07	1.22E-07	1.69E-07	1.25E-07	1.69E-07	1.25E-07
Benzo(a) pyreen	50-32-8	3060	1.67E-04	6.86E-10	3.06E-07	1.70E-10	1.22E-06	6.78E-10	1.22E-06	6.78E-10
Benzo(a)anthracene	56-55-3	2320	1.04E-04	2.43E-05	0.0343	2.52E-05	0.042	3.08E-05	0.042	3.08E-05
Benzotrichloride	98-07-7	5.12E+07	7.60E-05	6.30E-04	9.80E-08	3.30E-15	9.80E-08	3.25E-15	9.80E-08	3.25E-15
Benzylchloride	100-44-7	2.97	7.82E-05	1.51E-05	2.88E-07	1.65E-07	3.70E-07	2.12E-07	3.70E-07	2.12E-07
beta-hexachlorocyclohexan	319-85-17	49.9	8.76E-05	6.31E-06	4.53E-06	1.54E-07	6.56E-06	2.23E-07	6.56E-06	2.23E-07
Bis (chloromethyl)ether	542-88-1	0.232	7.98E-05	3.61E-06	7.62E-09	5.59E-08	7.64E-09	5.60E-08	7.64E-09	5.60E-08
Bromodichloromethane	75-27-4	2.11	8.04E-05	7.18E-05	1.34E-06	1.08E-06	1.37E-06	1.10E-06	1.37E-06	1.10E-06
Cadmium (long term)	7440-43-9	285	3.27E-03	9.90E-12	1.50E-05	8.90E-08	1.50E-05	8.95E-08	1.50E-05	8.95E-08
Cadmium (short term)	7440-43-9	285	2.64E-03	8.00E-12	1.40E-06	8.10E-09	4.10E-06	2.45E-08	4.10E-06	2.45E-08
Carbendazim	10605-21-7	0.844	7.89E-03	1.73E-12	1.31E-07	2.63E-07	2.23E-07	4.49E-07	2.23E-07	4.49E-07
Carbontetrachloride	56-23-5	7.02	1.20E-04	3.80E-02	1.60E-04	3.90E-05	1.60E-04	3.87E-05	1.60E-04	3.87E-05
Chloroform	67-66-3	1.79	9.19E-05	3.16E-04	5.03E-06	4.78E-06	5.13E-06	4.87E-06	5.13E-06	4.87E-06
Chromium (long term)	7440-47-3	2.16E+04	6.73E-04	3.00E-13	8.30E-06	6.50E-10	8.30E-06	6.53E-10	8.30E-06	6.53E-10
Chromium (short term)	7440-47-3	2.16E+04	5.42E-04	2.40E-13	5.00E-08	3.90E-12	2.00E-07	1.57E-11	2.00E-07	1.57E-11
Copper (long term)	7440-50-8	810	1.11E-03	1.60E-13	2.10E-06	4.30E-09	2.10E-06	4.41E-09	2.10E-06	4.41E-09
Copper (short term)	7440-50-8	810	8.92E-04	1.30E-13	7.70E-08	1.60E-10	2.70E-07	5.67E-10	2.70E-07	5.67E-10
Dibenz(a)anthracene	53-70-3	1.11E+04	1.51E-04	8.20E-06	0.296	4.53E-05	0.541	8.29E-05	0.541	8.29E-05
Dibutylftalaat	84-74-2	252	4.82E-04	3.25E-08	5.26E-07	3.55E-09	2.10E-06	1.42E-08	2.10E-06	1.42E-08
Dichloromethane	75-09-2	0.614	8.38E-05	2.26E-04	6.60E-07	1.83E-06	6.62E-07	1.83E-06	6.62E-07	1.83E-06

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity) EUSES output

Emissions to water 10.000 kg/d - Resulting concentrations in :										
		K soil/water	Water	Air	Agricult. soil	Porewater AS	Natural soil	Porewater NS	Indust. soil	Porewater IS
Substance	CAS-number	[m3/m3]	[mg/l]	[mg/m3]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]
Dichlorvos	62-73-7	1.51	5.32E-05	3.90E-09	4.35E-09	4.90E-09	1.71E-08	1.93E-08	1.71E-08	1.93E-08
Diethylhexylphthalate	117-81-7	4.09E+04	6.85E-05	5.01E-07	4.62E-06	1.92E-10	1.84E-05	7.65E-10	1.84E-05	7.65E-10
Dioxins		5.99E+03	1.72E-04	7.61E-06	2.50E-03	7.10E-07	9.95E-03	2.82E-06	9.95E-03	2.82E-06
Diquat-dibromide	85-00-7	43	1.82E-03	1.41E-20	5.19E-11	2.05E-12	1.70E-10	6.72E-12	1.70E-10	6.72E-12
Diuron	330-54-1	7.47	1.15E-03	1.09E-14	9.24E-10	2.10E-10	3.28E-09	7.46E-10	3.28E-09	7.46E-10
DNOC		3.46	3.72E-04	2.40E-08	2.56E-07	1.26E-07	9.98E-07	4.90E-07	9.98E-07	4.90E-07
Epichloorhydrin	106-89-8	0.28	6.42E-05	1.16E-05	2.84E-08	1.73E-07	2.93E-08	1.78E-07	2.93E-08	1.78E-07
Ethylene oxide	75-21-8	0.222	3.01E-04	3.58E-04	2.92E-05	2.23E-04	3.04E-05	2.33E-04	3.04E-05	2.33E-04
Fentin-acetate		22.9	3.03E-04	1.46E-10	2.73E-08	2.03E-09	1.07E-07	7.94E-09	1.07E-07	7.94E-09
Fluoranthene	206-44-0	639	2.33E-04	2.19E-07	8.88E-07	2.36E-09	3.54E-06	9.42E-09	3.54E-06	9.42E-09
Formaldehyde	50-00-0	0.286	7.80E-05	2.50E-06	6.20E-09	3.70E-08	6.40E-09	3.80E-08	6.40E-09	3.80E-08
Hexachlorobenzene	118-74-1	1.66E+03	1.61E-04	2.01E-03	5.14E-03	5.28E-06	0.0165	1.69E-05	0.0165	1.69E-05
Lead (long term)	7439-92-1	3.60E+06	6.27E-04	2.60E-14	8.00E-07	3.80E-10	8.00E-07	3.78E-13	8.00E-07	3.78E-13
Lead (short term)	7439-92-1	3.60E+06	5.05E-04	2.10E-14	9.80E-09	4.70E-12	3.80E-08	1.79E-14	3.80E-08	1.79E-14
Lindane (gamma HCCH)	58-89-9	49.9	8.22E-05	2.91E-05	1.59E-05	5.42E-07	1.76E-05	6.00E-07	1.76E-05	6.00E-07
Malathion	121-75-5	6.58	6.44E-04	8.99E-09	7.36E-08	1.90E-08	2.92E-07	7.54E-08	2.92E-07	7.54E-08
Maneb	12427-38-2	5.12	6.59E-05	2.87E-08	2.84E-06	9.44E-07	1.00E-05	3.32E-06	1.00E-05	3.32E-06
Mecoprop	7085-19-0	10.2	3.68E-04	1.44E-12	2.72E-09	4.53E-10	1.07E-08	1.78E-09	1.07E-08	1.78E-09
Mercury	7439-97-6	4.95E+03	7.73E-04	1.58E-04	0.804	2.76E-04	0.804	2.76E-04	0.804	2.76E-04
Mercury (short term)	7439-97-6	4.95E+03	5.95E-04	1.01E-04	0.0106	3.65E-06	0.04	1.37E-05	0.04	1.37E-05
Metabenzthiazuron		1.72	3.65E-03	5.43E-12	1.33E-07	1.32E-07	3.25E-07	3.21E-07	3.25E-07	3.21E-07
Metamitron		0.378	8.19E-04	3.05E-17	2.76E-11	1.24E-10	6.71E-11	3.02E-10	6.71E-11	3.02E-10
Metribuzin	21087-64-4	1.02	3.09E-04	1.23E-14	6.25E-10	1.04E-09	1.91E-09	3.18E-09	1.91E-09	3.18E-09
Mevinphos	7786-34-7	0.305	2.21E-04	4.62E-13	1.27E-10	7.09E-10	4.90E-10	2.73E-09	4.90E-10	2.73E-09
Monolinuron		2.49	1.43E-03	1.10E-09	4.44E-07	3.03E-07	1.47E-06	1.00E-06	1.47E-06	1.00E-06
Nickel (long term)	7440-02-0	840	3.30E-03	3.00E-12	2.20E-05	4.50E-08	2.20E-05	4.45E-08	2.20E-05	4.45E-08
Nickel (short term)	7440-02-0	840	2.67E-03	2.40E-12	8.00E-07	1.60E-09	2.80E-06	5.67E-09	2.80E-06	5.67E-09
Parathion	56-38-2	46.3	1.26E-04	1.96E-09	3.44E-08	1.26E-09	1.36E-07	4.99E-09	1.36E-07	4.99E-09
Pentachlorophenol	87-86-5	531	1.37E-03	1.62E-06	2.05E-05	6.57E-08	8.20E-05	2.63E-07	8.20E-05	2.63E-07
Perchloroethylene	127-18-4	21.8	7.73E-05	1.86E-04	2.80E-06	2.19E-07	2.86E-06	2.23E-07	2.86E-06	2.23E-07
Phenol	108-95-2	0.82	6.50E-04	1.20E-08	1.40E-07	2.97E-07	4.20E-07	8.71E-07	4.20E-07	8.71E-07
Polychlorobiphenyls		3.56E+03	8.79E-05	2.30E-04	1.95E-03	9.33E-07	1.95E-03	9.31E-07	1.95E-03	9.31E-07
Propylene oxide	75-56-9	0.23	2.26E-04	2.90E-04	1.23E-05	9.09E-05	1.63E-05	1.20E-04	1.63E-05	1.20E-04
Simazine	122-34-9	2.4	1.40E-03	1.05E-12	1.63E-08	1.15E-08	5.28E-08	3.74E-08	5.28E-08	3.74E-08
Styrene	100-42-5	11.4	7.59E-05	7.31E-07	2.11E-08	3.14E-09	3.21E-08	4.79E-09	3.21E-08	4.79E-09
Thiram	137-26-8	1.33	7.72E-04	1.42E-09	1.88E-08	2.41E-08	6.54E-08	8.36E-08	6.54E-08	8.36E-08
Toluene	108-88-3	6.41	7.54E-05	1.62E-05	1.78E-07	4.72E-08	2.06E-07	5.46E-08	2.06E-07	5.46E-08
Trifluralin	1582-09-8	309	1.68E-04	8.99E-07	2.48E-06	1.36E-08	9.55E-06	5.25E-08	9.55E-06	5.25E-08
Vinylchloride	75-56-9	1.91	7.62E-05	1.09E-05	1.53E-09	1.36E-09	1.53E-09	1.36E-09	1.53E-09	1.36E-09
Zinc (long term)	7440-66-6	375	8.10E-04	3.10E-13	9.90E-07	4.50E-09	9.90E-07	4.49E-09	9.90E-07	4.49E-09
Zinc (short term)	7440-66-6	375	6.53E-04	2.50E-13	7.20E-08	3.20E-10	2.30E-07	1.04E-09	2.30E-07	1.04E-09

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity) EUSES output

Emissions to agricultural soil 10.000 kg/d - Resulting concentrations in :										
		K soil/water	Water	Air	Agricult. soil	Porewater AS	Natural soil	Porewater NS	Indust. soil	Porewater IS
Substance	CAS-number	[m3/m3]	[mg/l]	[mg/m3]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]
1,2- dichloroethane	107-06-2	1.59	1.71E-06	3.17E-04	1.11E-04	1.18E-04	1.65E-06	1.76E-06	1.65E-06	1.76E-06
1,2,3-trichloorbenzeen	87-61-6	85.5	3.79E-07	4.57E-05	4.97E-03	9.89E-05	1.75E-05	3.48E-07	1.75E-05	3.48E-07
1,2,4-trichloorbenzeen	120-82-1	68.4	2.58E-07	1.98E-05	3.27E-03	8.13E-05	6.92E-06	1.72E-07	6.92E-06	1.72E-07
1,2-dibromoethane	106-93-4	1.79	2.81E-06	1.92E-04	3.26E-04	3.10E-04	3.12E-06	2.96E-06	3.12E-06	2.96E-06
1,3,5-trichloorbenzeen	108-70-3	93.9	1.35E-06	5.49E-04	2.50E-03	4.52E-05	7.71E-05	1.40E-06	7.71E-05	1.40E-06
1,3-butadiene	106-99-0	1.75	4.65E-08	3.69E-07	8.25E-04	8.02E-04	4.41E-08	4.28E-08	4.41E-08	4.28E-08
1,4-dioxane	123-91-1	0.236	4.55E-08	3.93E-06	4.36E-05	3.13E-04	8.48E-09	6.11E-08	8.48E-09	6.11E-08
2,4,6-trichlorophenol	88-06-2	7.34	7.83E-07	3.92E-06	1.23E-03	2.85E-04	1.67E-06	3.87E-07	1.67E-06	3.87E-07
2,4-D	94-75-7	7.34	9.96E-10	1.80E-11	3.48E-04	8.06E-05	3.43E-08	7.94E-09	3.43E-08	7.94E-09
Acetaldehyde	75-07-0	0.31	5.02E-08	3.78E-06	5.49E-05	3.01E-04	1.06E-08	5.81E-08	1.06E-08	5.81E-08
Acrolein	107-02-8	0.555	3.50E-05	1.80E-04	7.01E-04	2.15E-03	2.10E-05	6.43E-05	2.10E-05	6.43E-05
Acrylonitril	107-13-1	0.268	3.08E-07	1.44E-05	7.61E-05	4.82E-04	5.85E-08	3.71E-07	5.85E-08	3.71E-07
alpha-hexachlorocyclohexan	319-84-6	43	6.50E-08	3.93E-06	4.95E-03	1.96E-04	2.04E-06	8.07E-08	2.04E-06	8.07E-08
Arsenic (long term)	7440-38-2	1470	5.80E-04	2.70E-10	14.8	0.0171	2.50E-03	2.89E-06	2.50E-03	2.89E-06
Arsenic (short term)	7440-38-2	1470	1.30E-04	7.70E-12	0.424	4.90E-04	7.60E-06	8.79E-09	7.60E-06	8.79E-09
Atrazine	1912-24-9	5.02	1.51E-07	8.75E-11	2.11E-03	7.13E-04	9.86E-07	3.34E-07	9.86E-07	3.34E-07
Azinphos-methyl	86-50-0	6.58	3.16E-08	3.40E-12	2.21E-03	5.71E-04	4.55E-08	1.18E-08	4.55E-08	1.18E-08
Bentazon	25057-89-0	0.32	1.94E-07	1.34E-10	1.38E-03	7.31E-03	1.92E-06	1.02E-05	1.92E-06	1.02E-05
Benzene	71-43-2	2.29	1.20E-07	3.07E-05	1.18E-04	8.71E-05	1.75E-07	1.30E-07	1.75E-07	1.30E-07
Benzo(a) pyreen	50-32-8	3060	2.88E-08	7.69E-12	0.0127	7.02E-06	1.37E-08	7.61E-12	1.37E-08	7.61E-12
Benzo(a)anthracene	56-55-3	2320	1.82E-06	1.96E-05	0.349	2.56E-04	0.0339	2.48E-05	0.0339	2.48E-05
Benzotrichloride	98-07-7	5.12E+07	8.00E-08	6.40E-04	2.60E-06	8.70E-14	9.90E-08	3.29E-15	9.90E-08	3.29E-15
Benzylchloride	100-44-7	2.97	1.57E-07	1.19E-05	3.87E-04	2.22E-04	2.91E-07	1.67E-07	2.91E-07	1.67E-07
beta-hexachlorocyclohexan	319-85-17	49.9	6.42E-08	3.70E-06	5.41E-03	1.85E-04	3.85E-06	1.31E-07	3.85E-06	1.31E-07
Bis(chloromethyl)ether	542-88-1	0.232	5.33E-08	3.94E-06	4.28E-05	3.14E-04	8.33E-09	6.10E-08	8.33E-09	6.10E-08
Bromodichloromethane	75-27-4	2.11	1.02E-06	7.66E-05	3.81E-04	3.07E-04	1.46E-06	1.18E-06	1.46E-06	1.18E-06
Cadmium (long term)	7440-43-9	285	1.54E-04	6.90E-10	3.43	0.0204	1.00E-03	5.96E-06	1.00E-03	5.96E-06
Cadmium (short term)	7440-43-9	285	1.40E-05	7.80E-11	0.387	2.31E-03	4.00E-05	2.39E-07	4.00E-05	2.39E-07
Carbendazim	10605-21-7	0.844	2.18E-06	1.84E-11	4.76E-03	9.59E-03	2.37E-06	4.77E-06	2.37E-06	4.77E-06
Carbontetrachloride	56-23-5	7.02	3.90E-05	3.80E-02	2.50E-04	6.10E-05	1.60E-04	3.87E-05	1.60E-04	3.87E-05
Chloroform	67-66-3	1.79	4.52E-06	3.08E-04	3.28E-04	3.11E-04	5.00E-06	4.75E-06	5.00E-06	4.75E-06
Chromium (long term)	7440-47-3	2.16E+04	5.30E-04	1.30E-10	58	4.56E-03	3.60E-03	2.83E-07	3.60E-03	2.83E-07
Chromium (short term)	7440-47-3	2.16E+04	3.19E-06	9.90E-13	0.433	3.41E-05	7.90E-07	6.22E-11	7.90E-07	6.22E-11
Copper (long term)	7440-50-8	810	1.40E-04	5.50E-11	8.98E+00	0.0188	7.15E-04	1.50E-06	7.15E-04	1.50E-06
Copper (short term)	7440-50-8	810	5.05E-06	2.60E-12	4.16E-01	8.74E-04	5.40E-06	1.13E-08	5.40E-06	1.13E-08
Dibenz(a)anthracene	53-70-3	1.11E+04	5.90E-06	3.93E-06	0.932	1.43E-04	0.259	3.97E-05	0.259	3.97E-05
Dibutylftalaat	84-74-2	252	9.39E-09	1.40E-10	1.40E-03	9.43E-06	9.07E-09	6.12E-11	9.07E-09	6.12E-11
Dichloromethane	75-09-2	0.614	1.77E-06	2.27E-04	6.14E-05	1.70E-04	6.63E-07	1.84E-06	6.63E-07	1.84E-06

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity) EUSES output

Emissions to agricultural soil 10.000 kg/d - Resulting concentrations in :										
		K soil/water	Water	Air	Agricult. soil	Porewater AS	Natural soil	Porewater NS	Indust. soil	Porewater IS
Substance	CAS-number	[m3/m3]	[mg/l]	[mg/m3]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]
Dichlorvos	62-73-7	1.51	4.36E-10	1.93E-09	8.69E-05	9.80E-05	8.49E-09	9.56E-09	8.49E-09	9.56E-09
Diethylhexylphthalate	117-81-7	4.09E+04	1.86E-09	1.94E-09	1.92E-03	7.97E-08	7.13E-08	2.96E-12	7.13E-08	2.96E-12
Dioxins		5.99E+03	7.24E-08	3.04E-08	0.0267	7.59E-06	3.97E-05	1.13E-08	3.97E-05	1.13E-08
Diquat-dibromide	85-00-7	43	1.05E-06	1.12E-19	0.0404	1.63E-03	1.34E-09	5.30E-11	1.34E-09	5.30E-11
Diuron	330-54-1	7.47	8.11E-08	7.60E-14	3.93E-03	8.95E-04	2.29E-08	5.21E-09	2.29E-08	5.21E-09
DNOC		3.46	1.48E-08	6.26E-09	3.68E-04	1.81E-04	3.06E-07	1.50E-07	3.06E-07	1.50E-07
Epichloorhydrin	106-89-8	0.28	1.64E-07	1.52E-05	4.98E-05	3.03E-04	3.84E-08	2.33E-07	3.84E-08	2.33E-07
Ethylene oxide	75-21-8	0.222	9.28E-05	4.10E-04	7.31E-04	5.59E-03	3.48E-05	2.66E-04	3.48E-05	2.66E-04
Fentin-acetate		22.9	9.43E-09	1.10E-10	1.99E-03	1.48E-04	8.02E-08	5.95E-09	8.02E-08	5.95E-09
Fluoranthene	206-44-0	639	1.58E-08	6.15E-10	4.93E-03	1.31E-05	9.94E-09	2.64E-11	9.94E-09	2.64E-11
Formaldehyde	50-00-0	0.286	3.50E-08	2.70E-06	5.10E-05	3.00E-04	6.90E-09	4.10E-08	6.90E-09	4.10E-08
Hexachlorobenzene	118-74-1	1.66E+03	4.58E-06	1.67E-04	0.0405	4.16E-05	1.37E-03	1.40E-06	1.37E-03	1.40E-06
Lead (long term)	7439-92-1	3.60E+06	2.39E-04	6.60E-11	28.1	0.0133	2.00E-03	9.44E-10	2.00E-03	9.44E-10
Lead (short term)	7439-92-1	3.60E+06	2.95E-06	1.00E-12	0.43	2.03E-04	1.80E-06	8.50E-13	1.80E-06	8.50E-13
Lindane (gamma HCCH)	58-89-9	49.9	3.86E-07	2.71E-05	8.03E-03	2.74E-04	1.64E-05	5.59E-07	1.64E-05	5.59E-07
Malathion	121-75-5	6.58	4.44E-09	5.39E-10	2.18E-04	5.62E-05	1.75E-08	4.52E-09	1.75E-08	4.52E-09
Maneb	12427-38-2	5.12	1.05E-08	2.35E-08	2.34E-03	7.78E-04	8.21E-06	2.73E-06	8.21E-06	2.73E-06
Mecoprop	7085-19-0	10.2	3.35E-09	2.52E-12	4.78E-04	7.98E-05	1.88E-08	3.13E-09	1.88E-08	3.13E-09
Mercury	7439-97-6	4.95E+03	4.65E-04	3.16E-04	22.4	7.70E-03	1.61	5.53E-04	1.61	5.53E-04
Mercury (short term)	7439-97-6	4.95E+03	6.19E-06	4.86E-06	0.428	1.47E-04	1.92E-03	6.59E-07	1.92E-03	6.59E-07
Metabenzthiazuron		1.72	6.68E-07	5.78E-11	4.63E-03	4.58E-03	3.46E-06	3.42E-06	3.46E-06	3.42E-06
Metamitron		0.378	8.21E-08	1.55E-15	1.03E-03	4.62E-03	3.41E-09	1.53E-08	3.41E-09	1.53E-08
Metribuzin	21087-64-4	1.02	1.94E-08	7.85E-13	1.33E-03	2.22E-03	1.22E-07	2.03E-07	1.22E-07	2.03E-07
Mevinphos	7786-34-7	0.305	1.99E-09	4.97E-12	5.17E-05	2.88E-04	5.27E-09	2.94E-08	5.27E-09	2.94E-08
Monolinuron		2.49	1.71E-07	2.87E-09	2.03E-03	1.39E-03	3.84E-06	2.62E-06	3.84E-06	2.62E-06
Nickel (long term)	7440-02-0	840	4.15E-04	1.80E-10	9.26	0.0187	1.40E-03	2.83E-06	1.40E-03	2.83E-06
Nickel (short term)	7440-02-0	840	1.51E-05	8.20E-12	0.417	8.44E-04	9.60E-06	1.94E-08	9.60E-06	1.94E-08
Parathion	56-38-2	46.3	3.89E-09	2.11E-10	2.13E-03	7.82E-05	1.47E-08	5.40E-10	1.47E-08	5.40E-10
Pentachlorophenol	87-86-5	531	4.40E-08	1.29E-09	2.18E-03	6.99E-06	6.51E-08	2.08E-10	6.51E-08	2.08E-10
Perchloroethylene	127-18-4	21.8	2.19E-07	1.84E-04	3.25E-04	2.53E-05	2.82E-06	2.20E-07	2.82E-06	2.20E-07
Phenol	108-95-2	0.82	5.50E-08	9.90E-09	1.15E-03	2.39E-03	3.60E-07	7.46E-07	3.60E-07	7.46E-07
Polychlorobiphenyls		3.56E+03	8.10E-07	2.75E-04	0.0824	3.94E-05	2.33E-03	1.11E-06	2.33E-03	1.11E-06
Propylene oxide	75-56-9	0.23	4.36E-05	2.56E-04	4.35E-04	3.21E-03	1.44E-05	1.06E-04	1.44E-05	1.06E-04
Simazine	122-34-9	2.4	9.87E-08	1.07E-11	2.34E-03	1.65E-03	5.38E-07	3.81E-07	5.38E-07	3.81E-07
Styrene	100-42-5	11.4	3.80E-09	4.31E-07	6.00E-04	8.96E-05	1.89E-08	2.82E-09	1.89E-08	2.82E-09
Thiram	137-26-8	1.33	2.32E-08	6.24E-10	7.47E-04	9.57E-04	2.88E-08	3.68E-08	2.88E-08	3.68E-08
Toluene	108-88-3	6.41	4.70E-08	1.40E-05	2.32E-04	6.16E-05	1.78E-07	4.72E-08	1.78E-07	4.72E-08
Trifluralin	1582-09-8	309	2.43E-08	1.51E-08	9.52E-03	5.24E-05	1.61E-07	8.86E-10	1.61E-07	8.86E-10
Vinylchloride	75-56-9	1.91	1.37E-09	1.10E-05	3.03E-06	2.69E-06	1.55E-09	1.38E-09	1.55E-09	1.38E-09
Zinc (long term)	7440-66-6	375	4.90E-05	2.40E-10	4.45	0.0202	7.70E-04	3.49E-06	7.70E-04	3.49E-06
Zinc (short term)	7440-66-6	375	3.53E-06	2.20E-11	0.397	1.80E-03	2.00E-05	9.07E-08	2.00E-05	9.07E-08

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity) EUSES output

Emissions to industrial soil 10.000 kg/d - Resulting concentrations in :											
		K soil/water	Water	Air	Agricult. soil	Porewater AS	Natural soil	Porewater NS	Indust. soil	Porewater IS
Substance	CAS-number	[m3/m3]	[mg/l]	[mg/m3]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]
1,2- dichloroethane	107-06-2	1.59	1.72E-06	3.19E-04	1.65E-06	1.76E-06	1.66E-06	1.77E-06	2.98E-04	3.19E-04
1,2,3-trichloorbenzeen	87-61-6	85.5	6.04E-07	7.28E-05	1.75E-05	3.48E-07	2.79E-05	5.55E-07	0.0214	4.25E-04
1,2,4-trichloorbenzeen	120-82-1	68.4	5.60E-07	4.30E-05	6.92E-06	1.72E-07	1.50E-05	3.73E-07	0.0192	4.77E-04
1,2-dibromoethane	106-93-4	1.79	2.87E-06	1.96E-04	3.12E-06	2.97E-06	3.18E-06	3.02E-06	8.91E-04	8.46E-04
1,3,5-trichloorbenzeen	108-70-3	93.9	1.66E-06	6.72E-04	7.71E-05	1.40E-06	9.43E-05	1.71E-06	8.14E-03	1.47E-04
1,3-butadiene	106-99-0	1.75	9.42E-08	7.47E-07	4.41E-08	4.29E-08	8.94E-08	8.68E-08	4.51E-03	4.38E-03
1,4-dioxane	123-91-1	0.236	4.57E-08	3.94E-06	8.48E-09	6.10E-08	8.50E-09	6.12E-08	1.18E-04	8.50E-04
2,4,6-trichlorophenol	88-06-2	7.34	2.65E-06	1.33E-05	1.67E-06	3.87E-07	5.64E-06	1.31E-06	0.0112	2.59E-03
2,4-D	94-75-7	7.34	3.94E-09	7.13E-11	3.43E-08	7.95E-09	1.36E-07	3.15E-08	3.71E-03	8.59E-04
Acetaldehyde	75-07-0	0.31	5.18E-08	3.91E-06	1.06E-08	5.81E-08	1.09E-08	5.98E-08	1.53E-04	8.39E-04
Acrolein	107-02-8	0.555	5.90E-05	3.00E-04	2.00E-05	6.50E-05	3.50E-05	1.07E-04	3.20E-03	9.80E-03
Acrylonitril	107-13-1	0.268	3.22E-07	1.50E-05	5.85E-08	3.70E-07	6.11E-08	3.88E-07	2.15E-04	1.36E-03
alpha-hexachlorocyclohexan	319-84-6	43	9.07E-08	5.48E-06	2.04E-06	8.08E-08	2.85E-06	1.13E-07	0.0186	7.35E-04
Arsenic (long term)	7440-38-2	1470	5.80E-04	2.70E-10	2.50E-03	2.90E-06	2.50E-03	2.89E-06	40	4.63E-02
Arsenic (short term)	7440-38-2	1470	4.93E-05	2.80E-11	7.60E-06	8.80E-09	2.80E-05	3.24E-08	4.22	4.88E-03
Atrazine	1912-24-9	5.02	5.50E-07	3.18E-10	9.86E-07	3.34E-07	3.58E-06	1.21E-06	0.0207	7.01E-03
Azinphos-methyl	86-50-0	6.58	1.17E-07	1.26E-11	4.55E-08	1.17E-08	1.68E-07	4.34E-08	0.0221	5.71E-03
Bentazon	25057-89-0	0.32	3.83E-07	2.65E-10	1.92E-06	1.02E-05	3.78E-06	2.01E-05	7.32E-03	3.89E-02
Benzene	71-43-2	2.29	1.24E-07	3.16E-05	1.75E-07	1.30E-07	1.81E-07	1.34E-07	3.26E-04	2.42E-04
Benzo(a) pyreen	50-32-8	3060	1.15E-07	3.07E-11	1.37E-08	7.60E-12	5.47E-08	3.04E-11	0.136	7.56E-05
Benzo(a)anthracene	56-55-3	2320	2.23E-06	2.41E-05	0.0339	2.49E-05	0.0416	3.05E-05	1.1	8.06E-04
Benzotrichloride	98-07-7	5.12E+07	8.00E-08	6.40E-04	9.90E-08	3.30E-15	9.90E-08	3.29E-15	6.90E-06	2.29E-13
Benzylchloride	100-44-7	2.97	2.01E-07	1.52E-05	2.91E-07	1.67E-07	3.74E-07	2.14E-07	1.34E-04	7.67E-05
beta-hexachlorocyclohexan	319-85-17	49.9	9.30E-08	5.37E-06	3.85E-06	1.31E-07	5.59E-06	1.90E-07	0.0212	7.22E-04
Bis (chloromethyl)ether	542-88-1	0.232	5.35E-08	3.95E-06	8.33E-09	6.10E-08	8.35E-09	6.12E-08	1.16E-04	8.50E-04
Bromodichloromethane	75-27-4	2.11	1.05E-06	7.83E-05	1.46E-06	1.18E-06	1.50E-06	1.21E-06	1.05E-03	8.46E-04
Cadmium (long term)	7440-43-9	285	1.54E-04	6.90E-10	1.00E-03	6.20E-06	1.00E-03	5.96E-06	9.25	5.52E-02
Cadmium (short term)	7440-43-9	285	4.19E-05	2.30E-10	4.00E-05	2.40E-07	1.20E-04	7.16E-07	3.12	1.86E-02
Carbendazim	10605-21-7	0.844	3.72E-06	3.15E-11	2.37E-06	4.78E-06	4.05E-06	8.16E-06	0.0219	4.41E-02
Carbontetrachloride	56-23-5	7.02	3.90E-05	3.90E-02	1.60E-04	4.00E-05	1.70E-04	4.12E-05	4.11E-04	9.95E-05
Chloroform	67-66-3	1.79	4.61E-06	3.14E-04	5.00E-06	4.75E-06	5.10E-06	4.84E-06	8.93E-04	8.48E-04
Chromium (long term)	7440-47-3	2.16E+04	5.30E-04	1.30E+10	3.60E-03	2.90E-07	3.60E-03	2.83E-07	156	1.23E-02
Chromium (short term)	7440-47-3	2.16E+04	1.25E-05	3.90E-12	7.90E-07	6.20E-11	3.10E-06	2.44E-10	4.58	3.60E-04
Copper (long term)	7440-50-8	810	1.35E-04	5.50E-11	7.10E-04	1.50E-06	7.10E-04	1.49E-06	24.2	5.08E-02
Copper (short term)	7440-50-8	810	1.77E-05	9.00E-12	5.40E-06	1.10E-08	1.90E-05	3.99E-08	3.95	8.29E-03
Dibenz(a)anthracene	53-70-3	1.11E+04	1.08E-05	7.19E-06	0.259	3.97E-05	0.474	7.26E-05	4.38	6.71E-04
Dibutylftalaat	84-74-2	252	3.75E-08	5.60E-10	9.07E-09	6.13E-11	3.62E-08	2.44E-10	0.0151	1.02E-04
Dichloromethane	75-09-2	0.614	1.78E-06	2.27E-04	6.63E-07	1.83E-06	6.65E-07	1.84E-06	1.65E-04	4.57E-04

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity) EUSES output

Emissions to industrial soil 10.000 kg/d - Resulting concentrations in :										
		K soil/water	Water	Air	Agricult. soil	Porewater AS	Natural soil	Porewater NS	Indust. soil	Porewater IS
Substance	CAS-number	[m3/m3]	[mg/l]	[mg/m3]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]	[mg/kgwwt]	[mg/l]
Dichlorvos	62-73-7	1.51	1.72E-09	7.61E-09	8.49E-09	9.57E-09	3.34E-08	3.76E-08	9.24E-04	1.04E-03
Diethylhexylphthalate	117-81-7	4.09E+04	7.44E-09	7.74E-09	7.13E-09	2.96E-12	2.84E-07	1.18E-11	0.0207	8.60E-07
Dioxins		5.99E+03	2.87E-07	1.21E-07	3.97E-05	1.13E-08	1.58E-04	4.48E-08	0.287	8.15E-05
Diquat-dibromide	85-00-7	43	3.44E-06	3.65E-19	1.34E-09	5.31E-11	4.38E-09	1.73E-10	0.356	1.41E-02
Diuron	330-54-1	7.47	2.88E-07	2.70E-13	2.29E-08	5.21E-09	8.14E-08	1.85E-08	0.0377	8.58E-03
DNOC		3.46	5.75E-08	2.44E-08	3.06E-07	1.50E-07	1.19E-06	5.85E-07	3.86E-03	1.90E-03
Epichloorhydrin	106-89-8	0.28	1.69E-07	1.56E-05	3.84E-08	2.33E-07	3.95E-08	2.40E-07	1.38E-04	8.38E-04
Ethylene oxide	75-21-8	0.222	9.67E-05	4.27E-04	3.48E-05	2.67E-04	3.63E-05	2.78E-04	2.00E-03	1.53E-02
Fentin-acetate		22.9	3.69E-08	4.28E-10	8.02E-08	5.96E-09	3.14E-07	2.33E-08	0.021	1.56E-03
Fluoranthene	206-44-0	639	6.30E-08	2.45E-09	9.94E-09	2.64E-11	3.96E-08	1.05E-10	0.0531	1.41E-04
Formaldehyde	50-00-0	0.286	3.60E-08	2.70E-06	6.80E-09	4.10E-08	7.10E-09	4.22E-08	1.40E-04	8.32E-04
Hexachlorobenzene	118-74-1	1.66E+03	1.47E-05	5.35E-04	1.37E-03	1.40E-06	4.39E-03	4.50E-06	0.352	3.60E-04
Lead (long term)	7439-92-1	3.60E+06	2.39E-04	6.60E-10	2.00E-03	9.70E-07	2.00E-03	9.44E-10	75.8	3.58E-05
Lead (short term)	7439-92-1	3.60E+06	1.13E-05	3.80E-12	1.80E-06	8.60E-10	7.00E-06	3.31E-12	4.44	2.10E-06
Lindane (gamma HCCH)	58-89-9	49.9	4.28E-07	3.00E-05	1.64E-05	5.60E-07	1.82E-05	6.20E-07	0.024	8.18E-04
Malathion	121-75-5	6.58	1.76E-08	2.14E-09	1.75E-08	4.52E-09	6.94E-08	1.79E-08	2.33E-03	6.02E-04
Maneb	12427-38-2	5.12	3.72E-08	8.29E-08	8.21E-06	2.73E-06	2.90E-05	9.63E-06	0.0223	7.40E-03
Mecoprop	7085-19-0	10.2	1.32E-08	9.97E-12	1.88E-08	3.15E-09	7.46E-08	1.24E-08	5.11E-03	8.52E-04
Mercury	7439-97-6	4.95E+03	4.65E-04	3.16E-04	1.61	5.54E-04	1.61	5.53E-04	57.8	1.99E-02
Mercury (short term)	7439-97-6	4.95E+03	2.33E-05	1.83E-05	1.92E-03	6.59E-07	7.23E-03	2.48E-06	4.36	1.50E-03
Metabenzthiazuron		1.72	1.62E-06	1.41E-10	3.46E-06	3.42E-06	8.42E-06	8.32E-06	0.0304	3.00E-02
Metamitron		0.378	2.00E-07	3.77E-15	3.41E-09	1.53E-08	8.28E-09	3.72E-08	6.74E-03	3.03E-02
Metribuzin	21087-64-4	1.02	5.91E-08	2.39E-12	1.22E-07	2.03E-07	3.72E-07	6.20E-07	0.011	1.83E-02
Mevinphos	7786-34-7	0.305	7.66E-09	1.91E-11	5.27E-09	2.93E-08	2.03E-08	1.13E-07	5.36E-04	2.99E-03
Monolinuron		2.49	5.65E-07	9.51E-09	3.84E-06	2.62E-06	1.27E-05	8.67E-06	0.0182	1.24E-02
Nickel (long term)	7440-02-0	840	4.15E-04	1.80E-10	1.40E-03	2.70E-06	1.40E-03	2.83E-06	25	5.06E-02
Nickel (short term)	7440-02-0	840	5.34E-05	2.90E-11	9.60E-06	2.00E-08	3.40E-05	6.88E-08	3.97	8.03E-03
Parathion	56-38-2	46.3	1.54E-08	8.36E-10	1.47E-08	5.39E-10	5.80E-08	2.13E-09	0.0227	8.33E-04
Pentachlorophenol	87-86-5	531	1.76E-07	5.15E-09	6.51E-08	2.09E-10	2.60E-07	8.32E-10	0.0235	7.52E-05
Perchloroethylene	127-18-4	21.8	2.23E-07	1.88E-04	2.82E-06	2.20E-07	2.87E-06	2.24E-07	8.88E-04	6.92E-05
Phenol	108-95-2	0.82	1.60E-07	2.90E-08	3.60E-07	7.40E-07	1.00E-06	2.07E-06	9.07E-03	1.88E-02
Polychlorobiphenyls		3.56E+03	8.10E-07	2.75E-04	2.33E-03	1.12E-06	2.33E-03	1.11E-06	0.219	1.05E-04
Propylene oxide	75-56-9	0.23	5.76E-05	3.38E-04	1.44E-05	1.06E-04	1.90E-05	1.40E-04	1.53E-03	1.13E-02
Simazine	122-34-9	2.4	3.21E-07	3.48E-11	5.38E-07	3.81E-07	1.75E-06	1.24E-06	0.0205	1.45E-02
Styrene	100-42-5	11.4	5.79E-09	6.56E-07	1.89E-08	2.82E-09	2.88E-08	4.29E-09	2.47E-03	3.68E-04
Thiram	137-26-8	1.33	8.07E-08	2.17E-09	2.88E-08	3.69E-08	1.00E-07	1.28E-07	7.02E-03	8.97E-03
Toluene	108-88-3	6.41	5.45E-08	1.63E-05	1.78E-07	4.72E-08	2.06E-07	5.46E-08	7.26E-04	1.93E-04
Trifluralin	1582-09-8	309	9.35E-08	5.82E-08	1.61E-07	8.83E-10	6.18E-07	3.40E-09	0.0989	5.44E-04
Vinylchloride	75-56-9	1.91	1.37E-09	1.10E-05	1.55E-09	1.38E-09	1.55E-09	1.38E-09	8.18E-06	7.28E-06
Zinc (long term)	7440-66-6	375	4.90E-05	2.40E-10	7.70E-04	3.50E-06	7.70E-04	3.49E-06	12	5.44E-02
Zinc (short term)	7440-66-6	375	1.11E-05	6.80E-11	2.00E-05	8.80E-08	6.20E-05	2.81E-07	3.38	1.53E-02

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity) EUSES output

Fate factors	Fate factors for emissions to air				Fate factors for emissions to water			
	Fair, water	Fair, nat. soil	Fair, agri. soil	Fair, ind. soil	Fwater, water	Fwater, nat. soil	Fwater, agri. soil	Fwater, ind. soil
		porewater	porewater	porewater		porewater	porewater	porewater
Substance	m2a/l	m2a/l	m2a/l	m2a/l	m2a/l	m2a/l	m2a/l	m2a/l
1,2,3-trichlorobenzene	7.39E-07	6.86E-07	4.31E-07	6.86E-07	7.43E-05	6.04E-07	3.80E-07	6.04E-07
1,2,4-trichlorobenzene	9.06E-07	6.13E-07	2.82E-07	6.13E-07	8.17E-05	5.71E-07	2.62E-07	5.71E-07
1,3,5-trichlorobenzene	1.77E-06	1.82E-06	1.49E-06	1.82E-06	7.21E-05	1.63E-06	1.33E-06	1.63E-06
2,4-D	3.20E-06	8.25E-05	2.09E-05	8.25E-05	1.09E-04	1.60E-09	4.04E-10	1.60E-09
Arsenic (long term)	6.41E-04	4.56E-03	4.57E-03	4.56E-03	2.86E-03	4.33E-08	4.24E-08	4.33E-08
Arsenic (short term)	1.08E-04	4.81E-04	1.30E-04	4.81E-04	2.29E-03	3.65E-09	9.86E-10	3.65E-09
Atrazine	4.92E-05	4.24E-04	1.17E-04	4.24E-04	2.65E-03	1.80E-07	4.95E-08	1.80E-07
Azinphos-methyl	1.46E-05	3.62E-04	9.75E-05	3.62E-04	7.55E-04	1.75E-09	4.71E-10	1.75E-09
Bentazon	2.40E-05	3.71E-03	1.88E-03	3.71E-03	8.18E-04	1.38E-07	6.98E-08	1.38E-07
Benzene	1.23E-07	1.34E-07	1.30E-07	1.34E-07	7.33E-05	1.24E-07	1.20E-07	1.24E-07
Benzo(a)pyreen	1.40E-07	1.91E-07	4.77E-08	1.91E-07	1.65E-04	6.68E-10	1.68E-10	6.68E-10
Cadmium (long term)	2.44E-04	5.45E-03	5.44E-03	5.45E-03	3.23E-03	8.82E-08	8.78E-08	8.82E-08
Cadmium (short term)	1.10E-04	1.84E-03	6.14E-04	1.84E-03	2.60E-03	2.41E-08	7.99E-09	2.41E-08
Carbendazim	2.18E-04	4.01E-03	2.36E-03	4.01E-03	7.78E-03	4.43E-07	2.59E-07	4.43E-07
Chromium (long term)	5.27E-04	1.22E-03	1.21E-03	1.22E-03	6.64E-04	6.44E-10	6.41E-10	6.44E-10
Chromium (short term)	2.55E-05	3.56E-05	9.08E-06	3.56E-05	5.35E-04	1.55E-11	3.85E-12	1.55E-11
Copper (long term)	1.62E-04	5.01E-03	5.02E-03	5.01E-03	1.09E-03	4.35E-09	4.24E-09	4.35E-09
Copper (short term)	3.99E-05	8.18E-04	2.33E-04	8.18E-04	8.80E-04	5.59E-10	1.58E-10	5.59E-10
Dibutylftalaat	3.22E-06	1.17E-06	2.93E-07	1.17E-06	4.75E-04	1.40E-08	3.50E-09	1.40E-08
Dichlorvos	5.34E-07	1.84E-05	4.69E-06	1.84E-05	5.25E-05	1.90E-08	4.83E-09	1.90E-08
Diethylhexylphthalate	1.05E-07	3.97E-09	9.96E-10	3.97E-09	6.76E-05	7.54E-10	1.89E-10	7.54E-10
Dioxins	6.10E-06	6.41E-06	1.62E-06	6.41E-06	1.70E-04	2.79E-06	7.00E-07	2.79E-06
Diquat-dibromide	5.66E-05	1.39E-03	4.25E-04	1.39E-03	1.80E-03	6.63E-12	2.02E-12	6.63E-12
Diuron	3.40E-05	8.39E-04	2.36E-04	8.39E-04	1.13E-03	7.36E-10	2.07E-10	7.36E-10
DNOC	1.39E-05	1.79E-04	4.60E-05	1.79E-04	3.67E-04	4.84E-07	1.24E-07	4.84E-07
Fentin-acetate	6.45E-07	1.00E-05	2.56E-06	1.00E-05	2.99E-04	7.83E-09	2.00E-09	7.83E-09
Fluoranthene	5.53E-07	7.77E-08	1.94E-08	7.77E-08	2.30E-04	9.29E-09	2.33E-09	9.29E-09
Hexachlorobenzene	5.56E-05	1.73E-05	5.40E-06	1.73E-05	1.59E-04	1.67E-05	5.21E-06	1.67E-05
Lead (long term)	2.48E-04	3.53E-06	3.53E-03	3.53E-06	6.18E-04	3.73E-13	3.75E-10	3.73E-13
Lead (short term)	2.35E-05	2.07E-07	5.40E-05	2.07E-07	4.98E-04	1.77E-14	4.64E-12	1.77E-14
Lindane (gamma HCH)	4.34E-07	6.45E-07	5.82E-07	6.45E-07	8.11E-05	5.91E-07	5.35E-07	5.91E-07
Malathion	7.19E-06	1.75E-05	4.41E-06	1.75E-05	6.35E-04	7.44E-08	1.87E-08	7.44E-08
Maneb	9.80E-07	3.57E-04	1.02E-04	3.57E-04	6.50E-05	3.27E-06	9.31E-07	3.27E-06
Mecoprop	1.07E-05	8.17E-05	2.07E-05	8.17E-05	3.63E-04	1.76E-09	4.47E-10	1.76E-09
Mercury	6.33E-04	1.22E-03	1.22E-03	1.22E-03	7.62E-04	2.72E-04	2.72E-04	2.72E-04
Mercury (short term)	3.41E-04	7.21E-05	1.91E-05	7.21E-05	5.87E-04	1.35E-05	3.60E-06	1.35E-05
Metabenzthiazuron	1.06E-04	2.86E-03	1.17E-03	2.86E-03	3.60E-03	3.17E-07	1.30E-07	3.17E-07
Metamitron	2.44E-05	2.99E-03	1.23E-03	2.99E-03	8.08E-04	2.98E-10	1.22E-10	2.98E-10
Metribuzin	9.12E-06	1.79E-03	5.87E-04	1.79E-03	3.05E-04	3.14E-09	1.03E-09	3.14E-09
Mevinphos	5.96E-06	2.68E-04	6.96E-05	2.68E-04	2.18E-04	2.69E-09	6.99E-10	2.69E-09
Monolinuron	2.03E-05	5.62E-04	1.70E-04	5.62E-04	1.41E-03	9.90E-07	2.99E-07	9.90E-07
Nickel (long term)	4.95E-04	4.99E-03	4.99E-03	4.99E-03	3.25E-03	4.39E-08	4.44E-08	4.39E-08
Nickel (short term)	1.20E-04	7.92E-04	2.25E-04	7.92E-04	2.63E-03	5.59E-09	1.58E-09	5.59E-09
Parathion	1.26E-07	1.18E-06	2.99E-07	1.18E-06	1.24E-04	4.93E-09	1.24E-09	4.93E-09
Pentachlorophenol	7.48E-05	4.61E-06	1.15E-06	4.61E-06	1.35E-03	2.59E-07	6.48E-08	2.59E-07
Polychlorobiphenyls	7.07E-07	1.10E-06	1.10E-06	1.10E-06	8.67E-05	9.18E-07	9.20E-07	9.18E-07
Simazine	3.69E-05	1.26E-03	3.90E-04	1.26E-03	1.38E-03	3.69E-08	1.13E-08	3.69E-08
Thiram	3.22E-07	7.61E-06	2.19E-06	7.61E-06	7.61E-04	8.24E-08	2.38E-08	8.24E-08
Toluene	5.65E-08	5.73E-08	4.93E-08	5.73E-08	1.60E-05	7.44E-05	5.39E-08	4.66E-08
Trifluralin	2.23E-07	8.25E-08	2.14E-08	8.25E-08	1.66E-04	5.18E-08	1.34E-08	5.18E-08
Zinc (long term)	7.08E-05	5.37E-03	5.37E-03	5.37E-03	7.99E-04	4.43E-09	4.44E-09	4.43E-09
Zinc (short term)	2.79E-05	1.52E-03	4.79E-04	1.52E-03	6.44E-04	1.03E-09	3.16E-10	1.03E-09

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity)

Fate factors	Fate factors for emissions to agricultural soil				Fate factors for emissions to industrial soil			
	F agri. soil, air	Fagri. soil, nat. soil	F agri..soil, agri. soil	F agri..soil, ind. soil	F ind..soil, water	F ind..soil, nat. soil	F ind..soil, agri. soil	F ind..soil, ind. soil
		porewater	porewater	porewater		porewater	porewater	porewater
Substance	m2a/l	m2a/l	m2a/l	m2a/l	m2a/l	m2a/l	m2a/l	m2a/l
1,2,3-trichlorobenzene	3.74E-07	3.43E-07	9.75E-05	3.43E-07	5.96E-07	5.47E-07	3.43E-07	4.20E-04
1,2,4-trichlorobenzene	2.54E-07	1.70E-07	8.02E-05	1.70E-07	5.52E-07	3.68E-07	1.70E-07	4.71E-04
1,3,5-trichlorobenzene	1.33E-06	1.38E-06	4.46E-05	1.38E-06	1.64E-06	1.68E-06	1.38E-06	1.45E-04
2,4-D	9.82E-10	7.84E-09	7.95E-05	7.84E-09	3.89E-09	3.11E-08	7.84E-09	8.47E-04
Arsenic (long term)	5.72E-04	2.85E-06	1.69E-02	2.85E-06	5.72E-04	2.85E-06	2.86E-06	4.56E-02
Arsenic (short term)	1.28E-04	8.67E-09	4.83E-04	8.67E-09	4.86E-05	3.19E-08	8.68E-09	4.81E-03
Atrazine	1.49E-07	3.29E-07	7.03E-04	3.29E-07	5.42E-07	1.20E-06	3.29E-07	6.91E-03
Azinphos-methyl	3.12E-08	1.16E-08	5.63E-04	1.16E-08	1.15E-07	4.28E-08	1.15E-08	5.63E-03
Bentazon	1.91E-07	1.01E-05	7.21E-03	1.01E-05	3.78E-07	1.98E-05	1.01E-05	3.84E-02
Benzene	1.18E-07	1.28E-07	8.59E-05	1.28E-07	1.22E-07	1.33E-07	1.28E-07	2.39E-04
Benzo(a)pyreen	2.84E-08	7.51E-12	6.92E-06	7.51E-12	1.13E-07	3.00E-11	7.50E-12	7.45E-05
Cadmium (long term)	1.52E-04	5.88E-06	2.01E-02	5.88E-06	1.52E-04	5.88E-06	6.12E-06	5.44E-02
Cadmium (short term)	1.38E-05	2.35E-07	2.28E-03	2.35E-07	4.13E-05	7.06E-07	2.37E-07	1.84E-02
Carbendazim	2.15E-06	4.71E-06	9.46E-03	4.71E-06	3.67E-06	8.05E-06	4.71E-06	4.35E-02
Chromium (long term)	5.23E-04	2.79E-07	4.50E-03	2.79E-07	5.23E-04	2.79E-07	2.86E-07	1.21E-02
Chromium (short term)	3.15E-06	6.13E-11	3.36E-05	6.13E-11	1.23E-05	2.41E-10	6.12E-11	3.56E-04
Copper (long term)	1.38E-04	1.48E-06	1.85E-02	1.48E-06	1.33E-04	1.47E-06	1.48E-06	5.01E-02
Copper (short term)	4.98E-06	1.12E-08	8.62E-04	1.12E-08	1.75E-05	3.93E-08	1.08E-08	8.18E-03
Dibutylftalaat	9.26E-09	6.03E-11	9.30E-06	6.03E-11	3.70E-08	2.41E-10	6.05E-11	1.00E-04
Dichlorvos	4.30E-10	9.43E-09	9.67E-05	9.43E-09	1.70E-09	3.71E-08	9.44E-09	1.03E-03
Diethylhexylphthalate	1.83E-09	2.92E-12	7.86E-08	2.92E-12	7.34E-09	1.16E-11	2.92E-12	8.49E-07
Dioxins	7.14E-08	1.11E-08	7.49E-06	1.11E-08	2.83E-07	4.42E-08	1.11E-08	8.03E-05
Diquat-dibromide	1.04E-06	5.23E-11	1.61E-03	5.23E-11	3.39E-06	1.71E-10	5.24E-11	1.39E-02
Diuron	8.00E-08	5.14E-09	8.83E-04	5.14E-09	2.84E-07	1.83E-08	5.14E-09	8.46E-03
DNOC	1.46E-08	1.48E-07	1.79E-04	1.48E-07	5.67E-08	5.77E-07	1.48E-07	1.87E-03
Fentin-acetate	9.30E-09	5.87E-09	1.46E-04	5.87E-09	3.64E-08	2.30E-08	5.88E-09	1.54E-03
Fluoranthene	1.56E-08	2.61E-11	1.29E-05	2.61E-11	6.21E-08	1.04E-10	2.60E-11	1.39E-04
Hexachlorobenzene	4.52E-06	1.38E-06	4.10E-05	1.38E-06	1.45E-05	4.43E-06	1.38E-06	3.56E-04
Lead (long term)	2.36E-04	9.32E-10	1.31E-02	9.32E-10	2.36E-04	9.32E-10	9.57E-07	3.53E-05
Lead (short term)	2.91E-06	8.38E-13	2.00E-04	8.38E-13	1.11E-05	3.26E-12	8.48E-10	2.07E-06
Lindane (gamma HCH)	3.81E-07	5.51E-07	2.70E-04	5.51E-07	4.22E-07	6.12E-07	5.52E-07	8.06E-04
Malathion	4.38E-09	4.46E-09	5.54E-05	4.46E-09	1.74E-08	1.77E-08	4.46E-09	5.94E-04
Maneb	1.04E-08	2.69E-06	7.67E-04	2.69E-06	3.67E-08	9.50E-06	2.69E-06	7.30E-03
Mecoprop	3.30E-09	3.09E-09	7.87E-05	3.09E-09	1.30E-08	1.23E-08	3.11E-09	8.40E-04
Mercury	4.59E-04	5.45E-04	7.59E-03	5.45E-04	4.59E-04	5.45E-04	5.46E-04	1.96E-02
Mercury (short term)	6.11E-06	6.50E-07	1.45E-04	6.50E-07	2.30E-05	2.45E-06	6.50E-07	1.48E-03
Metabenzthiazuron	6.59E-07	3.37E-06	4.52E-03	3.37E-06	1.60E-06	8.21E-06	3.37E-06	2.96E-02
Metamitron	8.10E-08	1.51E-08	4.56E-03	1.51E-08	1.97E-07	3.67E-08	1.51E-08	2.99E-02
Metribuzin	1.91E-08	2.01E-07	2.19E-03	2.01E-07	5.83E-08	6.12E-07	2.00E-07	1.81E-02
Mevinphos	1.96E-09	2.90E-08	2.84E-04	2.90E-08	7.56E-09	1.12E-07	2.89E-08	2.95E-03
Monolinuron	1.69E-07	2.59E-06	1.37E-03	2.59E-06	5.57E-07	8.55E-06	2.58E-06	1.23E-02
Nickel (long term)	4.09E-04	2.79E-06	1.84E-02	2.79E-06	4.09E-04	2.79E-06	2.66E-06	4.99E-02
Nickel (short term)	1.49E-05	1.92E-08	8.32E-04	1.92E-08	5.27E-05	6.79E-08	1.97E-08	7.92E-03
Parathion	3.84E-09	5.32E-10	7.71E-05	5.32E-10	1.52E-08	2.10E-09	5.32E-10	8.22E-04
Pentachlorophenol	4.34E-08	2.06E-10	6.89E-06	2.06E-10	1.74E-07	8.21E-10	2.06E-10	7.42E-05
Polychlorobiphenyls	7.99E-07	1.10E-06	3.89E-05	1.10E-06	7.99E-07	1.10E-06	1.10E-06	1.03E-04
Simazine	9.73E-08	3.76E-07	1.63E-03	3.76E-07	3.17E-07	1.22E-06	3.76E-07	1.43E-02
Thiram	2.29E-08	3.63E-08	9.44E-04	3.63E-08	7.96E-08	1.26E-07	3.64E-08	8.85E-03
Toluene	4.64E-08	4.66E-08	6.08E-05	4.66E-08	5.38E-08	5.39E-08	4.66E-08	1.90E-04
Trifluralin	2.40E-08	8.74E-10	5.17E-05	8.74E-10	9.22E-08	3.35E-09	8.71E-10	5.37E-04
Zinc (long term)	4.83E-05	3.44E-06	1.99E-02	3.44E-06	4.83E-05	3.44E-06	3.45E-06	5.37E-02
Zinc (short term)	3.48E-06	8.94E-08	1.78E-03	8.94E-08	1.09E-05	2.77E-07	8.68E-08	1.51E-02

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity)

Effect analysis	Average NOEC		Hazard units for 1 kg/jr in Europe			
			(mPEC/NEC = dC/A)			
	Aquatic toxicity	Terrestric toxicity	Hazard units for emissions to air			
	coefficient A	coefficient A	HU air, water	HU air, nat. soil	HU air, agri. soil	HU air, ind. soil
Substance	(mg/l)	(mg/l)				
1,2,3-trichlorobenzene	1.04E+00	1.04E+00	1.96E-13	1.82E-13	1.15E-13	1.82E-13
1,2,4-trichlorobenzene	1.24E+00	1.24E+00	2.02E-13	1.37E-13	6.30E-14	1.37E-13
1,3,5-trichlorobenzene	7.93E-01	7.93E-01	6.17E-13	6.36E-13	5.20E-13	6.36E-13
2,4-D	2.57E+00	2.57E+00	3.44E-13	8.89E-12	2.25E-12	8.89E-12
Arsenic (long term)	**4.45E-01**	4.45E-01	3.99E-10	2.84E-09	2.85E-09	2.84E-09
Arsenic (short term)	**4.45E-01**	4.45E-01	6.76E-11	3.00E-10	8.11E-11	3.00E-10
Atrazine	9.33E-02	9.33E-02	1.46E-10	1.26E-09	3.48E-10	1.26E-09
Azinphos-methyl	1.51E-03	1.51E-03	2.68E-09	6.64E-08	1.79E-08	6.64E-08
Bentazon	2.51E+01	2.51E+01	2.64E-13	4.10E-11	2.08E-11	4.10E-11
Benzene	2.86E+00	2.86E+00	1.20E-14	1.30E-14	1.26E-14	1.30E-14
Benzo(a)pyreen	8.05E-03	6.08E-05	4.82E-12	8.69E-10	2.17E-10	8.69E-10
Cadmium (long term)	1.19E-02	3.25E-02	5.66E-09	4.64E-08	4.64E-08	4.64E-08
Cadmium (short term)	1.19E-02	3.25E-02	2.56E-09	1.56E-08	5.24E-09	1.56E-08
Carbendazim	8.51E-02	8.51E-02	7.09E-10	1.31E-08	7.67E-09	1.31E-08
Chromium (long term)	**1.71E-02**	1.71E-02	8.51E-09	1.97E-08	1.96E-08	1.97E-08
Chromium (short term)	**1.71E-02**	1.71E-02	4.13E-10	5.75E-10	1.47E-10	5.75E-10
Copper (long term)	1.33E-02	2.00E-01	3.38E-09	6.92E-09	6.94E-09	6.92E-09
Copper (short term)	1.33E-02	2.00E-01	8.34E-10	1.13E-09	3.22E-10	1.13E-09
Dibutylftalaat	5.21E-01	5.21E-01	1.71E-12	6.23E-13	1.56E-13	6.23E-13
Dichlorvos	5.21E-01	5.21E-01	2.84E-13	9.81E-12	2.50E-12	9.81E-12
Diethylhexylphthalate	1.88E-01	1.88E-01	1.54E-13	5.84E-15	1.46E-15	5.84E-15
Dioxins	2.29E-06	2.29E-06	7.37E-07	7.75E-07	1.96E-07	7.75E-07
Diquat-dibromide	2.69E-02	2.69E-02	5.83E-10	1.43E-08	4.38E-09	1.43E-08
Diuron	8.71E-03	8.71E-03	1.08E-09	2.67E-08	7.50E-09	2.67E-08
DNOC	1.00E+00	1.00E+00	3.85E-12	4.97E-11	1.27E-11	4.97E-11
Fentin-acetate	6.76E-04	6.76E-04	2.64E-10	4.11E-09	1.05E-09	4.11E-09
Fluoranthene	1.03E-01	1.03E-01	1.49E-12	2.09E-13	5.22E-14	2.09E-13
Hexachlorobenzene	2.32E-02	2.32E-02	6.64E-10	2.06E-10	6.44E-11	2.06E-10
Lead (long term)	1.49E-01	2.23E-02	4.61E-10	4.39E-11	4.39E-08	4.39E-11
Lead (short term)	1.49E-01	2.23E-02	4.38E-11	2.57E-12	6.72E-10	2.57E-12
Lindane (gamma HCH)	1.70E-02	1.70E-02	7.07E-12	1.05E-11	9.48E-12	1.05E-11
Malathion	6.90E-03	6.90E-03	2.89E-10	7.02E-10	1.77E-10	7.02E-10
Maneb	4.27E-01	4.27E-01	6.36E-13	2.32E-10	6.59E-11	2.32E-10
Mecoprop	4.79E+01	4.79E+01	6.16E-14	4.72E-13	1.20E-13	4.72E-13
Mercury (long term)	**8.61E-02**	8.61E-02	2.04E-09	3.94E-09	3.94E-09	3.94E-09
Mercury (short term)	**8.61E-02**	8.61E-02	1.10E-09	2.32E-10	6.16E-11	2.32E-10
Metabenzthiazuron	4.47E-01	4.47E-01	6.54E-11	1.77E-09	7.27E-10	1.77E-09
Metamitron	3.80E+00	3.80E+00	1.78E-12	2.18E-10	8.99E-11	2.18E-10
Metribuzin	1.70E-01	1.70E-01	1.49E-11	2.92E-09	9.56E-10	2.92E-09
Mevinphos	5.75E-03	5.75E-03	2.87E-10	1.29E-08	3.35E-09	1.29E-08
Monolinuron	2.45E-01	2.45E-01	2.30E-11	6.36E-10	1.92E-10	6.36E-10
Nickel (long term)	**4.04E-02**	4.04E-02	3.39E-09	3.42E-08	3.42E-08	3.42E-08
Nickel (short term)	**4.04E-02**	4.04E-02	8.24E-10	5.43E-09	1.54E-09	5.43E-09
Parathion	8.91E-04	8.91E-04	3.92E-11	3.67E-10	9.29E-11	3.67E-10
Pentachlorophenol	9.82E-02	1.75E-02	2.11E-10	7.29E-11	1.82E-11	7.29E-11
Polychlorobiphenyls	8.00E-04	8.00E-04	2.45E-10	3.82E-10	3.82E-10	3.82E-10
Simazine	4.07E-02	4.07E-02	2.51E-10	8.61E-09	2.65E-09	8.61E-09
Thiram	1.55E-03	1.55E-03	5.75E-11	1.36E-09	3.91E-10	1.36E-09
Toluene	2.03E+00	1.66E+01	7.73E-15	9.56E-16	8.23E-16	9.56E-16
Trifluralin	3.80E-03	3.80E-03	1.62E-11	6.01E-12	1.56E-12	6.01E-12
Zinc (long term)	8.69E-02	1.07E-01	2.26E-10	1.39E-08	1.39E-08	1.39E-08
Zinc (short term)	8.69E-02	1.07E-01	8.89E-11	3.94E-09	1.25E-09	3.94E-09

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity)

Effect analysis	Average NOEC		Hazard units for 1 kg/jr in Europe			
			(mPEC/NEC = dC/A)			
	Aquatic toxicity	Terrestric toxicity	Hazard units for emissions to water			
	coefficient A	coefficient A	HU water, water	HU water, nat. soil	HU water, agri. soil	HU water, ind. soil
Substance	(mg/l)	(mg/l)				
1,2,3-trichlorobenzene	1.04E+00	1.04E+00	1.97E-11	1.61E-13	1.01E-13	1.61E-13
1,2,4-trichlorobenzene	1.24E+00	1.24E+00	1.82E-11	1.27E-13	5.86E-14	1.27E-13
1,3,5-trichlorobenzene	7.93E-01	7.93E-01	2.52E-11	5.70E-13	4.65E-13	5.70E-13
2,4-D	2.57E+00	2.57E+00	1.18E-11	1.72E-16	4.36E-17	1.72E-16
Arsenic (long term)	**4.45E-01**	4.45E-01	1.78E-09	2.70E-14	2.64E-14	2.70E-14
Arsenic (short term)	**4.45E-01**	4.45E-01	1.43E-09	2.27E-15	6.14E-16	2.27E-15
Atrazine	9.33E-02	9.33E-02	7.88E-09	5.34E-13	1.47E-13	5.34E-13
Azinphos-methyl	1.51E-03	1.51E-03	1.38E-07	3.20E-13	8.65E-14	3.20E-13
Bentazon	2.51E+01	2.51E+01	9.02E-12	1.52E-15	7.71E-16	1.52E-15
Benzene	2.86E+00	2.86E+00	7.11E-12	1.20E-14	1.17E-14	1.20E-14
Benzo(a)pyreen	8.05E-03	6.08E-05	5.67E-09	3.05E-12	7.64E-13	3.05E-12
Cadmium (long term)	1.19E-02	3.25E-02	7.49E-08	7.52E-13	7.48E-13	7.52E-13
Cadmium (short term)	1.19E-02	3.25E-02	6.05E-08	2.06E-13	6.81E-14	2.06E-13
Carbendazim	8.51E-02	8.51E-02	2.53E-08	1.44E-12	8.44E-13	1.44E-12
Chromium (long term)	**1.71E-02**	1.71E-02	1.07E-08	1.04E-14	1.04E-14	1.04E-14
Chromium (short term)	**1.71E-02**	1.71E-02	8.64E-09	2.51E-16	6.22E-17	2.51E-16
Copper (long term)	1.33E-02	2.00E-01	2.29E-08	6.01E-15	5.86E-15	6.01E-15
Copper (short term)	1.33E-02	2.00E-01	1.84E-08	7.73E-16	2.18E-16	7.73E-16
Dibutylftalaat	5.21E-01	5.21E-01	2.53E-10	7.44E-15	1.86E-15	7.44E-15
Dichlorvos	5.21E-01	5.21E-01	2.79E-11	1.01E-14	2.57E-15	1.01E-14
Diethylhexylphthalate	1.88E-01	1.88E-01	9.93E-11	1.11E-15	2.78E-16	1.11E-15
Dioxins	2.29E-06	2.29E-06	2.05E-05	3.37E-07	8.47E-08	3.37E-07
Diquat-dibromide	2.69E-02	2.69E-02	1.85E-08	6.83E-17	2.08E-17	6.83E-17
Diuron	8.71E-03	8.71E-03	3.61E-08	2.34E-14	6.59E-15	2.34E-14
DNOC	1.00E+00	1.00E+00	1.02E-10	1.34E-13	3.44E-14	1.34E-13
Fentin-acetate	6.76E-04	6.76E-04	1.22E-07	3.21E-12	8.20E-13	3.21E-12
Fluoranthene	1.03E-01	1.03E-01	6.17E-10	2.50E-14	6.25E-15	2.50E-14
Hexachlorobenzene	2.32E-02	2.32E-02	1.90E-09	1.99E-10	6.22E-11	1.99E-10
Lead (long term)	1.49E-01	2.23E-02	1.15E-09	4.63E-18	4.66E-15	4.63E-18
Lead (short term)	1.49E-01	2.23E-02	9.28E-10	2.20E-19	5.76E-17	2.20E-19
Lindane (gamma HCH)	1.70E-02	1.70E-02	1.32E-09	9.64E-12	8.71E-12	9.64E-12
Malathion	6.90E-03	6.90E-03	2.55E-08	2.99E-12	7.52E-13	2.99E-12
Maneb	4.27E-01	4.27E-01	4.22E-11	2.12E-12	6.04E-13	2.12E-12
Mecoprop	4.79E+01	4.79E+01	2.10E-12	1.02E-17	2.58E-18	1.02E-17
Mercury (long term)	**8.61E-02**	8.61E-02	2.45E-09	8.77E-10	8.76E-10	8.77E-10
Mercury (short term)	**8.61E-02**	8.61E-02	1.89E-09	4.36E-11	1.16E-11	4.36E-11
Metabenzthiazuron	4.47E-01	4.47E-01	2.23E-09	1.96E-13	8.07E-14	1.96E-13
Metamitron	3.80E+00	3.80E+00	5.89E-11	2.17E-17	8.92E-18	2.17E-17
Metribuzin	1.70E-01	1.70E-01	4.97E-10	5.12E-15	1.67E-15	5.12E-15
Mevinphos	5.75E-03	5.75E-03	1.05E-08	1.30E-13	3.37E-14	1.30E-13
Monolinuron	2.45E-01	2.45E-01	1.59E-09	1.12E-12	3.38E-13	1.12E-12
Nickel (long term)	**4.04E-02**	4.04E-02	2.23E-08	3.01E-13	3.04E-13	3.01E-13
Nickel (short term)	**4.04E-02**	4.04E-02	1.80E-08	3.83E-14	1.08E-14	3.83E-14
Parathion	8.91E-04	8.91E-04	3.86E-08	1.53E-12	3.86E-13	1.53E-12
Pentachlorophenol	9.82E-02	1.75E-02	3.81E-09	4.09E-12	1.02E-12	4.09E-12
Polychlorobiphenyls	8.00E-04	8.00E-04	3.00E-08	3.18E-10	3.19E-10	3.18E-10
Simazine	4.07E-02	4.07E-02	9.40E-09	2.51E-13	7.72E-14	2.51E-13
Thiram	1.55E-03	1.55E-03	1.36E-07	1.47E-11	4.25E-12	1.47E-11
Toluene	2.03E+00	1.66E+01	2.18E-12	1.24E-12	8.99E-16	7.77E-16
Trifluralin	3.80E-03	3.80E-03	1.21E-08	3.78E-12	9.78E-13	3.78E-12
Zinc (long term)	8.69E-02	1.07E-01	2.55E-09	1.15E-14	1.15E-14	1.15E-14
Zinc (short term)	8.69E-02	1.07E-01	2.05E-09	2.67E-15	8.20E-16	2.67E-15

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity)

Effect analysis	Average NOEC		Hazard units for 1 kg/jr in Europe			
			(mPEC/NEC = dC/A)			
	Aquatic toxicity	Terrestric toxicity	Hazard units for emissions to agricultural soil			
	coefficient A	coefficient A	HU agri. soil, water	HU agri. soil, nat. soil	HU agri. soil, agri. Soil*	HU agri. soil, ind. soil
Substance	(mg/l)	(mg/l)				
1,2,3-trichlorobenzene	1.04E+00	1.04E+00	9.94E-14	9.12E-14	0	9.12E-14
1,2,4-trichlorobenzene	1.24E+00	1.24E+00	5.68E-14	3.79E-14	0	3.79E-14
1,3,5-trichlorobenzene	7.93E-01	7.93E-01	4.65E-13	4.81E-13	0	4.81E-13
2,4-D	2.57E+00	2.57E+00	1.06E-16	8.45E-16	0	8.45E-16
Arsenic (long term)	**4.45E-01**	4.45E-01	3.56E-10	1.78E-12	0	1.78E-12
Arsenic (short term)	**4.45E-01**	4.45E-01	7.99E-11	5.40E-15	0	5.40E-15
Atrazine	9.33E-02	9.33E-02	4.42E-13	9.78E-13	0	9.78E-13
Azinphos-methyl	1.51E-03	1.51E-03	5.72E-12	2.13E-12	0	2.13E-12
Bentazon	2.51E+01	2.51E+01	2.11E-15	1.11E-13	0	1.11E-13
Benzene	2.86E+00	2.86E+00	1.15E-14	1.24E-14	0	1.24E-14
Benzo(a)pyreen	8.05E-03	6.08E-05	9.77E-13	3.42E-14	0	3.42E-14
Cadmium (long term)	1.19E-02	3.25E-02	3.53E-09	5.01E-11	0	5.01E-11
Cadmium (short term)	1.19E-02	3.25E-02	3.21E-10	2.01E-12	0	2.01E-12
Carbendazim	8.51E-02	8.51E-02	7.00E-12	1.53E-11	0	1.53E-11
Chromium (long term)	**1.71E-02**	1.71E-02	8.45E-09	4.52E-12	0	4.52E-12
Chromium (short term)	**1.71E-02**	1.71E-02	5.08E-11	9.91E-16	0	9.91E-16
Copper (long term)	1.33E-02	2.00E-01	2.88E-09	2.05E-12	0	2.05E-12
Copper (short term)	1.33E-02	2.00E-01	1.04E-10	1.55E-14	0	1.55E-14
Dibutylftalaat	5.21E-01	5.21E-01	4.93E-15	3.21E-17	0	3.21E-17
Dichlorvos	5.21E-01	5.21E-01	2.29E-16	5.02E-15	0	5.02E-15
Diethylhexylphthalate	1.88E-01	1.88E-01	2.70E-15	4.30E-18	0	4.30E-18
Dioxins	2.29E-06	2.29E-06	8.64E-09	1.34E-09	0	1.34E-09
Diquat-dibromide	2.69E-02	2.69E-02	1.07E-11	5.38E-16	0	5.38E-16
Diuron	8.71E-03	8.71E-03	2.54E-12	1.63E-13	0	1.63E-13
DNOC	1.00E+00	1.00E+00	4.04E-15	4.11E-14	0	4.11E-14
Fentin-acetate	6.76E-04	6.76E-04	3.81E-12	2.41E-12	0	2.41E-12
Fluoranthene	1.03E-01	1.03E-01	4.19E-14	7.01E-17	0	7.01E-17
Hexachlorobenzene	2.32E-02	2.32E-02	5.40E-11	1.65E-11	0	1.65E-11
Lead (long term)	1.49E-01	2.23E-02	4.39E-10	1.16E-14	0	1.16E-14
Lead (short term)	1.49E-01	2.23E-02	5.42E-12	1.04E-17	0	1.04E-17
Lindane (gamma HCH)	1.70E-02	1.70E-02	6.20E-12	8.98E-12	0	8.98E-12
Malathion	6.90E-03	6.90E-03	1.76E-13	1.79E-13	0	1.79E-13
Maneb	4.27E-01	4.27E-01	6.72E-15	1.74E-12	0	1.74E-12
Mecoprop	4.79E+01	4.79E+01	1.91E-17	1.79E-17	0	1.79E-17
Mercury (long term)	**8.61E-02**	8.61E-02	1.48E-09	1.76E-09	0	1.76E-09
Mercury (short term)	**8.61E-02**	8.61E-02	1.97E-11	2.09E-12	0	2.09E-12
Metabenzthiazuron	4.47E-01	4.47E-01	4.08E-13	2.09E-12	0	2.09E-12
Metamitron	3.80E+00	3.80E+00	5.90E-15	1.10E-15	0	1.10E-15
Metribuzin	1.70E-01	1.70E-01	3.12E-14	3.27E-13	0	3.27E-13
Mevinphos	5.75E-03	5.75E-03	9.46E-14	1.40E-12	0	1.40E-12
Monolinuron	2.45E-01	2.45E-01	1.91E-13	2.92E-12	0	2.92E-12
Nickel (long term)	**4.04E-02**	4.04E-02	2.80E-09	1.91E-11	0	1.91E-11
Nickel (short term)	**4.04E-02**	4.04E-02	1.02E-10	1.31E-13	0	1.31E-13
Parathion	8.91E-04	8.91E-04	1.19E-12	1.65E-13	0	1.65E-13
Pentachlorophenol	9.82E-02	1.75E-02	1.22E-13	3.25E-15	0	3.25E-15
Polychlorobiphenyls	8.00E-04	8.00E-04	2.77E-10	3.80E-10	0	3.80E-10
Simazine	4.07E-02	4.07E-02	6.63E-13	2.56E-12	0	2.56E-12
Thiram	1.55E-03	1.55E-03	4.09E-12	6.49E-12	0	6.49E-12
Toluene	2.03E+00	1.66E+01	6.34E-15	7.77E-16	0	7.77E-16
Trifluralin	3.80E-03	3.80E-03	1.75E-12	6.37E-14	0	6.37E-14
Zinc (long term)	8.69E-02	1.07E-01	1.54E-10	8.95E-12	0	8.95E-12
Zinc (short term)	8.69E-02	1.07E-01	1.11E-11	2.32E-13	0	2.32E-13

*) Already included in Land-use

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity)

Effect analysis	Average NOEC		Hazard units for 1 kg/jr in Europe			
			(mPEC/NEC = dC/A)			
	Aquatic toxicity	Terrestric toxicity	Hazard units for emissions to industrial soil			
	coefficient A	coefficient A	HU is, water	HU is, nat soil	HU is, agri soil	HU is, ind soil
Substance	(mg/l)	(mg/l)				
1,2,3-trichlorobenzene	1.04E+00	1.04E+00	1.58E-13	1.45E-13	9.12E-14	1.12E-10
1,2,4-trichlorobenzene	1.24E+00	1.24E+00	1.23E-13	8.21E-14	3.79E-14	1.05E-10
1,3,5-trichlorobenzene	7.93E-01	7.93E-01	5.72E-13	5.88E-13	4.82E-13	5.08E-11
2,4-D	2.57E+00	2.57E+00	4.19E-16	3.35E-15	8.45E-16	9.13E-11
Arsenic (long term)	**4.45E-01**	4.45E-01	3.56E-10	1.78E-12	1.78E-12	2.84E-08
Arsenic (short term)	**4.45E-01**	4.45E-01	3.03E-11	1.99E-14	5.41E-15	3.00E-09
Atrazine	9.33E-02	9.33E-02	1.61E-12	3.55E-12	9.78E-13	2.05E-08
Azinphos-methyl	1.51E-03	1.51E-03	2.12E-11	7.85E-12	2.12E-12	1.03E-06
Bentazon	2.51E+01	2.51E+01	4.17E-15	2.19E-13	1.11E-13	4.23E-10
Benzene	2.86E+00	2.86E+00	1.19E-14	1.29E-14	1.24E-14	2.32E-11
Benzo(a)pyreen	8.05E-03	6.08E-05	3.90E-12	1.37E-13	3.42E-14	3.40E-07
Cadmium (long term)	1.19E-02	3.25E-02	3.53E-09	5.01E-11	5.21E-11	4.64E-07
Cadmium (short term)	1.19E-02	3.25E-02	9.60E-10	6.02E-12	2.02E-12	1.56E-07
Carbendazim	8.51E-02	8.51E-02	1.19E-11	2.62E-11	1.53E-11	1.42E-07
Chromium (long term)	**1.71E-02**	1.71E-02	8.45E-09	4.52E-12	4.62E-12	1.96E-07
Chromium (short term)	**1.71E-02**	1.71E-02	1.99E-10	3.89E-15	9.88E-16	5.75E-09
Copper (long term)	1.33E-02	2.00E-01	2.78E-09	2.03E-12	2.04E-12	6.92E-08
Copper (short term)	1.33E-02	2.00E-01	3.65E-10	5.44E-14	1.50E-14	1.13E-08
Dibutylftalaat	5.21E-01	5.21E-01	1.97E-14	1.28E-16	3.22E-17	5.35E-11
Dichlorvos	5.21E-01	5.21E-01	9.03E-16	1.97E-14	5.02E-15	5.46E-10
Diethylhexylphthalate	1.88E-01	1.88E-01	1.08E-14	1.71E-17	4.29E-18	1.25E-12
Dioxins	2.29E-06	2.29E-06	3.42E-08	5.35E-09	1.35E-09	9.72E-06
Diquat-dibromide	2.69E-02	2.69E-02	3.49E-11	1.76E-15	5.39E-16	1.43E-07
Diuron	8.71E-03	8.71E-03	9.03E-12	5.81E-13	1.63E-13	2.69E-07
DNOC	1.00E+00	1.00E+00	1.57E-14	1.60E-13	4.10E-14	5.18E-10
Fentin-acetate	6.76E-04	6.76E-04	1.49E-11	9.42E-12	2.41E-12	6.30E-07
Fluoranthene	1.03E-01	1.03E-01	1.67E-13	2.79E-16	7.00E-17	3.74E-10
Hexachlorobenzene	2.32E-02	2.32E-02	1.73E-10	5.30E-11	1.65E-11	4.25E-09
Lead (long term)	1.49E-01	2.23E-02	4.39E-10	1.16E-14	1.19E-11	4.39E-10
Lead (short term)	1.49E-01	2.23E-02	2.08E-11	4.05E-17	1.05E-14	2.57E-11
Lindane (gamma HCH)	1.70E-02	1.70E-02	6.88E-12	9.96E-12	9.00E-12	1.31E-08
Malathion	6.90E-03	6.90E-03	6.97E-13	7.10E-13	1.79E-13	2.38E-08
Maneb	4.27E-01	4.27E-01	2.38E-14	6.16E-12	1.75E-12	4.74E-09
Mecoprop	4.79E+01	4.79E+01	7.53E-17	7.09E-17	1.80E-17	4.86E-12
Mercury (long term)	**8.61E-02**	8.61E-02	1.48E-09	1.76E-09	1.76E-09	6.30E-08
Mercury (short term)	**8.61E-02**	8.61E-02	7.40E-11	7.88E-12	2.09E-12	4.75E-09
Metabenzthiazuron	4.47E-01	4.47E-01	9.90E-13	5.09E-12	2.09E-12	1.84E-08
Metamitron	3.80E+00	3.80E+00	1.44E-14	2.68E-15	1.10E-15	2.18E-09
Metribuzin	1.70E-01	1.70E-01	9.50E-14	9.96E-13	3.26E-13	2.95E-08
Mevinphos	5.75E-03	5.75E-03	3.64E-13	5.38E-12	1.39E-12	1.42E-07
Monolinuron	2.45E-01	2.45E-01	6.30E-13	9.67E-12	2.92E-12	1.39E-08
Nickel (long term)	**4.04E-02**	4.04E-02	2.80E-09	1.91E-11	1.82E-11	3.42E-07
Nickel (short term)	**4.04E-02**	4.04E-02	3.61E-10	4.65E-13	1.35E-13	5.43E-08
Parathion	8.91E-04	8.91E-04	4.72E-12	6.53E-13	1.65E-13	2.56E-07
Pentachlorophenol	9.82E-02	1.75E-02	4.90E-13	1.30E-14	3.26E-15	1.17E-09
Polychlorobiphenyls	8.00E-04	8.00E-04	2.77E-10	3.80E-10	3.82E-10	3.57E-08
Simazine	4.07E-02	4.07E-02	2.15E-12	8.32E-12	2.56E-12	9.75E-08
Thiram	1.55E-03	1.55E-03	1.42E-11	2.25E-11	6.50E-12	1.58E-06
Toluene	2.03E+00	1.66E+01	7.35E-15	8.99E-16	7.77E-16	3.17E-12
Trifluralin	3.80E-03	3.80E-03	6.72E-12	2.44E-13	6.35E-14	3.91E-08
Zinc (long term)	8.69E-02	1.07E-01	1.54E-10	8.95E-12	8.97E-12	1.39E-07
Zinc (short term)	8.69E-02	1.07E-01	3.49E-11	7.20E-13	2.26E-13	3.93E-08

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity)

Damage analysis: Egalitarian PAFm2yr per kg					
	Marginal damage	PAFm2yr per kg emitted in Europe			
	dPAF/dHU	Emissions to			
Substance		Air	Water	Agricultural soil	Industrial soil
1,2,3-trichlorobenzene	0.59	3.51E-01	1.56E+00	1.43E-01	2.41E+01
1,2,4-trichlorobenzene	0.59	2.54E-01	1.39E+00	6.03E-02	2.26E+01
1,3,5-trichlorobenzene	0.59	1.29E+00	2.73E+00	7.49E-01	1.19E+01
2,4-D	0.59	1.46E+01	7.56E-01	1.27E-03	1.95E+01
Arsenic (long term)	0.59	5.92E+03	1.14E+02	2.55E+01	6.10E+03
Arsenic (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Atrazine	0.59	2.09E+03	5.06E+02	1.49E+00	4.39E+03
Azinphos-methyl	0.59	1.10E+05	8.87E+03	3.55E+00	2.21E+05
Bentazon	0.59	7.33E+01	5.81E-01	1.66E-01	9.08E+01
Benzene	0.59	2.75E-02	4.80E-01	1.93E-02	4.97E+00
Benzo(a)pyreen	0.59	1.42E+03	3.68E+02	1.14E-01	7.25E+04
Cadmium (long term)	0.59	9.65E+04	4.80E+03	3.01E+02	9.94E+04
Cadmium (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbendazim	0.59	2.40E+04	1.63E+03	2.34E+01	3.03E+04
Chromium (long term)	0.59	4.13E+04	6.87E+02	5.48E+02	4.24E+04
Chromium (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper (long term)	0.59	1.46E+04	1.47E+03	1.88E+02	1.50E+04
Copper (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibutylftalaat	0.59	1.13E+00	1.62E+01	3.64E-04	1.14E+01
Dichlorvos	0.59	1.61E+01	1.81E+00	7.52E-03	1.17E+02
Diethylhexylphthalate	0.59	1.94E-02	6.37E+00	1.79E-04	2.67E-01
Dioxins	0.59	1.32E+06	1.87E+06	2.56E+03	2.09E+06
Diquat-dibromide	0.59	2.39E+04	1.18E+03	6.84E-01	3.05E+04
Diuron	0.59	4.43E+04	2.31E+03	4.07E-01	5.75E+04
DNOC	0.59	8.19E+01	6.73E+00	6.17E-02	1.11E+02
Fentin-acetate	0.59	6.77E+03	7.85E+03	3.84E+00	1.35E+05
Fluoranthene	0.59	4.37E-01	3.96E+01	2.79E-03	8.00E+01
Hexachlorobenzene	0.59	3.88E+02	4.55E+02	2.82E+01	9.96E+02
Lead (long term)	0.59	2.54E+04	7.39E+01	2.82E+01	1.29E+02
Lead (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lindane (gamma HCH)	0.59	2.16E+01	1.04E+02	1.38E+01	2.83E+03
Malathion	0.59	1.17E+03	1.64E+03	2.79E-01	5.09E+03
Maneb	0.59	3.84E+02	6.23E+00	2.61E+00	1.02E+03
Mecoprop	0.59	7.79E-01	1.35E-01	2.79E-05	1.04E+00
Mercury (long term)	0.59	8.29E+03	1.97E+03	2.72E+03	1.68E+04
Mercury (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Metabenzthiazuron	0.59	3.07E+03	1.43E+02	3.15E+00	3.93E+03
Metamitron	0.59	3.78E+02	3.77E+00	2.03E-03	4.66E+02
Metribuzin	0.59	4.92E+03	3.18E+01	4.91E-01	6.29E+03
Mevinphos	0.59	2.13E+04	6.73E+02	2.09E+00	3.03E+04
Monolinuron	0.59	1.06E+03	1.04E+02	4.38E+00	2.97E+03
Nickel (long term)	0.59	7.10E+04	1.43E+03	2.08E+02	7.32E+04
Nickel (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Parathion	0.59	6.05E+02	2.48E+03	3.24E-01	5.46E+04
Pentachlorophenol	0.59	1.33E+02	2.51E+02	1.27E-02	2.51E+02
Polychlorobiphenyls	0.59	8.07E+02	2.58E+03	5.86E+02	8.35E+03
Simazine	0.59	1.44E+04	6.03E+02	3.87E+00	2.08E+04
Thiram	0.59	2.26E+03	8.74E+03	9.96E+00	3.38E+05
Toluene	0.59	2.40E-03	1.73E+00	1.57E-03	6.79E-01
Trifluralin	0.59	1.09E+01	7.80E+02	2.07E-01	8.36E+03
Zinc (long term)	0.59	2.89E+04	1.63E+02	2.32E+01	2.98E+04
Zinc (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity)

Damage analysis: Hierarchist PAFm2yr per kg					
	Marginal damage	PAFm2yr per kg emitted in Europe			
	dPAF/dHU	Emissions to			
Substance		Air	Water	Agricultural soil	Industrial soil
1,2,3-trichlorobenzene	0.59	3.51E-01	1.56E+00	1.43E-01	2.41E+01
1,2,4-trichlorobenzene	0.59	2.54E-01	1.39E+00	6.03E-02	2.26E+01
1,3,5-trichlorobenzene	0.59	1.29E+00	2.73E+00	7.49E-01	1.19E+01
2,4-D	0.59	1.46E+01	7.56E-01	1.27E-03	1.95E+01
Arsenic (long term)	0.59	5.92E+03	1.14E+02	2.55E+01	6.10E+03
Arsenic (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Atrazine	0.59	2.09E+03	5.06E+02	1.49E+00	4.39E+03
Azinphos-methyl	0.59	1.10E+05	8.87E+03	3.55E+00	2.21E+05
Bentazon	0.59	7.33E+01	5.81E-01	1.66E-01	9.08E+01
Benzene	0.59	2.75E-02	4.80E-01	1.93E-02	4.97E+00
Benzo(a)pyreen	0.59	1.42E+03	3.68E+02	1.14E-01	7.25E+04
Cadmium (long term)	0.59	9.65E+04	4.80E+03	3.01E+02	9.94E+04
Cadmium (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbendazim	0.59	2.40E+04	1.63E+03	2.34E+01	3.03E+04
Chromium (long term)	0.59	4.13E+04	6.87E+02	5.48E+02	4.24E+04
Chromium (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper (long term)	0.59	1.46E+04	1.47E+03	1.88E+02	1.50E+04
Copper (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibutylftalaat	0.59	1.13E+00	1.62E+01	3.64E-04	1.14E+01
Dichlorvos	0.59	1.61E+01	1.81E+00	7.52E-03	1.17E+02
Diethylhexylphthalate	0.59	1.94E-02	6.37E+00	1.79E-04	2.67E-01
Dioxins	0.59	1.32E+06	1.87E+06	2.56E+03	2.09E+06
Diquat-dibromide	0.59	2.39E+04	1.18E+03	6.84E-01	3.05E+04
Diuron	0.59	4.43E+04	2.31E+03	4.07E-01	5.75E+04
DNOC	0.59	8.19E+01	6.73E+00	6.17E-02	1.11E+02
Fentin-acetate	0.59	6.77E+03	7.85E+03	3.84E+00	1.35E+05
Fluoranthene	0.59	4.37E-01	3.96E+01	2.79E-03	8.00E+01
Hexachlorobenzene	0.59	3.88E+02	4.55E+02	2.82E+01	9.96E+02
Lead (long term)	0.59	2.54E+04	7.39E+01	2.82E+01	1.29E+02
Lead (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lindane (gamma HCH)	0.59	2.16E+01	1.04E+02	1.38E+01	2.83E+03
Malathion	0.59	1.17E+03	1.64E+03	2.79E-01	5.09E+03
Maneb	0.59	3.84E+02	6.23E+00	2.61E+00	1.02E+03
Mecoprop	0.59	7.79E-01	1.35E-01	2.79E-05	1.04E+00
Mercury (long term)	0.59	8.29E+03	1.97E+03	2.72E+03	1.68E+04
Mercury (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Metabenzthiazuron	0.59	3.07E+03	1.43E+02	3.15E+00	3.93E+03
Metamitron	0.59	3.78E+02	3.77E+00	2.03E-03	4.66E+02
Metribuzin	0.59	4.92E+03	3.18E+01	4.91E-01	6.29E+03
Mevinphos	0.59	2.13E+04	6.73E+02	2.09E+00	3.03E+04
Monolinuron	0.59	1.06E+03	1.04E+02	4.38E+00	2.97E+03
Nickel (long term)	0.59	7.10E+04	1.43E+03	2.08E+02	7.32E+04
Nickel (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Parathion	0.59	6.05E+02	2.48E+03	3.24E-01	5.46E+04
Pentachlorophenol	0.59	1.33E+02	2.51E+02	1.27E-02	2.51E+02
Polychlorobiphenyls	0.59	8.07E+02	2.58E+03	5.86E+02	8.35E+03
Simazine	0.59	1.44E+04	6.03E+02	3.87E+00	2.08E+04
Thiram	0.59	2.26E+03	8.74E+03	9.96E+00	3.38E+05
Toluene	0.59	2.40E-03	1.73E+00	1.57E-03	6.79E-01
Trifluralin	0.59	1.09E+01	7.80E+02	2.07E-01	8.36E+03
Zinc (long term)	0.59	2.89E+04	1.63E+02	2.32E+01	2.98E+04
Zinc (short term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity)

Damage analysis: Individualist PAFm2yr per kg					
	Marginal damage	PAFm2yr per kg emitted in Europe			
	dPAF/dHU	Emissions to			
Substance		Air	Water	Agricultural soil	Industrial soil
1,2,3-trichlorobenzene	0.59	3.51E-07	1.56E+00	1.43E-01	2.41E+01
1,2,4-trichlorobenzene	0.59	2.54E-01	1.39E+00	6.03E-02	2.26E+01
1,3,5-trichlorobenzene	0.59	1.29E+00	2.73E+00	7.49E-01	1.19E+01
2,4-D	0.59	1.46E+01	7.56E-01	1.27E-03	1.95E+01
Arsenic (long term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic (short term)	0.59	5.00E+02	9.14E+01	5.13E+00	6.43E+02
Atrazine	0.59	2.09E+03	5.06E+02	1.49E+00	4.39E+03
Azinphos-methyl	0.59	1.10E+05	8.87E+03	3.55E+00	2.21E+05
Bentazon	0.59	7.33E+01	5.81E-01	1.66E-01	9.08E+01
Benzene	0.59	2.75E-02	4.80E-01	1.93E-02	4.97E+00
Benzo(a)pyreen	0.59	1.42E+03	3.68E+02	1.14E-01	7.25E+04
Cadmium (long term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium (short term)	0.59	2.66E+04	3.87E+03	2.35E+01	3.35E+04
Carbendazim	0.59	2.40E+04	1.63E+03	2.34E+01	3.03E+04
Chromium (long term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium (short term)	0.59	9.70E+02	5.54E+02	3.26E+00	1.24E+03
Copper (long term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper (short term)	0.59	1.93E+03	1.18E+03	6.69E+00	2.44E+03
Dibutylftalaat	0.59	1.13E+00	1.62E+01	3.64E-04	1.14E+01
Dichlorvos	0.59	1.61E+01	1.81E+00	7.52E-03	1.17E+02
Diethylhexylphthalate	0.59	1.94E-02	6.37E+00	1.79E-04	2.67E-01
Dioxins	0.59	1.32E+06	1.87E+06	2.56E+03	2.09E+06
Diquat-dibromide	0.59	2.39E+04	1.18E+03	6.84E-01	3.05E+04
Diuron	0.59	4.43E+04	2.31E+03	4.07E-01	5.75E+04
DNOC	0.59	8.19E+01	6.73E+00	6.17E-02	1.11E+02
Fentin-acetate	0.59	6.77E+03	7.85E+03	3.84E+00	1.35E+05
Fluoranthene	0.59	4.37E-01	3.96E+01	2.79E-03	8.00E+01
Hexachlorobenzene	0.59	3.88E+02	4.55E+02	2.82E+01	9.96E+02
Lead (long term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead (short term)	0.59	3.94E+02	5.95E+01	3.48E-01	6.83E+00
Lindane (gamma HCH)	0.59	2.16E+01	1.04E+02	1.38E+01	2.83E+03
Malathion	0.59	1.17E+03	1.64E+03	2.79E-01	5.09E+03
Maneb	0.59	3.84E+02	6.23E+00	2.61E+00	1.02E+03
Mecoprop	0.59	7.79E-01	1.35E-01	2.79E-05	1.04E+00
Mercury (long term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury (short term)	0.59	4.53E+02	1.93E+02	4.39E+00	1.03E+03
Metabenzthiazuron	0.59	3.07E+03	1.43E+02	3.15E+00	3.93E+03
Metamitron	0.59	3.78E+02	3.77E+00	2.03E-03	4.66E+02
Metribuzin	0.59	4.92E+03	3.18E+01	4.91E-01	6.29E+03
Mevinphos	0.59	2.13E+04	6.73E+02	2.09E+00	3.03E+04
Monolinuron	0.59	1.06E+03	1.04E+02	4.38E+00	2.97E+03
Nickel (long term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (short term)	0.59	9.06E+03	1.16E+03	6.73E+00	1.16E+04
Parathion	0.59	6.05E+02	2.48E+03	3.24E-01	5.46E+04
Pentachlorophenol	0.59	1.33E+02	2.51E+02	1.27E-02	2.51E+02
Polychlorobiphenyls	0.59	8.07E+02	2.58E+03	5.86E+02	8.35E+03
Simazine	0.59	1.44E+04	6.03E+02	3.87E+00	2.08E+04
Thiram	0.59	2.26E+03	8.74E+03	9.96E+00	3.38E+05
Toluene	0.59	2.40E-03	1.73E+00	1.57E-03	6.79E-01
Trifluralin	0.59	1.09E+01	7.80E+02	2.07E-01	8.36E+03
Zinc (long term)	0.59	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc (short term)	0.59	6.61E+03	1.31E+02	1.06E+00	8.39E+03

Table 5.1 (continued): Damage to Ecosystem Quality (ecotoxicity)

Calculation of marginal PAF			
	CombiPAF (at beta = 0.4)	Hazard Units (standardised concentrations)	Slope of the damage curve:
	Fraction	HU (C/A)	(dPAF/dHU)
	0.05	0.066408325	0.77658
	0.0501	0.066537098	
	0.1	0.132163799	0.73886
	0.101	0.133517277	
(average combiPAF Europe)	0.223	0.316733081	**0.59333**
	0.224	0.31841797	
	0.3	0.458228404	0.49696
	0.301	0.460240672	
	0.4	0.68835852	0.37798
	0.401	0.691004392	
	0.5	1.0000029	0.27093
	0.501	1.003693919	
	0.6	1.452733104	0.17895
	0.601	1.458318709	
	0.7	2.182327979	0.10415
	0.701	2.191927085	
	0.8	3.58525059	0.04822
	0.801	3.605990182	
	0.9	7.566426877	0.01279
	0.901	7.644622414	
	0.99	68.87574004	0.00002
	0.999	579.3170645	

Table 5.1 (continued): Calculation of marginal PAF to determine the slope for Combi-PAF Europe

5.3. Damage to Ecosystem Quality caused by acidificaton and eutrophication

Most of the data needed has already been presented in the main report. We summarise the fate and damage factors here again in tables 5.2 and 5.3.

	Deposition increase moll per year per hectare	Deposition increase in kg/m2/yr	Resulting Acidity pH	Change in pH	Resulting Nutrient availability	Change in Nutrient availability
Reference	0		4.648		7077.33	
SOx	10	6.4*E-5	4.646	-0.0018	7075.61	-1.72
NOx	10	4.6*E.5	4.547	-0.1010	7089.31	11.98
NH3	10	1.7*E-5	4.648	-0.0004	7090.22	12.89

Table 5.2: Main results for the fate modelling with SMART.

Emission	Deposition increase in kg/m2*yr	Average PDF in the Netherlands	Damage to Ecosystem Quality in PDFm2yr per kg emitted substance (100% deposition in natural areas[2])	Damage to Ecosystem Quality in PDFm2yr per kg emitted substance in Europe (60% deposition in natural areas)
reference value		0.746429		
SOx	6.4*E-5	0.746540	1.73	1.04
NOx	4.6*E.5	0.746867	9.52	5.71
NH3	1.7*E-5	0.746870	25.94	15.56

Table 5.3: Damage caused by three emissions. The standard deviation for the average values in the Netherlands is 0.32.

[2] The resulting figures are larger than one. This is because of the chosen units. A deposition of a kg per m^2 is an extremely high dose. If the damage would be expressed per hectare the figure would be 4 orders of magnitude lower

5.4. Damage to Ecosystem Quality caused by land-use

[KÖLLNER 1998/1999] uses the Corine classification for land-cover. This table can be used in two ways:

- The assessment if a certain type of land-cover can be regarded as Hi or Li use. This is important for the regional PDF.
- The assessment of the local PDF values for area types that have not been defined here.

So far local PDF values have only been defined for a few land-use types. These have been printed in the table below against a grey background. The land-use types in italic are added by Köllner, as it was sometimes necessary to be more specific than the Corine classification.

		Description
1. Artificial surfaces		
1.1. Urban fabric	1.1.1. Continuous urban fabric	Most of the land is covered by buildings. Roads and artificially surfaced area cover almost all the ground. Non-linear areas of vegetation and bare soil are exceptional. At least 80% of the total area are sealed.
	1.1.2. Discontinuous urban fabric	Most of the land is covered by structures. Buildings, roads and artificially surfaced areas associated with vegetated areas and bare soil, which occupy discontinuous but significant surfaces. Less than 80% of the total area are sealed.
	1.1.3. Urban fallow	
1.2. Industrial, commercial and transport	1.2.1. Industrial or commercial units	Artificially surfaced areas (with concrete, asphalt, tamacadam, or stabilised, e.g. beaten earth) devoid of vegetation occupy most of the area in question, which also contains buildings and/or vegetated areas.
	1.2.2. Road and rail networks and associated land	Motorways, railways, including associated installations (stations, platforms, embankments). Minimum width to include: I 00 m.
	1.2.2.1 Road networks	
	1.2.2.2 Rail networks	
	1.2.3. Port areas	Infrastructure of port areas, including quays, dockyards and marinas.
	1.2.4. Airports	Airport installations: runways, buildings and associated land.
	1.2.5. Industrial fallow	
1.3. Mine, dump and construction sites	1.3.1. Mineral extraction sites	Areas with open-pit extraction of industrial minerals (sandpits, quarries) or other minerals (open cast mines). Includes flooded gravel pits, except for river-bed extraction.
	1.3.2. Dump sites	Landfill or mine dump sites, industrial or public.
	1.3.3. Construction sites	Spaces under construction development, soil or bedrock excavations, earthworks.
	1.3.4. Mining fallow	
1.4. Artificial, non-agricultural vegetated areas	1.4.1. Green urban areas	Areas with vegetation within urban fabric. Includes parks and cemeteries with vegetation.
	1.4.2. Sport and leisure facilities	Camping grounds, sports grounds, leisure parks, golf courses, racecourses, etc. Includes formal parks not surrounded by urban zones.
2. Agri-cultural areas		
2.1. Arable land		Cultivated areas regularly ploughed and generally under a rotation system.
	2.1.1. Non-irrigated arable land	Cereals, legumes, fodder crops, root crops and fallow land. Includes flower and tree (nurseries) cultivation and vegetables, whether open field, under plastic or glass (includes market gardening). Includes aromatic, medicinal and culinary plants. Excludes permanent pastures.
	2.2.1.1 conventional	Chemical-synthetic and organic fertiliser, pesticides are applied.
	2.2.2.2 integrated	Chemical-synthetic and organic fertiliser, pesticides are applied. However, the input of these substances is reduced.
	2.2.2.3 biological	Chemical-synthetic fertiliser and pesticides are not allowed, organic fertiliser is applied.
	2.2.2.4 energy crops	including energy forests
	2.2.2.5 agricultural fallow	
	2.1.2. Permanently irrigated land	Crops irrigated permanently and periodically, using a permanent infrastructure (irrigation channels, drainage network). Most of these crops could not be cultivated without an artificial water supply. Does not include sporadically irrigated land.
	2.1.3. Rice fields	Land developed for rice cultivation. Flat surfaces with irrigation channels. Surfaces regularly flooded.
2.2. Permanent crops		Crops not under a rotation system which provide repeated harvests and occupy the land for a long period before it is ploughed and replanted: mainly plantations of woody crops. Excludes pastures, grazing lands and forests.
	2.2.1. Vineyards	Areas planted with vines.
	2.2.1.1 Intensive vineyards	
	2.2.1.1 Extensive vineyards	
	2.2.2. Fruit trees and berry plantations	Parcels planted with fruit trees or shrubs: single or mixed fruit species, fruit trees associated with permanently grassed surfaces. Includes chestnut and walnut groves.

	2.2.2.1 Intensive fruit trees and berry plantations	
	2.2.2.2 Extensive fruit trees and berry plantations	
	2.2.3. Olive groves	Areas planted with olive trees, including mixed occurrence of olive trees and vines on the same parcel.
2.3. Pastures	2.3.1. Pastures and meadows	Dense, predominantly graminoid grass cover, of floral composition, not under a rotation system. Mainly used for grazing, but the fodder may be harvested mechanically. Includes areas with hedges (bocage).
	2.3.1.1 Intensive pasture and meadows	Meadows mechanically harvested 3 or more times per year.
	2.3.1.1 Extensive pasture and meadows	Meadows mechanically harvested 1 or 2 times per year.
2.4. Heterogeneous agricultural areas	2.4.1. Annual crops associated with permanent crops	Non-permanent crops (arable lands or pasture) associated with permanent crops on the same parcel.
	2.4.2. Complex cultivation	Juxtaposition of small parcels of diverse annual crops, pasture and/or permanent crops.
	2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation	Areas principally occupied by agriculture, interspersed with significant natural areas.
	2.4.4. Agro-forestry areas	Annual crops or grazing land under the wooded cover of forestry species.
3. Forests and semi-natural areas		
3.1. Forests	3.1.1. Broad-leaved forest	Vegetation formation composed principally of trees, including shrub and bush understories, where broad-leaved species predominate. (Presence of conifers 0-10%)
	3.1.1.1 Broad leafed plantations	
	3.1.1.2 Semi-natural broad-leaved forests	
	3.1.2. Coniferous forest	Vegetation formation composed principally of trees, including shrub and bush understories, where coniferous species predominate. (Presence of conifers 91-100%)
	3.1.2.1 Coniferous plantations	
	3.1.2.2 Semi-natural coniferous forests	
	3.1.3. Mixed forest	Vegetation formation composed principally of trees, including shrub and bush understories, where broad-leaved and coniferous species co-dominate.
	3.1.3.1 Mixed broad-leaved forest	Presence of conifers 11-50%
	3.1.3.2 Mixed coniferous forest	Presence of conifers 51-90%
	3.1.4 Certified forests	e.g. Forest Stewardship Council (FSC)- label
3.2. Shrub and/or herbaceous vegetation associations	3.2.1. Natural grassland	Low productivity grassland. Often situated in areas of rough uneven ground. Frequently includes rocky areas, briars, and heathland.
	3.2.2. Moors and heathland	Vegetation with low and closed cover, dominated by bushes, shrubs and herbaceous plants (heath, briars, broom, gorse, laburnum, etc.).
	3.2.3. Sclerophyllous vegetation	Bushy sclerophyllous vegetation. Includes maquis and garrige. Maquis: a dense vegetation association composed of numerous shrubs associated with siliceous soils in the Mediterranean environment. Garrigue: discontinuous bushy associations of Mediterranean calcareous plateaus. Generally composed of kermes oak, arbutus, lavender, thyme, cistus, etc. May include a few isolated trees.
	3.2.4. Transitional woodland/shrub	Bushy or herbaceous vegetation with scattered trees. Can represent either woodland degradation or forest regeneration/colonisation.
3.3. Open spaces with little or no vegetation	3.3.1. Beaches, dunes, and sand plains	Beaches, dunes and expanses of sand or pebbles in coastal or continental , including beds of stream channels with torrential regime.
	3.3.2. Bare rock	Scree, cliffs, rocks and outcrops.
	3.3.3. Sparsely vegetated areas	Includes steppes, tundra and badlands. Scattered high-attitude vegetation.
	3.3.4. Burnt areas	Areas affected by recent fires, still mainly black.
	3.3.5. Glaciers and perpetual snow	Land covered by glaciers or permanent snowfields.
4. Wetlands		
4.1. Inland wetlands		Non-forested areas either partially, seasonally or permanently waterlogged. The water may be stagnant or circulating.
	4.1.1. Inland marshes	Low-lying land usually flooded in winter, and more or less saturated by water all year round.

	4.1.2. Peatbogs	Peatland consisting mainly of decomposed moss and vegetable matter. May or may not be exploited.
4.2. Coastal wetlands		Non-wooded areas either tidally, seasonally or permanently waterlogged with brackish or saline water.
	4.2.1. Salt marshes	Vegetated low-lying areas, above the high-tide line, susceptible to flooding by sea water. Often in the process of filling in, gradually being colonised by halophilic plants.
	4.2.2. Salines	Salt-pans, active or in process. Sections of salt marsh exploited for the production of salt by evaporation. They are clearly distinguishable from the rest of the marsh by their segmentation and embankment systems.
	4.2.3. Intertidal flats	Generally unvegetated expanses of mud, sand or rock lying between high and low water-marks. On contour on maps.
5. Water bodies		
5.1. Inland waters	5.1.1. Water courses	Natural or artificial water-courses serving as water drainage channels. Includes canals. Minimum width to include: 100 m.
	5.1.2. Water bodies	Natural or artificial stretches of water.
	5.1.2.1 Artificial lakes	
5.2. Marine waters	5.2.1. Coastal lagoons	Unvegetated stretches of salt or brackish waters separated from the sea by a tongue of land or other similar topography. These water bodies can be connected with the sea at limited points, either permanently or for parts of the year only.
	5.2.2. Estuaries	The mouth of a river within which the tide ebbs and flows.
	5.2.3. Sea and ocean	Zone seaward of the lowest tide limit.

Table 5.4. CORINE land-cover – Nomenclature definitions Classification of land-cover types according to Commission of the European Communities. Additional types, which are not included in the CORINE land-cover typology, are indicated by italic letters. The land-cover types , for which characterisation values have been computed are printed against a grey background.

6. Resources

The main report explains the M values according to [CHAPMAN 1983] and [VRIES 1988]. Based on these values [MÜLLER-WENK 1998-1] calculates the surplus energy when the current cumulative extraction (Q) has reached a level that is 5 times as high. It is difficult to determine when this point will be reached.

In the table below the surplus energy data is reproduced on the basis of data from Vries and Chapman. The averages of these results are used here. The differences between the authors are used to calculate the squared geometric standard deviation, This deviation is only representing the influence of the differences between the data sources. The other factors, such as the uncertainty in the estimates of Q and the present energy requirements will add a constant value of 0.5 to these uncertainties. These values are given in the last column.
The data are calculated per kg of mineral (the metal content) and per kg of ore, as LCA inventory tables specify either the ore or the mineral. Only one of these should be applied.

Hierarchist and Egalitarian	M according to Chapman	M according to de Vries	Surplus energy Chapman	Surplus energy de Vries	Average surplus energy per kg mineral	Ore grade	average surplus energy per kg of extracted ore
Aluminium	25	22	2.38	2.38	2.38	0.21	0.500
Chromium	17	4	0.333	1.5	0.9165	0.3	0.275
Copper	1.6	5	60	13.4	36.7	0.0113	0.415
Iron		18	0.051	0.051	0.051	0.57	0.029
Lead	3.4	3	6.7	8	7.35	0.05	0.368
Manganese	19	7	0.176	0.45	0.313	0.45	0.141
Mercury	2	3	211	120	165.5	0.005	0.828
Molybdenum	6.29	6	41	41	41	0.001	0.041
Nickel	2.9	6	32	15.5	23.75	0.015	0.356
Tungsten	6	3	92	217	154.5	0.006	0.927
Tin		1	600	600	600	0.0001	0.060
Zinc	7.3	5	3.25	4.93	4.09	0.04	0.164

Table 6.1: Surplus energy values (damage factors) for minerals in MJ per kg extracted mineral and ore.

The surplus energy data for fossil fuels differ per perspective. The tables below specify the surplus energy per MJ extracted resource per cultural perspective. The uncertainty has not been calculated, but a σ_g^2 of 1.5 for the hierarchist perspective and a σ_g^2 of 2 for the egalitarian perspective seem reasonable estimates. The fossil fuels are not included in the individualist perspective.

Egalitarian (all in MJ per extracted MJ)	conventional energy use (MJ/MJ)	To be replaced by	Extraction energy (MJ/MJ)	surplus energy MJ/MJ
1. Conventional natural gas	0.010	coal shale mix	0.099	0.089
2. Conventional oil, average extraction 1990	0.016	coal shale mix	0.099	0.083
3. Hard coal, open pit mining	0.017	coal shale mix	0.099	0.082
4. Crude oil, secondary extraction	0.023	coal shale mix	0.099	0.076
5. Hard coal, underground mining	0.034	coal shale mix	0.099	0.065
6. Brown coal, open pit mining	0.038	coal shale mix	0.099	0.061
7. Crude oil, tertiary extraction	0.110	crude oil tert. pr.	0.11	0.000
8. Crude oil from oil shale	0.160	oil shale	0.16	0.000
9. Crude oil from tar sand	0.230	tar sand	0.23	0.000

Table 6.2: Surplus energy values (damage factors) for fossil fuels (Egalitarian)

Hierarchist (all in MJ per extracted MJ)	conventional energy use (MJ/MJ)	To be replaced by	Extraction energy (MJ/MJ)	surplus energy MJ/MJ
1. Conventional natural gas	0.010	oil shale	0.16	0.150
2. Conventional oil, average extraction 1990	0.016	oil shale	0.16	0.144
3. Hard coal, open pit mining	0.017	brown coal	0.038	0.021
4. Crude oil, secondary extraction	0.023	brown coal	0.038	0.015
5. Hard coal, underground mining	0.034	brown coal	0.038	0.004
6. Brown coal, open pit mining	0.038	brown coal	0.038	0.000
7. Crude oil, tertiary extraction	0.110	oil shale	0.16	0.050
8. Crude oil from oil shale	0.160	oil shale	0.16	0.000
9. Crude oil from tar sand	0.230	tar sand	0.23	0.000

Table 6.3: Surplus energy values (damage factors) for fossil fuels (Hierarchist)

7. Damage assessment

7.1. p.m.

7.2. Normalisation

7.2.1. Emission data

In the annex table 7.1, the emission data for Europe, used for the calculation of normalisation values are summarised. Part of the list from [BLONK ET AL 1997] is updated for the Eco-indicator 99 with more recent data on emissions in Europe.

For most substances emissions are not reported for all countries involved and the extrapolation method based on energy use that is also applied in [BLONK ET AL 1997] is used here to estimated the total European emission. This extrapolation method was introduced in the Eco-indicator 95 methodology [GOEDKOOP 1995]. The method is based on the assumption that the industrial structure and thus the emission pattern is represented best by the energy use of the country. The emissions are calculated in a spreadsheet, where the emission of a country is connected to the energy use of that country. For a specific substance, the energy use of all countries with known emissions of that substance is added up. By dividing the known emission by the corresponding energy use, the emission per joule energy use is determined. Subsequently, an estimate of the total European emission of that substance can be determined by multiplying the calculated emission per Joule with the total European energy use.

In formula: $E_t = P_t * (E_k / P_k)$

E_t = Total emission in Europe
P_t = Total energy-use in Europe
E_k = Known emission
P_k = Energy use of countries with known emissions

For eight bulk air emissions, new data from all countries was available from the 1994 Corinair inventory [EEA 1997]. For the emission of dust particles (PM_{10}) emission data from [HOFSTETTER 1998]are used.
For air emissions of persistent organic substances and metals new data for only 4 to 8 countries, depending on the type of substance, was available. Therefore, for these substances between 50% to 80% of the emissions of these substances had to be estimated by means of energy extrapolation. In most cases this was an improvement to the estimates in [BLONK ET AL 1997] because in the update data were available for more countries and the data are more recent.
For most water and soil emissions no data were available except for the Netherlands [VROM-ER 38]. This means that the emission estimates for the whole of Europe had to be extrapolated from only one country. Therefore the estimates are not very reliable, but at this moment there are no alternatives. In [BLONK ET AL 1997] the same procedure was used.

Emissions to air in Europe (1990-1992)			Update 1999 (this project)		
Source [Blonk et al 1997]					
Substance name	(tons/yr)		(tons/yr)	Data Source	Comments
CO2	3.45E+09		3.30E+09	Corinair 1994	emission data available for all countries
CO	5.33E+07		4.65E+07	Corinair 1994	emission data available for all countries
CH4	2.39E+07		2.32E+07	Corinair 1994	emission data available for all countries
SO2	1.66E+07		1.21E+07	Corinair 1994	emission data available for all countries
N2O	9.78E+05		9.83E+05	Corinair 1994	emission data available for all countries
NO2	1.33E+07		1.29E+07	Corinair 1994	emission data available for all countries
NH3	4.03E+06		3.62E+06	Corinair 1994	emission data available for all countries
NMVOC	1.48E+07		1.32E+07	Corinair 1994	emission data available for all countries
PM10			5.17E+09	Hofstetter 1998	emission data for the whole of Europe
VOC	1.19E+07				
HCL	4.41E+05				
HF	8.95E+03				
CFC-11	1.63E+04				
CFC-12	6.46E+03				
CFC-113	1.40E+02				
CFC-115	9.82E+02				
Halon-1211	2.81E+02				
Halon-1301	8.42E+02				
CCl4 (tetrachloromethane)	7.86E+03		1.40E+04	Corinair 1994	Limited data, energy extrapolation
1,1,1-Trichloroethane	4.01E+04		1.16E+05	Corinair 1994	Limited data, energy extrapolation
Trichloroethylene			6.82E+04	Corinair 1994	Limited data, energy extrapolation
Tetrachloroethylene			5.46E+04	Corinair 1994	Limited data, energy extrapolation
Pentachlorophenol			3.20E+03	Corinair 1994	Limited data, energy extrapolation
Hexachlorobenzene			3.27E+00	Corinair 1994	Limited data, energy extrapolation
Trichlorobenzene			3.63E+03	Corinair 1994	Limited data, energy extrapolation
Hexachlororcyclohexane			7.16E+02	Corinair 1994	Limited data, energy extrapolation
SPM /PM10			5.17E+06	Corinair 1994	Limited data, energy extrapolation
HCFC-22	4.31E+04				
HCFC 141b	1.18E+04				
HCFC 142b	1.18E+04				
CH3Br	5.61E+02				
BENZENE	1.28E+05				
XYLENES	2.56E+05				
SURPLUS non halogenated aromates	2.30E+05				
SURPLUS ALIPHATES	5.82E+06				
PAH-total	5.69E+03		6.06E+03	Corinair 1994	Limited data, energy extrapolation
Anthracene	7.44E+02				
Benzo(a)anthracene	2.63E+02				
Benzo(b)fluoranthene	1.73E+02				
Benzo(a)pyrene	1.07E+02				
Benzo(g,h,i)perylene	6.98E+01				
Benzo(k)Fluoranthene	8.16E+01				
Chryseen	2.73E+02				
Fenantreen	6.90E+03				
Fluoranthene	2.07E+03				
Indeno(1,2,3cd)pyreen	6.37E+01				
Naftaleen	1.51E+04				
PCDD/PCDF (dioxinen)	1.30E-02		3.10E-03	Corinair 1994	Limited data, energy extrapolation
Arseen (As)	4.40E+02		3.59E+02	Corinair 1994	Limited data, energy extrapolation
Cadmium (Cd)	2.90E+02		1.94E+02	Corinair 1994	Limited data, energy extrapolation
Chroom (Cr)	2.76E+02		4.24E+02	Corinair 1994	Limited data, energy extrapolation
Kwik (Hg)	1.36E+02		1.25E+02	Corinair 1994	Limited data, energy extrapolation
Lood (Pb)	1.90E+04		1.34E+04	Corinair 1994	Limited data, energy extrapolation
Nikkel (Ni)	1.73E+03		1.59E+03	Corinair 1994	Limited data, energy extrapolation
Zink (Zn)	1.66E+04		7.20E+03	Corinair 1994	Limited data, energy extrapolation

Table 7.1: Emission data for Europe

Emissions to water in Europe (1990-1992)			Update 1999 (this project)		
Source [Blonk et al 1997]					
Substance name	(tons/yr)		(tons/yr)	Data Source	Comments
Mineral oil	1.67E+05				
Phenol	8.28E+02				
PAH 10 of VROM (unspecified)	3.15E+02		4.87E+02	ER 38	extrapolated from the Netherlands
Fluoranthene	2.41E+02		3.14E+02	ER 38	extrapolated from the Netherlands
Benzo(a)pyrene	6.35E+01		6.35E+01	ER 38	extrapolated from the Netherlands
Benzene	5.38E+03		4.34E+03	ER 38	extrapolated from the Netherlands
Toluene			9.86E+03	ER 38	extrapolated from the Netherlands
CCl4 (tetrachloromethane)			8.70E+00	ER 38	extrapolated from the Netherlands
1,1,1-Trichloroethane			1.16E+00	ER 38	extrapolated from the Netherlands
Trichloroethylene			4.12E+00	ER 38	extrapolated from the Netherlands
Tetrachloroethylene			8.70E+00	ER 38	extrapolated from the Netherlands
Pentachlorophenol			6.10E+00	ER 38	extrapolated from the Netherlands
Trichlorobenzene			8.00E+00	ER 38	extrapolated from the Netherlands
Hexachlororcyclohexane			3.51E+00	ER 38	extrapolated from the Netherlands
PCB,s			9.00E-02	ER 38	extrapolated from the Netherlands
Fluorides	3.65E+05				
Arsenic (As)	1.20E+02		9.86E+01	ER 38	extrapolated from the Netherlands
Cadmium (Cd)	3.43E+01		3.59E+01	ER 38	extrapolated from the Netherlands
Chromium (Cr)	6.05E+02		5.32E+02	ER 38	extrapolated from the Netherlands
Mercury (Hg)	1.52E+01		1.33E+01	ER 38	extrapolated from the Netherlands
Lead (Pb)	4.57E+03		2.48E+03	ER 38	extrapolated from the Netherlands
Nickel (Ni)	6.31E+02		5.93E+02	ER 38	extrapolated from the Netherlands
Copper (Cu)	3.39E+03		1.46E+03	ER 38	extrapolated from the Netherlands
Zinc (Zn)	1.59E+04		1.04E+01	ER 38	extrapolated from the Netherlands
Pesticides					
2,4-D	1.14E+01				
aldicarb	9.87E+01				
atrazin	1.81E+02				
azinfos-methyl	2.84E+01				
bentazon	3.11E+01				
captan	1.39E+02				
carbofuran	3.41E+01				
chloorfenvinfos	2.84E+01				
chloorpyrifos	2.84E+01				
chloridazon	3.11E+01				
dichloorvos	2.84E+01				
difenoxuron	1.24E+02				
DNOC	3.11E+01				
ethoprofos	9.30E+01				
fenmedifam	2.26E+01				
Fentin-acetate	1.76E+01				
fosfamidon	2.84E+01				
lindaan	7.91E+01				
mancozeb	1.60E+02				
maneb	1.60E+02				
MCPA	1.57E+01				
metam-Na	3.88E+02				
Mevinphos	2.84E+01				
oxydemeton	2.84E+01				
parathion-ethyl	2.84E+01				
permethrin	5.17E+00				
primicarb	3.41E+01				
propachloor	3.11E+01				
simazin	1.81E+02				
terbutryn	1.81E+02				
thiram	1.60E+02				
trifentin	1.76E+01				
trifentinhydroxide	1.76E+01				
zineb	1.60E+02				

Table 7.1 (continued): Emission data for Europe

Emissions to soil in Europe (1990-1992)			Update 1999 (this project)		
Source [Blonk et al 1997]					
Substance name	(tons/yr)		(tons/yr)	Data Source	Comments
Arseen (As)	5.34E+01		3.70E+01	ER 38	extrapolated from the Netherlands
Cadmium (Cd)	1.80E+02		1.58E+02	ER 38	extrapolated from the Netherlands
Chroom (Cr)	1.61E+03		1.32E+03	ER 38	extrapolated from the Netherlands
Kwik (Hg)	1.52E+01		5.18E+00	ER 38	extrapolated from the Netherlands
Lood (Pb)	8.04E+03		6.78E+03	ER 38	extrapolated from the Netherlands
Nikkel (Ni)	7.69E+02		6.45E+02	ER 38	extrapolated from the Netherlands
Koper (Cu)	2.15E+04		1.94E+04	ER 38	extrapolated from the Netherlands
Zink (Zn)	7.91E+04		6.58E+04	ER 38	extrapolated from the Netherlands

Table 7.1 (continued): Emission data for Europe

7.2.2. Normalisation values for carcinogenic substances

In the tables 7.2a, b, c and d the normalisation values for carcinogenic substances are calculated for emissions to air, water, industrial soil and agricultural soil respectively. Table 7.2e lists the totals with the contributions of the different emission compartments in percentages.

Emissions to air	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emission	Egalitarian	Hierarchist	Individualist
	DALYs/kg	DALYs/kg	DALYs/kg	(kg/yr)	DALYs/yr	DALYs/yr	DALYs/yr
Substance							
Arsenic (long term)	2.46E-02	2.46E-02		3.59E+05	8.85E+03	8.85E+03	
Arsenic (short term)			1.00E-03	3.59E+05			3.59E+02
Benzene	2.50E-06	2.50E-06	1.58E-06	1.28E+08	3.21E+02	3.21E+02	2.02E+02
Cadmium (long term)	1.35E-01	1.35E-01		1.94E+05	2.63E+04	2.63E+04	
Cadmium (short term)			1.03E-02	1.94E+05			2.00E+03
Chromium VI (long term)	1.75E+00	1.75E+00		4.24E+04	7.43E+04	7.43E+04	
Chromium VI (short term)			1.50E-02	4.24E+04			6.35E+02
Nickel (long term)	2.35E-02	2.35E-02		1.59E+06	3.74E+04	3.74E+04	
Nickel (short term)			6.79E-03	1.59E+06			1.08E+04
Benzo(a)pyreen	3.98E-03	3.98E-03		1.07E+05	4.25E+02	4.25E+02	
Benzo(a)anthracene	5.86E-02	5.86E-02		2.63E+05	1.54E+04	1.54E+04	
2.3.7.8. -TCDD-dioxin	1.79E+02	1.79E+02		3.10E+00	5.53E+02	5.53E+02	
alpha-hexachlorocyclohexan	3.00E-04	3.00E-04		2.40E+05	7.19E+01	7.19E+01	
beta-hexachlorocyclohexan	9.99E-05	9.99E-05		2.40E+05	2.40E+01	2.40E+01	
Carbontetrachloride	8.38E-04	8.38E-04		1.40E+07	1.17E+04	1.17E+04	
Lindane (gamma HCH)	3.49E-04	3.49E-04		2.40E+05	8.38E+01	8.38E+01	
Hexachlorobenzene	8.25E-02	8.25E-02		3.27E+03	2.70E+02	2.70E+02	
Pentachlorophenol	7.21E-03	7.21E-03		3.20E+06	2.31E+04	2.31E+04	
Perchloroethylene	4.82E-07	4.82E-07		5.46E+07	2.63E+01	2.63E+01	
1.1.2-Trichlorethane	1.10E-05			1.16E+08	1.27E+03		
Methylchloride	1.83E-05			1.00E+00	1.83E-05		
Trichlorethylene	7.95E-08			6.82E+07	5.42E+00		
Totals					2.00E+05	1.99E+05	1.40E+04

Table 7.2a: Normalisation values for carcinogenic substances (emissions to air)

Emissions to water	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emission	Egalitarian	Hierarchist	Individualist
	DALYs/kg	DALYs/kg	DALYs/kg	(kg/yr)	DALYs/yr	DALYs/yr	DALYs/yr
Substance							
Arsenic (long term)	6.57E-02	6.57E-02		9.86E+04	6.48E+03	6.48E+03	
Arsenic (short term)			3.42E-02	9.86E+04			3.37E+03
Benzene	4.12E-06	4.12E-06	2.45E-06	4.34E+06	1.79E+01	1.79E+01	1.06E+01
Cadmium (long term)	7.12E-02	7.12E-02		3.59E+04	2.55E+03	2.55E+03	
Cadmium (short term)			3.73E-02	3.59E+04			1.34E+03
Chromium VI (long term)	3.43E-01	3.43E-01		2.66E+05	9.11E+04	9.11E+04	
Chromium VI (short term)			1.79E-01	2.66E+05			4.76E+04
Nickel (long term)	3.11E-02	3.11E-02		5.93E+05	1.84E+04	1.84E+04	
Nickel (short term)			1.63E-02	5.93E+05			9.69E+03
Benzo(a)pyreen	2.99E+00	2.99E+00		6.35E+04	1.90E+05	1.90E+05	
Polychlorobiphenyls	3.91E-02	3.91E-02		9.00E+01	3.52E+00	3.52E+00	
alpha-hexachlorocyclohexan	6.85E-03	6.85E-03		1.17E+03	8.01E+00	8.01E+00	
beta-hexachlorocyclohexan	5.75E-03	5.75E-03		1.17E+03	6.73E+00	6.73E+00	
Carbontetrachloride	8.29E-04	8.29E-04		8.70E+03	7.21E+00	7.21E+00	
Dichlorvos	1.17E-05	1.17E-05		2.84E+04	3.33E-01	3.33E-01	
Lindane (gamma HCH)	4.16E-03	4.16E-03		1.17E+03	4.86E+00	4.86E+00	
Pentachlorophenol	2.29E-02	2.29E-02		6.10E+03	1.40E+02	1.40E+02	
Perchloroethylene	4.72E-07	4.72E-07		1.80E+03	8.49E-04	8.49E-04	
Trichlorethylene	7.97E-08			4.12E+03	3.28E-04		
Totals					3.10E+05	3.10E+05	6.20E+04

Table 7.2b: Normalisation values for carcinogenic substances (emissions to water)

Emissions to agricultural soil	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emission	Egalitarian	Hierarchist	Individualist
	DALYs/kg	DALYs/kg	DALYs/kg	kg/yr	DALYs/yr	DALYs/yr	DALYs/yr
Substance							
Dichlorvos	2.25E-05	2.25E-05		2.82E+06	6.33E+01	6.33E+01	
Lindane (gamma HCH)	8.64E-03	8.64E-03		7.83E+06	6.76E+04	6.76E+04	
Totals					6.77E+04	6.77E+04	0

Table 7.2c: Normalisation values for carcinogenic substances (emissions to agricultural soil)

Emissions to industrial soil	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emission	Egalitarian	Hierarchist	Individualist
	DALYs/kg	DALYs/kg	DALYs/kg	kg/yr	DALYs/yr	DALYs/yr	DALYs/yr
Substance							
Arsenic (long term)	1.32E-02	1.32E-02		3.70E+04	4.87E+02	4.87E+02	
Arsenic (short term)			7.28E-04	3.70E+04			2.69E+01
Cadmium (long term)	3.98E-03	3.98E-03		1.58E+05	6.28E+02	6.28E+02	
Cadmium (short term)			6.09E-04	1.58E+05			9.62E+01
Chromium (long term)	2.71E-01	2.71E-01		6.60E+05	1.79E+05	1.79E+05	
Chromium (short term)			4.13E-03	6.60E+05			2.73E+03
Nickel (long term)	3.94E-03	3.94E-03		6.45E+05	2.54E+03	2.54E+03	
Nickel (short term)			3.27E-04	6.45E+05			2.11E+02
Totals					1.83E+05	1.83E+05	3.06E+03

Table 7.2d: Normalisation values for carcinogenic substances (emissions to industrial soil)

Totals	Unit	Egalitarian	Hierarchist	Individualist
Air	DALYs/yr	1.99E+05	1.99E+05	1.40E+04
contribution	%	26	26	18
Water	DALYs/yr	3.10E+05	3.10E+05	6.20E+04
contribution	%	41	41	78
Agricultural soil	DALYs/yr	6.77E+04	6.77E+04	0
contribution	%	9	9	0
Industrial soil	DALYs/yr	1.83E+05	1.83E+05	3.06E+03
contribution	%	24	24	4
Total	DALYs/yr	7.60E+05	7.60E+05	7.91E+04

Table 7.2e: Normalisation values for carcinogenic substances (totals)

There is not a lot of difference between the egalitarian and hierarchist perspectives. For these perspectives emissions to air give the highest contributions. The DALYs are caused by heavy metals and several organic substances. Emissions to agricultural soil (only pesticides) give a very small contribution: only few pesticides are included in the list of carcinogenics.
The individualist perspective has a much lower damage for all compartments. Only few substances are included. In this perspective the total DALYs are determined mainly by heavy metals.

7.2.3. Normalisation values for respiratory effects

In the tables 7.3 and 7.4 the normalisation values for respiratory effects are calculated for inorganic substances and organic substances respectively. The contribution of PM10 is very important in all three perspectives. The total DALYs for inorganic substances are a lot higher for all three perspectives.

Emissions to air	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emission	Egalitarian	Hierarchist	Individualist
Inorganic substances	Dalys/kg	Dalys/kg	Dalys/kg	kg/yr	DALYs/yr	DALYs/yr	DALYs/yr
CO	7.31E-07			4.65E+10	3.40E+04	0.00E+00	0.00E+00
PM10	3.75E-04	3.75E-04	2.74E-04	5.17E+09*	1.94E+06	1.94E+06	1.42E+06
SOx (as SO2)	1.09E-06	1.09E-06		1.21E+10	1.32E+04	1.32E+04	0.00E+00
SOx (as SO2)	5.35E-05	5.35E-05	3.90E-05	1.21E+10	6.47E+05	6.47E+05	4.72E+05
NH3	7.00E-05	7.00E-05	5.10E-05	3.62E+09	2.53E+05	2.53E+05	1.85E+05
NH3	1.50E-05	1.50E-05		3.62E+09	5.42E+04	5.42E+04	0.00E+00
NOx (as NO2)	4.31E-07			1.29E+10	5.57E+03	0.00E+00	0.00E+00
NOx (as NO2)	8.74E-05	8.74E-05		1.29E+10	1.13E+06	1.13E+06	0.00E+00
NOx (as NO2)	1.28E-06	1.28E-06	1.19E-06	1.29E+10	1.65E+04	1.65E+04	1.53E+04
totals					4.09E+06	4.05E+06	2.09E+06

Table 7.3: Normalisation values for respiratory effects(inorganic substances to air)
**) Emission data for 1995 taken from [HOFSTETTER 1998]*

Emissions to air	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emission	Egalitarian	Hierarchist	Individualist
Organic substances	Dalys/kg	Dalys/kg	Dalys/kg	kg/yr	DALYs/yr	DALYs/yr	DALYs/yr
NMVOC	1.28E-06	1.28E-06	1.19E-06	1.32E+10	1.69E+04	1.69E+04	1.57E+04
VOCs (average)	6.46E-07	6.46E-07	6.40E-07	1.19E+10	7.69E+03	7.69E+03	7.62E+03
methane	1.28E-08	1.28E-08	1.19E-08	2.32E+10	2.96E+02	2.96E+02	2.75E+02
benzene	4.68E-07	4.68E-07	4.35E-07	1.28E+08	5.99E+01	5.99E+01	5.57E+01
o-xylene	2.30E-06	2.30E-06	2.14E-06	8.53E+07	1.96E+02	1.96E+02	1.82E+02
m-xylene	2.38E-06	2.38E-06	2.22E-06	8.53E+07	2.03E+02	2.03E+02	1.89E+02
p-xylene	2.21E-06	2.21E-06	2.06E-06	8.53E+07	1.89E+02	1.89E+02	1.75E+02
trichloroethene	6.98E-07	6.98E-07	6.49E-07	6.82E+07	4.76E+01	4.76E+01	4.42E+01
tetrachloroethene	6.21E-08	6.21E-08	5.78E-08	5.46E+07	3.39E+00	3.39E+00	3.15E+00
totals					2.60E+04	2.60E+04	2.42E+04

Table 7.4: Normalisation values for respiratory effects(organic substances to air)

7.2.4. Normalisation values for climate change

In the table below the damage factors are multiplied with the emissions from [BLONK ET AL 1997]. The figures for CO2, CH4 and N2O have been replaced by the more recent data from [EEA 1997]. The emission of ozone depleting substances is taken from the calculation in section 7.2.6. The last table shows the relative contribution from the different substances for the hierarchical perspectives. Clearly CO2 is dominating.

Substance	Damage factors				Normalisation values			
	Egalitarian	Hierarchist	Individualist	Emission	Egalitarian	Hierarchist	Individualist	Hierarchist
	DALYs(0,0)/t	DALYs(0,0)/t	DALYs(0,1)/t	t/yr	Dalys/yr	Dalys/yr	Dalys/yr	Contribution
Carbon Dioxide	2.10E-04	2.10E-04	2.00E-04	3.30E+09	6.93E+05	6.93E+05	6.60E+05	76%
Methane	4.40E-03	4.40E-03	4.40E-03	2.32E+07	1.02E+05	1.02E+05	1.02E+05	11%
Nitrous Oxide	6.90E-02	6.90E-02	6.70E-02	9.83E+05	6.78E+04	6.78E+04	6.59E+04	7%
Methylene chloride	1.90E-03	1.90E-03	1.90E-03	5.59E+02	1.06E+00	1.06E+00	1.06E+00	0%
CFC-11	2.20E-01	2.20E-01	2.20E-01	7.70E+03	1.69E+03	1.69E+03	1.69E+03	0%
CFC-12	1.40E+00	1.40E+00	1.30E+00	3.90E+03	5.46E+03	5.46E+03	5.07E+03	1%
CFC-113	6.30E-01	6.30E-01	6.20E-01	4.90E+01	3.09E+01	3.09E+01	3.04E+01	0%
HCFC-22	2.80E-01	2.80E-01	2.80E-01	4.73E+04	1.32E+04	1.32E+04	1.32E+04	1%
HCFC-142b	3.40E-01	3.40E-01	3.40E-01	6.90E+04	2.35E+04	2.35E+04	2.35E+04	3%
H1301 (i)	-7.10E+00	-7.10E+00	-7.00E+00	8.42E+02	-5.98E+03	-5.98E+03	-5.89E+03	-1%
HCFC-141b	5.20E-02	5.20E-02	5.20E-02	2.01E+05	1.05E+04	1.05E+04	1.05E+04	1%
Tetrachloromethane	-2.60E-01	-2.60E-01	-2.50E-01	1.40E+04	-3.64E+03	-3.64E+03	-3.50E+03	0%
Totals					**9.08E+05**	**9.08E+05**	**8.72E+05**	

Table 7.5: Calculation of normalisation values for greenhouse effect, based on the data of [BLONK ET AL 1997], the update 1999 in section 7.2.1 and calculation of emissions for ozone depleting substances in section 7.2.6 .

7.2.5. Normalisation values for ionising radiation

The normalisation for ionising radiation is based on the emissions per TWh electricity, as it is produced in France. The resulting damage is then multiplied with the nuclear power consumption in Europe. This procedure does not give a complete picture, as other nuclear industrial activities are excluded.

	Emission	Damage factor per kBq			Damage in DALYs per TWh		
Specific emissions		Egalitarian	Hierarchist	Individualist	Egalitarian	Hierarchist	Individualist
Unit	MBq/TWh	DALYs(0,0)/ kBq	DALYs(0,0)/ KBq	DALYs(0,1)/ kBq	DALYs(0,0)/yr	DALYs(0,0)/yr	DALYs(0,1)/yr
Airborne							
Radio. C14 p 1)	84300	2.10E-07	2.10E-07	1.60E-08	1.77E+01	1.77E+01	1.35E+00
Radio. Co58 p	0.496	4.30E-10	4.30E-10	3.60E-10	2.13E-07	2.13E-07	1.79E-07
Radio. Co60 p	0.496	1.60E-08	1.60E-08	1.40E-08	7.94E-06	7.94E-06	6.94E-06
Radio. Cs134 p	0.496	1.20E-08	1.20E-08	1.00E-08	5.95E-06	5.95E-06	4.96E-06
Radio. Cs137 p	0.496	1.30E-08	1.30E-08	1.10E-08	6.45E-06	6.45E-06	5.46E-06
Radio. H3 p	195800	1.40E-11	1.40E-11	1.20E-11	2.74E-03	2.74E-03	2.35E-03
Radio. I129 p	51.1	9.40E-07	9.40E-07	2.50E-07	4.80E-02	4.80E-02	1.28E-02
Radio. I131 p	3.648	1.60E-10	1.60E-10	1.30E-10	5.84E-07	5.84E-07	4.74E-07
Radio. I133 p	6.233	9.40E-12	9.40E-12	7.90E-12	5.86E-08	5.86E-08	4.92E-08
Radio. Kr85 p	7.21E+08	1.40E-13	1.40E-13	1.20E-13	1.01E-01	1.01E-01	8.65E-02
Radio. Pb210 p	0	1.50E-09	1.50E-09	1.30E-09	0.00E+00	0.00E+00	0.00E+00
Radio. Po210 p	0	1.50E-09	1.50E-09	1.30E-09	0.00E+00	0.00E+00	0.00E+00
Radio. Pu alpha p	2.33E-05	8.30E-08	8.30E-08	7.00E-08	1.93E-09	1.93E-09	1.63E-09
Radio. Pu238 p	1.02E-05	6.70E-08	6.70E-08	5.70E-08	6.83E-10	6.83E-10	5.81E-10
Radio. Ra226 p	0	9.10E-10	9.10E-10	7.60E-10	0.00E+00	0.00E+00	0.00E+00
Radio. Rn222 p	11000000	2.40E-11	2.40E-11	2.00E-11	2.64E-01	2.64E-01	2.20E-01
LT Radio. Rn222 p	0				0.00E+00	0.00E+00	0.00E+00
Radio. Th230 p	0	4.50E-08	4.50E-08	3.80E-08	0.00E+00	0.00E+00	0.00E+00
Radio. U234 p	45.596	9.70E-08	9.70E-08	8.20E-08	4.42E-03	4.42E-03	3.74E-03
Radio. U235 p	1.92735	2.10E-08	2.10E-08	1.70E-08	4.05E-05	4.05E-05	3.28E-05
Radio. U238 p	45.48174	8.20E-09	8.20E-09	6.90E-09	3.73E-04	3.73E-04	3.14E-04
Radio. Xe133 p	1070000	1.40E-13	1.40E-13	1.20E-13	1.50E-04	1.50E-04	1.28E-04
Waterborne							
Rad. Ag110m f	480	5.10E-10	5.10E-10	4.20E-10	2.45E-04	2.45E-04	2.02E-04
Rad. Am241 s	92.1	3.10E-08	3.10E-08	2.60E-08	2.86E-03	2.86E-03	2.39E-03
Rad. C14 s	45500	1.20E-09	1.20E-09	9.90E-10	5.46E-02	5.46E-02	4.50E-02
Rad. Cm alpha s	44.2	5.70E-08	5.70E-08	4.80E-08	2.52E-03	2.52E-03	2.12E-03
Rad. Co58 f	700	4.10E-11	4.10E-11	3.40E-11	2.87E-05	2.87E-05	2.38E-05
Rad. Co60 f	250	4.40E-08	4.40E-08	3.70E-08	1.10E-02	1.10E-02	9.25E-03
Rad. Co60 s	9100	3.90E-10	3.90E-10	3.30E-10	3.55E-03	3.55E-03	3.00E-03
Rad. Cs134 f	31	1.40E-07	1.40E-07	1.20E-07	4.34E-03	4.34E-03	3.72E-03
Rad. Cs134 s	1500	7.90E-11	7.90E-11	6.60E-11	1.19E-04	1.19E-04	9.90E-05
Rad. Cs137 f	53	1.70E-07	1.70E-07	1.40E-07	9.01E-03	9.01E-03	7.42E-03
Rad. Cs137 s	13800	7.90E-11	7.90E-11	6.70E-11	1.09E-03	1.09E-03	9.25E-04
Rad. H3 f	1400000	4.50E-13	4.50E-13	3.80E-13	6.30E-04	6.30E-04	5.32E-04
Rad. H3 s	28900000	6.90E-14	6.90E-14	5.80E-14	1.99E-03	1.99E-03	1.68E-03
Rad. I129 s	684	1.00E-07	1.00E-07	1.90E-08	6.84E-02	6.84E-02	1.30E-02
Rad. I131 f	13	5.00E-10	5.00E-10	4.20E-10	6.50E-06	6.50E-06	5.46E-06
Rad. Mn54 f	26	3.10E-10	3.10E-10	2.60E-10	8.06E-06	8.06E-06	6.76E-06
Rad. Pu alpha s	147.7	7.40E-09	7.40E-09	6.20E-09	1.09E-03	1.09E-03	9.16E-04
Rad. Ra 226 f	0	1.30E-10	1.30E-10	1.10E-10	0.00E+00	0.00E+00	0.00E+00
Rad. Ru106 s	87700	1.40E-10	1.40E-10	1.20E-10	1.23E-02	1.23E-02	1.05E-02
Rad. Sb124 f	110	8.20E-10	8.20E-10	6.90E-10	9.02E-05	9.02E-05	7.59E-05
Rad. Sb125 s	61700	1.50E-11	1.50E-11	1.20E-11	9.26E-04	9.26E-04	7.40E-04
Rad. Sr90 s	146000	4.00E-12	4.00E-12	3.40E-12	5.84E-04	5.84E-04	4.96E-04
Rad. U 238 f	7.83	2.30E-09	2.30E-09	1.90E-09	1.80E-05	1.80E-05	1.49E-05
Rad. U 238 s	6044.7	2.30E-11	2.30E-11	2.00E-11	1.39E-04	1.39E-04	1.21E-04
Rad. U234 f	11.57	2.40E-09	2.40E-09	2.00E-09	2.78E-05	2.78E-05	2.31E-05
Rad. U234 s	6370	2.30E-11	2.30E-11	1.90E-11	1.47E-04	1.47E-04	1.21E-04
Rad. U235 f	0.5967	2.30E-09	2.30E-09	2.00E-09	1.37E-06	1.37E-06	1.19E-06
Rad. U235 s	274	2.50E-11	2.50E-11	2.10E-11	6.85E-06	6.85E-06	5.75E-06
Total DALYs/TWh					1.83E+01	1.83E+01	1.78E+00
Nuclear energy in Europe (TWh)					560	560	560
Total damage in Europe (DALYs/yr)					1.02E+04	1.02E+04	9.95E+02

Table 7.6: Calculation of Normalisation , based on specific emissions of the French nuclear fuel cycle per TWh, according to [DREICER 1995]. [1]): to air: p: process specific emission; to water: f: to fresh water; s: to sea water; LT: long term; (Radon emissions occurring during 80'000 years [ESU 1996, VII]

7.2.6. Normalisation values for ozone layer depletion

Normalisation data are taken from [BLONK ET AL 1997]. These figures are based on production volumes from 1990. The problem with this source is that the production figures are changing very rapidly. Furthermore production data can be quite different from emission data.
The AFEAS [AFEAS 1999] provides more recent data, but does not make a specification for Europe. Interestingly next to production data AFEAS also presents emission data.

	production	production	emission	1997/1990	emiss/prod 97	Correction
	1990	1997	1997	production		
CFC11	233000	18600	110000	8%	591%	47%
CFC12	231000	32900	140000	14%	426%	61%
CFC113	175000	3000	6100	2%	203%	3%
CFC 114	15000	1200	2300	8%	192%	15%
CFC115	11300	800	7800	7%	975%	69%
HCFC141b	100	122000	43000	122000%	35%	43000%
HCFC22	214000	251000	235000	117%	94%	110%
HCFC142b	18800	40600	11600	216%	29%	62%

Table 7.7: World production data from 1990 and 1997 by AFEAS members, as well as estimated World emission data from 1997 (Source AFEAS 1999) These data have been used to develop a correction factor.

From this data, we can see two trends:

- There are big changes in production data from 1990 to 1997
- There are big differences between emission and production data

The last column in the table above presents a correction factor that includes both trends. A big problem is the correction factor for HCFC 141b. As 1990 was the year of introduction, the production was very low compared to the 1997 level. This makes extrapolation of the production rather dangerous (122000%). We use another conversion factor for this substance, based on the difference in production of HCFC 142b and HCFC 141b. The production of HCFC 141b in 1997 is three times higher. Therefore we assume that the European emission level for HCFC 141b is three times the HCFC142b level. In this case the correction factor is 17.
We have found no data on the emission trends from the producers that are not included in the AFEAS figures. Furthermore, we found no data trends for other substances.

If we would not use the correction and use the data from [BLONK ET AL 1997], the overall normalisation values would be only marginally different, as can be seen in the last row of the next table. This means that by coincidence the downward trend in the production of CFC is compensated by the upward trend of emissions of HCFCs.

	Damage factors			Emission	Correction	Corrected	Normalisation values		
Substance	Egalitarian	Hierarchist	Individualist	[BLONK ET AL 1997]		Emission	Egalitarian	Hierarchist	Individualist
	DALYs/kg	DALYs/kg	DALYs/kg	Tonnes		Tonnes	DALYs/yr	DALYs/yr	DALYs/yr
CFC-11	1.05E-03	1.05E-03	8.50E-04	16300	0.47	7695	8.08E+03	8.08E+03	6.54E+03
CFC-113	9.48E-04	9.48E-04	7.65E-04	1400	0.03	49	4.65E+01	4.65E+01	3.75E+01
CFC-114	8.95E-04	8.95E-04	7.23E-04	500	0.15	77	6.89E+01	6.89E+01	5.56E+01
CFC-115	4.21E-04	4.21E-04	3.40E-04	982	0.69	678	2.85E+02	2.85E+02	2.31E+02
CFC-12	8.63E-04	8.63E-04	6.97E-04	6430	0.61	3897	3.36E+03	3.36E+03	2.72E+03
tetrachloro-methane	1.26E-03	1.26E-03	1.02E-03	14000*	1.00	14000	1.76E+04	1.76E+04	1.43E+04
HALON-1211	5.37E-03	5.37E-03	4.34E-03	281	1.00	281	1.51E+03	1.51E+03	1.22E+03
HALON-1301	1.26E-02	1.26E-02	1.02E-02	842	1.00	842	1.06E+04	1.06E+04	8.59E+03
methyl bromide	6.74E-04	6.74E-04	5.44E-04	561	1.00	561	3.78E+02	3.78E+02	3.05E+02
HCFC-141b	1.05E-04	1.05E-04	8.50E-05	11800	17.00	200600	2.11E+04	2.11E+04	1.71E+04
HCFC-142b	5.26E-05	5.26E-05	4.25E-05	111800	0.62	68983	3.63E+03	3.63E+03	2.93E+03
HCFC-22	4.21E-05	4.21E-05	3.40E-05	43100	1.10	47329	1.99E+03	1.99E+03	1.61E+03
1,1,1-trichloro-ethane	1.26E-04	1.26E-04	1.02E-04	116000*	1.00	116000	1.46E+04	1.46E+04	1.18E+04
Totals							**8.32E+04**	**8.32E+04**	**6.73E+04**
Without correction							7.87E+04	7.87E+04	6.35E+04

Table 7.8: Normalisation data for ozone depletion. The one but last line contains the totals after correction. The last line contains the result from the calculation without correction. Figures with an asterisk are based on new data in [EEA 1997]

7.2.7. Normalisation values for ecotoxicity

In the tables 7.9a, b, c, d and e the normalisation for ecotoxicity is calculated. There is no difference between the hierarchist and egalitarian perspectives. The individualist perspective is based on a short term time frame for accumulation of heavy metals. This results in a difference of a factor of 5.

For the emissions to soil a specific emission compartment had to be chosen. The emissions of pesticides to soil are assumed to occur on agricultural soil, the emissions of metals to soil are assumed to occur on industrial soil. The main contribution to the total values is formed by the emission heavy metals to industrial soil. The total normalisation value in PAFm2yr/yr must be divided by 10 to convert it to PDF and combine it with the other damages to Ecosystem Quality.

Emissions to air	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emission	Egalitarian	Hierarchist	Individualist
Substance	PAFm2yr/kg	PAFm2yr/kg	PAFm2yr/kg	kg/yr	PAFm2yr/yr	PAFm2yr/yr	PAFm2yr/yr
1,2,3-trichlorobenzene	3.51E-01	3.51E-01	3.51E-07	1.21E+06	4.25E+05	4.25E+05	4.25E-01
1,2,4-trichlorobenzene	2.54E-01	2.54E-01	2.54E-01	1.21E+06	3.07E+05	3.07E+05	3.07E+05
1,3,5-trichlorobenzene	1.29E+00	1.29E+00	1.29E+00	1.21E+06	1.56E+06	1.56E+06	1.56E+06
Arsenic (long term)	5.92E+03	5.92E+03		3.59E+05	2.12E+09	2.12E+09	
Arsenic (short term)			5.00E+02	3.59E+05			1.79E+08
Benzene	2,75E-02	2.75E-02	2.75E-02	1.28E+08	3.52E+06	3.52E+06	3.52E+06
Benzo(a)pyreen	1.42E+03	1.42E+03	1.42E+03	1.07E+05	1.52E+08	1.52E+08	1.52E+08
Cadmium (long term)	9.65E+04	9.65E+04		1.94E+05	1.87E+10	1.87E+10	
Cadmium (short term)			2.66E+04	1.94E+05			5.16E+09
Chromium (long term)	4.13E+04	4.13E+04		4.24E+05	1.75E+10	1.75E+10	
Chromium (short term)			9.70E+02	4.24E+05			4.11E+08
Dioxins	1,32E+06	1.32E+06	1.32E+06	3.10E+00	4.09E+06	4.09E+06	4.09E+06
Fluoranthene	4,37E-01	4.37E-01	4.37E-01	2.07E+06	9.05E+05	9.05E+05	9.05E+05
Hexachlorobenzene	3.88E+02	3.88E+02	3.88E+02	3.27E+03	1.27E+06	1.27E+06	5.20E+09
Lead (long term)	2.54E+04	2.54E+04		1.34E+07	3.41E+11	3.41E+11	
Lead (short term)			3.94E+02	1.34E+07			5.28E+09
Mercury (long term)	8.29E+03	8.29E+03		1.25E+05	1.04E+09	1.04E+09	
Mercury (short term)			4.53E+02	1.25E+05			5.66E+07
Nickel (long term)	7.10E+04	7.10E+04		1.59E+06	1.13E+11	1.13E+11	
Nickel (short term)			9.06E+03	1.59E+06			1.44E+10
Pentachlorophenol	1.33E+02	1.33E+02	1.33E+02	3.20E+06	4.26E+08	4.26E+08	4.26E+08
Zinc (long term)	2.89E+04	2.89E+04		7.20E+06	2.08E+11	2.08E+11	
Zinc (short term)			6.61E+03	7.20E+06			4.76E+10
Total PAFm2yr					7.02E+11	7.02E+11	7.37E+10

Table 7.9a: Normalisation values for ecotoxicity (emissions to air)

Emissions to water	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emission	Egalitarian	Hierarchist	Individualist
Substance	PAFm2yr/kg	PAFm2yr/kg	PAFm2yr/kg	kg/yr	PAFm2yr/yr	PAFm2yr/yr	PAFm2yr/yr
1,2,3-trichlorobenzene	1.56E+00	1.56E+00	1.56E+00	2.67E+03	4.17E+03	4.17E+03	4.17E+03
1,2,4-trichlorobenzene	1.39E+00	1.39E+00	1.39E+00	2.67E+03	3.72E+03	3.72E+03	3.72E+03
1,3,5-trichlorobenzene	2.73E+00	2.73E+00	2.73E+00	2.67E+03	7.30E+03	7.30E+03	7.30E+03
Arsenic (long term)	1.14E+02	1.14E+02		9.86E+04	1.13E+07	1.13E+07	
Arsenic (short term)			9.14E+01	9.86E+04			9.01E+06
Atrazine	5.06E+02	5.06E+02	5.06E+02	1.81E+05	9.15E+07	9.15E+07	9.15E+07
Azinphos-methyl	8.87E+03	8.87E+03	8.87E+03	2.84E+04	2.52E+08	2.52E+08	2.52E+08
Bentazon	5.81E-01	5.81E-01	5.81E-01	3.11E+04	1.81E+04	1.81E+04	1.81E+04
Benzene	4.80E-01	4.80E-01	4.80E-01	4.34E+06	2.08E+06	2.08E+06	2.08E+06
Benzo(a)pyreen	3.68E+02	3.68E+02	3.68E+02	6.35E+04	2.34E+07	2.34E+07	2.34E+07
Cadmium (long term)	4.80E+03	4.80E+03		3.59E+04	1.72E+08	1.72E+08	
Cadmium (short term)			3.87E+03	3.59E+04			1.39E+08
Chromium (long term)	6.87E+02	6.87E+02		5.32E+05	3.66E+08	3.66E+08	
Chromium (short term)			5.54E+02	5.32E+05			2.95E+08
Copper (long term)	1.47E+03	1.47E+03		1.46E+06	2.14E+09	2.14E+09	
Copper (short term)			1.18E+03	1.46E+06			1.72E+09
Dichlorvos	1.81E+00	1.81E+00	1.81E+00	2.84E+04	5.13E+04	5.13E+04	5.13E+04
Diuron	2.31E+03	2.31E+03	2.31E+03	1.24E+05	2.87E+08	2.87E+08	2.87E+08
DNOC	6.73E+00	6.73E+00	6.73E+00	3.11E+04	2.09E+05	2.09E+05	2.09E+05
Fentin-acetate	7.85E+03	7.85E+03	7.85E+03	1.76E+04	1.38E+08	1.38E+08	1.38E+08
Fluoranthene	3.96E+01	3.96E+01	3.96E+01	3.14E+05	1.24E+07	1.24E+07	1.24E+07
Hexachlorobenzene	4.55E+02	4.55E+02	4.55E+02	2.76E+02	1.26E+05	1.26E+05	1.26E+05
Lead (long term)	7.39E+01	7.39E+01		2.48E+06	1.83E+08	1.83E+08	
Lead (short term)			5.95E+01	2.48E+06			1.48E+08
Lindane (gamma HCH)	1.04E+02	1.04E+02	1.04E+02	3.51E+03	3.65E+05	3.65E+05	3.65E+05
Maneb	6.23E+00	6.23E+00	6.23E+00	1.60E+05	9.96E+05	9.96E+05	9.96E+05
Mercury (long term)	1.97E+03	1.97E+03		1.33E+04	2.62E+07	2.62E+07	
Mercury (short term)			1.93E+02	1.33E+04			2.57E+06
Mevinphos	6.73E+02	6.73E+02	6.73E+02	2.84E+04	1.91E+07	1.91E+07	1.91E+07
Nickel (long term)	1.43E+03	1.43E+03		5.93E+05	8.48E+08	8.48E+08	
Nickel (short term)			1.16E+03	5.93E+05			6.85E+08
Parathion	2.48E+03	2.48E+03	2.48E+03	2.84E+04	7.04E+07	7.04E+07	7.04E+07
Pentachlorophenol	2.51E+02	2.51E+02	2.51E+02	6.10E+03	1.53E+06	1.53E+06	1.53E+06
Polychlorobiphenyls	2.58E+03	2.58E+03	2.58E+03	9.00E+01	2.32E+05	2.32E+05	2.32E+05
Simazine	6.03E+02	6.03E+02	6.03E+02	1.81E+05	1.09E+08	1.09E+08	1.09E+08
Thiram	8.74E+03	8.74E+03	8.74E+03	1.60E+05	1.40E+09	1.40E+09	1.40E+09
Toluene	1.73E+00	1.73E+00	1.73E+00	9.86E+06	1.71E+07	1.71E+07	1.71E+07
Zinc (long term)	1.63E+02	1.63E+02		1.04E+07	1.70E+09	1.70E+09	
Zinc (short term)			1.31E+02	1.04E+07			1.37E+09
Total water					7.87E+09	7.87E+09	5.10E+09

Table 7.9b: Normalisation values for ecotoxicity (emissions to water)

Emissions to agricultural soil (only pesticides)	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emissions	Egalitarian	Hierarchist	Individualist
Substance	PAFm2/kg	PAFm2/kg	PAFm2/kg	kg	PAFm2yr	PAFm2yr	PAFm2yr
2,4-D	1.27E-03	1.27E-03	1.27E-03	1.13E+06	1.43E+03	1.43E+03	1.43E+03
Atrazine	1.49E+00	1.49E+00	1.49E+00	1.79E+07	2.67E+07	2.67E+07	2.67E+07
Azinphos-methyl	3.55E+00	3.55E+00	3.55E+00	2.81E+06	9.97E+06	9.97E+06	9.97E+06
Bentazon	1.66E-01	1.66E-01	1.66E-01	3.08E+06	5.12E+05	5.12E+05	5.12E+05
Dichlorvos	7.52E-03	7.52E-03	7.52E-03	2.81E+06	2.11E+04	2.11E+04	2.11E+04
Diuron	4.07E-01	4.07E-01	4.07E-01	1.23E+07	5.01E+06	5.01E+06	5.01E+06
DNOC	6.17E-02	6.17E-02	6.17E-02	3.08E+06	1.90E+05	1.90E+05	1.90E+05
Fentin-acetate	3.84E+00	3.84E+00	3.84E+00	1.74E+06	6.68E+06	6.68E+06	6.68E+06
Lindane (gamma HCH)	1.38E+01	1.38E+01	1.38E+01	7.83E+06	1.08E+08	1.08E+08	1.08E+08
Maneb	2.61E+00	2.61E+00	2.61E+00	1.58E+07	4.12E+07	4.12E+07	4.12E+07
Mevinphos	2.09E+00	2.09E+00	2.09E+00	2.81E+06	5.88E+06	5.88E+06	5.88E+06
Parathion	3.24E-01	3.24E-01	3.24E-01	2.81E+06	9.10E+05	9.10E+05	9.10E+05
Simazine	3.87E+00	3.87E+00	3.87E+00	1.79E+07	6.92E+07	6.92E+07	6.92E+07
Thiram	9.96E+00	9.96E+00	9.96E+00	1.58E+07	1.57E+08	1.57E+08	1.57E+08
Total agricultural soil					4.32E+08	4.32E+08	4.32E+08

Table 7.9c: Normalisation values for ecotoxicity (emissions to agricultural soil)

Emissions to industrial soil (only metals)	Damage factors				Normalisation values		
	Egalitarian	Hierarchist	Individualist	Emissions	Egalitarian	Hierarchist	Individualist
Substance	PAFm2/kg	PAFm2/kg	PAFm2/kg	kg/yr	PAFm2yr	PAFm2yr	PAFm2yr
Arsenic (long term)	6.10E+03	6.10E+03		3.70E+04	2.26E+08	2.26E+08	
Arsenic (short term)			6.43E+02	3.70E+04			2.38E+07
Cadmium (long term)	9.94E+04	9.94E+04		1.58E+05	1.57E+10	1.57E+10	
Cadmium (short term)			3.35E+04	1.58E+05			5.29E+09
Chromium (long term)	4.24E+04	4.24E+04		1.32E+06	5.59E+10	5.59E+10	
Chromium (short term)			1.24E+03	1.32E+06			1.64E+09
Copper (long term)	1.50E+04	1.50E+04		1.94E+07	2.90E+11	2.90E+11	
Copper (short term)			2.44E+03	1.94E+07			4.73E+10
Lead (long term)	1.29E+02	1.29E+02		6.78E+06	8.73E+08	8.73E+08	
Lead (short term)			6.83E+00	6.78E+06			4.63E+07
Mercury (long term)	1.68E+04	1.68E+04		5.18E+03	8.71E+07	8.71E+07	
Mercury (short term)			1.03E+03	5.18E+03			5.34E+06
Nickel (long term)	7.32E+04	7.32E+04		6.45E+05	4.72E+10	4.72E+10	
Nickel (short term)			1.16E+04	6.45E+05			7.49E+09
Zinc (long term)	2.98E+04	2.98E+04		6.58E+07	1.96E+12	1.96E+12	
Zinc (short term)			8.39E+03	6.58E+07			5.52E+11
Total industrial soil					2.37E+12	2.37E+12	6.14E+11

Table 7.9d: Normalisation values for ecotoxicity (emissions to industrial soil)

	Egalitarian	Hierarchist	Individualist
Emissions to:			
air	7.02E+11	7.02E+11	7.37E+10
water	7.87E+09	7.87E+09	5.10E+09
agricultural soil	4.32E+08	4.32E+08	4.32E+08
industrial soil	2.37E+12	2.37E+12	6.14E+11
Totals	3.08E+12	3.08E+12	6.93E+11

Table 7.9e: Normalisation values for ecotoxicity (totals)

7.2.8. Normalisation values for acidification and eutrophication

Normalisation data is based on the Corinair inventory for 1994 [EEA 1997]. The contribution of SOx is remarkably low. This can be explained by the low or even negative contribution of this substance to the eutrophication.

Normalisation	Emission kg/year [EEA 1997]	Characterisation PDFm2yr/kg (60% deposition on natural areas)	PDFm2yr/yr in Europe	Percentage of total damage
SOx to air (as SO_2)	1.21E+10	1.04	1.26E+10	9%
NOx to air (as NO_2)	1.29E+10	5.71	7.37E+10	51%
NH3 to air	3.62E+09	15.56	5.63E+10	40%
Total			1.43E+11	

Table 7.10: Normalisation values for acidification/eutrophication

7.2.9. Normalisation values for land-use

Data for land-use are derived from Eurostat

	relative share of total area [EUROSTAT 1995]	Of which x% is organic or not intensive	Area (m2)	PDF	Damage in PDFm2yr/yr	% of total	% damage in Europe
Total surface			3.24E+12				
cropland	21.9%		4.97E+11	1.15	5.71E+11	38%	18%
organic arable		30.0%	2.13E+11	1.09	2.32E+11	15%	7%
grassland	13.6%		2.20E+11	1.13	2.49E+11	17%	8%
not intensive meadow		50.0%	2.20E+11	1.02	2.25E+11	15%	7%
long term crop	3.3%		1.07E+11	1.09	1.17E+11	8%	4%
woods	34.6%		1.12E+12		0.00E+00	0%	0%
Other soils	22.6%		7.32E+11		0.00E+00	0%	0%
Urban	4.0%		1.30E+11	0.84	1.09E+11	7%	3%
	100.0%		3.24E+12		**1.50E+12**	100%	46%

Table 7.11: Normalisation data for land-use

7.2.10. Normalisation values for Resources

The data on consumption of materials in Europe is scarce; [BLONK ET AL 1997] only gives a very few estimates for minerals. To get a better estimate, we used the apparent consumption data for the USA [USGS 1999]. These figures were divided by the number of US population (266 million) and multiplied by the European population (386 million).

Minerals	Characterisation Surplus energy at Q=5 (MJ/kg)	Normalisation kg/yr [BLONK ET AL 1997]	Apparent consumption USA in (kg/yr)	Extrapolated to Europe on per cap. basis (kg/yr)	Surplus energy [MJ/yr]
Aluminium	2.38		6.90E+06	1.00E+07	2.38E+07
Chromium	0.9165		5.20E+05	7.53E+05	6.90E+05
Copper	36.7		3.03E+06	4.39E+06	1.61E+08
Iron	0.051		1.13E+08	1.64E+08	8.36E+06
Lead	7.35	1.60E+09	1.72E+06	2.49E+06	1.83E+07
Manganese	0.313		7.55E+05	1.09E+06	3.41E+05
Mercury	165.5	1.53E+06	4.00E+05	5.80E+05	9.60E+07
Molybdenum	41		2.36E+07	3.42E+07	1.40E+09
Nickel	23.75		1.59E+08	2.30E+08	5.46E+09
Tin	600		5.30E+07	7.68E+07	4.61E+10
Tungsten	154.5		1.28E+07	1.85E+07	2.86E+09
Uranium		1.91E+08	0.00E+00	0.00E+00	0.00E+00
Zinc	4.09		1.52E+06	2.20E+06	9.00E+06
Surplus energy from minerals in MJ					5.61E+10

Table 7.12: Normalisation values for mineral resource consumption

For energy more data is available. The most recent data is [WORLD RESOURCES 1998-1999]. Unfortunately This source does not distinguish between different types of solid fuels [ESU 1996] estimates that about 36% of the coal used in Europe is brown coal, the rest is hard coal, of which 50% is extracted as open pit mining.

All in PJ	Traditional Fuels	Commercial energy (Prod-exp+import)	Primary non fossil energy for electricity	Gaseous	Liquid fuels	Solid fuels	total PJ
Austria	32	101	139	57	45	14	255
Belgium	20	2035	455	0	0	7	462
Denmark	29	738	4	210	384	0	598
Finland	64	1078	256	0	0	85	341
France{b}	98	9045	4383	130	123	230	4866
Germany	100	13511	1766	669	122	3303	586
Greece	15	1008	14	2	19	314	349
Iceland	0	51	27	0	0	0	27
Ireland	1	442	4	105	0	47	156
Italy	128	6906	274	760	219	4	1258
Netherlands	14	3367	45	2812	148	0	3006
Norway	11	905	441	1309	5911	8	7569
Portugal	6	716	32	0	0	3	35
Spain	28	3667	692	18	33	399	1142
Sweden	54	1717	1003	0	0	10	1013
Switzerland	23	928	401	0	0	0	401
Kingdom	105	908	993	2866	5181	1328	10671
Total Western Europe (PJ)	728	47123	10929	8938	12185	5752	32735

Table 7.13: Energy consumption in Europe per year

Based on these data, The normalisation values for fossil fuels for the different perspectives are demonstrated in the table below. For the individualist perspective no normalisation value for fossil fuel is calculated. It is assumed that the Individualist is not convinced that the depletion of fossil resources is a problem. This aspect is therefore not included in the individualist perspective.

Egalitarian	surplus energy MJ/MJ	Yearly consumption	Normalisation (MJ/yr)
Conventional natural gas	0.089	8.94E+12 MJ	7.95E+11
Conventional oil	0.083	1.22E+13 MJ	1.01E+12
Hard coal, open pit mining	0.082	1.84E+12 MJ	1.51E+11
Hard coal, underground mining	0.065	1.84E+12 MJ	1.20E+11
Brown coal, open pit mining	0.061	2.07E+12 MJ	1.26E+11
Normalisation value for Egalitarians (MJ/yr)			2.20E+12

Table 7.14: Normalisation values for fossil fuels for the egalitarian perspective

Hierarchist	surplus energy MJ/kg or MJ/MJ	yearly consumption	Normalisation (MJ/yr)
Conventional natural gas	0.15	8.94E+12 MJ	1.34E+12
Conventional oil	0.144	1.22E+13 MJ	1.75E+12
Hard coal, open pit mining	0.021	1.84E+12 MJ	3.87E+10
Hard coal, underground mining	0.004	1.84E+12 MJ	7.36E+09
Brown coal, open pit mining	0	2.07E+12 MJ	0.00E+00
Normalisation value for Hierarchist (MJ/yr)			3.14E+12

Table 7.15: Normalisation values for fossil fuels for the hierarchist perspective

7.2.11. Summary of the normalisation values

Egalitarian						
	Air	Water	Industrial soil	Agricultural soil	Total	per inhabitant
Carcinogenic effects [DALY/yr]	1.99E+05	3.10E+05	1.83E+05	6.77E+04	7.60E+05	2.00E-03
Respiratory (inorganic) [DALY/yr]	4.09E+06				4.09E+06	1.08E-02
Respiratory (organic) [DALY/yr]	2.60E+04				2.60E+04	6.84E-05
Climate Change [DALY/yr]	9.08E+05				9.08E+05	2.39E-03
Radiation [DALY/yr]	1.01E+04	9.84E+01			1.02E+04	2.68E-05
Ozone depletion [DALY/yr]	8.32E+04				8.32E+04	2.19E-04
Total Human health [DALY/yr]	**5.31E+06**	**3.10E+05**	**1.83E+05**	**6.77E+04**	**5.88E+06**	1.55E-02
Ecotoxicity (PAFm2yr/yr)	7.02E+11	7.87E+09	2.37E+12	4.32E+08	3.08E+12	8.11E+03
Ecotoxicity (PDFm2yr/yr)	7.02E+10	7.87E+08	2.37E+11	4.32E+07	3.08E+11	8.11E+02
Acidification/nutrification (PDF m2yr/yr)	1.43E+11				1.43E+11	3.75E+02
Land-use (PDF m2yr/yr)	1.50E+12				1.50E+12	3.95E+03
Total Ecosytem Quality (PDF.m2.yr/yr.)	**1.71E+12**	**7.87E+08**	**2.37E+11**	**4.32E+07**	**1.95E+12**	5.13E+03
Minerals [MJ/yr]					5.61E+10	1.48E+02
Fossil [MJ/yr					2.20E+12	5.79E+03
Total Resources [MJ/yr					**2.26E+12**	5.94E+03
Hierarchist						
	Air	Water	Industrial soil	Agricultural soil	Total	
Carcinogenic effects [DALY/yr]	1.99E+05	3.10E+05	1.83E+05	6.77E+04	7.60E+05	2.00E-03
Respiratory (inorganic) [DALY/yr]	4.05E+06				4.05E+06	1.07E-02
Respiratory (organic) [DALY/yr]	2.60E+04				2.60E+04	6.84E-05
Climate Change [DALY/yr]	9.08E+05				9.08E+05	2.39E-03
Radiation [DALY/yr]	1.01E+03	9.84E+01			1.02E+04	2.68E-05
Ozone depletion [DALY/yr]	8.32E+04				8.32E+04	2.19E-04
Total Human health [DALY/yr]	**5.27E+06**	**3.10E+05**	**1.83E+05**	**6.77E+04**	**5.84E+06**	1.54E-02
Ecotoxicity (PAFm2yr/yr)	7.02E+11	7.87E+09	2.37E+12	4.32E+08	3.08E+12	8.11E+03
Ecotoxicity (PDFm2yr/yr)	7.02E+10	7.87E+08	2.37E+11	4.32E+07	3.08E+11	8.11E+02
Acidification/nutrification (PDF m2yr/yr)	1.43E+11				1.43E+11	3.75E+02
Land-use (PDF m2yr/yr)	1.50E+12				1.50E+12	3.95E+03
Total Ecosytem Quality (PDF.m2.yr/yr.)	**1.71E+12**	**7.87E+08**	**2.37E+11**	**4.32E+07**	**1.95E+12**	5.13E+03
Minerals [MJ/yr]					5.61E+10	1.48E+02
Fossil [MJ/yr					3.14E+12	8.26E+03
Total Resources [MJ/yr					**3.20E+12**	8.41E+03
Individualist						
	Air	Water	Industrial soil	Agricultural soil	Total	
Carcinogenic effects [DALY/yr]	1.40E+04	6.20E+04	3.06E+03	0.00E+00	7.91E+04	2.08E-04
Respiratory (inorganic) [DALY/yr]	2.09E+06				2.09E+06	5.50E-03
Respiratory (organic) [DALY/yr]	2.42E+04				2.42E+04	6.37E-05
Climate Change [DALY/yr]	8.72E+05				9.09E+06	2.29E-03
Radiation [DALY/yr]	9.38E+02	5.74E+01			9.95E+02	2.62E-06
Ozone depletion [DALY/yr]	6.73E+04				6.73E+04	1.77E-04
Total Human health [DALY/yr]	**3.07E+06**	**6.21E+04**	**3.06E+03**	**0.00E+00**	**3.13E+06**	8.25E-03
Ecotoxicity (PAFm2yr/yr)	7.37E+10	5.10E+09	6.14E+11	4.32E+08	6.93E+11	1.82E+03
Ecotoxicity (PDFm2yr/yr)	7.37E+09	5.10E+08	6.14E+10	4.32E+07	6.93E+10	1.82E+02
Acidification/nutrification (PDF m2yr/yr)	1.43E+11				1.43E+11	3.76E+02
Land-use (PDF m2yr/yr)	1.50E+12				1.50E+12	3.95E+03
Total Ecosytem Quality (PDF.m2.yr/yr.)	**1.65E+12**	**2.62E+08**	**6.14E+10**	**4.32E+07**	**1.71E+12**	4.51E+03
Minerals [MJ/yr]					5.61E+10	1.48E+02
Fossil [MJ/yr					0.00E+00	0.00E+00
Total Resources [MJ/yr					**5.61E+10**	1.48E+02

Table 7.16: Normalisation values for Europe (totals for Europe and per habitant)

7.3. Weighting

The relevant data is described in the methodology report.

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