

In which  $D_{\text{refsub}}$  represents the damage factor for either CO<sub>2</sub>(as C), CH<sub>4</sub> or N<sub>2</sub>O presented in table 4.8, and  $GWP_{\text{refsub}}$  represents the global warming potential for one of the three reference substances.

#### 4.6.6. The role of cultural perspectives

The following choices are made for the three perspectives:

- Individualists use age weighting in the calculation of DALYs, and they use the short time perspective, which is set at 100 years.
- Hierarchists do not use age weighting, but would disregard the effect of displacements. They would argue that displacements are not a big problem if it is well organised.
- Egalitarians also do not use age weighting, but they do include the effects of displacements.

With these choices it is possible to calculate both the positive and negative damages (table 4.8).

		Negative damages			Positive damages			Negative damage as percentage of positive		
		Total E-attitude	Total H-attitude	Total I-attitude	Total E-attitude	Total H-attitude	Total I-attitude	E	H	I
		DALY <sub>(0,0)</sub>	DALY <sub>(0,0)</sub>	DALY <sub>(0,1)</sub>	DALY <sub>(0,0)</sub>	DALY <sub>(0,0)</sub>	DALY <sub>(0,1)</sub>			
CO <sub>2</sub> up to 2100	per tC			-1.8E-5			7.4E-4			2.4%
CO <sub>2</sub> up to 2200	per tC	-2.5E-5	-2.5E-5		7.5E-4	7.5E-4		3.3%	3.3%	
CH <sub>4</sub> up to 2100	per tCH <sub>4</sub>			-1.3E-4			4.4E-3			3.0%
CH <sub>4</sub> up to 2200	per tCH <sub>4</sub>	-2.0E-4	-1.9E-4		4.4E-3	4.4E-3		4.5%	4.3%	
N <sub>2</sub> O up to 2100	per tN <sub>2</sub> O			-1.5E-3			6.7E-2			2.2%
N <sub>2</sub> O up to 2200	per tN <sub>2</sub> O	-2.1E-3	-2.1E-3		6.9E-2	6.9E-2		3.0%	3.0%	

Table 4.8: Positive and negative human health damages per ton emitted substance, expressed in DALYs, for three cultural perspectives. The last three columns show the relative importance of the negative damages, which have not been incorporated

#### 4.6.7. Sources of uncertainty

The overall uncertainties for the damage factors are represented by a  $\sigma_g^2$  value that ranges from between 1 for CO<sub>2</sub> to 10. These are only the technical uncertainties. As stated in the beginning of this section, there are many conceptual uncertainties.

The following potential health effects are not considered in this assessment (see table 4.6):

- Other diseases than vascular diseases due to heat waves; death, injuries, psychological disorders, and damage to public health infrastructure due to extreme weather events;
- Other vector-borne diseases than malaria, schistosomiasis, dengue; infectious diseases<sup>13</sup>;
- Effects of malnutrition and hunger;
- Increased impact of pollutants at higher temperatures,
- Civil strife etc.

All these direct and indirect consequences may have significant effects on the damage assessment. It is therefore not clear whether the quantified effects are the most important ones!

Next to these data gaps [WATSON ET AL 1998:7] remind that "quantifying the projected health impacts is difficult because the extent of climate-induced health disorders depends on other factors – such as migration, provision of clean urban environments, improved nutrition, increased availability of potable water, improvements in sanitation, the extent of disease vector-control measures, changes in resistance of vector organisms to insecticides, and more widespread availability of health care."

<sup>13</sup> An illustrative example to indicate the importance of such omissions: The serious African horse sickness (mortality rate 95% in susceptible animals) appears to be directly related to the El Niño events (Nature, vol. 397, 18 February 1999, p.547). 13 of the 14 major epidemics in the horse sickness since 1803 coincided with the El Niño events.

## 7.5. The European LCA

Normalisation values for Europe are calculated using the report from [BLONK ET AL 1996]. The values from Blonk are updated with the latest European data on emissions, radiation and land-use (see annex report) In table 7.5 the normalisation values for Europe are summarised.

<b>Egalitarian</b>						
	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
<b>Total Human health [DALY/yr]</b>	<b>5.31E+06</b>	<b>3.10E+05</b>	<b>1.83E+05</b>	<b>6.77E+04</b>	<b>5.88E+06</b>	<b>1.55E-02</b>
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/nitrification (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
<b>Total Ecosystem Quality (PDF.m2.yr/yr.)</b>	<b>1.71E+12</b>	<b>7.87E+08</b>	<b>2.37E+11</b>	<b>4.32E+07</b>	<b>1.95E+12</b>	<b>5.13E+03</b>
Minerals [MJ/yr]					5.69E+10	1.50E+02
Fossil [MJ/yr]					2.20E+12	5.79E+03
<b>Total Resources [MJ/yr]</b>					<b>2.26E+12</b>	<b>5.94E+03</b>
<b>Hierarchist</b>						
	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
<b>Total Human health [DALY/yr]</b>	<b>5.27E+06</b>	<b>3.10E+05</b>	<b>1.83E+05</b>	<b>6.77E+04</b>	<b>5.84E+06</b>	<b>1.54E-02</b>
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/nitrification (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
<b>Total Ecosystem Quality (PDF.m2.yr/yr.)</b>	<b>1.71E+12</b>	<b>7.87E+08</b>	<b>2.37E+11</b>	<b>4.32E+07</b>	<b>1.95E+12</b>	<b>5.13E+03</b>
Minerals [MJ/yr]					5.69E+10	1.50E+02
Fossil [MJ/yr]					3.14E+12	8.26E+03
<b>Total Resources [MJ/yr]</b>					<b>3.20E+12</b>	<b>8.41E+03</b>
<b>Individualist</b>						
	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
<b>Total Human health [DALY/yr]</b>	<b>3.07E+06</b>	<b>6.21E+04</b>	<b>3.06E+03</b>	<b>0.00E+00</b>	<b>3.13E+06</b>	<b>8.25E-03</b>
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/nitrification (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
<b>Total Ecosystem Quality (PDF.m2.yr/yr.)</b>	<b>1.65E+12</b>	<b>2.62E+08</b>	<b>6.14E+10</b>	<b>4.32E+07</b>	<b>1.71E+12</b>	<b>4.51E+03</b>
Minerals [MJ/yr]					5.69E+10	1.50E+02
Fossil [MJ/yr]					0.00E+00	0.00E+00
<b>Total Resources [MJ/yr]</b>					<b>5.69E+10</b>	<b>1.50E+02</b>

Table 7.5: Normalisation values for Europe (totals for Europe and per inhabitant)

With the calculated normalisation figures and the weights it is possible to show the contribution of the impact categories to the three damage categories for the three perspectives:  
 For the hierarchist perspective (figure 7.9) the default weighting set is used, as we propose this combination as the default method. For the egalitarian and individualist perspective their matching weighting set is used.

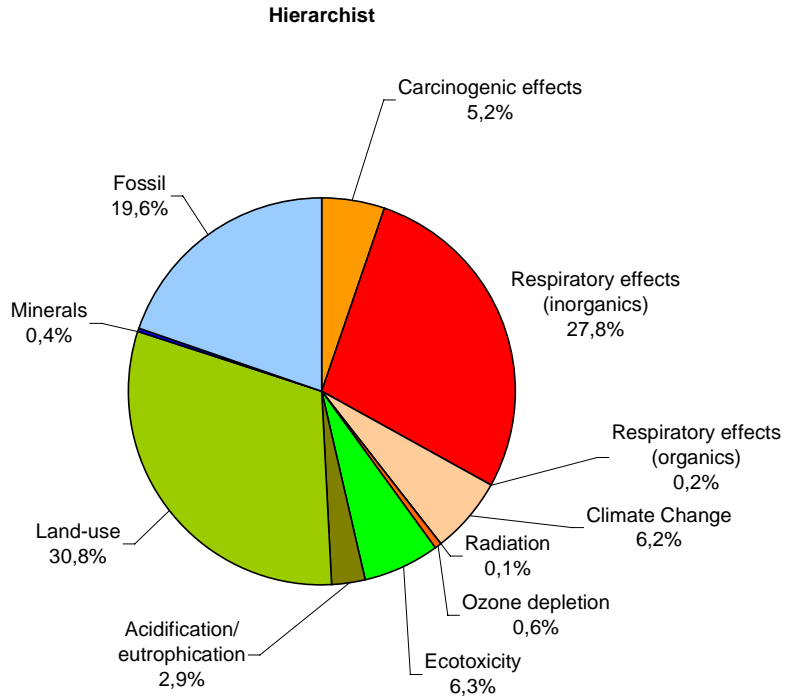


Figure 7.9.: Relative contribution of the impact categories to the European damage according to the hierarchist perspective, using the default weighting set (HH=40%,EQ=40%, R=20%).

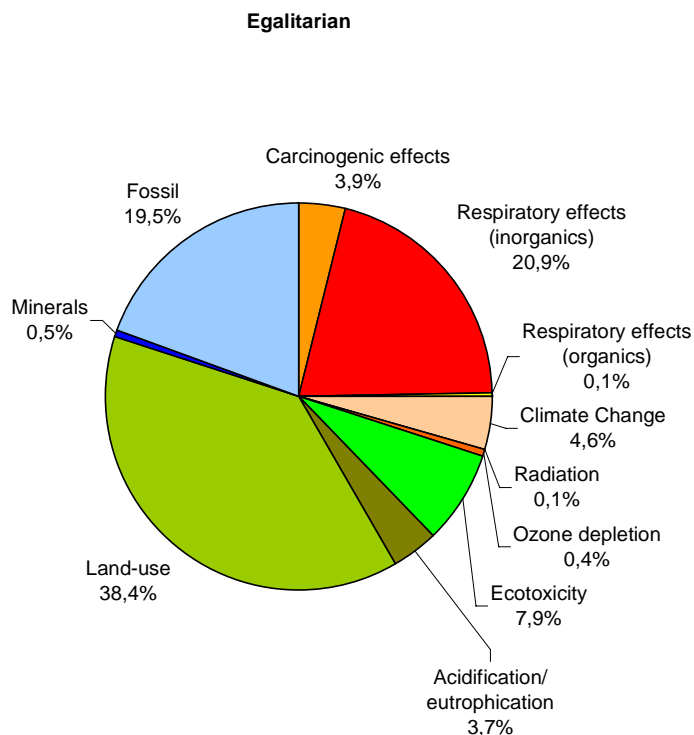


Figure 7.10. Relative contribution of the impact categories to the European damage according to the egalitarian perspective, using the weighting set for the egalitarian perspective (HH=30%,EQ=50%, R=20%).

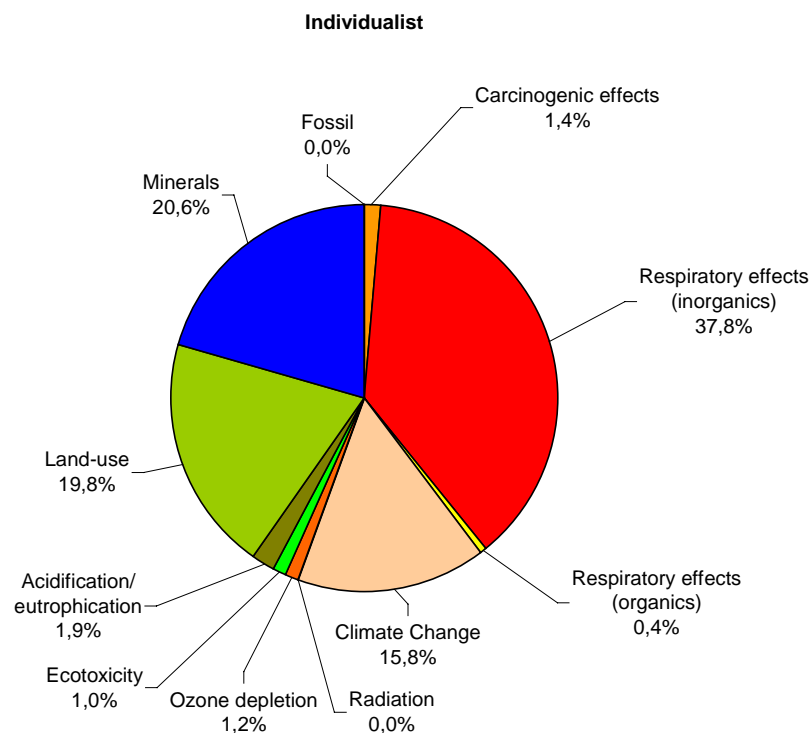


Figure 7.11: Relative contribution of the impact categories to the European damage according to the individualist perspective, using the weighting set for the individualist perspective (HH=55%, EQ=25%, R=20%).

The figures have been compiled by using the normalisation set of the yearly emissions, land-use and resource consumption per European inhabitant, as an input (inventory result) to the methodology. By definition, the result is 1000 Eco-indicator points<sup>34</sup>. The distribution of the shares over this result can be read as follows:

1. The weighting set determines which percentage of the damage is attributed to the damage categories.
2. The normalisation set determines the subdivision within the damage categories.

As explained in box 7.2 the result must be considered as a marginal and not an actual damage.

Therefore comparison with other methods to calculate the damages in Europe is not directly possible.

From these figures some important conclusions can be drawn:

- In the hierarchist perspective, combined with the default weighting, land-use, respiratory effects as a result of inorganic substances and fossil fuels are clearly the most important impact categories.
- Surprisingly, some impact categories turn out to be quite insignificant on the European scale. In all perspectives the damages caused by respiratory effects due to organic substances (“summer smog”), ionising radiation, and ozone depletion. Of course this does not mean that these impact categories are a non-issue. For instance if an LCA is made of a paint system with organic solvents, or a nuclear power plant or an airconditioner, these impact categories could become quite significant, or even dominant.
- The high importance of land-use, especially in the egalitarian case, has as a consequence that ecotoxicity and acidification/eutrophication seem relatively unimportant.
- In the individualist perspective, respiratory effects due to inorganic substances is dominating, while for instance carcinogenic effects are quite insignificant. This can be explained as the Individualist perspective only considers a small number of substances. As a result respiratory effects becomes

<sup>34</sup> The normalisation set is used to calculate the values for the three damage categories. In the normalisation step this result is divided by exactly the same normalisation factors. As a result the three normalised damage scores each have the value of one. As the sum of the weighting factors is 1000 (see box 8.1), multiplication with the weighting set results in the value 1000.

dominant within the human health damage category. As the weight of this category is relatively high (55%) respiratory effects dominate the picture.

- In the individualist perspective fossil fuels are not included, As the only remaining impact category is depletion of minerals, this becomes very important.
- There are very significant differences with the Eco-indicator 95 method in this method, the highest contribution came from ozone layer depletion, followed by pesticides, carcinogenic substances and acidification. The lower importance effects were heavy metals, winter smog and eutropication, while the lowest contribution came from summer smog and the greenhouse effect.

Perhaps the most important conclusion is that a damage approach such as the Eco-indicator 99 can show which impact categories are on average really important, and which are probably only important in specific cases. See also [BRAUNSCHWEIG et al 1998].

# 1 Damage factors in the hierarchist perspective (default) (H,A)

This annex lists the Eco-indicator 99 damage factors for the substance lists that can be found in most popular LCA databases. In this case the hierarchist perspective is used, combined with the default (average) weighting factors. Next to the damage factors two columns are added with the normalised and weighted damages. The normalisation factors and the weights are specified below:

	Normalisation	Weights
Human Health	1.54E-02	400
Ecosystem Quality	5.13E+03	400
Resources	8.41E+03	200

Below the impact categories are listed per damage category.

## 1.1 Damage category Human Health (H,A)

The human health damages are specified in DALYs. This is short for Disability Adjusted Life Years. A damage of 1 means one life year of one individual is lost, or one person suffers four year from a disability with a weight of 0.25.

### 1.1.1 Carcinogenic effects on humans (H,A)

For the fate and exposure it is important to distinguish emissions to soil between emissions in industrial (ind.) or agricultural (agr.) soil. All emissions of pesticides are assumed to occur in agricultural soil, all other emissions are assumed to occur in industrial (or urban) soil. No direct emissions are assumed to occur in natural soil.

Fate factors are calculated with EUSES. Substances from IARC substances groups 1, 2a and 2b are included.

All damage factors are expressed per kg emission. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,2-dibromoethane	2.60E-04	1.69E-02	6.75E+00
Air	1,2-dichloroethane	2.98E-05	1.94E-03	7.74E-01
Air	1,3-butadiene	1.58E-05	1.03E-03	4.10E-01
Air	1,4-dioxane	1.39E-07	9.03E-06	3.61E-03
Air	2,4,6-trichlorophenol	2.05E-06	1.33E-04	5.32E-02
Air	acetaldehyde	2.16E-07	1.40E-05	5.61E-03
Air	acrylonitrile	1.69E-05	1.10E-03	4.39E-01
Air	alpha-hexachlorocyclohexan	3.00E-04	1.95E-02	7.79E+00
Air	Arsenic	2.46E-02	1.60E+00	6.39E+02
Air	Bis(chloromethyl)ether	7.48E-03	4.86E-01	1.94E+02
Air	benzene	2.50E-06	1.62E-04	6.49E-02
Air	benzo(a)anthracene	5.86E-02	3.81E+00	1.52E+03
Air	benzo(a)pyrene	3.98E-03	2.58E-01	1.03E+02
Air	benzotrichloride	6.60E-03	4.29E-01	1.71E+02
Air	benzylchloride	1.04E-05	6.75E-04	2.70E-01
Air	beta-chlorocyclohexan	9.99E-05	6.49E-03	2.59E+00
Air	bromodichloromethane	8.76E-06	5.69E-04	2.28E-01
Air	Cadmium	1.35E-01	8.77E+00	3.51E+03
Air	Chromium (VI)	1.75	1.14E+02	4.55E+04
Air	di(2-ethylhexyl)phthalate	3.38E-05	2.19E-03	8.78E-01
Air	dibenz(a)anthracene	3.10E+01	2.01E+03	8.05E+05
Air	dichloromethane	4.36E-07	2.83E-05	1.13E-02
Air	Dichlorvos	3.15E-05	2.05E-03	8.18E-01
Air	2,3,7,8-TCDD Dioxin	1.79E+02	1.16E+04	4.65E+06
Air	epichlorohydrin	3.02E-07	1.96E-05	7.84E-03
Air	ethylene oxide	1.83E-04	1.19E-02	4.75E+00

Air	formaldehyde	9.91E-07	6.44E-05	2.57E-02
Air	gamma-HCH (Lindane)	3.49E-04	2.27E-02	9.06E+00
Air	Hexachlorobenzene	8.25E-02	5.36E+00	2.14E+03
Air	metals	5.20E-03	3.38E-01	1.35E+02
Air	Nickel	2.35E-02	1.53E+00	6.10E+02
Air	Nickel-refinery-dust	4.74E-02	3.08E+00	1.23E+03
Air	Nickel-subsulfide	9.48E-02	6.16E+00	2.46E+03
Air	PAH's	1.70E-04	1.10E-02	4.42E+00
Air	particles diesel soot	9.78E-06	6.35E-04	2.54E-01
Air	Polychlorobiphenyls	1.97E-03	1.28E-01	5.12E+01
Air	pentachlorophenol	7.21E-03	4.68E-01	1.87E+02
Air	propyleneoxide	1.17E-05	7.60E-04	3.04E-01
Air	styrene	2.44E-08	1.58E-06	6.34E-04
Air	perchloroethylene	4.82E-07	3.13E-05	1.25E-02
Air	carbontetrachloride	8.38E-04	5.44E-02	2.18E+01
Air	chloroform	2.63E-05	1.71E-03	6.83E-01
Air	vinyl chloride	2.09E-07	1.36E-05	5.43E-03
Water	1,2-dibromoethane	1.24E-03	8.05E-02	3.22E+01
Water	1,2-dichloroethane	2.98E-05	1.94E-03	7.74E-01
Water	1,3-butadiene	3.37E-04	2.19E-02	8.75E+00
Water	1,4-dioxane	9.21E-07	5.98E-05	2.39E-02
Water	2,4,6-trichlorophenol	1.05E-05	6.82E-04	2.73E-01
Water	acetaldehyde	9.23E-07	5.99E-05	2.40E-02
Water	acrylonitrile	4.16E-05	2.70E-03	1.08E+00
Water	alpha-hexachlorocyclohexan	6.85E-03	4.45E-01	1.78E+02
Water	Arsenic	6.57E-02	4.27E+00	1.71E+03
Water	Bis(chloromethyl)ether	1.54E-02	1.00E+00	4.00E+02
Water	benzene	4.12E-06	2.68E-04	1.07E-01
Water	benzo(a)anthracene	6.58E-01	4.27E+01	1.71E+04
Water	benzo(a)pyrene	2.99	1.94E+02	7.77E+04
Water	benzotrichloride	9.46E-03	6.14E-01	2.46E+02
Water	benzylchloride	1.98E-05	1.29E-03	5.14E-01
Water	beta-chlorocyclohexan	5.75E-03	3.73E-01	1.49E+02
Water	bromodichloromethane	9.36E-06	6.08E-04	2.43E-01
Water	Cadmium	7.12E-02	4.62E+00	1.85E+03
Water	Chromium (VI)	3.43E-01	2.23E+01	8.91E+03
Water	di(2-ethylhexyl)phthalate	6.64E-04	4.31E-02	1.72E+01
Water	dibenz(a)anthracene	4.07E+01	2.64E+03	1.06E+06
Water	dichloromethane	4.97E-07	3.23E-05	1.29E-02
Water	Dichlorvos	1.17E-05	7.60E-04	3.04E-01
Water	dioxins (TEQ)	2.02E+03	1.31E+05	5.25E+07
Water	epichlorohydrin	9.90E-07	6.43E-05	2.57E-02
Water	ethylene oxide	1.39E-04	9.03E-03	3.61E+00
Water	formaldehyde	4.97E-06	3.23E-04	1.29E-01
Water	gamma-HCH (Lindane)	4.16E-03	2.70E-01	1.08E+02
Water	hexachlorobenzene	1.25E-01	8.12E+00	3.25E+03
Water	Nickel	3.11E-02	2.02E+00	8.08E+02
Water	Nickel-subsulfide	5.02E-03	3.26E-01	1.30E+02
Water	Nickel-refinery-dust	1.00E-02	6.49E-01	2.60E+02
Water	PAH's	2.60E-03	1.69E-01	6.75E+01
Water	Polychlorobiphenyls	3.91E-02	2.54E+00	1.02E+03
Water	pentachlorophenol	2.29E-02	1.49E+00	5.95E+02
Water	propylene oxide	1.74E-05	1.13E-03	4.52E-01
Water	styrene	1.22E-06	7.92E-05	3.17E-02
Water	perchloroethylene	4.72E-07	3.06E-05	1,23E-02
Water	carbontetrachloride	8.29E-04	5.38E-02	2.15E+01
Water	chloroform	2.60E-05	1.69E-03	6.75E-01
Water	vinyl chloride	2.84E-07	1.84E-05	7.38E-03
Soil	1,2-dibromoethane (ind.)	3.81E-03	2.47E-01	9.90E+01
Soil	1,2-dichloroethane (ind.)	4.58E-04	2.97E-02	1.19E+01
Soil	1,3-butadiene (ind.)	1.20E-05	7.79E-04	3.12E-01
Soil	1,4-dioxane (ind.)	3.10E-07	2.01E-05	8.05E-03
Soil	2,4,6-trichlorophenol (ind.)	2.76E-06	1.79E-04	7.17E-02
Soil	acetaldehyde (ind.)	4.77E-07	3.10E-05	1.24E-02
Soil	acrylonitrile (ind.)	7.01E-05	4.55E-03	1.82E+00
Soil	alpha-hexachlorocyclohexan (agr.)	2.32E-02	1.51E+00	6.03E+02
Soil	Arsenic (ind.)	1.32E-02	8.57E-01	3.43E+02
Soil	Bis(chloromethyl)ether (ind.)	1.68E-02	1.09E+00	4.36E+02
Soil	benzene (ind.)	1.33E-05	8.64E-04	3.45E-01
Soil	benzo(a)anthracene (ind.)	1.60E-01	1.04E+01	4.16E+03
Soil	benzo(a)pyrene (ind.)	2.06E-03	1.34E-01	5.35E+01
Soil	benzotrichloride (ind.)	1.32E-01	8.57E+00	3.43E+03
Soil	benzylchloride (ind.)	4.16E-05	2.70E-03	1.08E+00

Soil	beta-chlorocyclohexan (agr.)	7.36E-03	4.78E-01	1.91E+02
Soil	bromodichloromethane (ind.)	7.82E-05	5.08E-03	2.03E+00
Soil	Cadmium (ind.)	3.98E-03	2.58E-01	1.03E+02
Soil	Chromium (ind.)	2.71E-01	1.76E+01	7.04E+03
Soil	di(2-ethylhexyl)phthalate(ind)	3.18E-07	2.06E-05	8.26E-03
Soil	dibenz(a)anthracene (ind.)	2.44E+01	1.58E+03	6.34E+05
Soil	dichloromethane (ind.)	5.99E-06	3.89E-04	1.56E-01
Soil	Dichlorvos (agr.)	2.25E-05	1.46E-03	5.84E-01
Soil	2,3,7,8-TCDD Dioxin (ind.)	7.06	4.58E+02	1.83E+05
Soil	epichloorhydrin (ind.)	1.30E-06	8.44E-05	3.38E-02
Soil	ethyleenoxide (ind.)	2.38E-03	1.55E-01	6.18E+01
Soil	formaldehyde (ind.)	1.83E-06	1.19E-04	4.75E-02
Soil	gamma-HCH (Lindane) (agr.)	8.64E-03	5.61E-01	2.24E+02
Soil	hexachlorobenzene (ind.)	1.47E-01	9.55E+00	3.82E+03
Soil	Nickel (ind.)	3.94E-03	2.56E-01	1.02E+02
Soil	Nickel-refinery-dust (ind.)	6.37E-03	4.14E-01	1.65E+02
Soil	Nickel-subsulfide (ind.)	1.27E-02	8.25E-01	3.30E+02
Soil	PCBs (ind.)	2.04E-02	1.32E+00	5.30E+02
Soil	pentachloorfenol (ind.)	1.26E-05	8.18E-04	3.27E-01
Soil	propyleenoxide (ind.)	1.40E-04	9.09E-03	3.64E+00
Soil	styrene (ind.)	2.09E-08	1.36E-06	5.43E-04
Soil	perchloroethylene (ind.)	6.00E-06	3.90E-04	1.56E-01
Soil	carbontetrachloride (ind.)	3.99E-02	2.59E+00	1.04E+03
Soil	chloroform (ind.)	4.12E-06	2.68E-04	1.07E-01
Soil	vinylchloride (ind.)	7.67E-07	4.98E-05	1.99E-02

### 1.1.2 Respiratory effects on humans caused by organic substances (H,A)

This impact category replaces more or less the summer smog category. Fate analysis is based on empirical data. All damage factors are expressed per kg emitted substance. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,1,1-trichloroethane	1.96E-08	1.27E-06	5.09E-04
Air	1,2,3-trimethyl benzene	2.72E-06	1.77E-04	7.06E-02
Air	1,2,4-trimethyl benzene	2.72E-06	1.77E-04	7.06E-02
Air	1,3,5-trimethyl benzene	2.98E-06	1.94E-04	7.74E-02
Air	1,3-butadiene	1.87E-06	1.21E-04	4.86E-02
Air	1-butene	2.30E-06	1.49E-04	5.97E-02
Air	1-butoxy propanol	9.36E-07	6.08E-05	2.43E-02
Air	1-hexene	1.87E-06	1.21E-04	4.86E-02
Air	1-methoxy 2-propanol	7.91E-07	5.14E-05	2.05E-02
Air	1-pentene	2.13E-06	1.38E-04	5.53E-02
Air	2,2-dimethyl butane	5.19E-07	3.37E-05	1.35E-02
Air	2,3-dimethyl butane	1.19E-06	7.73E-05	3.09E-02
Air	2-butoxy ethanol	9.36E-07	6.08E-05	2.43E-02
Air	2-ethoxy ethanol	8.34E-07	5.42E-05	2.17E-02
Air	2-hexanone	1.19E-06	7.73E-05	3.09E-02
Air	2-methoxy ethanol	6.47E-07	4.20E-05	1.68E-02
Air	2-methyl 1-butanol	8.51E-07	5.53E-05	2.21E-02
Air	2-methyl 1-butene	1.70E-06	1.10E-04	4.42E-02
Air	2-methyl 2-butanol	3.06E-07	1.99E-05	7.95E-03
Air	2-methyl 2-butene	1.79E-06	1.16E-04	4.65E-02
Air	2-methyl hexane	8.51E-07	5.53E-05	2.21E-02
Air	2-methyl pentane	9.36E-07	6.08E-05	2.43E-02
Air	2-pentanone	1.19E-06	7.73E-05	3.09E-02
Air	3,5-diethyl toluene	2.81E-06	1.82E-04	7.30E-02
Air	3,5-dimethyl ethyl benzene	2.81E-06	1.82E-04	7.30E-02
Air	3-hexanone	1.28E-06	8.31E-05	3.32E-02
Air	3-methyl 1-butanol	8.51E-07	5.53E-05	2.21E-02
Air	3-methyl 1-butene	1.45E-06	9.42E-05	3.77E-02
Air	3-methyl 2-butanol	7.91E-07	5.14E-05	2.05E-02
Air	3-methyl hexane	7.83E-07	5.08E-05	2.03E-02
Air	3-methyl pentane	1.02E-06	6.62E-05	2.65E-02
Air	3-pentanol	9.36E-07	6.08E-05	2.43E-02
Air	3-pentanone	8.51E-07	5.53E-05	2.21E-02
Air	acetaldehyde	1.36E-06	8.83E-05	3.53E-02
Air	acetic acid	2.13E-07	1.38E-05	5.53E-03
Air	acetone	2.04E-07	1.32E-05	5.30E-03
Air	propionaldehyde	1.70E-06	1.10E-04	4.42E-02

Air	alcohols	7.60E-07	4.94E-05	1.97E-02
Air	aldehydes	1.40E-06	9.09E-05	3.64E-02
Air	alkanes	7.50E-07	4.87E-05	1.95E-02
Air	alkenes	2.10E-06	1.36E-04	5.45E-02
Air	benzene	4.68E-07	3.04E-05	1.22E-02
Air	butane	7.57E-07	4.92E-05	1.97E-02
Air	butanol	1.36E-06	8.83E-05	3.53E-02
Air	butene	2.47E-06	1.60E-04	6.42E-02
Air	cis 1,2-dichloroethene	9.36E-07	6.08E-05	2.43E-02
Air	cis 2-butene	2.47E-06	1.60E-04	6.42E-02
Air	cis 2-hexene	2.30E-06	1.49E-04	5.97E-02
Air	cis 2-pentene	2.38E-06	1.55E-04	6.18E-02
Air	CxHy aromatic	2.10E-06	1.36E-04	5.45E-02
Air	CxHy chloro	3.50E-07	2.27E-05	9.09E-03
Air	CxHy halogenated	3.50E-07	2.27E-05	9.09E-03
Air	cyclohexane	6.21E-07	4.03E-05	1.61E-02
Air	cyclohexanol	9.36E-07	6.08E-05	2.43E-02
Air	cyclohexanone	6.47E-07	4.20E-05	1.68E-02
Air	decane	8.26E-07	5.36E-05	2.15E-02
Air	di-i-propyl ether	1.02E-06	6.62E-05	2.65E-02
Air	diacetone alcohol	5.62E-07	3.65E-05	1.46E-02
Air	dichloromethane	1.45E-07	9.42E-06	3.77E-03
Air	diethyl ether	1.02E-06	6.62E-05	2.65E-02
Air	dimethyl ether	3.74E-07	2.43E-05	9.71E-03
Air	dodecane	7.66E-07	4.97E-05	1.99E-02
Air	esters	3.70E-07	2.40E-05	9.61E-03
Air	ethane	2.64E-07	1.71E-05	6.86E-03
Air	ethane diol	8.26E-07	5.36E-05	2.15E-02
Air	ethanol	8.34E-07	5.42E-05	2.17E-02
Air	ethene	2.13E-06	1.38E-04	5.53E-02
Air	ethers	7.40E-07	4.81E-05	1.92E-02
Air	ethyl t-butyl ether	4.60E-07	2.99E-05	1.19E-02
Air	ethylacetate	4.60E-07	2.99E-05	1.19E-02
Air	ethylbenzene	1.53E-06	9.94E-05	3.97E-02
Air	acetylene	1.87E-07	1.21E-05	4.86E-03
Air	formaldehyde	1.11E-06	7.21E-05	2.88E-02
Air	formic acid	6.89E-08	4.47E-06	1.79E-03
Air	heptane	1.11E-06	7.21E-05	2.88E-02
Air	hexane	1.02E-06	6.62E-05	2.65E-02
Air	i-butane	6.64E-07	4.31E-05	1.72E-02
Air	i-butanol	8.09E-07	5.25E-05	2.10E-02
Air	i-butyraldehyde	1.11E-06	7.21E-05	2.88E-02
Air	i-pentane	8.51E-07	5.53E-05	2.21E-02
Air	i-propanol	2.98E-07	1.94E-05	7.74E-03
Air	i-propyl acetate	4.60E-07	2.99E-05	1.19E-02
Air	i-propyl benzene	1.11E-06	7.21E-05	2.88E-02
Air	isoprene	2.38E-06	1.55E-04	6.18E-02
Air	ketones	8.70E-07	5.65E-05	2.26E-02
Air	m-ethyl toluene	2.21E-06	1.44E-04	5.74E-02
Air	m-xylene	2.38E-06	1.55E-04	6.18E-02
Air	methane	1.28E-08	8.31E-07	3.32E-04
Air	methanol	2.81E-07	1.82E-05	7.30E-03
Air	methyl acetate	1.02E-07	6.62E-06	2.65E-03
Air	methyl chloride	1.11E-08	7.21E-07	2.88E-04
Air	methyl ethyl ketone	8.09E-07	5.25E-05	2.10E-02
Air	methyl formate	7.15E-08	4.64E-06	1.86E-03
Air	methyl i-butyl ketone	1.02E-06	6.62E-05	2.65E-02
Air	methyl i-propyl ketone	7.83E-07	5.08E-05	2.03E-02
Air	methyl propene	1.36E-06	8.83E-05	3.53E-02
Air	methyl t-butyl ether	3.32E-07	2.16E-05	8.62E-03
Air	methyl t-butyl ketone	6.98E-07	4.53E-05	1.81E-02
Air	n-butanol	1.36E-06	8.83E-05	3.53E-02
Air	n-butyl acetate	5.19E-07	3.37E-05	1.35E-02
Air	n-butyraldehyde	1.70E-06	1.10E-04	4.42E-02
Air	n-propanol	1.19E-06	7.73E-05	3.09E-02
Air	n-propyl acetate	6.21E-07	4.03E-05	1.61E-02
Air	n-propyl benzene	1.36E-06	8.83E-05	3.53E-02
Air	neopentane	3.74E-07	2.43E-05	9.71E-03
Air	NM VOC	1.28E-06	8.31E-05	3.32E-02
Air	nonane	8.51E-07	5.53E-05	2.21E-02
Air	o-ethyl toluene	1.96E-06	1.27E-04	5.09E-02
Air	o-xylene	2.30E-06	1.49E-04	5.97E-02
Air	octane	9.36E-07	6.08E-05	2.43E-02
Air	p-ethyl toluene	1.96E-06	1.27E-04	5.09E-02

Air	p-xylene	2.21E-06	1.44E-04	5.74E-02
Air	pentanal	1.62E-06	1.05E-04	4.21E-02
Air	pentane	8.51E-07	5.53E-05	2.21E-02
Air	propane	3.83E-07	2.49E-05	9.95E-03
Air	propane diol	1.02E-06	6.62E-05	2.65E-02
Air	propene	2.38E-06	1.55E-04	6.18E-02
Air	propanoic acide	3.23E-07	2.10E-05	8.39E-03
Air	s-butanol	8.51E-07	5.53E-05	2.21E-02
Air	s-butyl acetate	5.79E-07	3.76E-05	1.50E-02
Air	t-butanol	2.64E-07	1.71E-05	6.86E-03
Air	t-butyl acetate	1.36E-07	8.83E-06	3.53E-03
Air	perchloroethylene	6.21E-08	4.03E-06	1.61E-03
Air	toluene	1.36E-06	8.83E-05	3.53E-02
Air	trans 1,2-dichloroethene	8.43E-07	5.47E-05	2.19E-02
Air	trans 2-butene	2.47E-06	1.60E-04	6.42E-02
Air	trans 2-hexene	2.30E-06	1.49E-04	5.97E-02
Air	trans 2-pentene	2.38E-06	1.55E-04	6.18E-02
Air	trichloroethylene	6.98E-07	4.53E-05	1.81E-02
Air	chloroform	4.94E-08	3.21E-06	1.28E-03
Air	undecane	8.26E-07	5.36E-05	2.15E-02
Air	VOC	6.46E-07	4.19E-05	1.68E-02
Air	xylene	2.21E-06	1.44E-04	5.74E-02

### 1.1.3 Respiratory effects on humans caused by inorganic substances (H,A)

This impact category replaces more or less the winter smog category. Fate analysis is based on empirical data. All damage factors are expressed per kg emission. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	ammonia	8.50E-05	5.52E-03	2.21E+00
Air	dust (PM10)	3.75E-04	2.44E-02	9.74E+00
Air	dust (PM2.5)	7.00E-04	4.55E-02	1.82E+01
Air	TSP	1.10E-04	7.14E-03	2.86E+00
Air	NO	1.37E-04	8.90E-03	3.56E+00
Air	NO2	8.87E-05	5.76E-03	2.30E+00
Air	NOx	8.87E-05	5.76E-03	2.30E+00
Air	NOx (as NO2)	8.87E-05	5.76E-03	2.30E+00
Air	SO2	5.46E-05	3.55E-03	1.42E+00
Air	SO3	4.37E-05	2.84E-03	1.14E+00
Air	SOx	5.46E-05	3.55E-03	1.42E+00
Air	SOx (as SO2)	5.46E-05	3.55E-03	1.42E+00

### 1.1.4 Damages to human health caused by climate change (H,A)

Damage calculation was performed over a time scale of 200 years. The IPCC equivalence factors have been modified. As damage is not linear dependent on the atmospheric lifetime, a separate damage calculation is made for CO<sub>2</sub>, CH<sub>4</sub> en CH<sub>4</sub>:

- Gasses with an atmospheric lifetime below 20 years are assumed to behave like methane
- Gasses with an atmospheric lifetime between 20 and 100 years behave like CO<sub>2</sub>
- Gasses with an atmospheric lifetime oh more than 100 years are assumed to behave like N<sub>2</sub>O

This means that the IPCC equivalency factor table is split in three groups. All damage factors are expressed per kg substance. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	methyl chloroform	-4.3E-05	-2.79E-03	-1.12E+00
Air	perfluorethane	2.00E-03	1.30E-01	5.19E+01
Air	trifluoriodomethane	2.10E-07	1.36E-05	5.45E-03

Air	perfluormethane	1.40E-03	9.09E-02	3.64E+01
Air	CFC-11	2.20E-04	1.43E-02	5.71E+00
Air	CFC-113	6.30E-04	4.09E-02	1.64E+01
Air	CFC-12	1.40E-03	9.09E-02	3.64E+01
Air	carbon dioxide	2.10E-07	1.36E-05	5.45E-03
Air	methylene chloride	1.90E-06	1.23E-04	4.94E-02
Air	HALON-1301	-7.10E-03	-4.61E-01	-1.84E+02
Air	HCFC-123	6.60E-06	4.29E-04	1.71E-01
Air	HCFC-124	8.50E-05	5.52E-03	2.21E+00
Air	HCFC-141b	5.20E-05	3.38E-03	1.35E+00
Air	HCFC-142b	3.40E-04	2.21E-02	8.83E+00
Air	HCFC-22	2.80E-04	1.82E-02	7.27E+00
Air	HFC-125	5.70E-04	3.70E-02	1.48E+01
Air	HFC-134	2.10E-04	1.36E-02	5.45E+00
Air	HFC-134a	2.70E-04	1.75E-02	7.01E+00
Air	HFC-143	6.30E-05	4.09E-03	1.64E+00
Air	HFC-143a	7.80E-04	5.06E-02	2.03E+01
Air	HFC-152a	2.90E-05	1.88E-03	7.53E-01
Air	HFC-227ea	5.90E-04	3.83E-02	1.53E+01
Air	HFC-23	2.60E-03	1.69E-01	6.75E+01
Air	HFC-236fa	1.40E-03	9.09E-02	3.64E+01
Air	HFC-245ca	1.20E-04	7.79E-03	3.12E+00
Air	HFC-32	1.40E-04	9.09E-03	3.64E+00
Air	HFC-41	3.10E-05	2.01E-03	8.05E-01
Air	HFC-4310mee	2.70E-04	1.75E-02	7.01E+00
Air	methane	4.40E-06	2.86E-04	1.14E-01
Air	nitrous oxide	6.90E-05	4.48E-03	1.79E+00
Air	perfluorbutane	1.50E-03	9.74E-02	3.90E+01
Air	perfluorocyclobutane	1.90E-03	1.23E-01	4.94E+01
Air	perfluorhexane	1.60E-03	1.04E-01	4.16E+01
Air	perfluoropentane	1.70E-03	1.10E-01	4.42E+01
Air	perfluoropropane	1.50E-03	9.74E-02	3.90E+01
Air	sulphur hexafluoride	5.30E-03	3.44E-01	1.38E+02
Air	carbontetrachloride	-2.60E-04	-1.69E-02	-6.75E+00
Air	chloroform	8.30E-07	5.39E-05	2.16E-02

### 1.1.5 Human health effects caused by ionising radiation (H,A)

Fate-, and exposure models are based on studies for the French nuclear industry. All damage factors are based on a release of 1 Becquerel (Bq). The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	C-14	2.10E-10	1.36E-08	5.45E-06
Air	Co-58	4.30E-13	2.79E-11	1.12E-08
Air	Co-60	1.60E-11	1.04E-09	4.16E-07
Air	Cs-134	1.20E-11	7.79E-10	3.12E-07
Air	Cs-137	1.30E-11	8.44E-10	3.38E-07
Air	H-3	1.40E-14	9.09E-13	3.64E-10
Air	I-129	9.40E-10	6.10E-08	2.44E-05
Air	I-131	1.60E-13	1.04E-11	4.16E-09
Air	I-133	9.40E-15	6.10E-13	2.44E-10
Air	Kr-85	1.40E-16	9.09E-15	3.64E-12
Air	Pb-210	1.50E-12	9.74E-11	3.90E-08
Air	Po-210	1.50E-12	9.74E-11	3.90E-08
Air	Pu alpha	8.30E-11	5.39E-09	2.16E-06
Air	Pu-238	6.70E-11	4.35E-09	1.74E-06
Air	Ra-226	9.10E-13	5.91E-11	2.36E-08
Air	Rn-222	2.40E-14	1.56E-12	6.23E-10
Air	Th-230	4.50E-11	2.92E-09	1.17E-06
Air	U-234	9.70E-11	6.30E-09	2.52E-06
Air	U-235	2.10E-11	1.36E-09	5.45E-07
Air	U-238	8.20E-12	5.32E-10	2.13E-07
Air	Xe-133	1.40E-16	9.09E-15	3.64E-12
Water	Ag-110m	5.10E-13	3.31E-11	1.32E-08
Water	Co-58	4.10E-14	2.66E-12	1.06E-09
Water	Co-60	4.40E-11	2.86E-09	1.14E-06
Water	Cs-134	1.40E-10	9.09E-09	3.64E-06
Water	Cs-137	1.70E-10	1.10E-08	4.42E-06
Water	H-3	4.50E-16	2.92E-14	1.17E-11



Water	I-131	5.00E-13	3.25E-11	1.30E-08
Water	Mn-54	3.10E-13	2.01E-11	8.05E-09
Water	Ra-226	1.30E-13	8.44E-12	3.38E-09
Water	Sb-124	8.20E-13	5.32E-11	2.13E-08
Water	U-234	2.40E-12	1.56E-10	6.23E-08
Water	U-235	2.30E-12	1.49E-10	5.97E-08
Water	U-238	2.30E-12	1.49E-10	5.97E-08

### 1.1.6 Human health effects caused by ozone layer depletion (H,A)

All damage factors are expressed per kg release. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,1,1-trichloroethane	1.26E-04	8.18E-03	3.27E+00
Air	CFC-11	1.05E-03	6.82E-02	2.73E+01
Air	CFC-113	9.48E-04	6.16E-02	2.46E+01
Air	CFC-114	8.95E-04	5.81E-02	2.32E+01
Air	CFC-115	4.21E-04	2.73E-02	1.09E+01
Air	CFC-12	8.63E-04	5.60E-02	2.24E+01
Air	HALON-1201	1.47E-03	9.55E-02	3.82E+01
Air	HALON-1202	1.32E-03	8.57E-02	3.43E+01
Air	HALON-1211	5.37E-03	3.49E-01	1.39E+02
Air	HALON-1301	1.26E-02	8.18E-01	3.27E+02
Air	HALON-2311	1.47E-04	9.55E-03	3.82E+00
Air	HALON-2401	2.63E-04	1.71E-02	6.83E+00
Air	HALON-2402	7.37E-03	4.79E-01	1.91E+02
Air	HCFC-123	1.47E-05	9.55E-04	3.82E-01
Air	HCFC-124	3.16E-05	2.05E-03	8.21E-01
Air	HCFC-141b	1.05E-04	6.82E-03	2.73E+00
Air	HCFC-142b	5.26E-05	3.42E-03	1.37E+00
Air	HCFC-22	4.21E-05	2.73E-03	1.09E+00
Air	HCFC-225ca	2.11E-05	1.37E-03	5.48E-01
Air	HCFC-225cb	2.11E-05	1.37E-03	5.48E-01
Air	methyl bromide	6.74E-04	4.38E-02	1.75E+01
Air	methyl chloride	2.11E-05	1.37E-03	5.48E-01
Air	carbontetrachloride	1.26E-03	8.18E-02	3.27E+01

## 1.2 Damage category Ecosystem Quality (H,A)

The Ecosystem Quality damages are specified as PDF\*m<sup>2</sup>\*yr. PDF is short for Potentially Disappeared Fraction of Species. A damage of one means all species disappear from one m<sup>2</sup> during one year, or 10% of all species disappear from 10 m<sup>2</sup> during one year, or 10% of all species disappear from 1 m<sup>2</sup> during 10 years. Within the damage category Ecosystem Quality, special care is needed to avoid double counting when land-use is modelled. See the remarks under these damage categories.

### 1.2.1 Damage to Ecosystem Quality caused by ecotoxic emissions (H,A)

Fate analysis was done in EUSES. Pesticides that evaporate during application must be counted as air emissions. Pesticides that are accidentally sprayed in surface waters must be counted as water emissions. The remainder must be counted as soil emissions. The damage from pesticides in the agricultural soil as such (root zone) was deliberately excluded to avoid double counting with land-use. This means the damage factors in this list are based on secondary (leaching) emissions from the soil into surface and ground water and evaporation.

All damage factors are expressed per kg release. The unit of damage is PDF\*m<sup>2</sup>\*yr.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,2,3-trichlorobenzene	3.51E-02	6.84E-06	2.74E-03
Air	1,2,4-trichlorobenzene	2.54E-02	4.95E-06	1.98E-03
Air	1,3,5-trichlorobenzene	1.29E-01	2.51E-05	1.01E-02
Air	2,4-D	1.46E+00	2.85E-04	1.14E-01
Air	Arsenic	5.92E+02	1.15E-01	4.62E+01
Air	Atrazine	2.09E+02	4.07E-02	1.63E+01
Air	Azinphos-methyl	1.10E+04	2.14E+00	8.58E+02
Air	Bentazon	7.33E+00	1.43E-03	5.72E-01
Air	benzene	2.75E-03	5.36E-07	2.14E-04
Air	benzo(a)pyrene	1.42E+02	2.77E-02	1.11E+01
Air	Carbendazim	2.40E+03	4.68E-01	1.87E+02
Air	Cadmium	9.65E+03	1.88E+00	7.52E+02
Air	Chromium	4.13E+03	8.05E-01	3.22E+02
Air	Copper	1.46E+03	2.85E-01	1.14E+02
Air	di(2-ethylhexyl)phthalate	1.94E-03	3.78E-07	1.51E-04
Air	dibutylphthalate	1.13E-01	2.20E-05	8.81E-03
Air	Dichlorvos	1.61E+00	3.14E-04	1.26E-01
Air	2,3,7,8-TCDD Dioxin	1.32E+05	2.57E+01	1.03E+04
Air	Diquat-dibromide	2.39E+03	4.66E-01	1.86E+02
Air	Diuron	4.43E+03	8.64E-01	3.45E+02
Air	DNOC	8.19E+00	1.60E-03	6.39E-01
Air	fentin acetate	6.77E+02	1.32E-01	5.28E+01
Air	fluoranthene	4.37E-02	8.52E-06	3.41E-03
Air	gamma-HCH (Lindane)	2.16E+00	4.21E-04	1.68E-01
Air	Hexachlorobenzene	3.88E+01	7.56E-03	3.03E+00
Air	Mercury	8.29E+02	1.62E-01	6.46E+01
Air	Malathion	1.17E+02	2.28E-02	9.12E+00
Air	Maneb	3.84E+01	7.49E-03	2.99E+00
Air	Mecoprop	7.79E-02	1.52E-05	6.07E-03
Air	Metabenzthiazuron	3.07E+02	5.98E-02	2.39E+01
Air	metals	2.60E+02	5.07E-02	2.03E+01
Air	Metamitron	3.78E+01	7.37E-03	2.95E+00
Air	Metribuzin	4.92E+02	9.59E-02	3.84E+01
Air	Mevinphos	2.13E+03	4.15E-01	1.66E+02
Air	Monolinuron	1.06E+02	2.07E-02	8.27E+00
Air	Nickel	7.10E+03	1.38E+00	5.54E+02
Air	PAH's	7.80E-04	1.52E-07	6.08E-05
Air	Parathion	6.05E+01	1.18E-02	4.72E+00
Air	Lead	2.54E+03	4.95E-01	1.98E+02
Air	Polychlorobiphenyls	8.07E+01	1.57E-02	6.29E+00
Air	pentachlorophenol	1.33E+01	2.59E-03	1.04E+00
Air	Simazine	1.44E+03	2.81E-01	1.12E+02
Air	Thiram	2.26E+02	4.41E-02	1.76E+01
Air	toluene	2.40E-04	4.68E-08	1.87E-05
Air	Trifluralin	1.09E+00	2.12E-04	8.50E-02
Air	Zinc	2.89E+03	5.63E-01	2.25E+02
Water	1,2,3-trichlorobenzene	1.56E-01	3.04E-05	1.22E-02
Water	1,2,4-trichlorobenzene	1.39E-01	2.71E-05	1.08E-02
Water	1,3,5-trichlorobenzene	2.73E-01	5.32E-05	2.13E-02
Water	2,4-D	7.56E-02	1.47E-05	5.89E-03
Water	Arsenic	1.14E+01	2.22E-03	8.89E-01
Water	Atrazine	5.06E+01	9.86E-03	3.95E+00
Water	Azinphos-methyl	8.87E+02	1.73E-01	6.92E+01
Water	Bentazon	5.81E-02	1.13E-05	4.53E-03
Water	benzene	4.80E-02	9.36E-06	3.74E-03
Water	benzo(a)pyrene	3.68E+01	7.17E-03	2.87E+00
Water	Carbendazim	1.63E+02	3.18E-02	1.27E+01
Water	Cadmium	4.80E+02	9.36E-02	3.74E+01
Water	Chromium	6.87E+01	1.34E-02	5.36E+00
Water	Copper	1.47E+02	2.87E-02	1.15E+01
Water	di(2-ethylhexyl)phthalate	6.37E-01	1.24E-04	4.97E-02
Water	dibutylphthalate	1.62E+00	3.16E-04	1.26E-01
Water	Dichlorvos	1.81E-01	3.53E-05	1.41E-02
Water	dioxins (TEQ)	1.87E+05	3.65E+01	1.46E+04
Water	Diquat-dibromide	1.18E+02	2.30E-02	9.20E+00
Water	Diuron	2.31E+02	4.50E-02	1.80E+01
Water	DNOC	6.73E-01	1.31E-04	5.25E-02
Water	fentin acetate	7.85E+02	1.53E-01	6.12E+01
Water	fluoranthene	3.96E+00	7.72E-04	3.09E-01
Water	gamma-HCH (Lindane)	1.04E+01	2.03E-03	8.11E-01
Water	hexachlorobenzene	4.55E+01	8.87E-03	3.55E+00

## 2 Damage factors in the egalitarian perspective (E,E)

This annex lists the Eco-indicator 99 damage factors for the substance lists that can be found in most popular LCA databases. In this case the egalitarian perspective is used, combined with the matching weighting factors. Next to the damage factors two columns are added with the normalised and weighted damages. The normalisation factors and the weights are specified below.

	Normalisation	Weights
Human health	1.55E-02	300
Ecosystem Quality	5.13E+03	500
Resources	5.94E+03	200

Below the impact categories are listed per damage category.

### 2.1 Damage category Human Health (E,E)

The human health damages are specified in DALYs. This is short for Disability Adjusted Life Years. A damage of 1 means one life year of one individual is lost, or one person suffers four year from a disability with a weight of 0.25.

#### 2.1.1 Carcinogenic effects on humans (E,E)

For the fate and exposure it is important to distinguish emissions to soil between emissions in industrial (ind.) or agricultural (agr.) soil. All emissions of pesticides are assumed to occur in agricultural soil, all other emissions are assumed to occur in industrial (or urban) soil. No direct emissions are assumed to occur in natural soil. Fate factors are calculated with EUSES. Substances from IARC substances groups 1, 2a, 2b and 3 are included.

All damage factors are expressed per kg emission. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,1,1,2-tetrachlorethane	3.72E-05	2.40E-03	7.20E-01
Air	1,1,2,2-tetrachlorethane	2.86E-04	1.85E-02	5.54E+00
Air	1,1,2-trichlorethane	1.10E-05	7.10E-04	2.13E-01
Air	1,1-dichloroethene	3.43E-06	2.21E-04	6.64E-02
Air	1,2-dibromoethane	2.60E-04	1.68E-02	5.03E+00
Air	1,2-dichloroethane	2.98E-05	1.92E-03	5.77E-01
Air	1,3-butadiene	1.58E-05	1.02E-03	3.06E-01
Air	1,4-dioxane	1.39E-07	8.97E-06	2.69E-03
Air	2,4,6-trichlorophenol	2.05E-06	1.32E-04	3.97E-02
Air	3-methylcholanthrene	1.67E-01	1.08E+01	3.23E+03
Air	acetaldehyde	2.16E-07	1.39E-05	4.18E-03
Air	acrylonitrile	1.69E-05	1.09E-03	3.27E-01
Air	Aldrin	1.93E-01	1.25E+01	3.74E+03
Air	alpha-hexachlorocyclohexan	3.00E-04	1.94E-02	5.81E+00
Air	Arsenic	2.46E-02	1.59E+00	4.76E+02
Air	Bis(chloromethyl)ether	7.48E-03	4.83E-01	1.45E+02
Air	benzene	2.50E-06	1.61E-04	4.84E-02
Air	benzo(a)anthracene	5.86E-02	3.78E+00	1.13E+03
Air	benzo(a)pyrene	3.98E-03	2.57E-01	7.70E+01
Air	benzotrithloride	6.60E-03	4.26E-01	1.28E+02
Air	benzylchloride	1.04E-05	6.71E-04	2.01E-01
Air	beta-chlorocyclohexan	9.99E-05	6.45E-03	1.93E+00
Air	bis(2-chlorethyl)ether	4.03E-05	2.60E-03	7.80E-01
Air	bromodichloromethane	8.76E-06	5.65E-04	1.70E-01
Air	Cadmium	1.35E-01	8.71E+00	2.61E+03
Air	Chromium (VI)	1.75E+00	1.13E+02	3.39E+04

Air	di(2-ethylhexyl)phthalate	3.38E-05	2.18E-03	6.54E-01
Air	dibenz(a)anthracene	3.10E+01	2.00E+03	6.00E+05
Air	dibutylphthalate	3.43E-03	2.21E-01	6.64E+01
Air	dichloromethane	4.36E-07	2.81E-05	8.44E-03
Air	Dichlorvos	3.15E-05	2.03E-03	6.10E-01
Air	Dieldrin	2.70E+01	1.74E+03	5.23E+05
Air	2,3,7,8-TCDD Dioxin	1.79E+02	1.15E+04	3.46E+06
Air	epichlorohydrin	3.02E-07	1.95E-05	5.85E-03
Air	ethylene oxide	1.83E-04	1.18E-02	3.54E+00
Air	formaldehyde	9.91E-07	6.39E-05	1.92E-02
Air	gamma-HCH (Lindane)	3.49E-04	2.25E-02	6.75E+00
Air	Hexachlorobenzene	8.25E-02	5.32E+00	1.60E+03
Air	hexachlorobutadiene	4.30E-05	2.77E-03	8.32E-01
Air	hexachloroethane	1.99E-05	1.28E-03	3.85E-01
Air	metals	5.20E-03	3.35E-01	1.01E+02
Air	methyl chloride	1.83E-05	1.18E-03	3.54E-01
Air	Nickel	2.35E-02	1.52E+00	4.55E+02
Air	Nickel-refinery-dust	4.74E-02	3.06E+00	9.17E+02
Air	Nickel-subsulfide	9.48E-02	6.12E+00	1.83E+03
Air	PAH's	1.70E-04	1.10E-02	3.29E+00
Air	particles diesel soot	9.78E-06	6.31E-04	1.89E-01
Air	Polychlorobiphenyls	1.97E-03	1.27E-01	3.81E+01
Air	pentachlorophenol	7.21E-03	4.65E-01	1.40E+02
Air	propyleneoxide	1.17E-05	7.55E-04	2.26E-01
Air	styrene	2.44E-08	1.57E-06	4.72E-04
Air	perchloroethylene	4.82E-07	3.11E-05	9.33E-03
Air	carbon tetrachloride	8.38E-04	5.41E-02	1.62E+01
Air	trichloroethylene	7.95E-08	5.13E-06	1.54E-03
Air	chloroform	2.63E-05	1.70E-03	5.09E-01
Air	Trifluralin	1.10E-07	7.10E-06	2.13E-03
Air	vinyl chloride	2.09E-07	1.35E-05	4.05E-03
Water	1,1,1,2-tetrachlorethane	3.66E-05	2.36E-03	7.08E-01
Water	1,1,2,2-tetrachlorethane	2.78E-04	1.79E-02	5.38E+00
Water	1,1,2-trichlorethane	1.23E-05	7.94E-04	2.38E-01
Water	1,1-dichloroethene	5.88E-05	3.79E-03	1.14E+00
Water	1,2-dibromoethane	1.24E-03	8.00E-02	2.40E+01
Water	1,2-dichloroethane	2.98E-05	1.92E-03	5.77E-01
Water	1,3-butadiene	3.37E-04	2.17E-02	6.52E+00
Water	1,4-dioxane	9.21E-07	5.94E-05	1.78E-02
Water	2,4,6-trichlorophenol	1.05E-05	6.77E-04	2.03E-01
Water	3-methylcholanthrene	3.72E+01	2.40E+03	7.20E+05
Water	acetaldehyde	9.23E-07	5.95E-05	1.79E-02
Water	acrylonitrile	4.16E-05	2.68E-03	8.05E-01
Water	Aldrin	6.78E+00	4.37E+02	1.31E+05
Water	alpha-hexachlorocyclohexan	6.85E-03	4.42E-01	1.33E+02
Water	Arsenic	6.57E-02	4.24E+00	1.27E+03
Water	Bis(chloromethyl)ether	1.54E-02	9.94E-01	2.98E+02
Water	benzene	4.12E-06	2.66E-04	7.97E-02
Water	benzo(a)anthracene	6.58E-01	4.25E+01	1.27E+04
Water	benzo(a)pyrene	2.99	1.93E+02	5.79E+04
Water	benzotrithloride	9.46E-03	6.10E-01	1.83E+02
Water	benzylchloride	1.98E-05	1.28E-03	3.83E-01
Water	beta-chlorocyclohexan	5.75E-03	3.71E-01	1.11E+02
Water	bis(2-chlorethyl)ether	1.61E-04	1.04E-02	3.12E+00
Water	bromodichloromethane	9.36E-06	6.04E-04	1.81E-01
Water	Cadmium	7.12E-02	4.59E+00	1.38E+03
Water	Chromium (VI)	3.43E-01	2.21E+01	6.64E+03
Water	di(2-ethylhexyl)phthalate	6.64E-04	4.28E-02	1.29E+01
Water	dibenz(a)anthracene	4.07E+01	2.63E+03	7.88E+05
Water	dibutylphthalate	5.34E-02	3.45E+00	1.03E+03
Water	dichloromethane	4.79E-07	3.09E-05	9.27E-03
Water	Dichlorvos	1.17E-05	7.55E-04	2.26E-01
Water	Dieldrin	9.75E+01	6.29E+03	1.89E+06
Water	dioxins (TEQ)	2.02E+03	1.30E+05	3.91E+07
Water	epichlorohydrin	9.90E-07	6.39E-05	1.92E-02
Water	ethylene oxide	1.39E-04	8.97E-03	2.69E+00
Water	formaldehyde	4.97E-06	3.21E-04	9.62E-02
Water	gamma-HCH (Lindane)	4.16E-03	2.68E-01	8.05E+01
Water	hexachlorobenzene	1.25E-01	8.06E+00	2.42E+03
Water	hexachlorobutadiene	1.08E-04	6.97E-03	2.09E+00
Water	hexachloroethane	2.12E-05	1.37E-03	4.10E-01
Water	methyl chloride	1.78E-05	1.15E-03	3.45E-01
Water	Nickel	3.11E-02	2.01E+00	6.02E+02
Water	Nickel-subsulfide	1.00E-02	6.45E-01	1.94E+02

Water	Nickel-refinery-dust	5.02E-03	3.24E-01	9.72E+01
Water	PAH's	2.60E-03	1.68E-01	5.03E+01
Water	Polychlorobiphenyls	3.91E-02	2.52E+00	7.57E+02
Water	pentachlorophenol	2.29E-02	1.48E+00	4.43E+02
Water	propylene oxide	1.74E-05	1.12E-03	3.37E-01
Water	styrene	1.22E-06	7.87E-05	2.36E-02
Water	perchloroethylene	4.72E-07	3.05E-05	9.14E-03
Water	carbontetrachloride	8.29E-04	5.35E-02	1.60E+01
Water	trichloroethylene	7.97E-08	5.14E-06	1.54E-03
Water	chloroform	2.60E-05	1.68E-03	5.03E-01
Water	Trifluralin	7.93E-05	5.12E-03	1.53E+00
Water	vinyl chloride	2.84E-07	1.83E-05	5.50E-03
Soil	1,1,1,2-tetrachlorethane(ind.)	1.09E-03	7.03E-02	2.11E+01
Soil	1,1,2,2-tetrachlorethane(ind.)	7.54E-03	4.86E-01	1.46E+02
Soil	1,1,2-trichlorethane (ind.)	1.24E-04	8.00E-03	2.40E+00
Soil	1,1-dichloroethene (ind.)	5.57E-06	3.59E-04	1.08E-01
Soil	1,2-dibromoethane (ind.)	3.81E-03	2.46E-01	7.37E+01
Soil	1,2-dichloroethane (ind.)	4.58E-04	2.95E-02	8.86E+00
Soil	1,3-butadiene (ind.)	1.20E-05	7.74E-04	2.32E-01
Soil	1,4-dioxane (ind.)	3.10E-07	2.00E-05	6.00E-03
Soil	2,4,6-trichlorophenol (ind.)	2.76E-06	1.78E-04	5.34E-02
Soil	3-methylcholanthrene (ind.)	7.85E-01	5.06E+01	1.52E+04
Soil	acetaldehyde (ind.)	4.77E-07	3.08E-05	9.23E-03
Soil	acrylonitrile (ind.)	7.01E-05	4.52E-03	1.36E+00
Soil	Aldrin (agr.)	3.21E+01	2.07E+03	6.21E+05
Soil	alpha-hexachlorocyclohexan (agr.)	2.32E-02	1.50E+00	4.49E+02
Soil	Arsenic (ind.)	1.32E-02	8.52E-01	2.55E+02
Soil	Bis(chloromethyl)ether (ind.)	1.68E-02	1.08E+00	3.25E+02
Soil	benzene (ind.)	1.33E-05	8.58E-04	2.57E-01
Soil	benzo(a)anthracene (ind.)	1.60E-01	1.03E+01	3.10E+03
Soil	benzo(a)pyrene (ind.)	2.06E-03	1.33E-01	3.99E+01
Soil	benzotrithloride (ind.)	1.32E-01	8.52E+00	2.55E+03
Soil	benzylchloride (ind.)	4.16E-05	2.68E-03	8.05E-01
Soil	beta-chlorocyclohexan (agr.)	7.36E-03	4.75E-01	1.42E+02
Soil	bis(2-chloretyl)ether (ind.)	8.29E-05	5.35E-03	1.60E+00
Soil	bromodichloromethane (ind.)	7.82E-05	5.05E-03	1.51E+00
Soil	Cadmium (ind.)	3.98E-03	2.57E-01	7.70E+01
Soil	Chromium (ind.)	2.71E-01	1.75E+01	5.25E+03
Soil	di(2-ethylhexyl)phthalate(ind)	3.18E-07	2.05E-05	6.15E-03
Soil	dibenz(a)anthracene (ind.)	2.44E+01	1.57E+03	4.72E+05
Soil	dibutylphthalate (ind.)	6.00E-06	3.87E-04	1.16E-01
Soil	dichloromethane (ind.)	5.99E-06	3.86E-04	1.16E-01
Soil	Dichlorvos (agr.)	2.25E-05	1.45E-03	4.35E-01
Soil	Dieldrin (agr.)	4.17E+02	2.69E+04	8.07E+06
Soil	2,3,7,8-TCDD Dioxin (ind.)	7.06	4.55E+02	1.37E+05
Soil	epichloorhydrin (ind.)	1.30E-06	8.39E-05	2.52E-02
Soil	ethyleneoxide (ind.)	2.38E-03	1.54E-01	4.61E+01
Soil	formaldehyde (ind.)	1.83E-06	1.18E-04	3.54E-02
Soil	gamma-HCH (Lindane) (agr.)	8.64E-03	5.57E-01	1.67E+02
Soil	hexachlorobenzene (ind.)	1.47E-01	9.48E+00	2.85E+03
Soil	hexachlorobutadiene (ind.)	8.56E-04	5.52E-02	1.66E+01
Soil	hexachloroethane (ind.)	5.26E-04	3.39E-02	1.02E+01
Soil	methylchloride (ind.)	5.58E-04	3.60E-02	1.08E+01
Soil	Nickel (ind.)	3.94E-03	2.54E-01	7.63E+01
Soil	Nickel-refinery-dust (ind.)	6.37E-03	4.11E-01	1.23E+02
Soil	Nickel-subsulfide (ind.)	1.27E-02	8.19E-01	2.46E+02
Soil	PCBs (ind.)	2.04E-02	1.32E+00	3.95E+02
Soil	pentachloorfenol (ind.)	1.26E-05	8.13E-04	2.44E-01
Soil	propyleneoxide (ind.)	1.40E-04	9.03E-03	2.71E+00
Soil	styrene (ind.)	2.09E-08	1.35E-06	4.05E-04
Soil	perchloroethylene (ind.)	6.00E-06	3.87E-04	1.16E-01
Soil	carbontetrachloride (ind.)	3.99E-02	2.57E+00	7.72E+02
Soil	trichlorethene (ind.)	3.22E-07	2.08E-05	6.23E-03
Soil	chloroform (ind.)	4.12E-06	2.66E-04	7.97E-02
Soil	Trifluralin (agr.)	6.89E-05	4.45E-03	1.33E+00
Soil	vinylchloride (ind.)	7.67E-07	4.95E-05	1.48E-02
Soil	Trifluralin (agr.)	6.89E-05	4.45E-03	1.33E+00

## 2.1.2 Respiratory effects on humans caused by organic substances (E,E)

This impact category replaces more or less the summer smog category. Fate analysis is based on empirical data.

All damage factors are expressed per kg emitted substance. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,1,1-trichloroethane	1.96E-08	1.26E-06	3.79E-04
Air	1,2,3-trimethyl benzene	2.72E-06	1.75E-04	5.26E-02
Air	1,2,4-trimethyl benzene	2.72E-06	1.75E-04	5.26E-02
Air	1,3,5-trimethyl benzene	2.98E-06	1.92E-04	5.77E-02
Air	1,3-butadiene	1.87E-06	1.21E-04	3.62E-02
Air	1-butene	2.30E-06	1.48E-04	4.45E-02
Air	1-butoxy propanol	9.36E-07	6.04E-05	1.81E-02
Air	1-hexene	1.87E-06	1.21E-04	3.62E-02
Air	1-methoxy 2-propanol	7.91E-07	5.10E-05	1.53E-02
Air	1-pentene	2.13E-06	1.37E-04	4.12E-02
Air	2,2-dimethyl butane	5.19E-07	3.35E-05	1.00E-02
Air	2,3-dimethyl butane	1.19E-06	7.68E-05	2.30E-02
Air	2-butoxy ethanol	9.36E-07	6.04E-05	1.81E-02
Air	2-ethoxy ethanol	8.34E-07	5.38E-05	1.61E-02
Air	2-hexanone	1.19E-06	7.68E-05	2.30E-02
Air	2-methoxy ethanol	6.47E-07	4.17E-05	1.25E-02
Air	2-methyl 1-butanol	8.51E-07	5.49E-05	1.65E-02
Air	2-methyl 1-butene	1.70E-06	1.10E-04	3.29E-02
Air	2-methyl 2-butanol	3.06E-07	1.97E-05	5.92E-03
Air	2-methyl 2-butene	1.79E-06	1.15E-04	3.46E-02
Air	2-methyl hexane	8.51E-07	5.49E-05	1.65E-02
Air	2-methyl pentane	9.36E-07	6.04E-05	1.81E-02
Air	2-pentanone	1.19E-06	7.68E-05	2.30E-02
Air	3,5-diethyl toluene	2.81E-06	1.81E-04	5.44E-02
Air	3,5-dimethyl ethyl benzene	2.81E-06	1.81E-04	5.44E-02
Air	3-hexanone	1.28E-06	8.26E-05	2.48E-02
Air	3-methyl 1-butanol	8.51E-07	5.49E-05	1.65E-02
Air	3-methyl 1-butene	1.45E-06	9.35E-05	2.81E-02
Air	3-methyl 2-butanol	7.91E-07	5.10E-05	1.53E-02
Air	3-methyl hexane	7.83E-07	5.05E-05	1.52E-02
Air	3-methyl pentane	1.02E-06	6.58E-05	1.97E-02
Air	3-pentanol	9.36E-07	6.04E-05	1.81E-02
Air	3-pentanone	8.51E-07	5.49E-05	1.65E-02
Air	acetaldehyde	1.36E-06	8.77E-05	2.63E-02
Air	acetic acid	2.13E-07	1.37E-05	4.12E-03
Air	acetone	2.04E-07	1.32E-05	3.95E-03
Air	propionaldehyde	1.70E-06	1.10E-04	3.29E-02
Air	alcohols	7.60E-07	4.90E-05	1.47E-02
Air	aldehydes	1.40E-06	9.03E-05	2.71E-02
Air	alkanes	7.50E-07	4.84E-05	1.45E-02
Air	alkenes	2.10E-06	1.35E-04	4.06E-02
Air	benzene	4.68E-07	3.02E-05	9.06E-03
Air	butane	7.57E-07	4.88E-05	1.47E-02
Air	butanol	1.36E-06	8.77E-05	2.63E-02
Air	butene	2.47E-06	1.59E-04	4.78E-02
Air	cis 1,2-dichloroethene	9.36E-07	6.04E-05	1.81E-02
Air	cis 2-butene	2.47E-06	1.59E-04	4.78E-02
Air	cis 2-hexene	2.30E-06	1.48E-04	4.45E-02
Air	cis 2-pentene	2.38E-06	1.54E-04	4.61E-02
Air	CxHy aromatic	2.10E-06	1.35E-04	4.06E-02
Air	CxHy chloro	3.50E-07	2.26E-05	6.77E-03
Air	CxHy halogenated	3.50E-07	2.26E-05	6.77E-03
Air	cyclohexane	6.21E-07	4.01E-05	1.20E-02
Air	cyclohexanol	9.36E-07	6.04E-05	1.81E-02
Air	cyclohexanone	6.47E-07	4.17E-05	1.25E-02
Air	decane	8.26E-07	5.33E-05	1.60E-02

Air	di-i-propyl ether	1.02E-06	6.58E-05	1.97E-02
Air	diacetone alcohol	5.62E-07	3.63E-05	1.09E-02
Air	dichloromethane	1.45E-07	9.35E-06	2.81E-03
Air	diethyl ether	1.02E-06	6.58E-05	1.97E-02
Air	dimethyl ether	3.74E-07	2.41E-05	7.24E-03
Air	dodecane	7.66E-07	4.94E-05	1.48E-02
Air	esters	3.70E-07	2.39E-05	7.16E-03
Air	ethane	2.64E-07	1.70E-05	5.11E-03
Air	ethane diol	8.26E-07	5.33E-05	1.60E-02
Air	ethanol	8.34E-07	5.38E-05	1.61E-02
Air	ethene	2.13E-06	1.37E-04	4.12E-02
Air	ethers	7.40E-07	4.77E-05	1.43E-02
Air	ethyl t-butyl ether	4.60E-07	2.97E-05	8.90E-03
Air	ethylacetate	4.60E-07	2.97E-05	8.90E-03
Air	ethylbenzene	1.53E-06	9.87E-05	2.96E-02
Air	acetylene	1.87E-07	1.21E-05	3.62E-03
Air	formaldehyde	1.11E-06	7.16E-05	2.15E-02
Air	formic acid	6.89E-08	4.45E-06	1.33E-03
Air	heptane	1.11E-06	7.16E-05	2.15E-02
Air	hexane	1.02E-06	6.58E-05	1.97E-02
Air	i-butane	6.64E-07	4.28E-05	1.29E-02
Air	i-butanol	8.09E-07	5.22E-05	1.57E-02
Air	i-butyraldehyde	1.11E-06	7.16E-05	2.15E-02
Air	i-pentane	8.51E-07	5.49E-05	1.65E-02
Air	i-propanol	2.98E-07	1.92E-05	5.77E-03
Air	i-propyl acetate	4.60E-07	2.97E-05	8.90E-03
Air	i-propyl benzene	1.11E-06	7.16E-05	2.15E-02
Air	isoprene	2.38E-06	1.54E-04	4.61E-02
Air	ketones	8.70E-07	5.61E-05	1.68E-02
Air	m-ethyl toluene	2.21E-06	1.43E-04	4.28E-02
Air	m-xylene	2.38E-06	1.54E-04	4.61E-02
Air	methane	1.28E-08	8.26E-07	2.48E-04
Air	methanol	2.81E-07	1.81E-05	5.44E-03
Air	methyl acetate	1.02E-07	6.58E-06	1.97E-03
Air	methyl chloride	1.11E-08	7.16E-07	2.15E-04
Air	methyl ethyl ketone	8.09E-07	5.22E-05	1.57E-02
Air	methyl formate	7.15E-08	4.61E-06	1.38E-03
Air	methyl i-butyl ketone	1.02E-06	6.58E-05	1.97E-02
Air	methyl i-propyl ketone	7.83E-07	5.05E-05	1.52E-02
Air	methyl propene	1.36E-06	8.77E-05	2.63E-02
Air	methyl t-butyl ether	3.32E-07	2.14E-05	6.43E-03
Air	methyl t-butyl ketone	6.98E-07	4.50E-05	1.35E-02
Air	n-butanol	1.36E-06	8.77E-05	2.63E-02
Air	n-butyl acetate	5.19E-07	3.35E-05	1.00E-02
Air	n-butyraldehyde	1.70E-06	1.10E-04	3.29E-02
Air	n-propanol	1.19E-06	7.68E-05	2.30E-02
Air	n-propyl acetate	6.21E-07	4.01E-05	1.20E-02
Air	n-propyl benzene	1.36E-06	8.77E-05	2.63E-02
Air	neopentane	3.74E-07	2.41E-05	7.24E-03
Air	NMVOOC	1.28E-06	8.26E-05	2.48E-02
Air	nonane	8.51E-07	5.49E-05	1.65E-02
Air	o-ethyl toluene	1.96E-06	1.26E-04	3.79E-02
Air	o-xylene	2.30E-06	1.48E-04	4.45E-02
Air	octane	9.36E-07	6.04E-05	1.81E-02
Air	p-ethyl toluene	1.96E-06	1.26E-04	3.79E-02
Air	p-xylene	2.21E-06	1.43E-04	4.28E-02
Air	pentanal	1.62E-06	1.05E-04	3.14E-02
Air	pentane	8.51E-07	5.49E-05	1.65E-02
Air	propane	3.83E-07	2.47E-05	7.41E-03
Air	propane diol	1.02E-06	6.58E-05	1.97E-02
Air	propene	2.38E-06	1.54E-04	4.61E-02
Air	propanoic acide	3.23E-07	2.08E-05	6.25E-03
Air	s-butanol	8.51E-07	5.49E-05	1.65E-02
Air	s-butyl acetate	5.79E-07	3.74E-05	1.12E-02
Air	t-butanol	1.64E-07	1.70E-05	5.11E-03
Air	t-butyl acetate	2.36E-07	8.77E-06	2.63E-03
Air	perchloroethylene	6.21E-08	4.01E-06	1.20E-03

Air	toluene	1.36E-06	8.77E-05	2.63E-02
Air	trans 1,2-dichloroethene	8.43E-07	5.44E-05	1.63E-02
Air	trans 2-butene	2.47E-06	1.59E-04	4.78E-02
Air	trans 2-hexene	2.30E-06	1.48E-04	4.45E-02
Air	trans 2-pentene	2.38E-06	1.54E-04	4.61E-02
Air	trichloroethylene	6.98E-07	4.50E-05	1.35E-02
Air	chloroform	4.94E-08	3.19E-06	9.56E-04
Air	undecane	8.26E-07	5.33E-05	1.60E-02
Air	VOC	6.46E-07	4.17E-05	1.25E-02
Air	xylene	2.21E-06	1.43E-04	4.28E-02

### 2.1.3 Respiratory effects on humans caused by inorganic substances (E,E)

This impact category replaces more or less the winter smog category. Fate analysis is based on empirical data. All damage factors are expressed per kg emission. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	ammonia	8.50E-05	5.48E-03	1.65E+00
Air	CO	7.31E-07	4.72E-05	1.41E-02
Air	dust (PM10)	3.75E-04	2.42E-02	7.26E+00
Air	dust (PM2.5)	7.00E-04	4.52E-02	1.35E+01
Air	TSP	1.10E-04	7.10E-03	2.13E+00
Air	NO	1.37E-04	8.84E-03	2.65E+00
Air	NO2	8.91E-05	5.75E-03	1.72E+00
Air	NOx	8.91E-05	5.75E-03	1.72E+00
Air	NOx (as NO2)	8.91E-05	5.75E-03	1.72E+00
Air	SO2	5.46E-05	3.52E-03	1.06E+00
Air	SO3	4.37E-05	2.82E-03	8.46E-01
Air	SOx	5.46E-05	3.52E-03	1.06E+00
Air	SOx (as SO2)	5.46E-05	3.52E-03	1.06E+00

### 2.1.4 Damages to human health caused by climate change (E,E)

Damage calculation was performed over a time scale of 200 years. The IPCC equivalence factors have been modified. As damage is not linear dependent on the atmospheric lifetime, a separate damage calculation is made for CO<sub>2</sub>, CH<sub>4</sub> en CH<sub>4</sub>:

- Gasses with an atmospheric lifetime below 20 years are assumed to behave like methane
- Gasses with an atmospheric lifetime between 20 and 100 years behave like CO<sub>2</sub>
- Gasses with an atmospheric lifetime of more than 100 years are assumed to behave like N<sub>2</sub>O

This means that the IPCC equivalency factor table is split in three groups. All damage factors are expressed per kg substance. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	methyl chloroform	-4.3E-05	-2.77E-03	-8.32E-01
Air	perfluoroethane	2.00E-03	1.29E-01	3.87E+01
Air	trifluoroiodomethane	2.10E-07	1.35E-05	4.06E-03
Air	perfluormethane	1.40E-03	9.03E-02	2.71E+01
Air	CFC-11	2.20E-04	1.42E-02	4.26E+00
Air	CFC-113	6.30E-04	4.06E-02	1.22E+01
Air	CFC-12	1.40E-03	9.03E-02	2.71E+01
Air	carbon dioxide	2.10E-07	1.35E-05	4.06E-03
Air	methylene chloride	1.90E-06	1.23E-04	3.68E-02
Air	HALON-1301	-7.10E-03	-4.58E-01	-1.37E+02
Air	HCFC-123	6.60E-06	4.26E-04	1.28E-01

Air	HCFC-124	8.50E-05	5.48E-03	1.65E+00
Air	HCFC-141b	5.20E-05	3.35E-03	1.01E+00
Air	HCFC-142b	3.40E-04	2.19E-02	6.58E+00
Air	HCFC-22	2.80E-04	1.81E-02	5.42E+00
Air	HFC-125	5.80E-04	3.74E-02	1.12E+01
Air	HFC-134	2.10E-04	1.35E-02	4.06E+00
Air	HFC-134a	2.70E-04	1.74E-02	5.23E+00
Air	HFC-143	6.30E-05	4.06E-03	1.22E+00
Air	HFC-143a	7.80E-04	5.03E-02	1.51E+01
Air	HFC-152a	2.90E-05	1.87E-03	5.61E-01
Air	HFC-227ea	6.00E-04	3.87E-02	1.16E+01
Air	HFC-23	2.60E-03	1.68E-01	5.03E+01
Air	HFC-236fa	1.40E-03	9.03E-02	2.71E+01
Air	HFC-245ca	1.20E-04	7.74E-03	2.32E+00
Air	HFC-32	1.40E-04	9.03E-03	2.71E+00
Air	HFC-41	3.10E-05	2.00E-03	6.00E-01
Air	HFC-4310mee	2.70E-04	1.74E-02	5.23E+00
Air	methane	4.40E-06	2.84E-04	8.52E-02
Air	nitrous oxide	6.90E-05	4.45E-03	1.34E+00
Air	perfluorbutane	1.60E-03	1.03E-01	3.10E+01
Air	perfluorocyclobutane	1.90E-03	1.23E-01	3.68E+01
Air	perfluorhexane	1.60E-03	1.03E-01	3.10E+01
Air	perfluorpentane	1.70E-03	1.10E-01	3.29E+01
Air	perfluorpropane	1.60E-03	1.03E-01	3.10E+01
Air	sulphur hexafluoride	5.30E-03	3.42E-01	1.03E+02
Air	carbontetrachloride	-2.60E-04	-1.68E-02	-5.03E+00
Air	chloroform	8.40E-07	5.42E-05	1.63E-02

## 2.1.5 Human health effects caused by ionising radiation (E,E)

Fate-, and exposure models are based on studies for the French nuclear industry. All damage factors are based on a release of 1 Becquerel (Bq). The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	C-14	2.10E-10	1.35E-08	4.06E-06
Air	Co-58	4.30E-13	2.77E-11	8.32E-09
Air	Co-60	1.60E-11	1.03E-09	3.10E-07
Air	Cs-134	1.20E-11	7.74E-10	2.32E-07
Air	Cs-137	1.30E-11	8.39E-10	2.52E-07
Air	H-3	1.40E-14	9.03E-13	2.71E-10
Air	I-129	9.40E-10	6.06E-08	1.82E-05
Air	I-131	1.60E-13	1.03E-11	3.10E-09
Air	I-133	9.40E-15	6.06E-13	1.82E-10
Air	Kr-85	1.40E-16	9.03E-15	2.71E-12
Air	Pb-210	1.50E-12	9.68E-11	2.90E-08
Air	Po-210	1.50E-12	9.68E-11	2.90E-08
Air	Pu alpha	8.30E-11	5.35E-09	1.61E-06
Air	Pu-238	6.70E-11	4.32E-09	1.30E-06
Air	Ra-226	9.10E-13	5.87E-11	1.76E-08
Air	Rn-222	2.40E-14	1.55E-12	4.65E-10
Air	Th-230	4.50E-11	2.90E-09	8.71E-07
Air	U-234	9.70E-11	6.26E-09	1.88E-06
Air	U-235	2.10E-11	1.35E-09	4.06E-07
Air	U-238	8.20E-12	5.29E-10	1.59E-07
Air	Xe-133	1.40E-16	9.03E-15	2.71E-12
Water	Ag-110m	5.10E-13	3.29E-11	9.87E-09
Water	Co-58	4.10E-14	2.65E-12	7.94E-10
Water	Co-60	4.40E-11	2.84E-09	8.52E-07
Water	Cs-134	1.40E-10	9.03E-09	2.71E-06
Water	Cs-137	1.70E-10	1.10E-08	3.29E-06
Water	H-3	4.50E-16	2.90E-14	8.71E-12
Water	I-131	5.00E-13	3.23E-11	9.68E-09
Water	Mn-54	3.10E-13	2.00E-11	6.00E-09
Water	Ra-226	1.30E-13	8.39E-12	2.52E-09
Water	Sb-124	8.20E-13	5.29E-11	1.59E-08
Water	U-234	2.40E-12	1.55E-10	4.65E-08
Water	U-235	2.30E-12	1.48E-10	4.45E-08
Water	U-238	2.30E-12	1.48E-10	4.45E-08

## 2.1.6 Human health effects caused by ozone layer depletion (E,E)

All damage factors are expressed per kg release. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,1,1-trichloroethane	1.26E-04	8.13E-03	2.44E+00
Air	CFC-11	1.05E-03	6.77E-02	2.03E+01
Air	CFC-113	9.48E-04	6.12E-02	1.83E+01
Air	CFC-114	8.95E-04	5.77E-02	1.73E+01
Air	CFC-115	4.21E-04	2.72E-02	8.15E+00
Air	CFC-12	8.63E-04	5.57E-02	1.67E+01
Air	HALON-1201	1.47E-03	9.48E-02	2.85E+01
Air	HALON-1202	1.32E-03	8.52E-02	2.55E+01
Air	HALON-1211	5.37E-03	3.46E-01	1.04E+02
Air	HALON-1301	1.26E-02	8.13E-01	2.44E+02
Air	HALON-2311	1.47E-04	9.48E-03	2.85E+00
Air	HALON-2401	2.63E-04	1.70E-02	5.09E+00
Air	HALON-2402	7.37E-03	4.75E-01	1.43E+02
Air	HCFC-123	1.47E-05	9.48E-04	2.85E-01
Air	HCFC-124	3.16E-05	2.04E-03	6.12E-01
Air	HCFC-141b	1.05E-04	6.77E-03	2.03E+01
Air	HCFC-142b	5.26E-05	3.39E-03	1.02E+00
Air	HCFC-22	4.21E-05	2.72E-03	8.15E-01
Air	HCFC-225ca	2.11E-05	1.36E-03	4.08E-01
Air	HCFC-225cb	2.11E-05	1.36E-03	4.08E-01
Air	methyl bromide	6.74E-04	4.35E-02	1.30E+01
Air	methyl chloride	2.11E-05	1.36E-03	4.08E-01
Air	carbontetrachloride	1.26E-03	8.13E-02	2.44E+01

## 2.2 Damage category Ecosystem Quality (E,E)

The Ecosystem Quality damages are specified as PDF\*m<sup>2</sup>\*yr. PDF is short for Potentially Disappeared Fraction of Species. A damage of one means all species disappear from one m<sup>2</sup> during one year, or 10% of all species disappear from 10 m<sup>2</sup> during one year, or 10% of all species disappear from 1 m<sup>2</sup> during 10 years. Within the damage category Ecosystem Quality special care is needed to avoid double counting when land-use is modelled; see the remarks under these damage categories.

### 2.2.1 Damage to Ecosystem Quality caused by ecotoxic emissions (E,E)

Fate analysis was done in EUSES.

Pesticides that evaporate during application must be counted as air emissions. Pesticides that are accidentally sprayed in surface waters must be counted as water emissions. The remainder must be counted as soil emissions. The damage from pesticides in the agricultural soil as such (root zone) was deliberately excluded to avoid double counting with land-use. This means the damage factors in this list are based on secondary (leaching) emissions from the soil into surface and ground water and evaporation.

All damage factors are expressed per kg release. The unit of damage is PDF\*m<sup>2</sup>\*yr.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,2,3-trichlorobenzene	3.51E-02	6.84E-06	3.42E-03
Air	1,2,4-trichlorobenzene	2.54E-02	4.95E-06	2.48E-03
Air	1,3,5-trichlorobenzene	1.29E-01	2.51E-05	1.26E-02
Air	2,4-D	1.46E+00	2.85E-04	1.42E-01
Air	Arsenic	5.92E+02	1.15E-01	5.77E+01

## 3 Damage factors in the individualist perspective (I,I)

This annex lists the Eco-indicator 99 damage factors for the substance lists that can be found in most popular LCA databases. In this case the individualist perspective is used, combined with the matching weighting factors. Next to the damage factors two columns are added with the normalised and weighted damages. The normalisation factors and the weights are specified below.

	Normalisation	Weights
Human health	8.25E-03	550
Ecosystem Quality	4.51E+03	250
Resources	1.50E+02	200

Below the impact categories are listed per damage category.

### 3.1 Damage category Human Health (I,I)

The human health damages are specified in DALYs. This is short for Disability Adjusted Life Years. In the individualis perspective, DALY calculations are based on age weighting.

#### 3.1.1 Carcinogenic effects on humans (I,I)

For the fate and exposure it is important to distinguish emissions to soil between emissions in industrial (ind.) or agricultural (agr.) soil. All emissions of pesticides are assumed to occur in agricultural soil, all other emissions are assumed to occur in industrial (or urban) soil. No direct emissions are assumed to occur in natural soil. Fate factors are calculated with EUSES. Substances from IARC substances groups 1are included.

All damage factors are expressed per kg emission. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	Arsenic	1.00E-03	1.21E-01	6.67E+01
Air	Bis(chloromethyl)ether	4.83E-03	5.85E-01	3.22E+02
Air	benzene	1.58E-06	1.92E-04	1.05E-01
Air	Cadmium	1.03E-02	1.25E+00	6.87E+02
Air	Chromium (VI)	1.50E-02	1.82E+00	1.00E+03
Air	metals	2.20E-04	2.67E-02	1.47E+01
Air	Nickel	6.79E-03	8.23E-01	4.53E+02
Air	Nickel-refinery-dust	2.22E-03	2.69E-01	1.48E+02
Air	Nickel-subsulfide	4.44E-03	5.38E-01	2.96E+02
Air	vinyl chloride	1.34E-07	1.62E-05	8.93E-03
Water	Arsenic	3.42E-02	4.15E+00	2.28E+03
Water	Bis(chloromethyl)ether	9.96E-03	1.21E+00	6.64E+02
Water	benzene	2.45E-06	2.97E-04	1.63E-01
Water	Cadmium	3.73E-02	4.52E+00	2.49E+03
Water	Chromium (VI)	1.79E-01	2.17E+01	1.19E+04
Water	Nickel	1.63E-02	1.98E+00	1.09E+03
Water	Nickel-subsulfide	2.65E-02	3.21E+00	1.77E+03
Water	Nickel-refinery-dust	5.29E-02	6.41E+00	3.53E+03
Water	vinyl chloride	1.73E-07	2.10E-05	1.15E-02
Soil	Arsenic (ind.)	7.28E-04	8.82E-02	4.85E+01
Soil	Bis(chloromethyl)ether (ind.)	1.08E-02	1.31E+00	7.20E+02
Soil	benzene (ind.)	8.35E-06	1.01E-03	5.57E-01
Soil	Cadmium (ind.)	6.09E-04	7.38E-02	4.06E+01

Soil	Chromium (ind.)	4.13E-03	5.01E-01	2.75E+02
Soil	Nickel (ind.)	3.27E-04	3.96E-02	2.18E+01
Soil	Nickel-refinery-dust (ind.)	5.31E-04	6.44E-02	3.54E+01
Soil	Nickel-subsulfide (ind.)	1.06E-03	1.28E-01	7.07E+01
Soil	vinylchloride (ind.)	4.92E-07	5.96E-05	3.28E-02

#### 3.1.2 Respiratory effects on humans caused by organic substances (I,I)

This impact category replaces more or less the summer smog category. Fate analysis is based on empirical data.

All damage factors are expressed per kg emitted substance. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,1,1-trichloroethane	1.82E-08	2.21E-06	1.21E-03
Air	1,2,3-trimethyl benzene	2.53E-06	3.07E-04	1.69E-01
Air	1,2,4-trimethyl benzene	2.53E-06	3.07E-04	1.69E-01
Air	1,3,5-trimethyl benzene	2.77E-06	3.36E-04	1.85E-01
Air	1,3-butadiene	1.74E-06	2.11E-04	1.16E-01
Air	1-butene	2.14E-06	2.59E-04	1.43E-01
Air	1-butoxy propanol	8.70E-07	1.05E-04	5.80E-02
Air	1-hexene	1.74E-06	2.11E-04	1.16E-01
Air	1-methoxy 2-propanol	7.36E-07	8.92E-05	4.91E-02
Air	1-pentene	1.98E-06	2.40E-04	1.32E-01
Air	2,2-dimethyl butane	4.83E-07	5.85E-05	3.22E-02
Air	2,3-dimethyl butane	1.11E-06	1.35E-04	7.40E-02
Air	2-butoxy ethanol	8.70E-07	1.05E-04	5.80E-02
Air	2-ethoxy ethanol	7.75E-07	9.39E-05	5.17E-02
Air	2-hexanone	1.11E-06	1.35E-04	7.40E-02
Air	2-methoxy ethanol	6.01E-07	7.28E-05	4.01E-02
Air	2-methyl 1-butanol	7.91E-07	9.59E-05	5.27E-02
Air	2-methyl 1-butene	1.58E-06	1.92E-04	1.05E-01
Air	2-methyl 2-butanol	2.85E-07	3.45E-05	1.90E-02
Air	2-methyl 2-butene	1.66E-06	2.01E-04	1.11E-01
Air	2-methyl hexane	7.91E-07	9.59E-05	5.27E-02
Air	2-methyl pentane	8.70E-07	1.05E-04	5.80E-02
Air	2-pentanone	1.11E-06	1.35E-04	7.40E-02
Air	3,5-diethyl toluene	2.61E-06	3.16E-04	1.74E-01
Air	3,5-dimethyl ethyl benzene	2.61E-06	3.16E-04	1.74E-01
Air	3-hexanone	1.19E-06	1.44E-04	7.93E-02
Air	3-methyl 1-butanol	7.91E-07	9.59E-05	5.27E-02
Air	3-methyl 1-butene	1.35E-06	1.64E-04	9.00E-02
Air	3-methyl 2-butanol	7.36E-07	8.92E-05	4.91E-02
Air	3-methyl hexane	7.28E-07	8.82E-05	4.85E-02
Air	3-methyl pentane	9.50E-07	1.15E-04	6.33E-02
Air	3-pentanol	8.70E-07	1.05E-04	5.80E-02
Air	3-pentanone	7.91E-07	9.59E-05	5.27E-02
Air	acetaldehyde	1.27E-06	1.54E-04	8.47E-02
Air	acetic acid	1.98E-07	2.40E-05	1.32E-02
Air	acetone	1.90E-07	2.30E-05	1.27E-02
Air	propionaldehyde	1.58E-06	1.92E-04	1.05E-01
Air	alcohols	7.10E-07	8.61E-05	4.73E-02
Air	aldehydes	1.30E-06	1.58E-04	8.67E-02
Air	alkanes	6.90E-07	8.36E-05	4.60E-02
Air	alkenes	2.00E-06	2.42E-04	1.33E-01
Air	benzene	4.35E-07	5.27E-05	2.90E-02
Air	butane	7.04E-07	8.53E-05	4.69E-02
Air	butanol	1.27E-06	1.54E-04	8.47E-02
Air	butene	2.29E-06	2.78E-04	1.53E-01
Air	cis 1,2-dichloroethene	8.70E-07	1.05E-04	5.80E-02
Air	cis 2-butene	2.29E-06	2.78E-04	1.53E-01
Air	cis 2-hexene	2.14E-06	2.59E-04	1.43E-01
Air	cis 2-pentene	2.22E-06	2.69E-04	1.48E-01
Air	CxHy aromatic	1.90E-06	2.30E-04	1.27E-01
Air	CxHy chloro	3.20E-07	3.88E-05	2.13E-02
Air	CxHy halogenated	3.20E-07	3.88E-05	2.13E-02
Air	cyclohexane	5.78E-07	7.01E-05	3.85E-02
Air	cyclohexanol	8.70E-07	1.05E-04	5.80E-02

Air	cyclohexanone	6.01E-07	7.28E-05	4.01E-02
Air	decane	7.68E-07	9.31E-05	5.12E-02
Air	di-i-propyl ether	9.50E-07	1.15E-04	6.33E-02
Air	diacetone alcohol	5.22E-07	6.33E-05	3.48E-02
Air	dichloromethane	1.35E-07	1.64E-05	9.00E-03
Air	diethyl ether	9.50E-07	1.15E-04	6.33E-02
Air	dimethyl ether	3.48E-07	4.22E-05	2.32E-02
Air	dodecane	7.12E-07	8.63E-05	4.75E-02
Air	esters	3.40E-07	4.12E-05	2.27E-02
Air	ethane	2.45E-07	2.97E-05	1.63E-02
Air	ethane diol	7.68E-07	9.31E-05	5.12E-02
Air	ethanol	7.75E-07	9.39E-05	5.17E-02
Air	ethene	1.98E-06	2.40E-04	1.32E-01
Air	ethers	6.80E-07	8.24E-05	4.53E-02
Air	ethyl t-butyl ether	4.27E-07	5.18E-05	2.85E-02
Air	ethylacetate	4.27E-07	5.18E-05	2.85E-02
Air	ethylbenzene	1.42E-06	1.72E-04	9.47E-02
Air	acetylene	1.74E-07	2.11E-05	1.16E-02
Air	formaldehyde	1.03E-06	1.25E-04	6.87E-02
Air	formic acid	6.41E-08	7.77E-06	4.27E-03
Air	heptane	1.03E-06	1.25E-04	6.87E-02
Air	hexane	9.50E-07	1.15E-04	6.33E-02
Air	i-butane	6.17E-07	7.48E-05	4.11E-02
Air	i-butanol	7.52E-07	9.12E-05	5.01E-02
Air	i-butyraldehyde	1.03E-06	1.25E-04	6.87E-02
Air	i-pentane	7.91E-07	9.59E-05	5.27E-02
Air	i-propanol	2.77E-07	3.36E-05	1.85E-02
Air	i-propyl acetate	4.27E-07	5.18E-05	2.85E-02
Air	i-propyl benzene	1.03E-06	1.25E-04	6.87E-02
Air	isoprene	2.22E-06	2.69E-04	1.48E-01
Air	ketones	8.10E-07	9.82E-05	5.40E-02
Air	m-ethyl toluene	2.06E-06	2.50E-04	1.37E-01
Air	m-xylene	2.22E-06	2.69E-04	1.48E-01
Air	methane	1.19E-08	1.44E-06	7.93E-04
Air	methanol	2.61E-07	3.16E-05	1.74E-02
Air	methyl acetate	9.50E-08	1.15E-05	6.33E-03
Air	methyl chloride	1.03E-08	1.25E-06	6.87E-04
Air	methyl ethyl ketone	7.52E-07	9.12E-05	5.01E-02
Air	methyl formate	6.65E-08	8.06E-06	4.43E-03
Air	methyl i-butyl ketone	9.50E-07	1.15E-04	6.33E-02
Air	methyl i-propyl ketone	7.28E-07	8.82E-05	4.85E-02
Air	methyl propene	1.27E-06	1.54E-04	8.47E-02
Air	methyl t-butyl ether	3.09E-07	3.75E-05	2.06E-02
Air	methyl t-butyl ketone	6.49E-07	7.87E-05	4.33E-02
Air	n-butanol	1.27E-06	1.54E-04	8.47E-02
Air	n-butyl acetate	4.83E-07	5.85E-05	3.22E-02
Air	n-butyraldehyde	1.58E-06	1.92E-04	1.05E-01
Air	n-propanol	1.11E-06	1.35E-04	7.40E-02
Air	n-propyl acetate	5.78E-07	7.01E-05	3.85E-02
Air	n-propyl benzene	1.27E-06	1.54E-04	8.47E-02
Air	neopentane	3.48E-07	4.22E-05	2.32E-02
Air	NMVOG	1.19E-06	1.44E-04	7.93E-02
Air	nonane	7.91E-07	9.59E-05	5.27E-02
Air	o-ethyl toluene	1.82E-06	2.21E-04	1.21E-01
Air	o-xylene	2.14E-06	2.59E-04	1.43E-01
Air	octane	8.70E-07	1.05E-04	5.80E-02
Air	p-ethyl toluene	1.82E-06	2.21E-04	1.21E-01
Air	p-xylene	2.06E-06	2.50E-04	1.37E-01
Air	pentanal	1.50E-06	1.82E-04	1.00E-01
Air	pentane	7.91E-07	9.59E-05	5.27E-02
Air	propane	3.56E-07	4.32E-05	2.37E-02
Air	propane diol	9.50E-07	1.15E-04	6.33E-02
Air	propene	2.22E-06	2.69E-04	1.48E-01
Air	propanoic acide	3.01E-07	3.65E-05	2.01E-02
Air	s-butanol	7.91E-07	9.59E-05	5.27E-02
Air	s-butyl acetate	5.38E-07	6.52E-05	3.59E-02
Air	t-butanol	2.45E-07	2.97E-05	1.63E-02
Air	t-butyl acetate	1.27E-07	1.54E-05	8.47E-03
Air	perchloroethylene	5.78E-08	7.01E-06	3.85E-03
Air	toluene	1.27E-06	1.54E-04	8.47E-02
Air	trans 1,2-dichloroethene	7.83E-07	9.49E-05	5.22E-02
Air	trans 2-butene	2.29E-06	2.78E-04	1.53E-01
Air	trans 2-hexene	2.14E-06	2.59E-04	1.43E-01
Air	trans 2-pentene	2.22E-06	2.69E-04	1.48E-01

Air	trichloroethylene	6.49E-07	7.87E-05	4.33E-02
Air	chloroform	4.59E-08	5.56E-06	3.06E-03
Air	undecane	7.68E-07	9.31E-05	5.12E-02
Air	VOC	6.00E-07	7.27E-05	4.00E-02
Air	xylene	2.06E-06	2.50E-04	1.37E-01

### 3.1.3 Respiratory effects on humans caused by inorganic substances (I,I)

This impact category replaces more or less the winter smog category. Fate analysis is based on empirical data. All damage factors are expressed per kg emission. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	ammonia	5.10E-05	6.18E-03	3.40E+00
Air	dust (PM10)	2.74E-04	3.32E-02	1.83E+01
Air	dust (PM2.5)	5.10E-04	6.18E-02	3.40E+01
Air	TSP	8.03E-05	9.73E-03	5.35E+00
Air	NO	1.83E-06	2.22E-04	1.22E-01
Air	NO2	1.19E-06	1.44E-04	7.93E-02
Air	NOx	1.19E-06	1.44E-04	7.93E-02
Air	NOx (as NO2)	1.19E-06	1.44E-04	7.93E-02
Air	SO2	3.90E-05	4.73E-03	2.60E+00
Air	SO3	3.12E-05	3.78E-03	2.08E+00
Air	SOx	3.90E-05	4.73E-03	2.60E+00
Air	SOx (as SO2)	3.90E-05	4.73E-03	2.60E+00

### 3.1.4 Damages to human health caused by climate change (I,I)

Damage calculation was performed over a time scale of 200 years. The IPCC equivalence factors have been modified. As damage is not linear dependent on the atmospheric lifetime, a separate damage calculation is made for CO<sub>2</sub>, CH<sub>4</sub> en CH<sub>4</sub>:

- Gasses with an atmospheric lifetime below 20 years are assumed to behave like methane
- Gasses with an atmospheric lifetime between 20 and 100 years behave like CO<sub>2</sub>
- Gasses with an atmospheric lifetime oh more than 100 years are assumed to behave like N<sub>2</sub>O

This means that the IPCC equivalency factor table is split in three groups. All damage factors are expressed per kg substance. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	methyl chloroform	-4.2E-05	-5.09E-03	-2.80E+00
Air	perfluorethane	2.00E-03	2.42E-01	1.33E+02
Air	trifluoroiodomethane	2.10E-07	2.55E-05	1.40E-02
Air	perfluormethane	1.40E-03	1.70E-01	9.33E+01
Air	CFC-11	2.20E-04	2.67E-02	1.47E+01
Air	CFC-113	6.20E-04	7.52E-02	4.13E+01
Air	CFC-12	1.30E-03	1.58E-01	8.67E+01
Air	carbon dioxide	2.00E-07	2.42E-05	1.33E-02
Air	methylene chloride	1.90E-06	2.30E-04	1.27E-01
Air	HALON-1301	-7.00E-03	-8.48E-01	-4.67E+02
Air	HCFC-123	6.60E-06	8.00E-04	4.40E-01
Air	HCFC-124	8.50E-05	1.03E-02	5.67E+00
Air	HCFC-141b	5.20E-05	6.30E-03	3.47E+00
Air	HCFC-142b	3.40E-04	4.12E-02	2.27E+01
Air	HCFC-22	2.80E-04	3.39E-02	1.87E+01
Air	HFC-125	5.70E-04	6.91E-02	3.80E+01
Air	HFC-134	2.10E-04	2.55E-02	1.40E+01
Air	HFC-134a	7.70E-04	9.33E-02	5.13E+01
Air	HFC-143	6.20E-05	7.52E-03	4.13E+00

Air	HFC-143a	1.00E-02	1.21E+00	6.67E+02
Air	HFC-152a	2.90E-05	3.52E-03	1.93E+00
Air	HFC-227ea	5.90E-04	7.15E-02	3.93E+01
Air	HFC-23	2.50E-03	3.03E-01	1.67E+02
Air	HFC-236fa	1.40E-03	1.70E-01	9.33E+01
Air	HFC-245ca	1.20E-04	1.45E-02	8.00E+00
Air	HFC-32	1.30E-04	1.58E-02	8.67E+00
Air	HFC-41	3.10E-05	3.76E-03	2.07E+00
Air	HFC-4310mee	2.70E-04	3.27E-02	1.80E+01
Air	methane	4.40E-06	5.33E-04	2.93E-01
Air	nitrous oxide	6.70E-05	8.12E-03	4.47E+00
Air	perfluorbutane	1.50E-03	1.82E-01	1.00E+02
Air	perfluorocyclobutane	1.90E-03	2.30E-01	1.27E+02
Air	perfluorhexane	1.60E-03	1.94E-01	1.07E+02
Air	perfluoropentane	1.60E-03	1.94E-01	1.07E+02
Air	perfluorpropane	1.50E-03	1.82E-01	1.00E+02
Air	sulphur hexafluoride	5.20E-03	6.30E-01	3.47E+02
Air	carbontetrachloride	-2.50E-04	-3.03E-02	-1.67E+01
Air	chloroform	8.30E-07	1.01E-04	5.53E-02

### 3.1.5 Human health effects caused by ionising radiation (I,I)

Fate-, and exposure models are based on studies for the French nuclear industry. All damage factors are based on a release of 1 Becquerel (Bq). The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	C-14	1.60E-11	1.94E-09	1.07E-06
Air	Co-58	3.60E-13	4.36E-11	2.40E-08
Air	Co-60	1.40E-11	1.70E-09	9.33E-07
Air	Cs-134	1.00E-11	1.21E-09	6.67E-07
Air	Cs-137	1.10E-11	1.33E-09	7.33E-07
Air	H-3	1.20E-14	1.45E-12	8.00E-10
Air	I-129	2.50E-10	3.03E-08	1.67E-05
Air	I-131	1.30E-13	1.58E-11	8.67E-09
Air	I-133	7.90E-15	9.58E-13	5.27E-10
Air	Kr-85	1.20E-16	1.45E-14	8.00E-12
Air	Pb-210	1.30E-12	1.58E-10	8.67E-08
Air	Po-210	1.30E-12	1.58E-10	8.67E-08
Air	Pu alpha	7.00E-11	8.48E-09	4.67E-06
Air	Pu-238	5.70E-11	6.91E-09	3.80E-06
Air	Ra-226	7.60E-13	9.21E-11	5.07E-08
Air	Rn-222	2.00E-14	2.42E-12	1.33E-09
Air	Th-230	3.80E-11	4.61E-09	2.53E-06
Air	U-234	8.20E-11	9.94E-09	5.47E-06
Air	U-235	1.70E-11	2.06E-09	1.13E-06
Air	U-238	6.90E-12	8.36E-10	4.60E-07
Air	Xe-133	1.20E-16	1.45E-14	8.00E-12
Water	Ag-110m	4.20E-13	5.09E-11	2.80E-08
Water	Co-58	3.40E-14	4.12E-12	2.27E-09
Water	Co-60	3.70E-11	4.48E-09	2.47E-06
Water	Cs-134	1.20E-10	1.45E-08	8.00E-06
Water	Cs-137	1.40E-10	1.70E-08	9.33E-06
Water	H-3	3.80E-16	4.61E-14	2.53E-11
Water	I-131	4.20E-13	5.09E-11	2.80E-08
Water	Mn-54	2.60E-13	3.15E-11	1.73E-08
Water	Ra-226	1.10E-13	1.33E-11	7.33E-09
Water	Sb-124	6.90E-13	8.36E-11	4.60E-08
Water	U-234	2.00E-12	2.42E-10	1.33E-07
Water	U-235	2.00E-12	2.42E-10	1.33E-07
Water	U-238	1.90E-12	2.30E-10	1.27E-07

### 3.1.6 Human health effects caused by ozone layer depletion (I,I)

All damage factors are expressed per kg release. The unit of damage is DALYs.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,1,1-trichloroethane	1.02E-04	1.24E-02	6.80E+00
Air	CFC-11	8.50E-04	1.03E-01	5.67E+01
Air	CFC-113	7.65E-04	9.27E-02	5.10E+01
Air	CFC-114	7.23E-04	8.76E-02	4.82E+01
Air	CFC-115	3.40E-04	4.12E-02	2.27E+01
Air	CFC-12	6.97E-04	8.45E-02	4.65E+01
Air	HALON-1201	1.19E-03	1.44E-01	7.93E+01
Air	HALON-1202	1.06E-03	1.28E-01	7.07E+01
Air	HALON-1211	4.34E-03	5.26E-01	2.89E+02
Air	HALON-1301	1.02E-02	1.24E+00	6.80E+02
Air	HALON-2311	1.19E-04	1.44E-02	7.93E+00
Air	HALON-2401	2.13E-04	2.58E-02	1.42E+01
Air	HALON-2402	5.95E-03	7.21E-01	3.97E+02
Air	HCFC-123	1.19E-05	1.44E-03	7.93E-01
Air	HCFC-124	2.55E-05	3.09E-03	1.70E+00
Air	HCFC-141b	8.50E-05	1.03E-02	5.67E+00
Air	HCFC-142b	4.25E-05	5.15E-03	2.83E+00
Air	HCFC-22	3.40E-05	4.12E-03	2.27E+00
Air	HCFC-225ca	1.70E-05	2.06E-03	1.13E+00
Air	HCFC-225cb	1.70E-05	2.06E-03	1.13E+00
Air	methyl bromide	5.44E-04	6.59E-02	3.63E+01
Air	methyl chloride	1.70E-05	2.06E-03	1.13E+00
Air	carbontetrachloride	1.02E-03	1.24E-01	6.80E+01

## 3.2 Damage category Ecosystem Quality (I,I)

The Ecosystem Quality damages are specified as PDF\*m<sup>2</sup>\*yr. PDF is short for Potentially Disappeared Fraction of Species. A damage of one means all species disappear from one m<sup>2</sup> during one year, or 10% of all species disappear from 10 m<sup>2</sup> during one year, or 10% of all species disappear from 1 m<sup>2</sup> during 10 years. Within the damage category Ecosystem Quality special care is needed to avoid double counting when land-use is modelled; see the remarks under these damage categories.

### 3.2.1 Damage to Ecosystem Quality caused by ecotoxic emissions (I,I)

Fate analysis was done in EUSES.

Pesticides that evaporate during application must be counted as air emissions. Pesticides that are accidentally sprayed in surface waters must be counted as water emissions. The remainder must be counted as soil emissions. The damage from pesticides in the agricultural soil as such (root zone) was deliberately excluded to avoid double counting with land-use. This means the damage factors in this list are based on secondary (leaching) emissions from the soil into surface and ground water and evaporation.

All damage factors are expressed per kg release. The unit of damage is PDF\*m<sup>2</sup>\*yr.

Com-part-ment	Substances	Damage factor	Normalised damage factor	Weighted damage factor
Air	1,2,3-trichlorobenzene	3.51E-02	7.78E-06	1.95E-03
Air	1,2,4-trichlorobenzene	2.54E-02	5.63E-06	1.41E-03
Air	1,3,5-trichlorobenzene	1.29E-01	2.86E-05	7.15E-03
Air	2,4-D	1.46E+00	3.24E-04	8.09E-02
Air	Arsenic	5.00E+01	1.11E-02	2.77E+00
Air	Atrazine	2.09E+02	4.63E-02	1.16E+01
Air	Azinphos-methyl	1.10E+04	2.44E+00	6.10E+02
Air	Bentazon	7.33E+00	1.63E-03	4.06E-01
Air	benzene	2.75E-03	6.10E-07	1.52E-04
Air	benzo(a)pyrene	1.42E+02	3.15E-02	7.87E+00
Air	Carbendazim	2.40E+03	5.32E-01	1.33E+02
Air	Cadmium	2.66E+03	5.90E-01	1.47E+02
Air	Chromium	9.70E+01	2.15E-02	5.38E+00
Air	Copper	1.93E+02	4.28E-02	1.07E+01