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DEVELOPMENT AND APPLICATION OF A METHODOLOGY TO RANK MATERIALS BASED ON THEIR ENVIRONMENTAL IMPACTS

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1 Introduction

Motivation
The Dutch Parliament has asked for more clarity regarding the definition of a "materials policy". As an answer to that, the government has promised in the 4th Environmental Policy Plan (NMP4, 2001) to develop an indicator for dematerialisation and a monitoring system for materials. At the moment several research institutes are engaged in the development of both. However, in the NMP-4 a clear problem definition as well as policy aims and goals are missing. This leads to the question, what problem should be solved by doing something about materials. Priorities can be set only when this is clear. The NMP-4 does contain a list with materials, or rather rough groups of materials, which should be the subject of such a policy: fossil fuels, wood, food, water, plastics, building materials and metals. This selection is not motivated. On first appearance it seems to be a list with the major flows in terms of volume and weight. However, this does not automatically imply that these are the major flows in terms of their contribution to environmental problems. This is one of the basic issues of discussion in the field of dematerialisation. In this report, we try to build a bridge between mass flows on the one hand, and environmental impacts on the other. The aim is to develop and apply a methodology to weigh materials with regard to both volume and impacts. This methodology then can be the basis to prioritise between materials and identify the most urgent materials to address in a dematerialisation policy. In the application, fossil fuels as energy carriers are excepted, since these are already the subject of energy policies. However the methodology will be applicable to this class of materials as well.

At present, there is no policy yet called "dematerialisation policy". Nevertheless, there are various policies that influence materials flows, either directly or indirectly. Examples are energy policies, waste management policies, policies regarding packaging, substance policies etc. For such policies, policy goals often exist. This report also contains a brief overview of existing policies, to better enable to define priorities for a new policy.

Aims of the investigation
The aim of the investigation is to develop and apply a methodology to identify the materials that contribute most to the environmental problems in the Netherlands, with the exception of fossil fuels as energy carriers.

Contents of the report
In Chapter 2, the concept of dematerialisation is introduced and discussed, in relation to the concept of de-linking or de-coupling (of economic growth and environmental pressure). Chapter 3 contains a classification and selection of materials to be included in the analysis. In Chapter 4, the Eurostat method of accounting for material flows is introduced and the results for the Netherlands are summarised. This provides the volume, or rather weight, of the materials. Chapter 5 then provides the environmental impacts. Here, with the help of one of the major LCA databases, the CMLCA program and some additional information, the contribution of the materials to the environmental problems will be specified on a per kilogram basis. In Chapter 6, both types of information are combined and a priority list of materials is composed. Chapter 7 contains a short description of existing policies. Chapter 8 finally is dedicated to conclusions, discussions and recommendations.

2 Dematerialisation

2.1 The concept of dematerialisation

Dematerialisation is often mentioned as a strategy or as an indicator in the framework of sustainable development. Dematerialisation can be defined as the reduction of the throughput of materials in human societies. It can be measured on different geographical scale levels like nations, regions and cities but also on within different sectors of industry, households and in products (MIPS, according to von Weizsäcker et al., 1997). One can distinguish *absolute* (or strong) dematerialisation and *relative* (or weak) dematerialisation. When the total amount of material inputs in a society is decreasing this is called absolute dematerialisation. When the amount of material input is going down per unit of GDP or per capita the term relative dematerialisation is used. Current trends show that on aggregate and in absolute terms both material inflows and material outflows of industrialised societies are increasing. However, the material inputs and outputs per unit of GDP are decreasing, so relative dematerialisation actually takes place. A closer study of the figures and trends shows that both in the use of primary materials and in industrial production there are clear examples of dematerialisation per unit of product, e.g. by material substitution, efficiency improvement and other economic factors. On the other hand however consumers tend to have increasing material wants which is of course closely connected to economic growth and increasing wealth.

A very important phenomenon for dematerialisation may be the shift from matter to information. One trend that can be seen in industrialised societies is that information is gradually becoming more valued then matter. Some matter cannot be replaced by information, but what seems to be occurring is that for every object or service we develop or use, the information density and knowledge inherent in it is rising. Examples of this increasing information density are easily found when today's products are compared with their predecessors e.g.: a T-Ford compared to a Smart car, old carphones compared to modern cellular phones, CRT computer monitors compared to LCD displays, etc..

In practice dematerialisation can be accomplished via different routes, for example:

- increasing the efficiency of material use (using less materials for a specific function)
- materials substitution (exchanging heavy materials with light materials)
- re-use / recycling of materials (using materials for multiple functions)
- sharing (use of products by more than one consumer)

One option for dematerialisation is the transition from products to services, or “servicizing”. Servicizing focuses on the development of product-based services. Consumers no longer buy products but instead pay for services. This will increase the involvement of the producer with the product in its use phase. Buying and selling are replaced into different property rights options like producer take-back and leasing and pooling arrangements. Value is not created by creating a product with a certain value added but by the function that is provided by the producer, the product is just a means of delivering that function. According to White, Stoughton and Feng (1999) incentives to develop servicizing in a modern competitive market appear when 3 principles are in place:

- when the business arrangement serves to internalise use or disposal costs;
- when the product in question has significant value at end-of-life;
- when provision of the product is viewed as a cost, rather than a profit centre

2.2 Limitations of the dematerisalisation concept: from dematerialisation to de-linking

Although the shift to a dematerialised world is normally thought of as a step towards a sustainable world, not all individual shifts are necessarily good from an environmental point of view. Unwanted side-effects can occur in specific situations for example:

- lighter materials are not necessarily more environmentally friendly than heavier materials;
- a shift in materials may cause side-effects due to reduction of life span, need for more transportation, tendency to throw away instead of repair, reduced recycleability etc.;
- lengthening of life span may lead to fossilisation of equipment: obsolete energy intensive equipment must be kept in use longer, reducing waste but also maintaining a high energy use;
- lengthening of life span may cause stock building in society, which may lead to a “time bomb” of delayed waste generation;
- computerisation, instead of reducing material requirements, leads to new possibilities that may increase material flows and energy use (e.g., the quite considerable energy use of electronic networks);
- recovery and recycling may have unwanted side effects due to extra transportation and energy use.

A specific type of side effect is called the "rebound effect". One well-known example of that is related to the introduction of low-energy light bulbs. The introduction of these very efficient light bulbs with low energy costs gave people the idea that the energy use and costs were so low that it did not matter if they would leave them switched on 24 hours a day. The introduction of new and eco-efficient products can thus cause counterproductive shifts in consumer behaviour. A similar example is the introduction of highly efficient heating systems that reduce the cost of energy to customers. Customers in turn respond by having higher standards of warmth and therefore, increased energy consumption. Rebound effects can also occur in a very indirect way e.g. consumers will spend the money which is saved by the use of these new heating systems and light bulbs for other purposes for example to buy flying tickets for an extra holiday.

For this reason, there is an ongoing discussion on the value of kilograms as an indicator for environmental pressure. It may be better to broaden the scope from "dematerialisation" to "de-linking", a more general concept referring to the need for a reduction of environmental pressure at an ongoing economic growth. One of the possible indicators for environmental pressure is kilograms of materials, but there are other options as well, for example square meters (as in the Ecological Footprint, Rees & Wackernagel (1996)), eco-points (as in the Eco-indicator, Goedkoop & Spriensma, 2000) or contribution to specific environmental problems (as in the NAMEA accounts). The Ministry of the Environment some years ago selected this last option.

While it is very useful to keep track of phenomena like the rebound effect, it is not always easy to consider them when formulating a dematerialisation policy. These things often appear unexpectedly, as nasty surprises. To some extent however it is possible to give some extra depth to the mere kilograms. In this report, we try to combine mass flow information with information on environmental impacts. Thus, we intend to build a bridge between the kilograms and the impacts and on another level between the worlds of Material Flow Accounting (MFA) and Life Cycle Assessment (LCA).

3 Methodology for prioritising materials

3.1 Methods to assess the problem causing properties of materials

Whether or not a material is problematical, and therefore should be subject to a materials policy, can be judged in various ways:

- based on the volume of production and use: the contribution in mass to the total of materials
- based on the environmental problems: starting from the environmental problems mentioned above one arrives through a practical approach rapidly at the important materials
- based on the life-cycle impacts of the total life cycle of the materials, including all related aspects such as energy, transport, land use and auxilliary materials.
- based on the function of the materials.

Below, these four options will be briefly discussed and a choice will be made between them.

3.1.1 Mass

At present, weighing on a mass basis is the most common way. This connects to the Factor-4 approach, as supported for example by the Wuppertal Institute (von Weiszäcker et al., 1997), and as operationalised by Eurostat (Eurostat, 2000) and EEA (Bringezu & Schütz, 2000) in various mass based indicators. The idea behind this is that mass, although indirectly, is a useful indicator for environmental problems. More mass usually means more energy use, more waste and more emissions. This approach has a certain beauty because of the simplicity of both the message and the approach. The scientific discussion on the sense and nonsense of this approach is by no means finalised, but in the meantime the mass based indicators gain territory in circles of policy makers. Based on mass, by far the most important material is water. Fossil fuels are a good second. Third are building materials, after that biomass, including agricultural production. A long way after that we find the larger metals (Fe and Al) and chemicals (chlorine, fertilisers). Smaller-scale chemicals and metals cannot be detected because their weight in kilograms disappears behind the dot. This indicates the most important weakness of the approach, since small-scale chemicals can have large environmental impacts. The advantage of the mass-based accounts and indicators is that the starting point is an encompassing list of (raw) materials and products. In principle this list offers all kinds of opportunities to focus on details.

3.1.2 Environmental problems

The second possible starting point is the environmental problems themselves. Starting at climate change, we arrive via CO_2 and other greenhouse gases to (chlorinated) C-compounds, as can be found in biomass and plastics. Toxicity brings us quickly to pesticides, heavy metals, chemicals giving rise to POPs and suchlike. Acidification brings us again to C-containing compounds, which always contain S as a trace material, and via ammonia to fertiliser and biomass again. Biodiversity leads on the one hand to the materials connected to processes occupying a lot of space, especially agricultural products, on the other hand to extractions of wood and fish species. In international perspective, mining may be relevant as a space occupying and landscape deteriorating activity, which brings us to for example aluminium. Waste generation leads to packaging and the materials paper, glass and plastics. Depletion of resources occurs in relation to rare metals, uranium, and some of the biotic resources. It is possible to arrive at a list of causes for most of these environmental problems. The advantage of this approach is that the relevance is imminently clear. On the other hand, it is not always easy to translate from causes (target groups or plants) to materials. Also, the thus selected list of materials is not complete but limited to the selection of environmental problems and the gut feeling of the investigator. Materials not associated with the identified problems are out of sight. This can be a pity when policy changes priorities, or new problems are discovered.

3.1.3 Life cycle impacts

The third option is a life-cycle approach. Not only the materials themselves, but everything connected to them is part of the picture: energy use for extraction and production, transport, the use of auxilliary materials, land use, other emissions at the production- or waste stage etc.. In the priority list, the energy- and transport intensive materials will soon have a high priority. For example, Hekkert (2000) shows that by dematerialisation the climate change problem may be reduced significantly. A second group of materials scoring highly will be the materials having a high impact factor themselves, or lead to very toxic emissions in the production or use stage (for example dioxin formation in waste incineration, or Hg-emissions during chlorine production). This approach will certainly bring new and relevant aspects, which are important for the comparison of materials on their environmental impacts. But there are some problems as well. A life-cycle approach assumes a functional unit, which is not possible for a material since it is used for more purposes. Another problem is the risk for double counting. Hg emissions take place during chlorine production and therefore count for the material of chlorine, but through the same reasoning it is also an application of Hg and therefore counts for the material of mercury. Last but not least, such an approach is very labour-intensive. The whole life-cycle needs to be specified on a detailed level: all production processes involved need to be specified, all applications of the material must be identified, of all those applications we must know what their life span is and what will happen to them in the waste stage, especially whether or not they are recycled and if yes, how. Within the framework of this project, an approach like that is not feasible for a large number of materials.

3.1.4 Functions

A fourth possibility is to approach the question from a functional angle, such as for example Baccini & Brunner (1991) tried to do. People have to eat, so it is not possible just to abandon agriculture if it appears that agricultural biomass belongs to the most problematical materials. Within the broad function of food supply however, it is possible to optimise. Putting for example protein supply in the centre, meat will probably be more of an environmental burden than soy. For other basic functions, similar comparisons can be made. Housing is an essential function, but there is still the choice between different building materials. Cleaning can be done with more or less water, or with more or less solvents and cleaning agents. The advantage of this approach is that it enables to include substitutability, so it is one step further in the direction of a materials policy. On the other hand, it may be a bit further removed from what one usually has in mind thinking of a materials policy.

3.1.5 Approach chosen in this study

As the most complete approach that still can be made operational we select the Life Cycle Impacts approach. For every considered material we will make an estimate of its contribution to the environmental problems throughout its life cycle. We will use two types of information: (1) the total cradle-to-grave impact of the material per kg, and (2) the number of kilograms of this material being produced and/or used. For establishing the per kg impacts, we will use the CML LCA software (Heijungs, 2003) and a standard LCA database, the ETH database (Frischknecht, 1996), supplemented with some estimates of our own. The ETH database contains a huge number of industrial, energy generation and waste treatment processes, which can be combined into process trees connected to functional units. The other main source of information is the Eurostat database of material flows (Eurostat, 2002). This database contains time series of imports, extractions, exports and emissions of products and materials for the EU-15 countries and is the basis for the above-mentioned material based indicators. By combining these two basic sources of information, we will be able to determine a top-twenty of the most environmentally problematical materials. This will be elaborated below. In Section 3.2, the environmental problems to which the materials contribute will be treated. In Section 3.3, we describe how we will use the information from the ETH and Eurostat databases to come to a comparative assessment of materials.

3.2 Environmental problems related to materials

RIVM distinguishes the following environmental problems in the invitation to tender:

- climate change
- waste production
- acidification
- loss of biodiversity
- toxicity and external safety risks
- depletion of resources
- landscape degradation

The LCA methodology, and concurrently also the CMLCA software, distinguishes its own "impact categories". These are partly identical to the above-mentioned environmental problems but partly different. If we use the LCA software, this implies that a translation must be made between the LCA impact categories and the problems listed above. In most cases, it will be no problem to tune them to each other. We propose to make the translation in the following way:

RIVM list of environmental problems	LCA impact categories (with impact potentials)	Translation
climate change	global warming (GWP) ozone layer depletion (ODP)	global warming ozone layer depletion
waste production	- final solid waste production (FSW)	In the LCA Inventory, each process specifies kg waste formation. The total of these kgs waste for the process tree is taken as a measure for waste production.
acidification	acidification (AP)	acidification
loss of biodiversity	- land use competition (LUC)	Loss of biodiversity can be the result of many environmental problems, so there is a double-count in making this an impact category. We translate it here into loss of habitat, being the only aspect not double-counting, indicated by space occupation. We add per material the m^2/y space occupation for all processes of the process tree, which is specified in the LCA Inventory.
toxicity and external safety	human toxicity (HTP) terrestrial ecotoxicity (TETP) fresh water ecotoxicity (FAETP) marine ecotoxicity (MAETP)	the 4 toxicity categories could be added to 1 or 2 (human and ecosystem).
depletion of resources	depletion of abiotic resources (ADP)	depletion of abiotic resources NB for depletion of biotic resources, no operational indicator is available in LCA.
landscape degradation	-	The m^2 space occupation also must serve as an indicator for landscape degradation. No separate indicator will be developed.
-	eutrophication (EP)	eutrophication
-	radiation (DALY)	radiation

-	photochemical oxidant formation (POCP)	photochemical oxidant formation

Therefore, the only environmental problem not included is Landscape degradation. On the other hand, there are three extras: eutrophication, radiation and photochemical oxidant formation.

3.3 Further specification of the approach

3.3.1 Calculation of cradle-to-grave impacts of materials

We specify the impacts per kg of material as follows:

For the *extraction and production phase* of the life cycle, we will use cradle-to-gate data from the ETH-database. For a number of materials, it is possible to specify this. In this phase, energy use, transport, space occupation etc. will be included in the assessment in a non-site-specific generic manner. The ETH-database is one of the largest and most complete LCA-databases. Of a large number of processes information is included on economic inputs (raw materials and energy) and outputs (products) in physical terms, as well as the environmental interventions (emissions, extractions, waste formation and space occupation). With the CMLCA program, designed to perform LCA studies, process trees can be defined for so-called functional units. As a functional unit, 1 kg of a specific material can be chosen. The process tree are all processes connected to the making of this kg, from the extraction of raw materials until the final delivery of the material. The CMLCA program delivers an ecoprofile for the process tree, i.e. a list of all environmental interventions that can be attributed to the process tree. This list then is subjected to the Life Cycle Impact Assessment (LCIA), scoring the environmental interventions on their contribution to specific environmental problems or "impact categories". Thus, a *cradle-to-gate* score per kg material on all the included impact categories is obtained.

For the *use phase* we cannot rely on such standardised information. Standard LCA databases do not contain data on impacts during use. This is mainly because of the immense variety of possible uses of materials in endless numbers of products. We will apply a simplified practical approach to estimate the emissions of the material itself during use. Other aspects, such as energy consumption in the use-phase, we ignore. This seems to be appropriate, since energy use depends on the product and not on the material. It cannot be regarded, as it can in the production phase, as being inherent to the material.
The simplified practical approach is as follows: it is possible to distinguish three general types of materials according to their characteristics of emissions during use. The impacts arise mainly from emissions of the material itself during use. The three material classes are:

1. Materials that have no emissions during use
2. Materials that have some degree of emissions during use
3. Materials for which the use equals the emission of the material.

Class 1 materials are materials like concrete, glass or wood. The assumption is that there is no leaching or corrosion, and all of the material ultimately ends up in the waste phase.
Class 2 materials are materials that are subject to wear, leaching, volatilisation or corrosion during use. It is therefore possible to estimate the fraction of material lost during the use. Two problems arise here. First, whether or not and to which extent leaching occurs is not only dependent on the material, but also on the product it is applied in. For example, copper in electronics is not corroding, but copper in water pipes is. It is quite difficult to estimate the fraction of the total material that is subject to conditions where corrosion or leaching happens. Second, it is a lot of work and may not be possible for all materials to find information on the rate of leaching or corrosion per year. Materials in this class are mainly metals, rubber and such. For this study, we will have to apply some crude assumptions. This will at least give the opportunity to assess the importance of the use phase in the total life cycle.

Class 3 materials are materials whose use equals their emission. This involves for example solvents, pesticides and fuels. It is relatively straightforward to estimate the impacts of this class of materials.
The emissions thus estimated then are again multiplied by the LCIA impact factors to obtain a score for the environmental impacts of the use phase.

For the *waste management phase* the division over landfill, incineration and re-use / recycling is important. Partly, this division is determined by policy. For another part, this is inherent to the material. For most metals the recycling rate is quite high, because metals are expensive and can be recovered relatively easily. Recycling of plastics has been a policy goal for a long time, but encounters a lot of problems due to the properties of the waste stream. For plastics, incineration is not a bad option because energy can be recovered, but building materials that are not recycled are almost completely landfilled since they cannot be incinerated. If known, the present end-of-life division will be used for determining the environmental impacts per material. For some materials, the ETH database contains waste management processes, which will be used. The emissions from the waste management phase again will be multiplied by the LCIA impact factors to obtain a score for the contribution of the waste phase to the environmental problems.
Recycling also influences the extraction and production phase. The more recycled material is available, the less new material is required. This also influences the environmental impacts per kilogram. How exactly this must be settled is not immediately obvious. Materials produced in the Netherlands could enter the waste stage somewhere else, outside the reach of the Dutch policy. Imported materials could come from primary or secondary materials. The ETH database has to deal with this as well, and does so in a certain way. It is beyond the scope of this project to assess in detail how recycling is treated in the ETH database and whether we think that is consistent or acceptable.

Finally, the scores from the three phases of the life cycle will be added per material. The materials then can be compared on a per kilogram basis.

3.3.2 Specification of kilograms of materials

To judge which material contributes most to the environmental problems, we not only need information on quality but also on quantity: the impact per kilogram must be multiplied by the number of kilograms "counting in". The next question is therefore, which kilograms count. If we start from all materials being produced and consumed in the Netherlands, there certainly will be double counting, which for some materials may amount to nearly 100%. A system definition based on production only ignores materials imported for consumption. A consumption system as used for the Ecological Footprint (Wackernagel & Rees, 1996) is blind for materials made in the Netherlands which are exported to other countries. Statistics, which is the main source of data on flows of materials, are based on a regional system definition. If we adhere to that, we ignore the cradle of the imports and the grave of the exports. Another difficulty is the fact that import data not only include finished materials, but also raw materials and products. Moreover, the domestic production in the Netherlands is in many cases not public, i.e. when there are only a few producers. Instead, the domestic extraction of raw materials is specified (Adriaanse et al., 1997; Matthews et al., 2000, Eurostat, 2002). For materials that are not raw materials at the same time therefore a separate specification must be made of how much is domestically produced. In Chapter 5, the volumes of the materials flows is treated further. Systems definitions are made in Chapter 7.

3.3.3 Drafting a priority list of materials

How many materials will be part of the priority list is not clear beforehand. It may be twenty, but it could also be ten or thirty, or even fifty. The most important criterion is that the major part of the environmental problems are covered. The extra step required to arrive at a priority list, is that the scores on the different environmental problems need to be weighed in one way or another. Which material is worse, one that contributes a lot to one problem, or a little to all? Depending on the results, we will take a practical approach. The development of a formal weighing method is not a part of this study. As an intermediate step, priority lists can be drafted per environmental problem. Then we can see whether or not the lists per problem coincide.

4 Selection and classification of materials

4.1 General classification

The concept of "materials" is not clearly defined. It comprises elements (aluminium), compounds (PVC), composites (carbon kevlar), or even rough categories of related resources (plastics). In the NMP-4 the following resources are mentioned as materials: fossil fuels, wood, food, water, plastics, construction materials and metals. In the invitation to tender, RIVM expresses the wish to study homogenous materials or groups of materials. As an example of a homogenous group, polyethylene is mentioned. The number of homogenous materials will be very large, probably in the thousands. For that reason, the starting point in this study will be rather homogenous groups of materials, more like the NMP-4 categories. Such a rough list then can be the start of more detailed investigations. Within a category, the similarities between the materials will be greater than the differences. For example, plastics all originate from fossil fuels and therefore have a similar "cradle"; the emissions during use will be negligible for all of them, and even the "grave" is similar: plastic wastes are all - for lack of a working system of plastics recycling - mostly incinerated. Within the group, details can be added based on chemical composition, additives or decomposition products of waste treatment. For the other inhomogenous groups a similar approach will be taken: grouping where possible, addition of details where necessary.

For the selection of materials to include we have two starting points: on the one hand, the Eurostat list of statistical categories of products and materials, and on the other hand the ETH-database of processes for LCA-studies. The Eurostat list is linked to the Material Flow Account for the Netherlands, which is the basis for estimating the weight of the materials entering and leaving our country. The ETH-database is equally important, because this will be used to estimate the environmental impacts per kilogram of material. Both lists converge but also show some discrepancies. Based on both we distinguish the following groups of materials:

1. Metals
   - 1.1 bulk metals
   - 1.2 heavy metals
   - 1.3 other metals
2. Chemicals and minerals
   - 2.1 for industrial use
   - 2.2 for consumer use
   - 2.3 for use in agriculture
3. Construction materials
   - 3.1 surface minerals (clay, sand, stone)
   - 3.2 refined construction materials (cement, concrete, brick)
4. Plastics
5. Biomass
   - 5.1 wood
   - 5.2 other vegetable products
   - 5.3 animal products
6. Other (not fitting any of the above categories)

These groups, with the exception of 6, show common characteristics besides differences, and thus can be the basis for a classification according to environmental impacts.

4.2 Selection of specific materials

The next question then is, which materials to include under the defined categories.

Metals
Both the Eurostat list and the ETH database contain many metals. Eurostat recognises besides the metals also ores, metal containing products and scrap. We propose not to include those separately. The environmental impacts of ore extraction will come out in the cradle-to-gate analysis per kilogram. The materials are naturally applied in products, but do not change their characteristics because of that. We will take the import of these products into account when we determine the amount of the material "going around" in the Netherlands. For practical reasons, we propose to take the ETH-list as the starting point. The number of metals is larger in the Eurostat database, but on the other hand, the ETH database delivers the cradle-to-gate impacts.

Chemicals and minerals
The Eurostat list is very detailed for all kinds of industrial minerals: salt, clay, sand, graphite, sulphur etc. etc. The ETH database does not contain a lot of these minerals, but is more extensive in listing chemicals like chlorine, caustic, ammonia, soda, hydrogen etc. etc.. ETH seems more relevant here, since the issue in this project is not mined resources but (semi)finished materials.

The consumer use of minerals and chemicals is, besides fossil fuel products like gas, petrol or LPG, quite limited. In this group one can think of cleaning agents, medicines, paints, coatings and suchlike. Such categories are distinguished in the Eurostat database. The ETH database is quite limited in this area. We have not succeeded in finding sufficient data for this sub-category.

The agricultural use of chemicals refers to fertilisers and pesticides. The ETH database does not contain either. For fertiliser, data are added from a specific report aimed at collecting data for fertilisers to use in LCA (Davis & Haglund, 1999). In this report, 25 different fertilisers are distinguished, of which 10 as an end product. This is more detailed than the Eurostat list, which provides us with three categories. Neither ETH nor Eurostat contain any information on pesticides. We will have to search for additional data.

Construction materials
Both databases include the bulk construction minerals such as clay, sand, limestone and gravel. Eurostat adds asphalt to this list, ETH offers concrete, cement, brick, gypsum, glass- and rockwool, and wood. Eurostat is more extensive in the different types of stone it includes. The starting point will be the ETH-database, both for practical reasons and because the materials included in it are one step more in the direction of "finished" materials.

Plastics
The Eurostat list contains only one category "plastics". In the ETH-database, eight different plastics are distinguished. We will start from the ETH-database for obvious reasons.

Biomass
Biomass data are limited to wood in the ETH-database. Eurostat on the other hand distinguishes a large number of categories of wood, fish, crops and animal agricultural products. For the purpose of this project there seems to be no need to be that detailed. On the other hand it is not acceptable to exclude biomass since it is an important flow associated with large environmental problems. We therefore propose to distinguish a limited number of categories of wood (possibly boreal / temperate / tropical), fish, crops, and a limited number of animal products (for example meat, milk, leather and wool). The criterion for distinguishing these categories is a difference in impacts. Between crops the differences will be small, as it will between different categories of

meat. As stated before, biomass data are not included in the ETH database and therefore are added from other sources.

Other
A large material in "other" is water. In the Eurostat list, water is not included. Water is excluded from the methodology, since the amounts are so large that every other material is dwarfed in comparison. This means that, although the per kilogram impacts are probably low, this flow is quantitatively very important and therefore should not be excluded when assessing environmental impacts of materials. Other materials in this category are paper / cardboard and glass, which also represent large flows.

4.3 List of materials

The table below contains the list of materials as distinguished by the Eurostat methodology (left), the ETH database (middle), and our selection (right), organised by the categories distinguished in section 3.1.

Eurostat	ETH	selection
1. Metals		
1.1 Bulk metals		
Aluminium	aluminium 0% rec.	aluminium 0% rec.
	aluminium 100% rec.	aluminium 100% rec.
Iron and Steel	raw iron	raw iron
	cast iron	cast iron
	steel (light alloyed)	steel (light alloyed)
	steel (not alloyed)	steel (not alloyed)
	steel (high alloyed)	steel (high alloyed)
	electro steel	electro steel
	blow steel	blow steel
1.2 Heavy metals		
	lead soft	lead soft
	lead hard	lead hard
	chromium	chromium
	copper	copper
	zinc	zinc
1.3 Others		
manganese	manganese	manganese
	nickel	nickel
palladium	palladium	palladium
platinum and platinum-group	platinum	platinum
(in platinum-group)	rhodium	rhodium
indium		
tungsten		
borate		
hafnium		
gold		
bismuth		
germanium		
tantalium		
gallium		

lithium		
niobium and tantalum		
tellurium		
rare earth group		
2. Minerals en chemicals		
2.1 Industrial minerals and chemicals		
salt	NaCl	NaCl
	chlorine	chlorine
	NaOH	NaOH
	HNO_3	HNO_3
	H_3PO_4	H_3PO_4
	HF	HF
	H_2SO_4	H_2SO_4
	NH_3	NH_3
	Al_2O_3	Al_2O_3
	$FeSO_4$	$FeSO_4$
sulphur	sulphur	sulphur
hydrogen	hydrogen	hydrogen
	soda	soda
	formaldehyd	formaldehyd
	phenol	phenol
	propylene glycol	propylene glycol
	HCl	HCl
	ethylene	ethylene
	ethylene oxide	ethylene oxide
	CaO	CaO
	$Ca(OH)_2$	$Ca(OH)_2$
	paraxylene	paraxylene
	styrene	styrene
	vinylchloride	vinylchloride
	barite	barite
	bentonite	bentonite
	zeolite	zeolite
	refrigerants	refrigerants
organic chemicals	organic chemicals	organic chemicals
anorganic chemicals	anorganic chemicals	anorganic chemicals
2.2 Consumer minerals and chemicals	*not included in ETH*	*ignored*
pharmaceuticals		
tannine		
etherical oils		
soaps		
photographic goods		
2.3 Agricultural minerals and chemicals	*not included in ETH*	*added from other sources:*
P fertiliser		phosphate rock
K fertiliser		K - salts
N fertiliser		kieserite
NPK- and other		NH_3NO_3

fertilisers		
		K_2SO_4
		$(NH_4)_2SO_4$
		$Ca(NO_3)_2$
		$K(NO_3)_2$
		$CaNO_3NH_3$ (CAN)
		urea
		urea - NH_3NO_3 (UAN)
		superphosphate
		tripelsuperphosphate
		PK - fertiliser
		ammonium phosphates
		NPK - fertiliser (2 vars)
pesticides		pesticides (Dutch profile)
2.4 Other minerals (unclear category)		*ignored*
graphite		
quartz		
mica		
pyrite		
gemstone		
explosives	explosives	
3. Building materials		
3.1 Surface minerals		
Gypsum and anhydrite	gypsum	gypsum
	gypsum (raw stone)	gypsum (raw stone)
Sand and gravel	sand (for construction)	sand (for construction)
	gravel (for concrete)	gravel (for concrete)
Common clay, clay for bricks etc.	clay and loam	clay and loam
Loam		
Limestone, chalk stone, calcite	limestone, dolomite	limestone, dolomite
Igneous rock		
Marble		
Sandstone		
Perlite		
Slate		
Tufaceous rock		
Dimension stone (?)		
Asbestos		
Crushed stone		
3.2 Finished materials		
	ceramic	ceramic
	concrete	concrete
	cement	cement
	rockwool	rockwool

4. Plastics		
4.1 Plastics	PE (high density)	PE (high density)
	PE (low density)	PE (low density)
	PP	PP
	PET (0% rec.)	PET (0% rec.)
	PS	PS
	PVC	PVC
	PC	PC
	rubber	rubber
	PUR	PUR
5. Biomass		
5.1 agricultural crops	*not included in ETH*	*added from other sources:*
long lists of crops		agricultural crops and grass
by-products of harvest		
5.2 forest biomass		
fuel wood	wood (massive)	wood (massive)
roundwood	wood (board)	wood (board)
natural cork		
others		
5.3 animal agricultural products	*not included in ETH*	*added from other sources:*
long lists of animal products		animal products
5.4 fish and game	*not included in ETH*	*ignored*
sea fish		
freshwater fish		
others		
game		
6. Others		
	water (decarbonated)	water (decarbonated)
	water (demineralised)	water (demineralised)
paper and board	paper	paper
	board	board
glass	glass (coated)	glass (coated)
	glass (not coated)	glass (not coated)
sand and salt for defrosting roads		

4.4 Addition of materials to the ETH database

Detailed process descriptions can be found in the background reports of the ETH-database. They will not be repeated in this report. As mentioned above, some important materials are not present in the ETH-database. For those materials, we had to find data and add them to the database. Additions were made for three groups of materials:

- fertilisers
- pesticides
- biomass from agriculture

Fertilisers

For fertilisers, cradle-to-gate LCA data can be found in a report by Chalmers: “Life Cycle Inventory (LCI) of Fertiliser Production (Davis & Haglund, 1999). These data were already in the right format and could be added to the ETH-database without problems. Data for the use phase are not available. Our assumption is that the use equals the emission to agricultural soil. There is no waste management phase.

Pesticides
For pesticide production no process data are available. Within the framework of this study it is not possible to collect these from industry. Detailed information is available however for the application of pesticides in the Netherlands in the year 1998. In Appendix 1 the application of pesticides is given per active compound, per application area and per sector (CBS data from Statline). The application of a pesticide is considered to be a 100% emission to the agricultural soil. This emission will have impacts on human toxicity an ecotoxicity. Impact factors are not available for all pesticides on the list. The pesticides for which a characterisation factor is available are marked in appendix 1. The total use of pesticides in the Netherlands in 1998 was about 6111 kton active substance. Pesticides for which a characterisation factor is available cover about 2469 kton, that is 40% of the total use.

With these data, it is possible to allocate the use of specific pesticides to specific crops. This large task is not conducted here due to lack of time. In this study one process is defined for the use of pesticides “1 kg application of pesticides for crop production”. The application profile of pesticides for which a characterisation factor is available is assumed to represent an average impact of the use of pesticides in the Netherlands.

Biomass from agriculture
Figures 4.1 and 4.2 give an overview of the process systems of production of crops and grass and animal products. These total flows based on the year 1998 are used to define two agricultural processes producing respectively 1 kg of crop/grass and 1 kg of animal product.

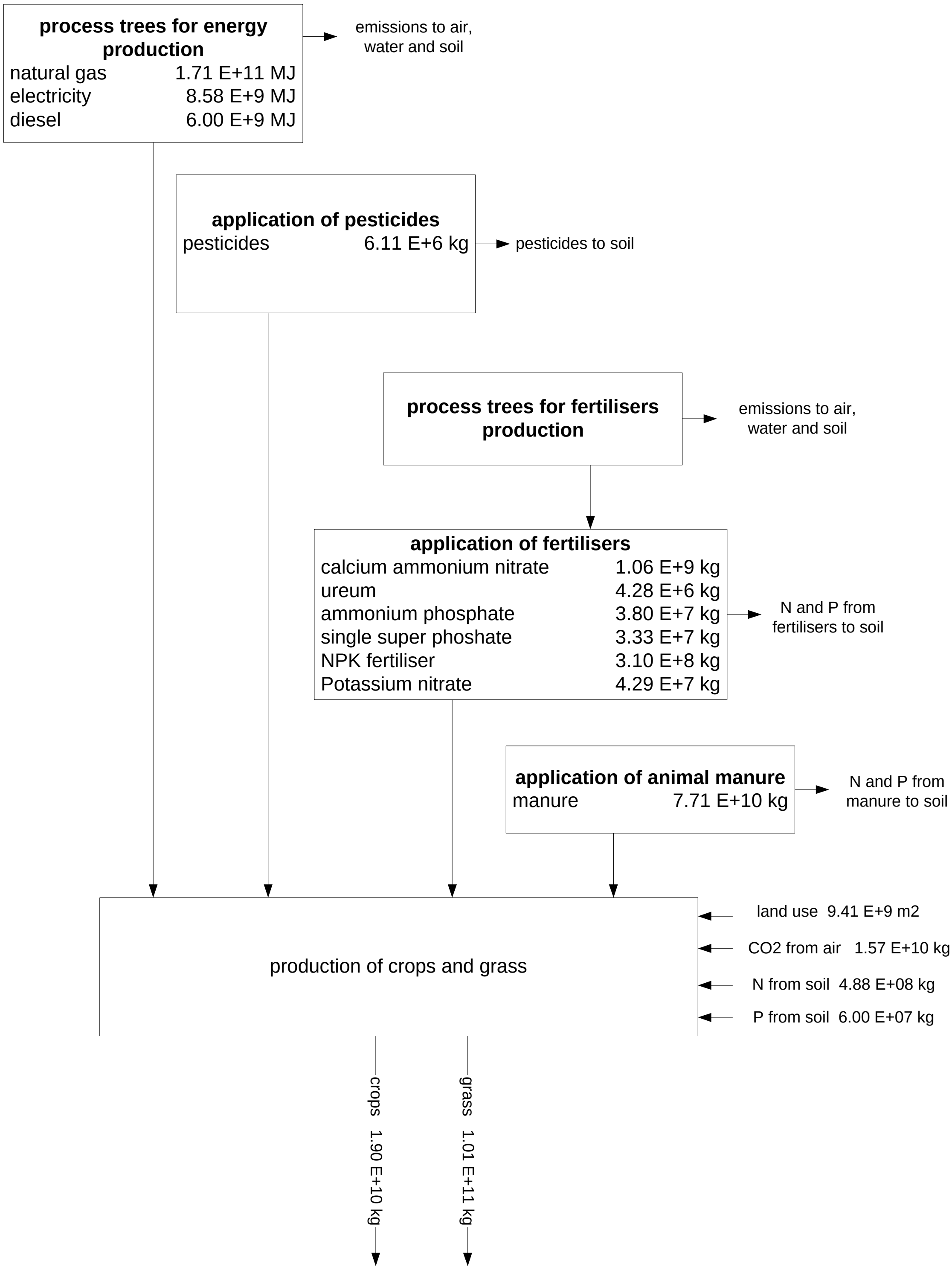


Figure 4.1 Process tree of crop and grass production

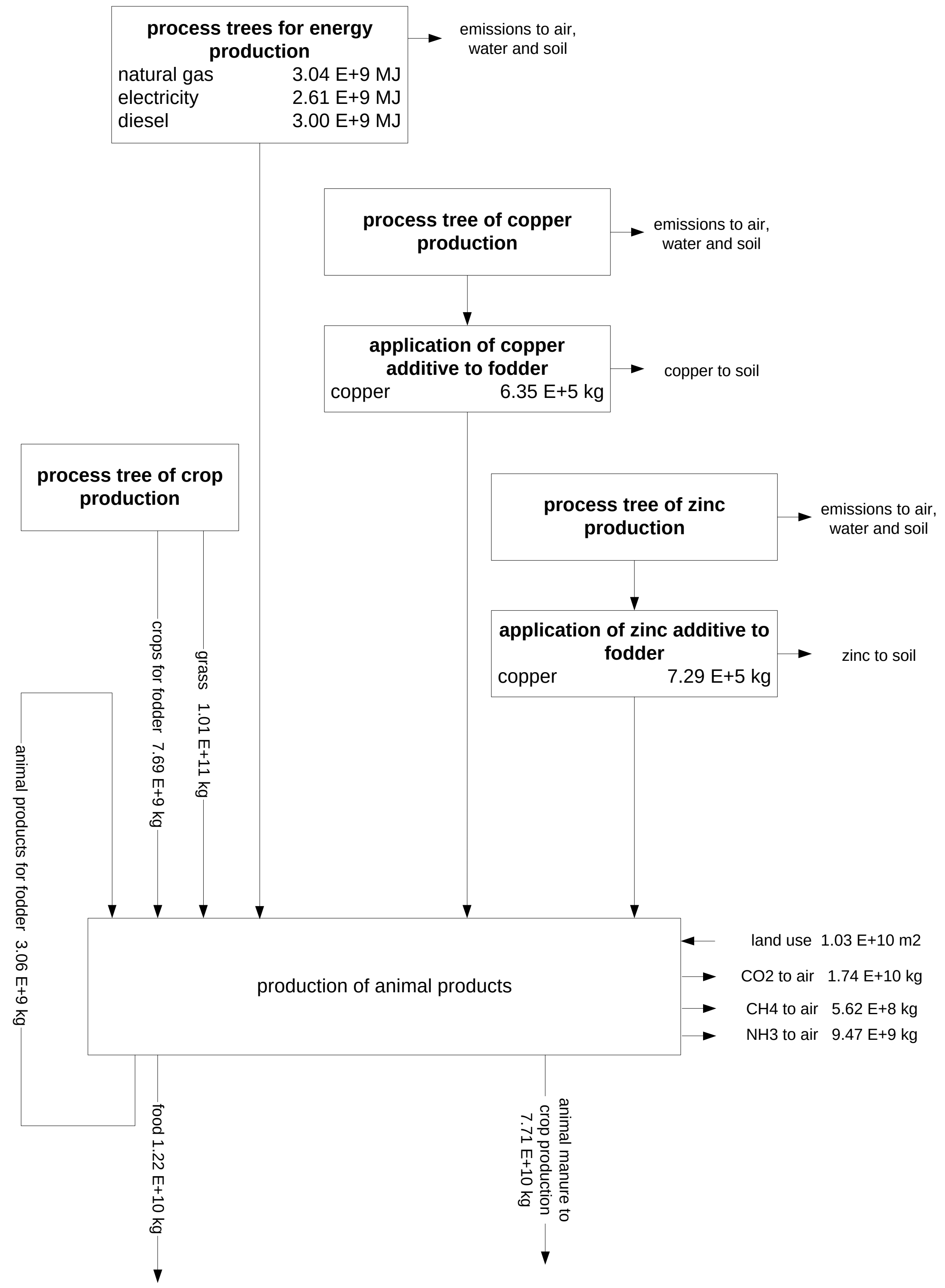


Figure 4.2 Process tree of animal products production

Data on energy consumption are from the statistical yearbook 1999 (CBS , 1999). The process tree for the production of energy is given by the ETH-database. Data on the consumption of pesticides are from CBS (see above). The consumption of fertilisers is given by FAO (http://www.fao.org/). The production and application of animal manure are from the statistical yearbook 1999 (CBS , 1999). Data concerning the production and consumption of crops are taken from the food balance sheets of FAO (http://www.fao.org/).

The application of fertilisers, and nitrogen and phosphorus in manure and pesticides are considered to be a 100% emission to the agricultural soil. The emissions of N and P caused by the use of manure are completely allocated to the process of crop and grass production. The uptake of the nutrients by the crops and grass are defined as an extraction from the soil. Data on nutrient extraction by crops and grass are given in the nutrient balance in the statistical yearbook 1999 (CBS , 1999). The carbon uptake by crops and grass is calculated from the total crop and grass production (15.6 E+9 kg) and the assumed average composition of organic materials, $C_{106}H_{263}O_{110}N_{16}P$.

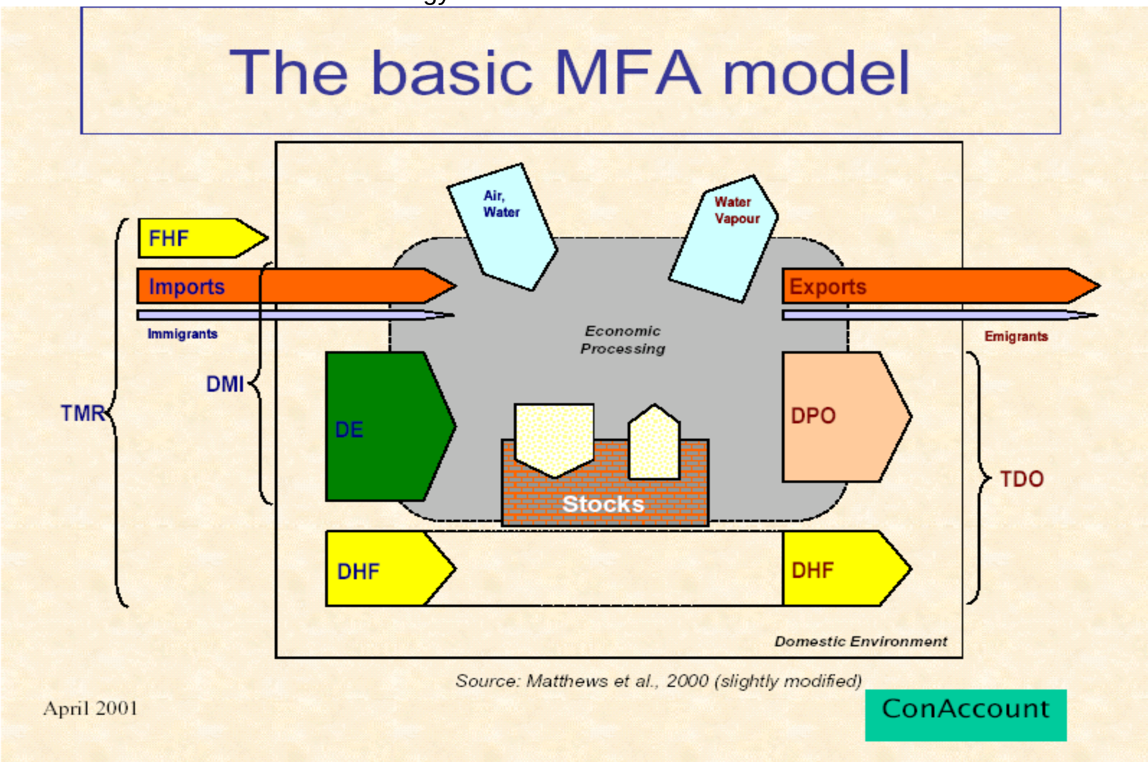
Data on the application of zinc and copper in additives for fodder are taken from Annema et al. (1995). The application of copper and zinc additives to fodder is considered to end up as an emission to the soil via manure. These emissions are completely allocated to the process of production of animal products. The process tree for the production of copper and zinc are given by the ETH-database. Emissions of carbon dioxide, methane and ammonia to air are given by respectively Matthews et al. (2000), Corinair, and the nutrient balance in the statistical yearbook 1999 (CBS , 1999).

5 Volumes of Materials: material flows in, out and through the Netherlands

5.1 Material Flow Accounting according to the Eurostat methodology

In 2000, Eurostat published a methodological guide to conduct Material Flow Accounting for national economies (Eurostat, 2000). This guide treats definitions, system boundaries, relations with other types of accounts such as Input Output Tables, and indicators that can be composed out of the Material Flow Account. For practical reasons, water is excluded as a material flow. The argument is that, although the information could be relevant for some purposes, it would render investigating the other flows useless, since the mass involved is some orders of magnitude smaller. Figure 5.1 below summarises the methodology and positions the mass flow indicators commonly used. On the left side, the system's inflows are listed: imports, domestic extractions (DE), and foreign and domestic hidden flows (FHF and DHF). Foreign hidden flows are not calculated with the Eurostat methodology, but they are included in the picture to point to the Total Material Requirement indicator (TMR). Outflows are pictured on the right side: exports, domestic processed outputs (DPO, being emissions and landfill of final waste), and the same DHF. Within the economic system accumulations may take place. Water and air are listed separately; these are balancing items mainly to match the incineration of fuels.

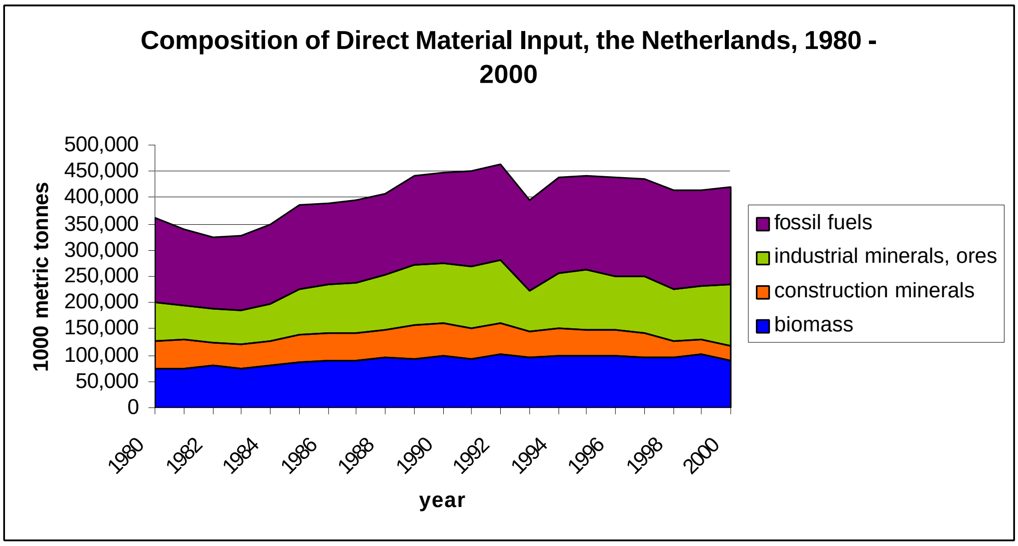
Figure 5.1 System boundaries of the Material Flow Accounting system according to the Eurostat methodology



5.2 Material flow database for the Netherlands

The aggregate Eurostat database (Eurostat, IFF 2002) shows the inflows and outflows for the EU countries in several rough categories. On the inflow side, four are distinguished: fossil fuels, industrial minerals and ores, construction minerals, and biomass. Figure 5.2 below shows the developments of the inflows over time from 1980 to 2000. In total, an increase can be observed until 1992, after that it has levelled off. Slight shifts can also be seen between the different materials: construction minerals have decreased lately, while industrial minerals have increased. The dip in 1993 cannot be explained - it probably has to do with the unification of the European market, which led to some modifications in statistical categories.

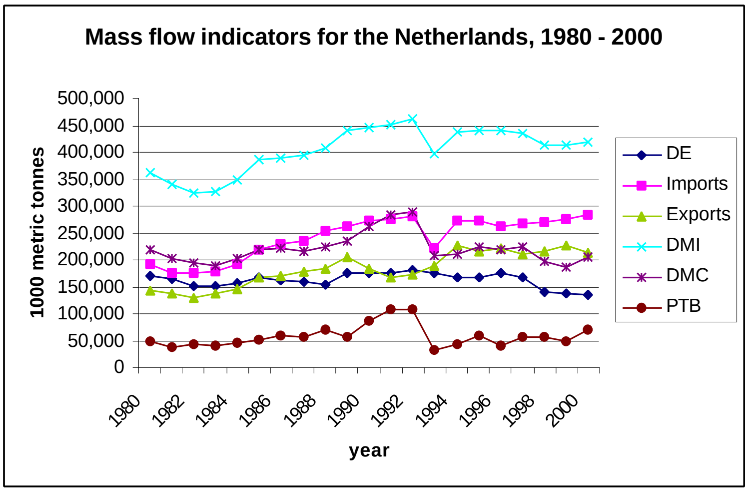
Figure 5.2 Inputs in the Dutch economy from imports and extractions, 1980 - 2000



5.3 Material flow indicators for the Netherlands

Figure 5.3 below shows the development of a number of mass related indicators, calculated according to the Eurostat methodology. The 1993 dip is visible here as well in all of the indicators related to the imports. The consumption related indicators show a fairly level trend, both imports and exports go up a little. This means there is an increase in trade, which has no bearing on the consumption behaviour.

Figure 5.3 Material flow indicators for the Netherlands, 1980 - 2000.



5.4 Data on the materials included in this study

According to the Eurostat methodology, the aggregate database is composed out of data on a great many (raw) materials and products. A large project financed by Eurostat, to apply the Eurostat methodology for all EU-15 countries, is ongoing at present. The project is not finalised yet but some of the underlying data were made available to us. However, for some groups of materials we had to find additional data because the statistical categories were too aggregate or unclear with regard to the material composition of the goods, or were not disclosed due to reasons of confidentiality. This was the case especially for plastics, metals and chemicals. Therefore we had to supply these data with data from other sources.

A further difficulty is that the Eurostat MFA-database does not contain data on production, but only on extraction. For a number of our materials, this is insufficient since they are produced out of different raw materials. Plastics is a good example: plastics are made out of fossil fuels. Data on fossil fuels are available, but their destination is not included in the database. This means that data on production should be obtained from elsewhere. The MFA database does not contain data on consumption either, since it concentrates only on the flows crossing the system boundaries. This means that production cannot be estimated as a balancing item either.

From all data we collected, we drafted materials balances for every material separately. For some materials these are quite reliable, for others they are not. It was not feasible within this project to include data on all the applications of the materials. Import and export data also contain finished products, but no information on the composition of these products. This means that we do not have a good picture of consumption. The consumption in the materials balance is the apparent consumption, including both consumer use and producer use, and excluding part of the use in finished products. To obtain a really reliable balance in fact requires a substance flow analysis for every material. This is outside the scope of this study. Finally, we haven't been able to find data on all the materials included in Appendix 2. Especially the chemicals used in industry are incomplete, as well as some of the rarer metals. Nevertheless, it provides a first basis for a prioritisation, which can be a start for improvement.

The result is a database on materials flows, given in Appendix 5. This database is put together from a number of different sources, and contains data for different years and of different quality. In Appendix 6 an overview is given of data sources and of the various problems related to those.

6 Impacts of Materials: contribution of materials to environmental problems per kg of weight

Appendix 2 shows a list of the environmental impacts associated with the materials. For each material and each impact category, three columns are presented: the cradle-to-gate impacts associated with extraction and production, the use-and-waste impacts associated with the use and final waste treatment of the materials, and the integrated cradle-to-grave impacts including the whole life cycle of the material. The lists per impact category are sorted according to the contribution of the materials to this category. On top we find the largest per kilogram contributors, on the bottom the smallest. We observe that the top scorers are always the same: the three precious metals rhodium, palladium and platinum. Especially the extraction of the metals out of their ores is a very polluting business. On the bottom we find, not unexpectedly, water. In between the lists vary according to the impact category.

6.1 Cradle-to-gate impacts of materials

The cradle-to-gate impacts of the materials are calculated using the ETH database for LCA studies together with the CMLCA program developed at CML. The ETH database provides ecoprofiles for a functional unit: the environmental interventions, i.e. emissions and extractions, associated with the process tree of the functional unit. Energy, auxilliary materials, land use etc. are all included in the process tree. As a functional unit, we defined 1 kg of a specific material. The ecoprofiles subsequently enter the CMLCA program, which translates them into potential contributions to the environmental impact categories as specified in Chapter 3. Appendix 2 shows the results. The ecoprofiles are not shown in Appendix 2. The database in combination with the CMLCA program enables to look back into the process tree and identify the processes contributing most to the various impact categories. We have performed this for a limited number of material-impact category combinations, also to check the calculations. Appendix 7 contains some results for palladium and platinum.

6.2 Impacts during use of materials

As stated in Section 3.3.1, use data are not included in the ETH database. Therefore we had to define our own approach. In general terms, the approach is stated in Section 3.3.1. There are a number of general considerations and assumptions involved with the estimation of impacts during use. These will be presented below. For the specific considerations and assumptions for each material, please consult Appendix 3.

- The main assumption made is that economies and environment are in a steady state. That means that all the inputs and outputs from the economy and environment are in balance, and that the losses during use can be attributed to that years input. This is of course not true, since the economy serves as a delay for many materials being stockpiled there. However, it would be too large a job to specify not only flows but also stocks within the framework of this project. The error made by assuming a steady state will be different per material.
- We consider the emissions only to be emissions if they are directly into the environment. Any material flows that go to sewage or waste deposition are by our definition entering the waste stage and are accounted for separately.
- We consider agricultural soil to be a part of the environment, and not the economy. This choice is debatable and is also still debated in both the LCA and the MFA community. On the one hand, agriculture is a sector just as any other, and uses soil to realise their production. On the other hand, the soil is out there in the environment. We made our choice on practical grounds: it connects to the Eurostat system definition.

After determining the emissions during use, use processes are defined per material and are added to the ETH database. Thus, the emissions during use can be added to the cradle-to-gate emissions.

6.3 Impacts during waste management

In the ETH database, waste treatment is not included in a satisfactory manner. Only for plastics the waste stage is included properly, as incineration with energy recovery. The general processes of waste treatment cannot be used, since we want to know what happens per material. One option is to allocate the general process to the materials entering it. This is difficult and a lot of work. The other option is to define waste management processes per material, based on mass balance. This is not difficult but implies a serious extension of the ETH database with basically nonsense processes. Both options therefore have their drawbacks. We take a practical mixed approach, as described below.

We distinguish four types of waste management:
- waste water treatment
- waste incineration
- landfill of final waste
- recycling.

Wastewater treatment is relevant for biomass and corrosive materials, mainly metals. For this, one process is defined, which implies the need for allocation. The ins and outs are described in Appendix 4.

In the Netherlands, most waste is incinerated. In the ETH database, incineration of plastics is included. We will use this process to describe the waste stage of the plastics. The assumption then is, that there is no recycling. This is not quite true but sufficiently for our purposes. Energy recovery is accounted for.

Landfill is especially relevant for building materials. By our definition, it also includes the secondary use, for example as filling materials for roads. Metals, in as far they are not recycled, are also assumed to end up in landfills. Incineration does not make these materials disappear, but will make them end up in slag or ashes, which are subsequently disposed of.

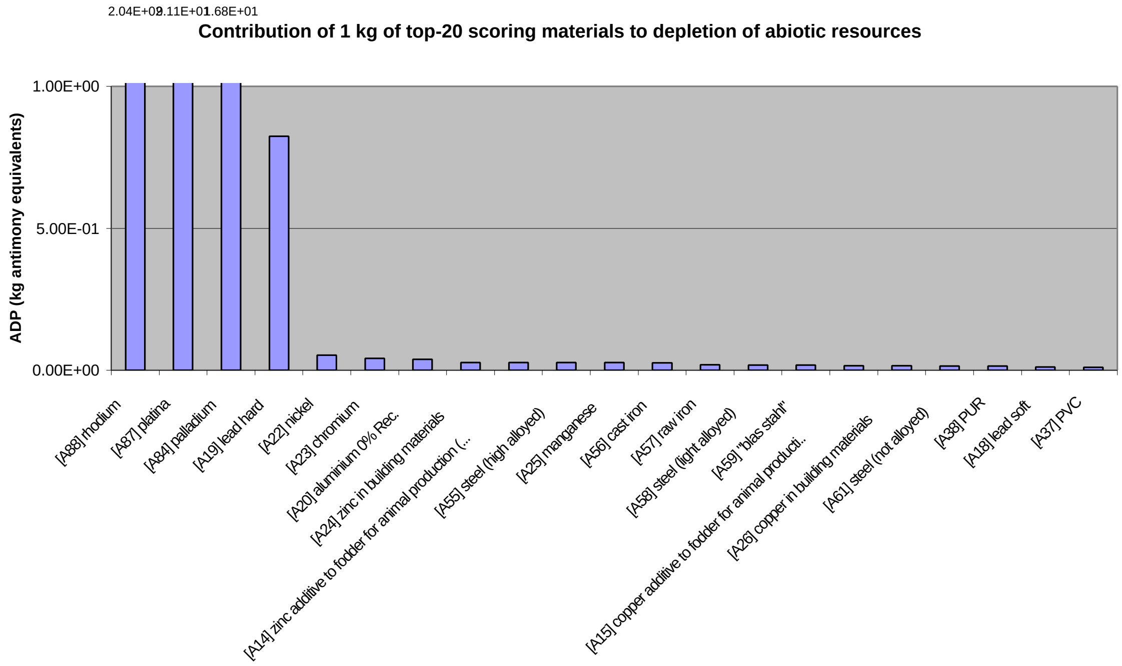
Recycling is relevant for building materials and for metals. As yet, it is not included in a satisfactory manner. The ETH database has for some metals included secondary materials in the production processes. The idea is then, that the need for virgin materials is less, which is supposed to come out in the requirement of raw materials and all involved processes. We have some doubts as to whether this is included in a consequent manner in the ETH database. Moreover, it is not possible to change the assumed percentage of recycled material, which is mostly stated to be 50%. In fact, it differs quite a lot per material. However, modifying basic data in the ETH database is beyond the scope of this project.

6.4 The per kg impacts of materials

Appendix 2 contains the results of the cradle-to-grave scores per kg of the selected materials. Comparing them to the cradle-to-gate scores gives an impression of how important the use and waste management stages are. For a lot of the materials they do not contribute much. It is possible to identify the dissipative materials clearly: pesticides, fertilisers, and for example the applications of zinc and copper as a fodder additive. Here, the emissions during use significantly contribute to the total score.

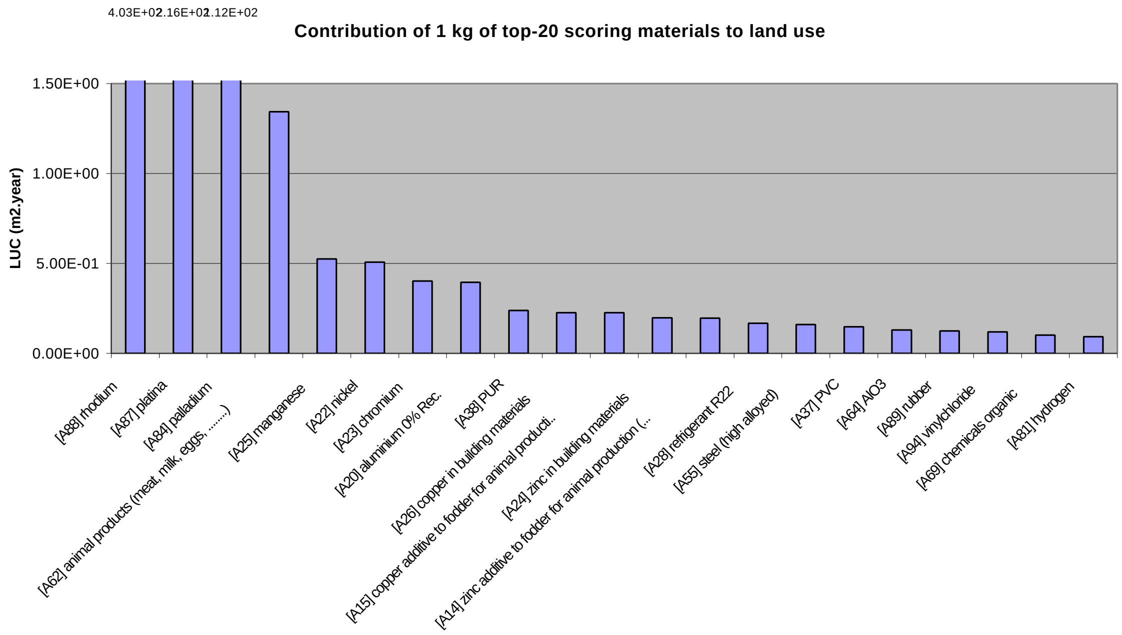
In Figures 6.1 - 6.5 below, the per kg top-twenty materials for a selected number of environmental impact categories is presented.

Figure 6.1 Top-twenty materials per kg score on Abiotic depletion



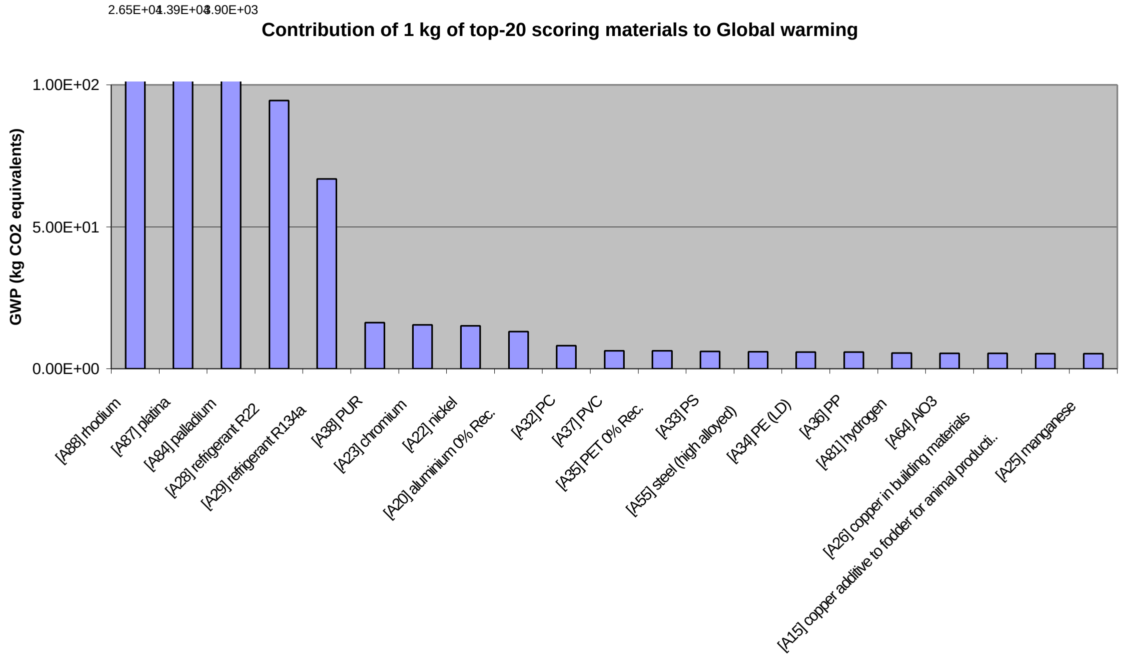
Rhodium, platinum and palladium have by far the highest score. They are off the scale, a factor 20 - 2000 higher than the no. 4 score, hard lead, which in turn is a factor 10 higher than the no. 5, nickel. From the no. 5 onwards, the score seems to go down very gradually. Almost all are metals, which was to be expected since they are non-renewable resources. Two plastics pop up at the bottom of the list: PUR and PVC. Probably it is the depletion of fossil fuels along the life cycle that make them score.

Figure 6.2 Top-twenty materials per kg score on Land use



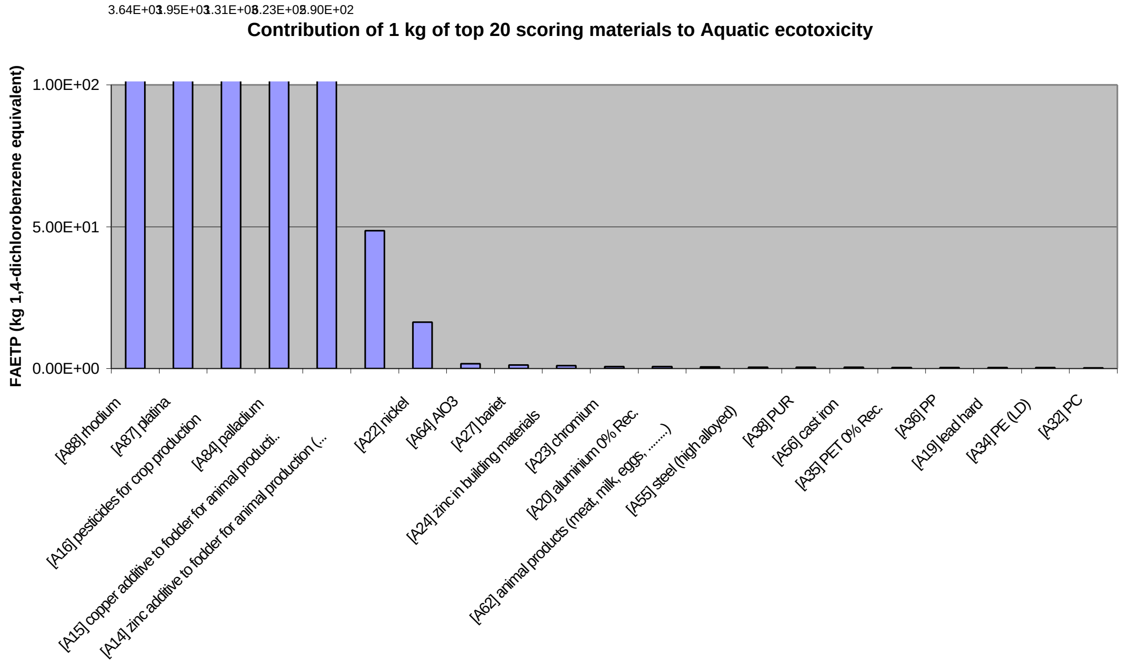
The highest scores are again for rhodium, platinum and palladium (of the scale, 100 - 400 times the no. 4 score). This is no doubt related to the mining. Precious metals occur in ores in very low concentrations, so a lot of mining needs to be done to obtain 1 kg of metal. The no. 4 score is animal products. Crop and grass are just outside the top-20. Animal production itself does not require much space, but requires a large input of crop and grass and therefore scores high on land use. The top twenty contains mainly metals and some plastics near the bottom.

Figure 6.3 Top-twenty materials per kg score on Global warming



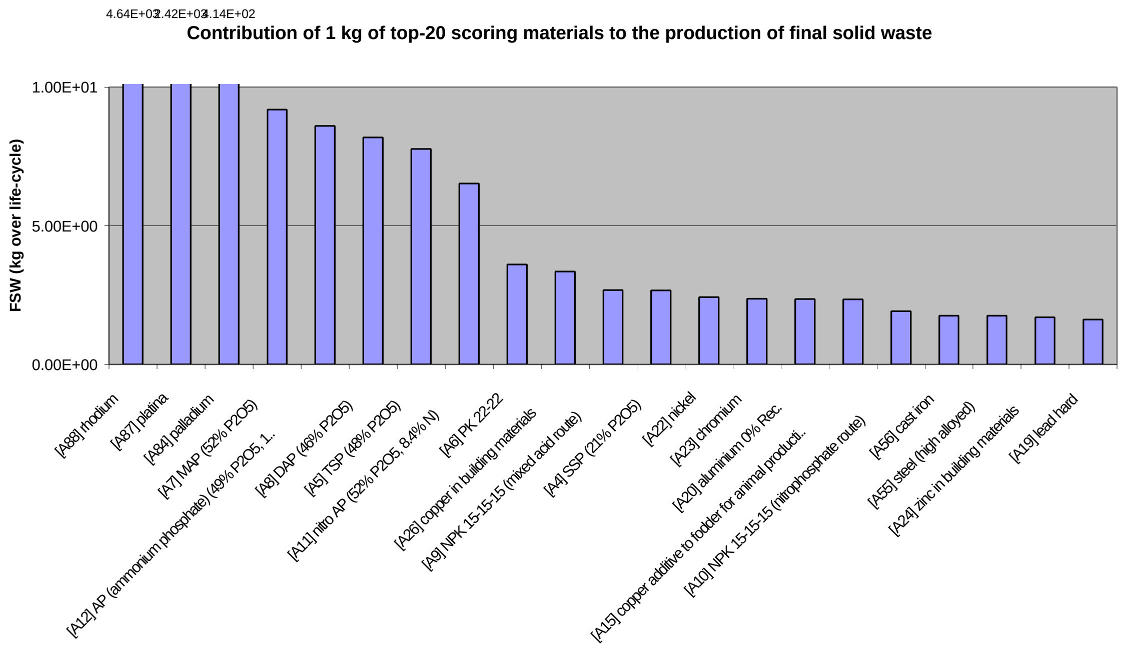
Again we find rhodium, platinum and palladium at the top - off the scale, 30 - 300 times the no. 4 score. The no. 4 and 5 are refrigerants, HFK compounds with a large global warming potential. For the remainder we find a number of plastics and again a number of metals, most likely due to the energy required for smelting.

Figure 6.4 Top-twenty materials per kg score on Aquatic ecotoxicity



Between the general top-scorers rhodium, platinum and palladium we find a new one: pesticides. On the fifth and sixth place copper and zinc additives appear, also an agriculture related application. These materials have their main problem in the use phase: the use more or less equals the emission to the environment, either directly or via animal manure. Animal products themselves appear on no. 13. The remainder of the list are plastics and metals.

Figure 6.5 Top-twenty materials per kg score on Final solid waste production



The three precious metals rhodium, platinum and palladium again have by far the highest score (a factor 100 - 1000 higher than the rest). After that, there are a number of phosphate fertilisers scoring between 5 and 10 kg waste / kg material. From no. 9 onwards it is a very gradual decrease, continuing way beyond the top 20. From 9 to 20 we find more phosphate fertilisers and some metals. This is not surprising: for both phosphates and metals a large amount of waste is generated during the extraction and production phase.

The high score of the precious metals on all environmental impact categories is most striking. In Appendix 7 we made an analysis of the contribution of the various processes involved in the scores. Apparently there are some good explanations for it. The amount of mining and the energy required to unlock the materials is considerable, leading to high scores on land use, global warming, acidification and euthrophication (via NOx). The high toxicity score is due to the emissions of other metals, occurring in the same or as platinum and palladium. Both are a by-product of other metals, mainly nickel. This will also increase the score on abiotic depletion.

The per kilogram score of the materials already provides relevant information. This information can be used especially for policy purposes, for example when assessing the environmental benefits of a substitution or a shift from one material to another. Nevertheless it is only half of the information required for prioritising. The other half is the information on the flows of these materials. The combination of the two enables to make up a top-twenty of most harmful materials. This is treated in the next chapter.

7 Combining volume and impact information: aggregate impacts of materials

7.1 System definitions

In order to calculate the impact of material flows we need to define the system that will be examined and the flows and impacts are measured across. This is a matter of some consideration, since in effect we combine a regionally and temporally demarcated (the Netherlands, per year) database with a non-time-and-location specific life cycle approach.

The generic Materials Flow Accounting model is discussed in section 4. From this generic model, we developed three more specific system descriptions that approach the problem of environmental impacts of material flows in the Netherlands from different perspectives. These approaches are :

1. Regional approach
2. Functional approach
3. Hybrid approach

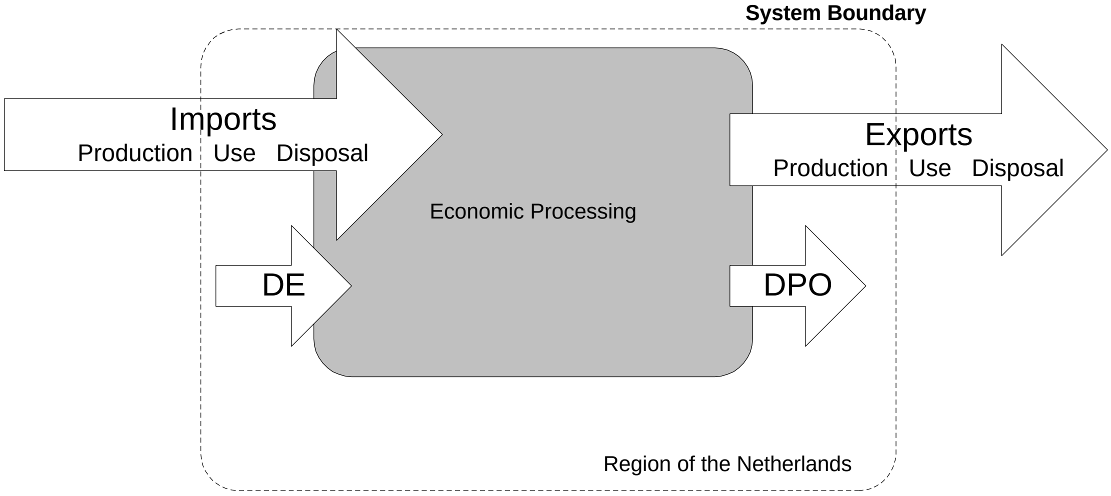
With all three approaches we assume a steady state of the economy and thus no stock build-up or depletion. Furthermore, the hidden flows are not taken into consideration, as presented in section 4. The three perspectives, with their respective system definitions are presented below.

7.1.1 The regional approach

The regional approach takes the geographic area of the Netherlands as the starting point. The impacts considered cover the environmental impacts that occur within the Netherlands. Environmental impacts that occur outside the country, such as cradle effect of imports and grave effects of the exports, are excluded.

The main advantage of this approach is that it accounts for the environmental impacts caused by environmental interventions taking place within the country, and therefore can be easily related to the Dutch environmental policy. However, the materials life cycles rarely are limited to the national boundaries. By ignoring the cradles or graves in other countries, one would underestimate the impact that a country is having on the environment if it imports materials that have a particularly damaging extraction and production phase, or exports materials that have a very damaging use and disposal phase.

A schematic system, corresponding to the regional approach, is presented below: system I, the regional system.



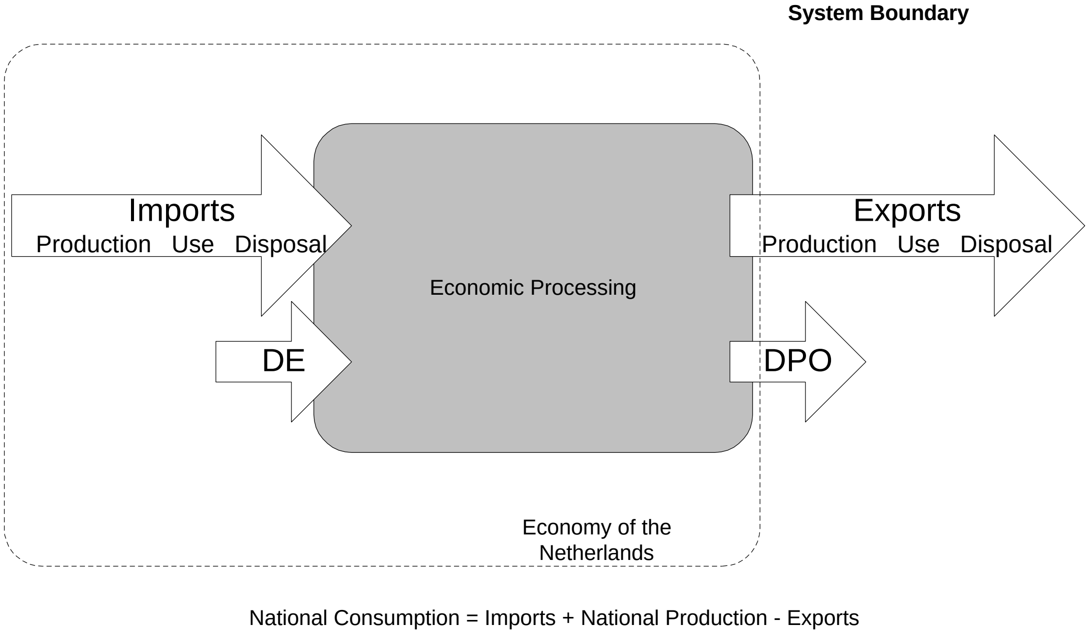
National Consumption = Imports + National Production - Exports - $\text{Imports}_{\text{Production}}$ - $\text{Exports}_{\text{Use and Disposal}}$

System I : The Regional System

7.1.2. The functional approach

The second possibility is to take a functional approach to measuring environmental impact of the Netherlands. We then consider the total consumption of materials within the economy of the Netherlands, in LCA terminology, as the functional unit. The environmental impact of the material flows associated with this functional unit is evaluated. The systems definition following from this approach is similar to the Ecological Footprint system, and also similar to the systems definition in the CE study on dematerialisation (De Bruyn et al., 2003)

This approach enables to see, in a way, the total impact of the economy of the country on the global environment. On the other side it masks the local impacts, and makes impact estimates more difficult if the destination fate of the exported materials is uncertain. A schematic system belonging to the functional approach is presented below: System II, the consumption based system.



System II : The Consumption based System

7.1.3. Hybrid systems

There are a number of hybrid system possible, depending on the questions one chooses to ask. Three possibilities are mentioned:

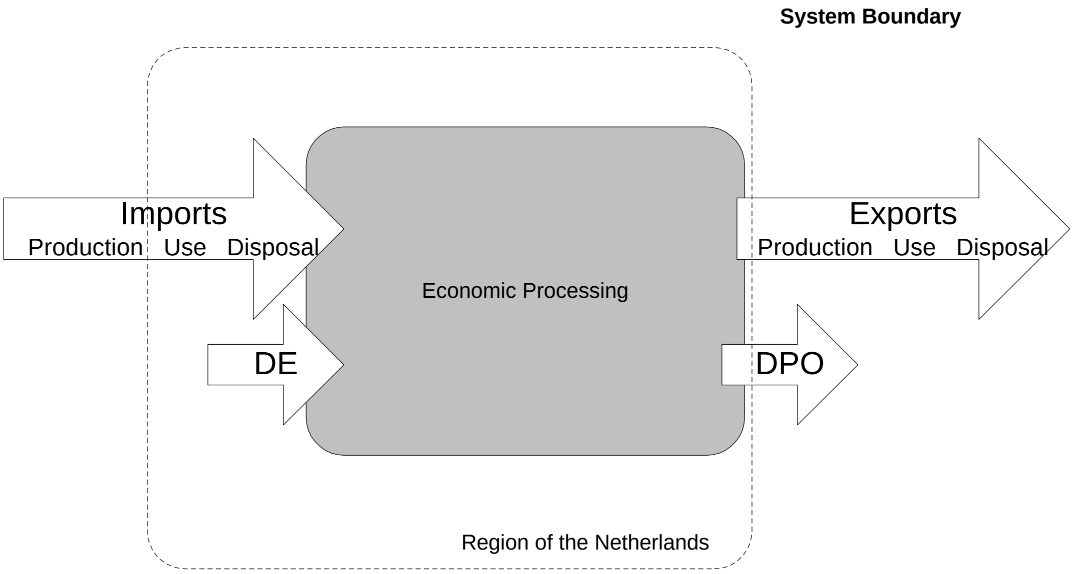
1. Regional effects of consumption system
2. Total Material Requirement system
3. Cradle-to-grave production system

In the first option, the consumption-based system is further limited with regional boundaries. The cradle of the imported materials used in the Netherlands as well as and the cradle-to-grave impacts of the exports are excluded. This is a rather limited model, excluding a lot of the life cycle, and deriving its interest mainly from the possibilities for comparison. It can be compared with either the regional system or the functional system. A comparison with the regional system shows the contribution of the consumption phase to the Dutch environmental problems. A comparison with the consumption-based system shows how much of the total life-cycle impacts of Dutch material use actually takes place within the Netherlands.

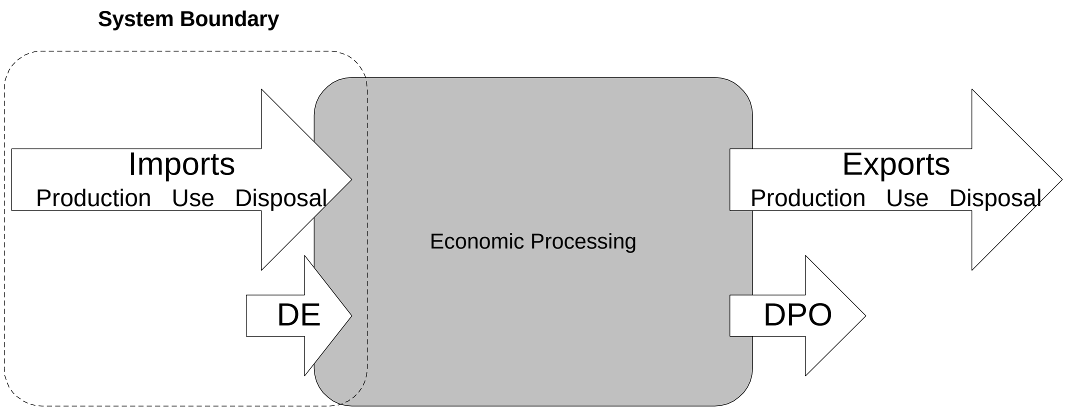
The second system is taken from the TMR-indicator of the Wuppertal approach. TMR, or Total Material Requirement, considers all inflows with their cradles, whether they are used within the country or are exported. This gives some double counting with an unclear meaning, and a bias against transport-countries such as the Netherlands. Nevertheless, this is a system definition in upcoming use.

In the third case the total life-cycle impacts of the materials produced in the Netherlands are considered, wherever they may take place. This gives a picture of the (global) impacts of our way of making money. It could be interesting to compare this with the consumption-based system as described in 7.1.2. This could give insight in the discrepancies between production and consumption, with regard to the environmental impacts it causes.

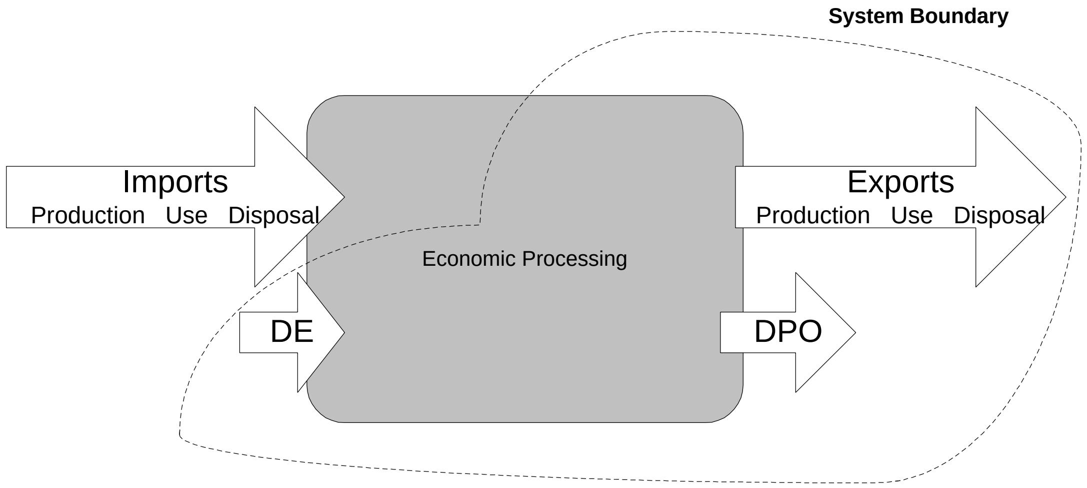
The schematic representations of these hybrid systems are presented below. In this report, we only elaborate the "Total effects of production" system, since this provides an interesting comparison with the consumption system. This is entered in the calculations and the presentation of the results as System III: Production based System.



Hybrid System : Regional effects of consumption



Hybrid System : Total Material Requirement



System III : The Production based System

7.2 Contribution of materials to selected environmental problems

For each of the three systems, two variants are calculated:
- the "list of materials" system variant
- the "excluding double-counting" system variant.

The "list of materials" system includes all materials we have data for separately. This enables to compare the different materials with regard to their environmental impacts. However, the scores per material cannot be added to a total for the whole system, since there is a lot of double counting. For example, ammonia is on the list separately, but so are fertilisers and so is biomass, while ammonia is used to produce fertilisers, which in turn are used to grow crops.

The "excluding double-counting" system is defined to enable adding up the materials. In this system, the ammonia that ends up in fertiliser is not counted, and neither is the fertiliser that is used to produce crop. The chain of crop production includes the impacts related to the production of ammonia and the production and use of fertiliser. In this system, the scores per material can indeed be added to a total for the Netherlands.

7.2.1 The regional system

To calculate the impacts of the regional system, material system variant, the following equation is used:

$$\text{Import} * I_{u+w} + \text{Export} * I_{p} + (\text{Production} - \text{Export}) * I_{p+u+w}$$

with Import, Export and Production in kg/year
I = Impact per kilogram, I_p being the impact of the production stage, I_{u+w} the impact of the use-and-waste stage, and I_{p+u+w} the total life cycle impact.
This means that the cradle of the imports is not counted, nor the grave of the exports.

For the "excluding double-counting" variant, a correction has been made to enable adding up. To this end, a number of materials flows in the column Production - Export have put to zero:

- pre-cursors to pesticides, such as NH_3, H_3PO_4 and suchlike, since they end up in fertilisers
- fertilisers, since these are included in crop production
- pesticides, for the same reason
- crop/grass, since this is included in animal products. This seems very crude, but it appears that 98% of the total crop and grass production in the Netherlands is used for fodder. This is due to the very large share of grass production in the total crop/grass production, and is typical for the Dutch situation.
- gravel, since this in included in concrete
- sand, since this is included in both concrete and glass

Appendix 8 shows the results. In Table 7.1 below, the top-twenty for some of the impact categories is shown to give an impression, taken from the "list of materials" system variant. Some materials seem to be dominant for the score on many impact categories, for example biomass, iron and steel, concrete, and paper. Others score high on some or just one impact category, for example plastics and some of the heavy metals.

Table 7.1 Regional system, top-twenty scoring materials on five selected environmental impact categories

ADP	LUC	GWP	FAETP	FSW
[A57] iron & steel	[A62] animal products	[A63] crop or grass	[A63] crop or grass	[A52] sand
[A20] aluminium 0% Rec.	[A63] crop or grass	[A62] animal products	[A16] pesticides	[A63] crop or grass
[A48] concrete	[A52] sand	[A57] iron & steel	[A62] animal products	[A48] concrete
[A62] animal products	[A57] iron & steel	[A42] paper	[A57] iron & steel	[A51] gravel
[A42] paper	[A48] concrete	[A31] PE (HD)	[A22] nickel	[A57] raw iron
[A63] crop or grass	[A42] paper	[A30] ammonia	[A15] copper additive to fodder	[A46] cement
[A46] cement	[A20] aluminium 0% Rec.	[A20] aluminium 0% Rec.	[A42] paper	[A62] animal products
[A37] PVC	[A37] PVC	[A36] PP	[A31] PE (HD)	[A47] ceramic
[A24] zinc	[A51] gravel	[A96] wood	[A20] aluminium 0% Rec.	[A43] glass
[A36] PP	[A36] PP	[A37] PVC	[A24] zinc	[A20] aluminium 0% Rec.
[A31] PE (HD)	[A31] PE (HD)	[A1] CAN	[A36] PP	[A9] NPK 15-15-15
[A70] chlorine	[A70] chlorine	[A33] PS	[A48] concrete	[A49] gypsum
[A1] CAN	[A24] zinc	[A48] concrete	[A37] PVC	[A42] paper
[A43] glass	[A47] ceramic	[A47] ceramic	[A46] cement	[A24] zinc
[A33] PS	[A30] ammonia	[A46] cement	[A33] PS	[A45] rockwool
[A30] ammonia	[A46] cement	[A52] sand	[A14] zinc additive to fodder	[A4] SSP
[A47] ceramic	[A33] PS	[A32] PC	[A27] barite	[A82] NaCl
[A45] rockwool	[A96] wood	[A24] zinc	[A1] CAN	[A37] PVC
[A82] NaCl	[A1] CAN	[A43] glass	[A70] chlorine	[A40] water (decarbonated)
[A52] sand	[A43] glass	[A70] chlorine	[A43] glass	[A26] copper

7.2.2 The consumption system

The consumption system takes into account all materials consumed in the Netherlands from cradle to grave. In formula:

Consumption * I_{p+u+w}

Consumption is the amount of yearly consumed materials in the Netherlands (kg/y), and I_{p+u+w} the cradle-to-grave impact per kg of material.

In the "list of materials" system variant, all flows used in the Netherlands have been included. For the final demand system, double countings have been subtracted according to the same rules as applied in § 7.2.1.

Table 7.2 Consumption system, top-twenty scoring materials on five selected environmental impact categories

ADP	LUC	GWP	FAETP	FSW
[A154] iron & steel	[A160] crop or grass	[A160] crop or grass	[A160] crop or grass	[A149] sand
[A117] aluminium 0% rec.	[A159] animal products	[A159] animal products	[A113] pesticides	[A160] crop or grass
[A143] cement	[A149] sand	[A154] iron & steel	[A159] animal products	[A145] concrete
[A160] crop or grass	[A154] iron & steel	[A139] paper	[A154] iron & steel	[A148] gravel
[A139] paper	[A145] concrete	[A117] aluminium 0% rec.	[A161] AlO3	[A154] iron & steel
[A145] concrete	[A139] paper	[A127] ammonia	[A119] nickel	[A143] cement
[A159] animal products	[A117] aluminium 0% rec.	[A161] AlO3	[A112] copper additive to fodder	[A159] animal products
[A161] AlO3	[A148] gravel	[A143] cement	[A139] paper	[A144] ceramic
[A121] zinc	[A193] wood	[A145] concrete	[A117] aluminium 0% rec.	[A140] glass
[A134] PVC	[A161] AlO3	[A128] PE (HD)	[A143] cement	[A117] aluminium 0% rec.
[A167] chlorine	[A143] cement	[A134] PVC	[A121] zinc	[A106] NPK 15-15-15
[A164] CaO	[A134] PVC	[A164] CaO	[A145] concrete	[A146] gypsum
[A123] copper	[A167] chlorine	[A144] ceramic	[A128] PE (HD)	[A123] copper
[A140] glass	[A144] ceramic	[A133] PP	[A133] PP	[A139] paper
[A119] nickel	[A127] ammonia	[A149] sand	[A134] PVC	[A109] AP
[A127] ammonia	[A123] copper	[A130] PS	[A164] CaO	[A164] CaO
[A144] ceramic	[A121] zinc	[A98] CAN	[A130] PS	[A142] rockwool
[A142] rockwool	[A140] glass	[A140] glass	[A111] zinc additive to fodder	[A121] zinc
[A193] wood	[A119] nickel	[A123] copper	[A124] barite	[A137] water (decarbonated)
[A149] sand	[A128] PE (HD)	[A121] zinc	[A140] glass	[A161] AlO3

In this system as well, biomass, iron and steel, paper and concrete score highly on most of the impact categories. Plastics also can be found in most of the top-twenties. Pesticides score high in the toxic category, but not at all on others. Some industrial minerals also can be found in the top-twenty.

7.2.3 The production system

The production system includes all chains from cradle-to-grave of the materials produced in the Netherlands:

Production * I_{p+u+w}

I_{p+u+w} being the cradle-to-grave impacts of the chain.

In the table below some results are presented.

Table 7.3 Production system, top-twenty scoring materials on five selected environmental impact categories

ADP	LUC	GWP	FAETP	FSW
[A154] iron & steel	[A159] animal products	[A160] crop or grass	[A160] crop or grass	[A149] sand
[A117] aluminium 0% rec.	[A160] crop or grass	[A159] animal products	[A159] animal products	[A160] crop or grass
[A145] concrete	[A149] sand	[A154] iron & steel	[A154] iron & steel	[A145] concrete
[A159] animal products	[A154] iron & steel	[A128] PE (HD)	[A128] PE (HD)	[A154] iron & steel
[A139] paper	[A145] concrete	[A139] paper	[A133] PP	[A148] gravel
[A160] crop or grass	[A139] paper	[A133] PP	[A139] paper	[A159] animal products
[A143] cement	[A117] aluminium 0% rec.	[A127] ammonia	[A121] zinc	[A144] ceramic
[A134] PVC	[A134] PVC	[A134] PVC	[A117] aluminium 0% rec.	[A143] cement
[A121] zinc	[A133] PP	[A117] aluminium 0% rec.	[A145] concrete	[A140] glass
[A133] PP	[A128] PE (HD)	[A130] PS	[A134] PVC	[A106] NPK 15-15-15
[A128] PE (HD)	[A121] zinc	[A98] CAN	[A130] PS	[A117] aluminium 0% rec.
[A167] chlorine	[A167] chlorine	[A145] concrete	[A143] cement	[A139] paper
[A98] CAN	[A144] ceramic	[A144] ceramic	[A129] PC	[A121] zinc
[A140] glass	[A148] gravel	[A129] PC	[A98] CAN	[A142] rockwool
[A130] PS	[A127] ammonia	[A143] cement	[A167] chlorine	[A101] SSP
[A127] ammonia	[A130] PS	[A149] sand	[A132] PET 0% rec	[A179] NaCl
[A144] ceramic	[A143] cement	[A121] zinc	[A140] glass	[A134] PVC
[A142] rockwool	[A193] wood	[A140] glass	[A127] ammonia	[A137] water (decarbonated)
[A179] NaCl	[A98] CAN	[A167] chlorine	[A179] NaCl	[A98] CAN
[A149] sand	[A140] glass	[A132] PET 0% rec	[A142] rockwool	[A128] PE (HD)

Biomass, iron and steel, concrete, paper and a number of plastics again determine the score in a number of impact categories.

7.2.4 Comparison of the systems

It can be seen quite clearly that the three systems lead to rather similar, although not identical, results. In table 7.4 below, the top-twenty for some of the impact categories is compared.

Table 7.4 Comparison of the top-twenty materials for the three systems, "list of materials" variant.

Land use competition			**Global warming**			**Aquatic ecotoxicity**		
Regional	*Consumption*	*Production*	*Regional*	*Consumption*	*Production*	*Regional*	*Consumption*	*Production*
animal products	crop or grass	animal products	crop or grass	crop or grass	crop or grass	crop or grass	crop or grass	crop or grass
crop or grass	animal products	crop or grass	animal products	animal products	animal products	pesticides	pesticides	animal products
sand	sand	sand	iron & steel	iron & steel	iron & steel	animal products	animal products	iron & steel
iron & steel	iron & steel	iron & steel	paper	paper	PE (HD)	iron & steel	iron & steel	PE (HD)
concrete	concrete	concrete	PE (HD)	Al 0% rec.	paper	nickel	AlO3	PP
paper	paper	paper	NH3	NH3	PP	copper additive	nickel	paper
Al 0% Rec.	Al 0% rec.	Al 0% rec.	Al 0% Rec.	AlO3	NH3	paper	copper additive	zinc
PVC	gravel	PVC	PP	cement	PVC	PE (HD)	paper	Al 0% rec.
gravel	wood	PP	wood	concrete	Al 0% rec.	Al 0% Rec.	Al 0% rec.	concrete
PP	AlO3	PE (HD)	PVC	PE (HD)	PS	zinc	cement	PVC
PE (HD)	cement	zinc	CAN	PVC	CAN	PP	zinc	PS
chlorine	PVC	chlorine	PS	CaO	concrete	concrete	concrete	cement
zinc	chlorine	ceramic	concrete	ceramic	ceramic	PVC	PE (HD)	PC
ceramic	ceramic	gravel	ceramic	PP	PC	cement	PP	CAN
NH3	NH3	NH3	cement	sand	cement	PS	PVC	chlorine
cement	copper	PS	sand	PS	sand	zinc additive	CaO	PET 0% rec
PS	zinc	cement	PC	CAN	zinc	barite	PS	glass
wood	glass	wood	zinc	glass	glass	CAN	zinc additive	NH3
CAN	nickel	CAN	glass	copper	chlorine	chlorine	barite	NaCl
glass	PE (HD)	glass	chlorine	zinc	PET 0% rec	glass	glass	rock-wool

The regional and the production system seem more alike and differ somewhat from the consumption system. For Land use for example, wood scores higher in the consumption system than in the production and regional system. This is of course due to the fact that the Netherlands imports most of its wood. Another example is PE connected to global warming. Here, the consumption system scores lower, suggesting that the Netherlands produces more PE than it uses, having the production impacts within the borders. For aquatic ecotoxicity, we see some examples to the contrary. Here, the regional system in some respects resembles the consumption system. This has to do with the dissipative use of pesticides, fertilisers and fodder additives in agriculture.

7.3 Contribution of materials to the total of environmental problems

In the above, the systems variant "double-counting excluded" was defined to enable adding up all materials to one score per environmental problem. The table below contains the results and compares the total scores on the environmental impact categories for the three systems. It should be kept in mind that these totals represent very crude estimates for several reasons:

- the list of 100 materials does not cover all materials
- of these 100 materials, only half is included because of data gaps
- both the impact data and the volume data contain large uncertainties.

Nevertheless, it provides a first estimate, which can be the basis for further improvement. For comparison, the Dutch total contribution to the impact categories, as specified by CML on their web site http://www.leidenuniv.nl/cml/ssp/databases/index.html, is added. This Dutch total is made up out of all emissions of the Emission Registration multiplied by the impact factors for each impact category. It can best be compared with the Regional system (System I). It gives an impression of the contribution of materials to the Dutch environmental problems.

Table 7.5 Comparison of the three systems regarding the added contributions of the materials to the environmental impact categories

	Dutch Total	System I	System II	System III
		Regional	Consumption	Production
ADP	1.7E+09	3.01E+08	2.57E+08	3.03E+08
LUC	3.0E+10	2.24E+10	1.47E+10	2.31E+10
GWP100	2.5E+11	1.54E+11	7.25E+10	1.27E+11
ODP	9.8E+05	3.03E+05	1.56E+05	3.04E+05
HTP	1.9E+11	4.86E+10	3.54E+10	5.17E+10
FAETP	7.5E+09	1.53E+10	1.12E+10	1.47E+10
MAETP	3.2E+12	6.42E+13	5.74E+13	6.54E+13
TETP	9.2E+08	9.27E+08	5.88E+08	9.73E+08
POCP	1.8E+08	5.94E+07	3.83E+07	6.05E+07
AP	6.7E+08	5.71E+08	5.73E+08	5.83E+08
EP	5.0E+08	3.00E+09	1.51E+09	3.60E+09
DALY	1.4E+02	3.97E+01	2.40E+01	4.12E+01
FSW	-	1.26E+11	6.89E+10	2.01E+11

For most of the impact categories, it looks like materials contribute roughly a quarter to a half to the total Dutch score. This seems quite a large contribution. For three of the four toxicity categories (FAETP, MAETP and TETP) as well as for eutrophication (EP) the Dutch total even seems to be lower than the contribution of the materials. We don't know what causes this. Possibly the fact that some "cradles" are included in our calculations which are not really located in the Netherlands contributes to this. Another possible explanation is that not all Dutch emissions are included in the emission registration. Especially for pesticides it is known that not all are included, while we did include all in this study, This may be the most important explanation. It shows, once again, that all figures need to be treated as very rough estimates.

Comparing the three different systems for the materials, it can be concluded that

- in general, the Production based system scores higher than the Consumption based system
- in general, the regional system follows the Production system quite closely.

If true, this suggests on the one hand that the Dutch consumption of materials causes in a world wide perspective less environmental problems than the materials produced in the Netherlands. Therefore it can be concluded that the Netherlands do not "export" their environmental problems, rather the contrary.

It also suggests that most of the environmental problems are related to the production phase of the materials. For many materials, especially all of the metals, building materials and biomass, this is clearly true. Some materials are an exception to this rule, like pesticides and fertilisers.

7.4 Priority list of materials

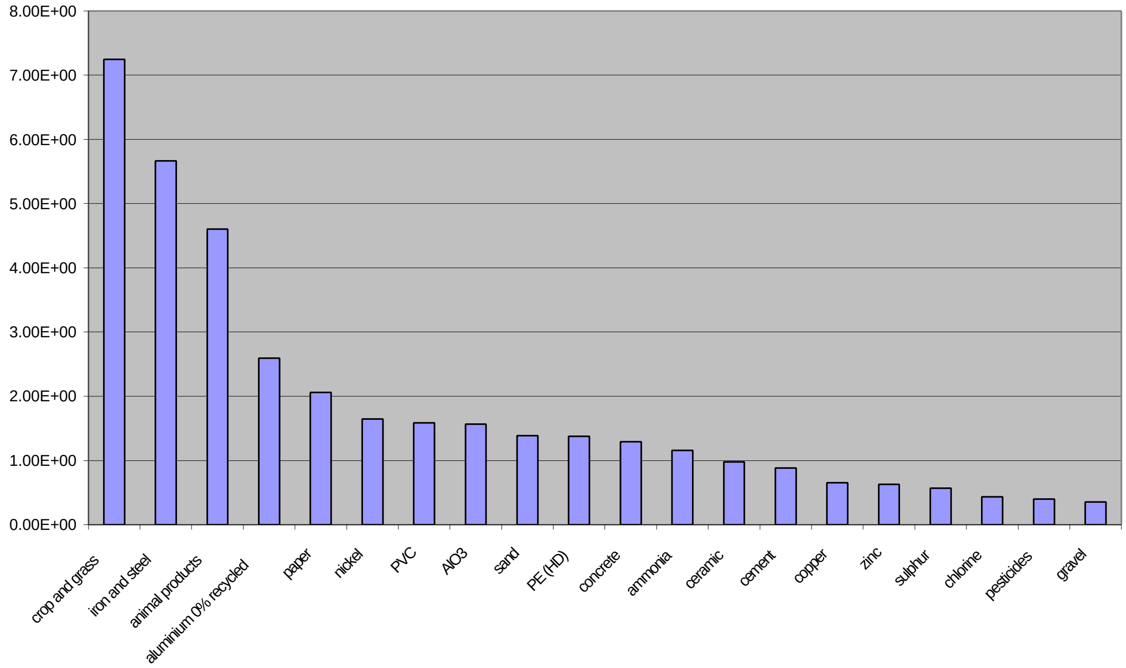
In the previous sections, we specified the contribution of the materials to each impact category separately. In this section, we try to specify the materials with an overall large contribution. We can identify easily some materials that appear in the top-twenty for all or most impact categories. Those are the materials that have a high per kilogram score, and also have large flows:

- animal products, crop and grass
- iron and steel, aluminium
- concrete and cement
- paper
- some of the plastics.

For some materials, the per kg impact score is high but the volumes are so small that they fall down to the bottom of the list. This is especially true for the precious metals. Some large flow materials, such as sand or ceramics (including bricks), don't score high despite their high volumes because the per kg impact is very low.

We made one attempt to add the scores for the different environmental impact categories per material. We did this for System II, the consumption based system, "list-of-materials" variant, for two reasons: (1) this is consistent with the system definition in the CE study (de Bruyn et al., 2003), and (2) the data for this system are somewhat more reliable than for System I, the regional system. System III we find interesting only for purposes of comparison. We weighed the impact categories equally, normalised to the highest score, and added the four toxicity categories to one. The result is presented in Figure 7.1.

Figure 7.1 Top-twenty of materials based on their environmental impacts, weighted equally (maximum score 10), System II Consumption based system, "list of materials" variant.



Large flows with high impacts per kg are at the top, as expected. Some materials come out that did not make many of the top-twenties for the separate categories, such as ammonia, sulphur and chlorine. Apparently these materials score consistently on all or most of the categories, so they pass the materials scoring highly on one or a few of the categories such as pesticides. There are no really small volume materials in the top-20. The precious metals, having a very large contribution per kg, can be found at rankings 29, 32 and 41. Copper and zinc are relatively small but contribute relatively a lot per kg so they still appear in the top-20. There seem to be no really dominating materials, contrary for what we found for the separate impact categories. The complete results can be found in

A note that must be made, not only for Figure 7.1 but in fact for all the result tables of Chapter 7, is that it makes a very large difference at what level of detail the materials are defined. For example, biomass is just divided into three categories - wood, crop and grass, and animal products - while there are ten plastics, twenty metals and even more chemicals. If biomass were divided into ten categories, the score for all of these would of course be much lower. This subject of scale is an important one that deserves attention for the future.

8 Conclusions, discussion, recommendations

8.1 Conclusions

A method has been developed to prioritise materials with regard to their contribution to environmental problems. The method is based on information on the environmental impacts of materials on the one hand, and information on the volumes of the materials on the other hand. It combines aspects of Material Flow Accounting (MFA) with aspects of Life-Cycle Assessment (LCA). The method appears to be applicable and in principle leads to relevant results.

The method has been applied to roughly 100 different materials. For all of them, the cradle-to-grave contribution to 13 environmental problems - or impact categories - has been specified. For about half of them, we were able to specify the flows in terms of kg / year.

The outcomes of the application of the method are subject to large uncertainties due to data gaps, data uncertainties, methodological choices and simplifications. The results therefore should be treated as indicative only and require further improvement before they can be the basis for policy on materials.

Some of the more robust conclusions are stated below:
1. Materials appear to have a large and sometimes major contribution to environmental problems.
2. The contribution of specific materials to specific environmental problems varies.
3. The contribution to environmental problems appear to lie mainly in the production phase. Some, but not many, materials are a clear exception to this rule.
4. Per kilogram of material, precious metals are by far the most polluting materials. Overall, they don't score highly because the volumes are extremely low.
5. Sometimes, the material itself contributes a lot to the score. In many cases however, it's the energy and auxilliary materials that determine the score. A policy on materials therefore should not focus only on reducing the use, but should also consider improvements in the processes, especially regarded the use of energy and auxilliary materials.
6. Top-scoring materials in general both have a relatively high contribution per kilogram, and have a relatively large volume of flows.
7. Top-scoring materials are biomass from agriculture (both vegetable and animal), iron and steel, aluminium, concrete and cement, some of the plastics and some of the more bulky heavy metals. Despite the uncertainties, these materials certainly deserve attention from policy.

8.2 Discussion

The data used for the quantification is incomplete in many respects and contains a large number of uncertainties. This is true for both impact data and volume data. Appendix 6 contains an elaboration of data gaps and uncertainties. Naturally these uncertainties have an influence on the robustness of the results. For the impact data, the implicit choices made for allocation in the ETH database have a large influence, as well as the assumptions made for recycling. The assumptions we made for the use and waste management phase are also quite crude. For the volume data, the exclusion of the products is for some materials a large problem. For some categories of materials, statistics are much better than for others. Data on consumption are not available at all, while data on production are incomplete, often for reasons of confidentiality.

A second issue is related to the systems definition. As stated in Chapter 7, it is not automatically clear which kilograms can be "counted in". We solved this by defining a number of different systems: a regional system, a consumption-based system and a production-based system. It appears that the differences between the systems are not very large. This is reassuring in two respects: (1) the conclusion about which materials to address first in policy is rather robust, and (2) the Netherlands apparently do not engage in "exporting" environmental problems, as has been suggested sometimes.

A potentially far-reaching choice was to assume a steady state for the materials' regime. This could not be avoided since we wanted to include cradle-to-grave chains and it was not possible within the framework of this study to specify the chains in time. Under steady state conditions it is possible to assume that the whole life-cycle takes place within one year. In fact this is not the case, since sometimes the life span of certain applications can amount to decades or even centuries. The impact category most effected by it is the final solid waste production. Building materials - large volumes, large life-spans - are assumed to become waste in the same year, and therefore score highly undeservedly.

Another choice with a potential large influence on the results is the choice for (categories of) materials. Some materials are defined on a high aggregation level, such as biomass. Others are defined on a much lower level, such as industrial chemicals. This has an impact on the volumes, and therefore on the end result: if agricultural biomass would have been divided into ten instead of two categories, each category separately would score much lower. Lumping heavy metals or plastics together would make them score much higher. In principle, the information needed to vary the level of aggregation is available in the databases. In this study it is not feasible due to time constraints.

The results of this project must, in view of the uncertainties mentioned above, be regarded as a pilot study: the method has been developed and has proven to be applicable, but the results are highly uncertain. That does not mean that every conclusion is liable to be proven untrue in future. Generally, it can be seen that a few materials dominate the score if we look at the results per impact category. Even under the large uncertainties as specified above, it may be expected that the dominating materials will remain the same. When the differences are smaller, the uncertainties may have a large influence. For most of the top 5 - 20 materials it must be suspected that their ranking order may be subject to change if better data become available.

8.3 Recommendations

A first group of recommendations is related to the improvement of the data used in this study. The largest gaps are, perhaps surprisingly, in the volume data rather than the impact data. For some materials, data are lacking completely. For others, we have imports and exports but not production and consumption. Consumption generally is not included in statistics. In order to improve the volume data sufficiently for policy to be able to act on the results, we recommend

- performing material flow analyses for the most important materials
- drafting improved material balances for the other materials.

The impact data also need to be improved in various points:

- the impact data on recycling need to be improved
- the very rough estimates for the impacts of use and waste management need to be improved.

Besides this, the implicit assumptions made in the ETH database for allocation must be checked and made explicit and, if necessary, must be harmonised.

A second group of recommendations refers to the choices made regarding the materials-to-be-included and the systems definition. These choices may have a large influence on the results. It is important that it is known how large the influence is. More specifically we recommend

- varying the level of aggregation of the materials or materials categories and see what the influence is on the outcomes
- looking into more detail which stages of the life-cycle are occurring actually within the Dutch borders and which are not

- looking into more detail into the dynamics of the system, in order to get an idea about the influence of the steady state assumption.

A third group of recommendations has to do with the further analysis of the databases and the results. Although liable to improvement, we have already a real treasure of information allowing for different interesting analyses. For example:

- looking into the emissions, processes and flows responsible for the score of a certain material on a certain environmental impact category. In the first place this serves as a check, in the second place it gives insight relevant for options of improvement. Is it just one process, or is it the total of all that determines the score? Is it the material itself or the energy required to make it? Is it the production stage or the use? Questions like these need to be answered before any policy can be formulated.
- making time series. The database now refers to one moment in time. In order to see whether or not dematerialisation occurs we must have different points in time. Both the volumes and the impacts are liable to change over time, dependent on all sorts of things such as population growth, welfare growth, technological development, alternatives etc. etc., and therefore the impacts related to materials use may change as well.
- compare the approach taken in this study to the much simpler MFA headline indicators. Are the outcomes really different from an approach looking at volumes only, or are the volumes indeed a good first approach? Some results suggest that this might be the case. The very high per kg impact for precious metals is in line with the very large MIPS for the gold ring as presented by Von Weizsäcker (1997). Large flow materials such as cement, concrete and biomass come out on top here as well. There are also some results to the contrary. It would be interesting to elaborate the overall picture.
- relating the contribution of the materials to environmental problems to their contribution to GDP. This could offer possibilities to develop an efficiency indicator of some kind, as one step towards policy.
- finding ways to determine the overall importance of a material for the total of environmental problems. In this study, we made one attempt: an equal weighting between the impact categories. Other weighing factors might lead to different results.

A final recommendation aims at a materials policy. The database and methodology presented here offers a basis to assess the influence of policy measures on the materials' contribution to environmental problems. Nevertheless it is not sufficient to generate options for policy. These should come, as we see it, from a general functional approach. Distinguishing rough functional categories (such as feeding, housing, transport etc.) could be a first step. The starting point then is that these functions must be fulfilled in one way or another. Food cannot be replaced, but one food product might be replaced by another. Housing is needed, but different building materials as well as different ways of building could be suggested. Just phasing out is no option from this point of view. Very different ways of fulfilling the same function can be specified and compared with the (improved) database provided here.

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Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)		use of pesticides with a characterisation factor (kg)	use profile 1 kg pest.
Fruits	*other applications*	1-naftylaceetamide	158			
Fruits	*other applications*	1-naftylazijnzuur	92			
Flower bulbs	*foliage destruction*	2,4-D	181			
arable crops	*Herbicides*	2,4-D	1 854			
Flower bulbs	*Herbicides*	2,4-D	281			
tree nursery products	*Herbicides*	2,4-D	147			
Fruits	*Herbicides*	2,4-D	612			
				3 076	3 076	1.25E-03
tree nursery products	*other applications*	3-indolylazijnzuur	24			
tree nursery products	*other applications*	3-indolylboterzuur	30			
Greenhouse flowers	*Insecticides*	abamectine	284			
Greenhouse vegetables	*Insecticides*	abamectine	44			
				328		
Flower bulbs	*Insecticides*	acefaat	196			
Greenhouse flowers	*Insecticides*	acefaat	5 696			
tree nursery products	*Insecticides*	acefaat	1 048			
Outdoor vegetables	*Insecticides*	acefaat	766			
				7 706	7 706	3.12E-03
arable crops	*Herbicides*	aclonifen	4 062			
arable crops	*soil disinfection*	aldicarb	19 628			
Flower bulbs	*soil disinfection*	aldicarb	1 643			
Greenhouse flowers	*soil disinfection*	aldicarb	510			
tree nursery products	*soil disinfection*	aldicarb	357			
Outdoor vegetables	*soil disinfection*	aldicarb	496			
Greenhouse flowers	*Insecticides*	aldicarb	449			
				23 082	23 082	9.35E-03
Greenhouse flowers	*Hulpstoffen*		132			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
		alkylarylpolyglycolether				
Flower bulbs	*soil disinfection*	alkyldimethylbenzyl-NH4Cl	77			
Flower bulbs	*soil disinfection*		77			
		alkyldimethylethylbenzyl-NH4Cl				
arable crops	*Herbicides*	amidosulfuron	600			
tree nursery products	*Insecticides*	amitraz	43			
Greenhouse vegetables	*Insecticides*	amitraz	25			
Fruits	*Insecticides*	amitraz	2 718			
				2 786		
Fruits	*Herbicides*	amitrol	2 858			
arable crops	*Herbicides*	asulam	2 434			
Flower bulbs	*Herbicides*	asulam	11 621			
tree nursery products	*Herbicides*	asulam	28			
				14 082		
arable crops	*Herbicides*	atrazin	104 701		104 701	4.24E-02
Fruits	*Insecticides*	azinfos-methyl	197		197	7.96E-05
arable crops	*Fungicides*	azoxystrobine	3 704			
tree nursery products	*Fungicides*	azoxystrobine	21			
				3 726		
Greenhouse flowers	*Insecticides*	Bacillus Thuringiensis	372			
tree nursery products	*Insecticides*	Bacillus Thuringiensis	14			
Greenhouse vegetables	*Insecticides*	Bacillus Thuringiensis	9 115			
Outdoor vegetables	*Insecticides*	Bacillus Thuringiensis	75			
Fruits	*Insecticides*	Bacillus Thuringiensis	989			
				10 565		
arable crops	*Herbicides*	benazolin-ethyl	274			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
arable crops	*Fungicides*	benomyl	1 192			
Greenhouse flowers	*Fungicides*	benomyl	204			
Champignons	*Fungicides*	benomyl	59			
Outdoor vegetables	*Fungicides*	benomyl	413			
				1 869	1 869	7.57E-04
arable crops	*Herbicides*	bentazon	52 237			
Flower bulbs	*Herbicides*	bentazon	904			
Outdoor vegetables	*Herbicides*	bentazon	1 656			
				54 797	54 797	2.22E-02
arable crops	*Herbicides*	bifenox	19 072			
Greenhouse flowers	*Insecticides*	bifenthrin	29		29	1.16E-05
Greenhouse flowers	*Fungicides*	bitertanol	1 047			
tree nursery products	*Fungicides*	bitertanol	307			
Greenhouse vegetables	*Fungicides*	bitertanol	468			
Fruits	*Fungicides*	bitertanol	278			
				2 101		
Greenhouse flowers	*other applications*	bromadiolon	0			
arable crops	*Herbicides*	bromoxynil	5 179			
arable crops	*Fungicides*	bromuconazool	3 026			
tree nursery products	*Insecticides*	broompropylaat	14			
Fruits	*Insecticides*	broompropylaat	276			
				290		
arable crops	*foliage destruction*	buminafos	17 734			
Greenhouse flowers	*Fungicides*	bupirimaat	3 050			
tree nursery products	*Fungicides*	bupirimaat	12			
Greenhouse vegetables	*Fungicides*	bupirimaat	837			
Outdoor vegetables	*Fungicides*	bupirimaat	419			
Fruits	*Fungicides*	bupirimaat	1 708			
				6 026		

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Greenhouse vegetables	*Insecticides*	buprofezin	22			
Flower bulbs	*other disinfection*	captan	37 398		37 398	1.51E-02
Greenhouse flowers	*other disinfection*	captan	301			
Flower bulbs	*Fungicides*	captan	2 076			
Greenhouse flowers	*Fungicides*	captan	548			
tree nursery products	*Fungicides*	captan	81			
Outdoor vegetables	*Fungicides*	captan	2 055			
Fruits	*Fungicides*	captan	234 340			
				276 798		
Fruits	*Insecticides*	carbaryl	363			
Fruits	*other applications*	carbaryl	1 738			
				2 101	2 101	8.51E-04
arable crops	*Herbicides*	carbeetamide	2 237			
tree nursery products	*Herbicides*	carbeetamide	101			
Outdoor vegetables	*Herbicides*	carbeetamide	1 332			
				3 670		
Flower bulbs	*other disinfection*	carbendazim	16 095			
Greenhouse flowers	*other disinfection*	carbendazim	89			
arable crops	*Fungicides*	carbendazim	16 397			
Flower bulbs	*Fungicides*	carbendazim	8 617			
Greenhouse flowers	*Fungicides*	carbendazim	2 718			
tree nursery products	*Fungicides*	carbendazim	451			
Champignons	*Fungicides*	carbendazim	971			
Greenhouse vegetables	*Fungicides*	carbendazim	946			
Outdoor vegetables	*Fungicides*	carbendazim	6 454			
Fruits	*Fungicides*	carbendazim	9 604			
				62 342	62 342	2.52E-02
Greenhouse flowers	*Insecticides*	carbofuran	1 465			
tree nursery products	*Insecticides*	carbofuran	261			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Outdoor vegetables	*Insecticides*	carbofuran	109			
				1 836	1 836	7.43E-04
Greenhouse flowers	*Insecticides*	chlofentezin	34			
Outdoor vegetables	*Insecticides*	chlofentezin	150			
				184		
Outdoor vegetables	*Herbicides*	chloorbromuron	1 256			
Flower bulbs	*soil disinfection*	chloorfacinon	0			
tree nursery products	*other applications*	chloorfacinon	0			
				0		
arable crops	*Insecticides*	chloorfenvinfos	612			
Outdoor vegetables	*Insecticides*	chloorfenvinfos	1 518			
				2 129	2 129	8.62E-04
arable crops	*other applications*	chloormequat	70 172			
Greenhouse flowers	*other applications*	chloormequat	2 083			
tree nursery products	*other applications*	chloormequat	17			
Fruits	*other applications*	chloormequat	10 845			
				83 118		
arable crops	*Herbicides*	chloorprofam	11 371			
Flower bulbs	*Herbicides*	chloorprofam	27 316			
tree nursery products	*Herbicides*	chloorprofam	1 141			
Outdoor vegetables	*Herbicides*	chloorprofam	4 137			
arable crops	*other applications*	chloorprofam	9 046			
				53 011	53 011	2.15E-02
arable crops	*Insecticides*	chloorpyrifos	1 873			
tree nursery products	*Insecticides*	chloorpyrifos	59			
Outdoor vegetables	*Insecticides*	chloorpyrifos	448			
				2 380	2 380	9.64E-04
Flower bulbs	*other disinfection*	chloorthalonil	6 195			
arable crops	*Fungicides*	chloorthalonil	200 851			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Flower bulbs	*Fungicides*	chloorthalonil	21 483			
Greenhouse flowers	*Fungicides*	chloorthalonil	2 322			
tree nursery products	*Fungicides*	chloorthalonil	1 624			
Champignons	*Fungicides*	chloorthalonil	86			
Outdoor vegetables	*Fungicides*	chloorthalonil	10 970			
				243 530	243 530	9.86E-02
arable crops	*Herbicides*	chloridazon	44 063			
Flower bulbs	*Herbicides*	chloridazon	17 864			
				61 927	61 927	2.51E-02
arable crops	*Herbicides*	clodinafop-propargyl	493			
arable crops	*Herbicides*	clopyralid	1 239			
Flower bulbs	*Herbicides*	clopyralid	4			
				1 243		
arable crops	*Herbicides*	cloquintoceet-mexyl	123			
arable crops	*Herbicides*	cyanazin	129			
Outdoor vegetables	*Herbicides*	cyanazin	128			
				257	257	1.04E-04
arable crops	*Herbicides*	cycloxydim	1 080			
Flower bulbs	*Herbicides*	cycloxydim	160			
tree nursery products	*Herbicides*	cycloxydim	23			
Outdoor vegetables	*Herbicides*	cycloxydim	50			
				1 313		
Fruits	*Insecticides*	cydia pomonella granulosevirus	108			
Greenhouse flowers	*Insecticides*	cyhexatin	241			
tree nursery products	*Insecticides*	cyhexatin	11			
Greenhouse vegetables	*Insecticides*	cyhexatin	608			
Outdoor vegetables	*Insecticides*	cyhexatin	218			
				1 078		

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
arable crops	*Fungicides*	cymoxanil	40 533			
arable crops	*Fungicides*	cyproconazool	1 754			
Greenhouse flowers	*Insecticides*	cyromazin	403		403	1.63E-04
Greenhouse flowers	*other applications*	daminozide	7 384			
tree nursery products	*other applications*	daminozide	423			
				7 806		
tree nursery products	*soil disinfection*	dazomet	1 368			
arable crops	*Insecticides*	deltamethrin	1 595			
Flower bulbs	*Insecticides*	deltamethrin	414			
Greenhouse flowers	*Insecticides*	deltamethrin	52			
tree nursery products	*Insecticides*	deltamethrin	16			
Champignons	*Insecticides*	deltamethrin	11			
Outdoor vegetables	*Insecticides*	deltamethrin	159			
				2 247	2 247	9.10E-04
arable crops	*Herbicides*	desmedifam	2 754			
Outdoor vegetables	*Herbicides*	desmetryn	493		493	2.00E-04
arable crops	*Insecticides*	diazinon	803			
Greenhouse flowers	*Insecticides*	diazinon	557			
Champignons	*Insecticides*	diazinon	152			
Outdoor vegetables	*Insecticides*	diazinon	90			
				1 602	1 602	6.49E-04
arable crops	*Herbicides*	dicamba	4 924			
tree nursery products	*Herbicides*	dichlobenil	654			
Outdoor vegetables	*Fungicides*	dichlofluanide	416			
Fruits	*Fungicides*	dichlofluanide	2 218			
				2 634		
arable crops	*Herbicides*	dichloorprop-P	630		630	2.55E-04
Greenhouse flowers	*Insecticides*	dichloorvos	763			
Champignons	*Insecticides*	dichloorvos	15			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Greenhouse vegetables	*Insecticides*	dichloorvos	1 551			
Outdoor vegetables	*Insecticides*	dichloorvos	88			
				2 417	2 417	9.79E-04
tree nursery products	*Insecticides*	dicofol	13			
Champignons	*other disinfection*	didecyldimethyl-NH4Cl	147			
Greenhouse flowers	*Insecticides*	dienochloor	4 097			
tree nursery products	*Insecticides*	dienochloor	180			
				4 278		
Flower bulbs	*other disinfection*	diethofencarb	216			
Flower bulbs	*Fungicides*	diethofencarb	135			
Greenhouse flowers	*Fungicides*	diethofencarb	91			
tree nursery products	*Fungicides*	diethofencarb	25			
Greenhouse vegetables	*Fungicides*	diethofencarb	579			
				1 046		
Greenhouse flowers	*Hulpstoffen*	diethyleenglycol	1 168			
Greenhouse vegetables	*Hulpstoffen*	diethyleenglycol	73			
				1 241		
Flower bulbs	*soil disinfection*	difenacum	0			
Fruits	*Fungicides*	difenoconazool	954			
Flower bulbs	*soil disinfection*	difethialon	0			
Greenhouse flowers	*other applications*	difethialon	0			
				0		
Greenhouse flowers	*Insecticides*	diflubenzuron	88			
Champignons	*Insecticides*	diflubenzuron	105			
Fruits	*Insecticides*	diflubenzuron	956			
				1 148		
arable crops	*Herbicides*	diflufenican	1 180			
arable crops	*Insecticides*	dimethoaat	27 944			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Flower bulbs	*Insecticides*	dimethoaat	825			
tree nursery products	*Insecticides*	dimethoaat	62			
Outdoor vegetables	*Insecticides*	dimethoaat	8 348			
Fruits	*Insecticides*	dimethoaat	312			
				37 490	37 490	1.52E-02
arable crops	*Fungicides*	dimethomorph	21 252			
Greenhouse flowers	*Fungicides*	dimethomorph	1 005			
tree nursery products	*Fungicides*	dimethomorph	27			
Outdoor vegetables	*Fungicides*	dimethomorph	497			
				22 781		
arable crops	*Herbicides*	dinoterb	10 973			
Outdoor vegetables	*Herbicides*	dinoterb	639			
				11 612	11 612	4.70E-03
arable crops	*foliage destruction*	diquat dibromide	77 465			
arable crops	*Herbicides*	diquat dibromide	3 963			
Flower bulbs	*Herbicides*	diquat dibromide	753			
Greenhouse flowers	*Herbicides*	diquat dibromide	42			
tree nursery products	*Herbicides*	diquat dibromide	851			
Outdoor vegetables	*Herbicides*	diquat dibromide	461			
Fruits	*Herbicides*	diquat dibromide	165			
				83 699	83 699	3.39E-02
tree nursery products	*Fungicides*	dithianon	42			
Fruits	*Fungicides*	dithianon	21 283			
				21 325		
arable crops	*Herbicides*	diuron	97			
Flower bulbs	*Herbicides*	diuron	342			
tree nursery products	*Herbicides*	diuron	359			
Outdoor vegetables	*Herbicides*	diuron	854			
Fruits	*Herbicides*	diuron	8 334			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	*Type of pesticide*	Active compound	use of pesticides (kg)			
				9 985	9 985	4.04E-03
arable crops	*foliage destruction*	DNOC	17 548		17 548	7.11E-03
Greenhouse flowers	*Fungicides*	dodemorf	10 157			
Fruits	*Fungicides*	dodine	6 663			
arable crops	*Fungicides*	epoxiconazool	17 375			
arable crops	*Herbicides*	EPTC	1 081			
arable crops	*Insecticides*	esfenvaleraat	724			
Flower bulbs	*Insecticides*	esfenvaleraat	622			
Outdoor vegetables	*Insecticides*	esfenvaleraat	17			
				1 363		
Greenhouse flowers	*other applications*	ethefon	18			
Greenhouse vegetables	*other applications*	ethefon	1 298			
Fruits	*other applications*	ethefon	44			
				1 360		
arable crops	*Herbicides*	ethofumesaat	50 468			
Outdoor vegetables	*Herbicides*	ethofumesaat	57			
				50 526		
arable crops	*soil disinfection*	ethoprofos	11 739			
Flower bulbs	*soil disinfection*	ethoprofos	4 514			
tree nursery products	*soil disinfection*	ethoprofos	55			
arable crops	*Insecticides*	ethoprofos	4 623			
				20 930	20 930	8.48E-03
Greenhouse flowers	*Fungicides*	etridiazool	6 277			
tree nursery products	*Fungicides*	etridiazool	12			
Greenhouse vegetables	*Fungicides*	etridiazool	472			
				6 761		
Greenhouse flowers	*soil disinfection*	fenamifos	1 112			
tree nursery products	*Fungicides*	fenarimol	29			
Greenhouse flowers	*Insecticides*	fenbutatinoxide	147			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
tree nursery products	*Insecticides*	fenbutatinoxide	126			
Greenhouse vegetables	*Insecticides*	fenbutatinoxide	619			
Outdoor vegetables	*Insecticides*	fenbutatinoxide	85			
Fruits	*Insecticides*	fenbutatinoxide	122			
				1 099		
arable crops	*Herbicides*	fenchlorazool-ethyl	403			
arable crops	*Herbicides*	fenmedifam	34 843			
tree nursery products	*Herbicides*	fenmedifam	58			
Outdoor vegetables	*Herbicides*	fenmedifam	1 344			
arable crops	*Fungicides*	fenmedifam	429			
				36 674		
tree nursery products	*Insecticides*	fenolen	57			
arable crops	*Herbicides*	fenoxaprop-P-ethyl	713			
Fruits	*Insecticides*	fenoxycarb	1 889			
arable crops	*Fungicides*	fenpiclonil	2 808			
arable crops	*Fungicides*	fenpropimorf	47 495			
Outdoor vegetables	*Fungicides*	fenpropimorf	1 607			
				49 101		
arable crops	*Fungicides*	fentin-acetaat	90 101			
Flower bulbs	*Fungicides*	fentin-acetaat	594			
Outdoor vegetables	*Fungicides*	fentin-acetaat	176			
				90 870	90 870	3.68E-02
arable crops	*Fungicides*	fentin-hydroxide	5 493		5 493	2.22E-03
arable crops	*Insecticides*	fenvaleraat	464			
Flower bulbs	*Insecticides*	fenvaleraat	200			
				665		
arable crops	*Herbicides*	fluazifop-P-butyl	951			
Flower bulbs	*Herbicides*	fluazifop-P-butyl	38			
Outdoor vegetables	*Herbicides*	fluazifop-P-butyl	144			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
				1 133		
Flower bulbs	*other disinfection*	fluazinam	6 336			
arable crops	*Fungicides*	fluazinam	203 530			
Flower bulbs	*Fungicides*	fluazinam	6 688			
				216 554		
Greenhouse flowers	*Insecticides*	flucycloxuron	268			
arable crops	*Herbicides*	fluroxypyr	14 114			
Flower bulbs	*other disinfection*	flutolanil	167			
arable crops	*Fungicides*	flutolanil	14 051			
Flower bulbs	*Fungicides*	flutolanil	3 603			
Greenhouse flowers	*Fungicides*	flutolanil	75			
				17 895		
Flower bulbs	*other disinfection*	folpet	7 966			
Flower bulbs	*Fungicides*	folpet	25 438			
				33 404	33 404	1.35E-02
Flower bulbs	*other disinfection*	formaldehyde	22 683			
Champignons	*other disinfection*	formaldehyde	26 750			
Flower bulbs	*Fungicides*	formaldehyde	16 975			
tree nursery products	*Fungicides*	formaldehyde	469			
Greenhouse vegetables	*Fungicides*	formaldehyde	55			
				66 931		
Outdoor vegetables	*Insecticides*	fosalon	642			
Fruits	*Insecticides*	fosalon	2 783			
				3 424		
tree nursery products	*other disinfection*	fosethyl-aluminium	3			
Flower bulbs	*Fungicides*	fosethyl-aluminium	178			
Greenhouse flowers	*Fungicides*	fosethyl-aluminium	3 614			
tree nursery products	*Fungicides*	fosethyl-aluminium	3 456			
Outdoor vegetables	*Fungicides*	fosethyl-aluminium	2 490			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
				9 742		
arable crops	*Insecticides*	fosfamidon	1 486			
Outdoor vegetables	*Insecticides*	fosfamidon	1 017			
				2 503		
Greenhouse flowers	*Fungicides*	furalaxyl	931			
tree nursery products	*Fungicides*	furalaxyl	23			
				954		
Greenhouse flowers	*other applications*	gibberella zuur A3	203			
tree nursery products	*other applications*	gibberella zuur A3	0			
Fruits	*other applications*	gibberella zuur A3	8			
				211		
Greenhouse flowers	*other applications*	gibberellin A4 + A7	21			
Fruits	*other applications*	gibberellin A4 + A7	47			
				68		
arable crops	*foliage destruction*	glufosinaat-ammonium	5 215			
tree nursery products	*Herbicides*	glufosinaat-ammonium	484			
Fruits	*Herbicides*	glufosinaat-ammonium	255			
				5 954		
Champignons	*other disinfection*	glutaaraldehyde	125			
arable crops	*foliage destruction*	glyfosaat	1 984			
Flower bulbs	*foliage destruction*	glyfosaat	2 139			
arable crops	*Herbicides*	glyfosaat	58 802			
Flower bulbs	*Herbicides*	glyfosaat	7 132			
Greenhouse flowers	*Herbicides*	glyfosaat	119			
tree nursery products	*Herbicides*	glyfosaat	4 643			
Outdoor vegetables	*Herbicides*	glyfosaat	13 492			
Fruits	*Herbicides*	glyfosaat	16 104			
				104 414	104 414	4.23E-02
Flower bulbs	*foliage destruction*	glyfosaat-trimesium	311			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
arable crops	*Herbicides*	glyfosaat-trimesium	9 963			
Flower bulbs	*Herbicides*	glyfosaat-trimesium	1 221			
tree nursery products	*Herbicides*	glyfosaat-trimesium	427			
Outdoor vegetables	*Herbicides*	glyfosaat-trimesium	165			
				12 086		
arable crops	*Fungicides*	guazatine	250			
Flower bulbs	*Herbicides*	haloxyfop-ethoxyethyl	86			
arable crops	*Herbicides*	haloxyfop-P-methyl	1 373			
Flower bulbs	*Herbicides*	haloxyfop-P-methyl	133			
tree nursery products	*Herbicides*	haloxyfop-P-methyl	23			
Outdoor vegetables	*Herbicides*	haloxyfop-P-methyl	73			
				1 602		
Greenhouse flowers	*Insecticides*	heptenofos	414			
tree nursery products	*Insecticides*	heptenofos	181			
				595	595	2.41E-04
Greenhouse flowers	*Insecticides*	hexythiazox	306			
tree nursery products	*Insecticides*	hexythiazox	47			
Greenhouse vegetables	*Insecticides*	hexythiazox	174			
				527		
arable crops	*other disinfection*	imazalil	117			
arable crops	*Fungicides*	imazalil	1 689			
Greenhouse flowers	*Fungicides*	imazalil	90			
Greenhouse vegetables	*Fungicides*	imazalil	704			
				2 599		
arable crops	*Insecticides*	imidacloprid	1 553			
Flower bulbs	*Insecticides*	imidacloprid	428			
Greenhouse flowers	*Insecticides*	imidacloprid	926			
tree nursery products	*Insecticides*	imidacloprid	90			
Greenhouse vegetables	*Insecticides*	imidacloprid	274			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	*Type of pesticide*	Active compound	use of pesticides (kg)			
Fruits	*Insecticides*	imidacloprid	776			
				4 047		
tree nursery products	*Insecticides*	indeen	375			
arable crops	*Herbicides*	ioxynil	6 396			
tree nursery products	*other disinfection*	iprodion	1			
arable crops	*Fungicides*	iprodion	1 060			
Greenhouse flowers	*Fungicides*	iprodion	991			
tree nursery products	*Fungicides*	iprodion	355			
Greenhouse vegetables	*Fungicides*	iprodion	274			
Outdoor vegetables	*Fungicides*	iprodion	8 270			
Fruits	*Fungicides*	iprodion	83			
				11 035	11 035	4.47E-03
arable crops	*Hulpstoffen*	iso-octylfenolpolyglycolether	4 357			
Outdoor vegetables	*Hulpstoffen*	iso-octylfenolpolyglycolether	763			
				5 119		
arable crops	*Herbicides*	isoproturon	65 964		65 964	2.67E-02
arable crops	*Herbicides*	isoxaflutool	1 095			
tree nursery products	*Fungicides*	kasugamycine	22			
arable crops	*Hulpstoffen*	koolzaadolie	399			
Fruits	*Fungicides*	koperhydroxide	712			
tree nursery products	*Fungicides*	koperoxychloride	119			
Outdoor vegetables	*Fungicides*	koperoxychloride	6 344			
Fruits	*Fungicides*	koperoxychloride	31 490			
				37 953		
tree nursery products	*Insecticides*	kresol	146			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	*Type of pesticide*	Active compound	use of pesticides (kg)			
arable crops	*Fungicides*	kresoxim-methyl	10 919			
Flower bulbs	*Fungicides*	kresoxim-methyl	517			
Greenhouse flowers	*Fungicides*	kresoxim-methyl	542			
tree nursery products	*Fungicides*	kresoxim-methyl	61			
Fruits	*Fungicides*	kresoxim-methyl	2 034			
				14 073		
arable crops	*Insecticides*	lambda-cyhalothrin	1 265			
Flower bulbs	*Insecticides*	lambda-cyhalothrin	525			
Outdoor vegetables	*Insecticides*	lambda-cyhalothrin	165			
				1 956		
arable crops	*Herbicides*	lenacil	1 305			
Flower bulbs	*Herbicides*	lenacil	300			
Outdoor vegetables	*Herbicides*	lenacil	119			
				1 725		
arable crops	*Insecticides*	lindaan	5 022			
Flower bulbs	*Insecticides*	lindaan	262			
Greenhouse flowers	*Insecticides*	lindaan	53			
				5 336	5 336	2.16E-03
arable crops	*Herbicides*	linuron	12 727			
Flower bulbs	*Herbicides*	linuron	422			
Greenhouse flowers	*Herbicides*	linuron	227			
tree nursery products	*Herbicides*	linuron	896			
Outdoor vegetables	*Herbicides*	linuron	2 562			
Fruits	*Herbicides*	linuron	189			
				17 025	17 025	6.89E-03
Champignons	*Insecticides*	malathion	311		311	1.26E-04
arable crops	*other applications*	maleine hydrazide	20 983			
Flower bulbs	*other disinfection*	mancozeb	153			
arable crops	*Fungicides*	mancozeb	748 859			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	*Type of pesticide*	Active compound	use of pesticides (kg)		
Flower bulbs	*Fungicides*	mancozeb	139 861		
Greenhouse flowers	*Fungicides*	mancozeb	1 536		
tree nursery products	*Fungicides*	mancozeb	871		
Outdoor vegetables	*Fungicides*	mancozeb	8 028		
Fruits	*Fungicides*	mancozeb	3 117		
			902 425		
arable crops	*Fungicides*	maneb	462 534		
Flower bulbs	*Fungicides*	maneb	77 835		
Greenhouse flowers	*Fungicides*	maneb	123		
tree nursery products	*Fungicides*	maneb	1 415		
Outdoor vegetables	*Fungicides*	maneb	5 544		
Fruits	*Fungicides*	maneb	1 381		
			548 832	548 832	2.22E-01
Flower bulbs	*foliage destruction*	MCPA	270		
arable crops	*Herbicides*	MCPA	62 030		
Flower bulbs	*Herbicides*	MCPA	337		
Greenhouse flowers	*Herbicides*	MCPA	37		
tree nursery products	*Herbicides*	MCPA	587		
Fruits	*Herbicides*	MCPA	6 140		
			69 402	69 402	2.81E-02
arable crops	*Herbicides*	mecoprop-P	74 159		
Flower bulbs	*Herbicides*	mecoprop-P	137		
tree nursery products	*Herbicides*	mecoprop-P	142		
Fruits	*Herbicides*	mecoprop-P	755		
			75 194	75 194	3.05E-02
arable crops	*Fungicides*	metalaxyl	12 689		
Flower bulbs	*Fungicides*	metalaxyl	494		
tree nursery products	*Fungicides*	metalaxyl	59		
Outdoor vegetables	*Fungicides*	metalaxyl	388		

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
				13 630		
Flower bulbs	*soil disinfection*	metaldehyde	5			
Greenhouse flowers	*other applications*	metaldehyde	339			
tree nursery products	*other applications*	metaldehyde	107			
Outdoor vegetables	*other applications*	metaldehyde	2 237			
				2 688		
arable crops	*Herbicides*	metamitron	131 945			
Flower bulbs	*Herbicides*	metamitron	22 228			
Greenhouse flowers	*Herbicides*	metamitron	629			
tree nursery products	*Herbicides*	metamitron	297			
				155 099	155 099	6.28E-02
tree nursery products	*Herbicides*	metazachloor	800			
Outdoor vegetables	*Herbicides*	metazachloor	2 085			
Fruits	*Herbicides*	metazachloor	230			
				3 116	3 116	1.26E-03
arable crops	*Herbicides*	methabenzthiazuron	1 294			
Outdoor vegetables	*Herbicides*	methabenzthiazuron	1 160			
				2 455	2 455	9.94E-04
Greenhouse flowers	*Insecticides*	methamidofos	343			
Flower bulbs	*soil disinfection*	methiocarb	82			
Greenhouse flowers	*Insecticides*	methiocarb	7 525			
tree nursery products	*Insecticides*	methiocarb	267			
Greenhouse vegetables	*Insecticides*	methiocarb	520			
Outdoor vegetables	*Insecticides*	methiocarb	2 868			
arable crops	*other disinfection*	methiocarb	161			
Greenhouse flowers	*other applications*	methiocarb	225			
tree nursery products	*other applications*	methiocarb	68			
Outdoor vegetables	*other applications*	methiocarb	1 097			
				12 814		

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Greenhouse flowers	*Insecticides*	methomyl	2 695			
tree nursery products	*Insecticides*	methomyl	25			
Greenhouse vegetables	*Insecticides*	methomyl	432			
				3 152	3 152	1.28E-03
Greenhouse flowers	*other applications*	methylesters van vetzuren C6-C12	231			
arable crops	*Fungicides*	metiram	70 796			
Fruits	*Fungicides*	metiram	5 279			
				76 075		
arable crops	*Herbicides*	metobromuron	12 085		12 085	4.89E-03
arable crops	*Herbicides*	metolachloor	82 776		82 776	3.35E-02
arable crops	*foliage destruction*	metoxuron	19 861			
Flower bulbs	*Herbicides*	metoxuron	360			
tree nursery products	*Herbicides*	metoxuron	71			
Outdoor vegetables	*Herbicides*	metoxuron	8 260			
				28 552		
arable crops	*Herbicides*	metribuzin	30 603			
Outdoor vegetables	*Herbicides*	metribuzin	245			
				30 848	30 848	1.25E-02
arable crops	*Herbicides*	metsulfuron-methyl	3 575			
Greenhouse flowers	*Insecticides*	mevinfos	1 136			
tree nursery products	*Insecticides*	mevinfos	19			
Outdoor vegetables	*Insecticides*	mevinfos	956			
				2 111	2 111	8.55E-04
arable crops	*Hulpstoffen*	minerale olie	298 098			
Flower bulbs	*Hulpstoffen*	minerale olie	244 026			
tree nursery products	*Hulpstoffen*	minerale olie	40			
Outdoor vegetables	*Hulpstoffen*	minerale olie	6 351			
Fruits	*Hulpstoffen*	minerale olie	1 844			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Fruits	*Insecticides*	minerale olie	126			
arable crops	*Herbicides*	minerale olie	1 098			
				551 583		
arable crops	*Herbicides*	monolinuron	14 403			
Greenhouse flowers	*Herbicides*	monolinuron	83			
tree nursery products	*Herbicides*	monolinuron	35			
Outdoor vegetables	*Herbicides*	monolinuron	163			
				14 683	14 683	5.95E-03
tree nursery products	*Insecticides*	naftaleen	806			
Fruits	*Insecticides*	naftaleen	131			
				937		
Champignons	*other disinfection*	natriumhypochloriet	5 501			
tree nursery products	*other applications*	natrium-p-tolueensulfonchloramide	2			
Fruits	*Fungicides*	nitrothal-isopropyl	4 455			
arable crops	*Hulpstoffen*	nonylfenol-polyethoxyethanol	8 686			
Greenhouse flowers	*Hulpstoffen*	nonylfenol-polyethoxyethanol	1 366			
tree nursery products	*Hulpstoffen*	nonylfenol-polyethoxyethanol	61			
Greenhouse vegetables	*Hulpstoffen*	nonylfenol-polyethoxyethanol	121			
Outdoor vegetables	*Hulpstoffen*	nonylfenol-polyethoxyethanol	1 606			
Fruits	*Hulpstoffen*	nonylfenol-polyethoxyethanol	293			
Greenhouse vegetables	*other applications*	nonylfenol-	9			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	*Type of pesticide*	Active compound	use of pesticides (kg)			
		polyethoxyethanol				
				12 142		
Greenhouse flowers	*Insecticides*	omethoaat	779			
tree nursery products	*Insecticides*	omethoaat	106			
Fruits	*Insecticides*	omethoaat	104			
				988		
arable crops	*soil disinfection*	oxamyl	5 132			
Greenhouse flowers	*soil disinfection*	oxamyl	305			
Greenhouse vegetables	*soil disinfection*	oxamyl	21			
Outdoor vegetables	*soil disinfection*	oxamyl	266			
Flower bulbs	*Insecticides*	oxamyl	670			
Greenhouse flowers	*Insecticides*	oxamyl	150			
Greenhouse vegetables	*Insecticides*	oxamyl	244			
				6 789	6 789	2.75E-03
arable crops	*Insecticides*	oxy-demeton-methyl	437			
Greenhouse flowers	*Insecticides*	oxy-demeton-methyl	52			
tree nursery products	*Insecticides*	oxy-demeton-methyl	13			
Outdoor vegetables	*Insecticides*	oxy-demeton-methyl	1 008			
				1 511	1 511	6.12E-04
Greenhouse flowers	*other applications*	paclobutrazol	6			
arable crops	*Herbicides*	paraquat-dichloride	11 546			
Flower bulbs	*Herbicides*	paraquat-dichloride	1 873			
Greenhouse flowers	*Herbicides*	paraquat-dichloride	187			
tree nursery products	*Herbicides*	paraquat-dichloride	2 143			
Greenhouse vegetables	*Herbicides*	paraquat-dichloride	3			
Outdoor vegetables	*Herbicides*	paraquat-dichloride	875			
Fruits	*Herbicides*	paraquat-dichloride	405			
				17 032		
Greenhouse flowers	*soil disinfection*	parathion (ethyl)	321			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)						
Sector	*Type of pesticide*	Active compound	use of pesticides (kg)			
arable crops	*Insecticides*	parathion (ethyl)	6 590			
Flower bulbs	*Insecticides*	parathion (ethyl)	164			
Greenhouse flowers	*Insecticides*	parathion (ethyl)	2 322			
tree nursery products	*Insecticides*	parathion (ethyl)	277			
Outdoor vegetables	*Insecticides*	parathion (ethyl)	1 634			
				11 308	11 308	4.58E-03
Greenhouse flowers	*Insecticides*	parathion-methyl	37			
tree nursery products	*Insecticides*	parathion-methyl	39			
				76	76	3.09E-05
Greenhouse flowers	*Fungicides*	penconazool	200			
Outdoor vegetables	*Fungicides*	penconazool	128			
				328		
arable crops	*Fungicides*	pencycuron	61 783			
arable crops	*Herbicides*	pendimethalin	7 347			
Outdoor vegetables	*Herbicides*	pendimethalin	165			
				7 512		
Greenhouse flowers	*Insecticides*	permethrin	372			
tree nursery products	*Insecticides*	permethrin	65			
Champignons	*Insecticides*	permethrin	6			
Outdoor vegetables	*Insecticides*	permethrin	244			
				687	687	2.78E-04
arable crops	*Insecticides*	pirimicarb	5 472			
Flower bulbs	*Insecticides*	pirimicarb	1 819			
Greenhouse flowers	*Insecticides*	pirimicarb	407			
tree nursery products	*Insecticides*	pirimicarb	177			
Greenhouse vegetables	*Insecticides*	pirimicarb	546			
Outdoor vegetables	*Insecticides*	pirimicarb	1 161			
Fruits	*Insecticides*	pirimicarb	1 770			
				11 352	11 352	4.60E-03

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Flower bulbs	*Insecticides*	pirimifos-methyl	1 534			
Greenhouse flowers	*Insecticides*	pirimifos-methyl	424			
tree nursery products	*Insecticides*	pirimifos-methyl	45			
				2 003		
Flower bulbs	*Hulpstoffen*	polyvinylacetaat	1 327			
Flower bulbs	*other disinfection*	prochloraz	12 438			
Greenhouse flowers	*other disinfection*	prochloraz	107			
arable crops	*Fungicides*	prochloraz	4 471			
Flower bulbs	*Fungicides*	prochloraz	15 888			
Greenhouse flowers	*Fungicides*	prochloraz	390			
tree nursery products	*Fungicides*	prochloraz	24			
Champignons	*Fungicides*	prochloraz	373			
				33 693		
Flower bulbs	*other disinfection*	procymidon	565			
arable crops	*Fungicides*	procymidon	1 050			
Flower bulbs	*Fungicides*	procymidon	6 236			
Greenhouse flowers	*Fungicides*	procymidon	259			
tree nursery products	*Fungicides*	procymidon	26			
Greenhouse vegetables	*Fungicides*	procymidon	174			
				8 311		
Flower bulbs	*Herbicides*	profam	51			
arable crops	*other applications*	profam	1 101			
				1 152		
Outdoor vegetables	*Herbicides*	prometryn	711			
arable crops	*Herbicides*	propachloor	59 122			
tree nursery products	*Herbicides*	propachloor	219			
Outdoor vegetables	*Herbicides*	propachloor	2 376			
				61 717	61 717	2.50E-02
Flower bulbs	*other disinfection*	propamocarb-	2 284			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	*Type of pesticide*	Active compound	use of pesticides (kg)			
		hydrochloride				
tree nursery products	*other disinfection*	propamocarb-hydrochloride	6			
arable crops	*Fungicides*	propamocarb-hydrochloride	177 069			
Greenhouse flowers	*Fungicides*	propamocarb-hydrochloride	2 608			
tree nursery products	*Fungicides*	propamocarb-hydrochloride	289			
Greenhouse vegetables	*Fungicides*	propamocarb-hydrochloride	7 187			
Outdoor vegetables	*Fungicides*	propamocarb-hydrochloride	6 274			
				195 716		
arable crops	*Fungicides*	propiconazool	5 235			
tree nursery products	*Fungicides*	propiconazool	115			
Outdoor vegetables	*Fungicides*	propiconazool	117			
				5 467		
Flower bulbs	*Insecticides*	propoxur	627			
Greenhouse flowers	*Insecticides*	propoxur	478			
tree nursery products	*Insecticides*	propoxur	245			
Greenhouse vegetables	*Insecticides*	propoxur	26			
Outdoor vegetables	*Insecticides*	propoxur	1 016			
Fruits	*Insecticides*	propoxur	2 258			
				4 649	4 649	1.88E-03
arable crops	*Herbicides*	propyzamide	3 157			
tree nursery products	*Herbicides*	propyzamide	57			
Outdoor vegetables	*Herbicides*	propyzamide	3 326			
				6 540		

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
arable crops	*Herbicides*	prosulfocarb	76 937			
Greenhouse flowers	*Insecticides*	pyrazofos	36			
arable crops	*Fungicides*	pyrazofos	5 141			
Greenhouse flowers	*Fungicides*	pyrazofos	79			
tree nursery products	*Fungicides*	pyrazofos	211			
Outdoor vegetables	*Fungicides*	pyrazofos	231			
				5 698	5 698	2.31E-03
arable crops	*Herbicides*	pyridaat	57 252			
tree nursery products	*Herbicides*	pyridaat	19			
Outdoor vegetables	*Herbicides*	pyridaat	1 248			
				58 519		
Greenhouse flowers	*Insecticides*	pyridaben	114			
Greenhouse vegetables	*Insecticides*	pyridaben	169			
				282		
Outdoor vegetables	*Fungicides*	pyrifenox	1 118			
Fruits	*Fungicides*	pyrifenox	183			
				6 986		
Outdoor vegetables	*Fungicides*	pyrimethanil	716			
Fruits	*Fungicides*	pyrimethanil	6 270			
				1 301		
Greenhouse flowers	*Insecticides*	pyriproxyfen	77			
Greenhouse vegetables	*Insecticides*	pyriproxyfen	213			
				290		
arable crops	*Herbicides*	quizalofop-ethyl	426			
arable crops	*Herbicides*	quizalofop-P-ethyl	605			
arable crops	*Herbicides*	rimsulfuron	642			
arable crops	*Herbicides*	sethoxydim	860			
Outdoor vegetables	*Herbicides*	sethoxydim	341			
				1 201		

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Flower bulbs	*Herbicides*	simazin	573			
Greenhouse flowers	*Herbicides*	simazin	71			
tree nursery products	*Herbicides*	simazin	3 244			
Outdoor vegetables	*Herbicides*	simazin	1 688			
Fruits	*Herbicides*	simazin	4 257			
				9 834	9 834	3.98E-03
arable crops	*Herbicides*	sulcotrion	37 612			
Greenhouse flowers	*Insecticides*	sulfotep	69			
Champignons	*Insecticides*	sulfotep	14			
				82		
arable crops	*Fungicides*	tebuconazool	2 246			
Outdoor vegetables	*Fungicides*	tebuconazool	1 498			
				3 744		
tree nursery products	*Insecticides*	tebufenpyrad	9			
Fruits	*Insecticides*	tebufenpyrad	166			
				175		
Greenhouse flowers	*Insecticides*	teflubenzuron	372			
Greenhouse vegetables	*Insecticides*	teflubenzuron	618			
				990		
arable crops	*Herbicides*	terbutryn	3 269			
arable crops	*Herbicides*	terbutylazin	3 288			
Flower bulbs	*other disinfection*	thiabendazool	1 235			
Greenhouse flowers	*other applications*	thiabendazool	2			
arable crops	*Fungicides*	thiabendazool	1 444			
				2 681		
Greenhouse flowers	*other applications*	thiodicarb	15			
tree nursery products	*other applications*	thiodicarb	11			
				26		
arable crops	*other disinfection*	thiofanaat-methyl	510			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)						
Sector	*Type of pesticide*	Active compound	use of pesticides (kg)			
Flower bulbs	*other disinfection*	thiofanaat-methyl	1 755			
tree nursery products	*other disinfection*	thiofanaat-methyl	2			
arable crops	*Fungicides*	thiofanaat-methyl	322			
Flower bulbs	*Fungicides*	thiofanaat-methyl	171			
Greenhouse flowers	*Fungicides*	thiofanaat-methyl	1 148			
tree nursery products	*Fungicides*	thiofanaat-methyl	252			
Champignons	*Fungicides*	thiofanaat-methyl	316			
Greenhouse vegetables	*Fungicides*	thiofanaat-methyl	550			
Fruits	*Fungicides*	thiofanaat-methyl	676			
				5 703		
arable crops	*Insecticides*	thiometon	351			
tree nursery products	*Insecticides*	thiometon	10			
Outdoor vegetables	*Insecticides*	thiometon	2 689			
				3 050		
tree nursery products	*other disinfection*	thiram	7			
Greenhouse flowers	*Fungicides*	thiram	946			
tree nursery products	*Fungicides*	thiram	618			
Greenhouse vegetables	*Fungicides*	thiram	522			
Outdoor vegetables	*Fungicides*	thiram	1 334			
Fruits	*Fungicides*	thiram	7 245			
				10 672	10 672	4.32E-03
Flower bulbs	*other disinfection*	tolclofos-methyl	1 510			
Flower bulbs	*Fungicides*	tolclofos-methyl	9 163			
Greenhouse flowers	*Fungicides*	tolclofos-methyl	3 268			
tree nursery products	*Fungicides*	tolclofos-methyl	391			
				14 332	14 332	5.80E-03
Flower bulbs	*other disinfection*	tolylfluanide	1 528			
Greenhouse flowers	*Fungicides*	tolylfluanide	1 048			
tree nursery products	*Fungicides*	tolylfluanide	78			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)						
Sector	*Type of pesticide*	Active compound	use of pesticides (kg)			
Greenhouse vegetables	*Fungicides*	tolylfluanide	4 497			
Outdoor vegetables	*Fungicides*	tolylfluanide	5 138			
Fruits	*Fungicides*	tolylfluanide	53 182			
				65 470		
arable crops	*Fungicides*	triadimenol	1 122			
tree nursery products	*Fungicides*	triadimenol	19			
Fruits	*Fungicides*	triadimenol	838			
				1 979		
arable crops	*Herbicides*	tri-allaat	7 851		7 851	3.18E-03
Greenhouse flowers	*Insecticides*	triazamaat	151			
tree nursery products	*Insecticides*	triazamaat	14			
				165		
tree nursery products	*Insecticides*	triazofos	175		175	7.08E-05
Greenhouse flowers	*Fungicides*	triflumizool	113			
Greenhouse vegetables	*Fungicides*	triflumizool	482			
				595		
arable crops	*Herbicides*	triflusulfuron-methyl	1 464			
Greenhouse flowers	*Fungicides*	triforine	211			
tree nursery products	*Fungicides*	triforine	33			
Outdoor vegetables	*Fungicides*	triforine	487			
				731		
arable crops	*other applications*	trinexapac-ethyl	2 353			
arable crops	*Fungicides*	validamycine	699			
tree nursery products	*Insecticides*	vamidothion	59			
Fruits	*Insecticides*	vamidothion	2 686			
				2 745		
Greenhouse flowers	*Herbicides*	verzadigde vetzuren	62			
Flower bulbs	*other disinfection*	vinchlozolin	1 439			
arable crops	*Fungicides*	vinchlozolin	4 303			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	Type of pesticide	Active compound	use of pesticides (kg)			
Flower bulbs	*Fungicides*	vinchlozolin	3 583			
Greenhouse flowers	*Fungicides*	vinchlozolin	339			
tree nursery products	*Fungicides*	vinchlozolin	132			
Outdoor vegetables	*Fungicides*	vinchlozolin	6 413			
				16 209		
tree nursery products	*Insecticides*	xylenol	8			
arable crops	*Fungicides*	zineb	120 757			
Flower bulbs	*Fungicides*	zineb	14 787			
Greenhouse flowers	*Fungicides*	zineb	199			
tree nursery products	*Fungicides*	zineb	393			
Outdoor vegetables	*Fungicides*	zineb	928			
				137 065	137 065	5.55E-02
tree nursery products	*other applications*	ziram	4			
Outdoor vegetables	*other applications*	ziram	227			
Fruits	*other applications*	ziram	69			
				300		
Fruits	*Insecticides*	zwavel	126			
Greenhouse flowers	*Fungicides*	zwavel	20 804			
tree nursery products	*Fungicides*	zwavel	2 033			
Greenhouse vegetables	*Fungicides*	zwavel	37 839			
Outdoor vegetables	*Fungicides*	zwavel	12 379			
Fruits	*Fungicides*	zwavel	36 882			
				110 062		
Data for 1995						
bulbs	Fungicides	formaldehyde	13 521			
vegetables under glass	Other disinfection (like greenhouses)	formaldehyde	61 065			
bulbs	Propagating-	formaldehyde	15 559			

Appendix 1: pesticides use (kg active compounds) per active compound per application area per sector, 1998,Netherlands (CBS)

Sector	*Type of pesticide*	Active compound	use of pesticides (kg)			
	materialprotection (mainly desinfection of bulbs in flower bulbs and tubers)					
vegetables under glass	Propagating-materialprotection (mainly desinfection of bulbs in flower bulbs and tubers)	formaldehyde	57			
		total		90 202	90 202	3.65E-02
		TOTAL	**6111 432**		**2469 343**	**1**

marked = characterisation factor is available

data for formaldehyde are for the year 1995

Appendix 2 Cradle-to-grave per kilogram contribution of materials to 13 environmental impact categories.

Table 1 Depletion of abiotic resources, land use competition and climate change

depletion of abiotic resources		Land use competition		climate change	
[C1] ADP (Guinee et al. 2001)		[C2] LUC (Guinee et al, 2001), m2*yr		[C3] GWP100 (Houghton et al., kg CO2 eq., 2001)	
rhodium	204	rhodium	403	rhodium	2.65E+04
platinum	91.1	platinum	216	platinum	1.39E+04
palladium	16.8	palladium	112	palladium	3.90E+03
lead hard	0.823	animal products (meat, milk, eggs, ...)	1.4	refrigerant R22	94.4
nickel	0.054	biomass for human food	1.01	refrigerant R134a	66.8
chromium	0.0426	crop or grass	0.611	PUR	16.2
aluminium 0% rec	0.0389	manganese	0.526	chromium	15.5
zinc additive to fodder	0.0277	nickel	0.508	nickel	15.1
zinc in building materials	0.0277	chromium	0.403	aluminium 0% rec	13.1
steel (high alloyed)	0.0274	aluminium 0% rec	0.395	PC	8.07
manganese	0.0273	PUR	0.24	PVC	6.33
cast iron	0.0265	copper in building materials	0.227	PET 0% rec	6.24
raw iron	0.0202	copper additive to fodder	0.226	PS (polystyrene)	6.13
steel (light alloyed)	0.0183	zinc in building materials	0.198	steel (high alloyed)	6
"blas stahl"	0.0181	zinc additive to fodder	0.197	PE (LD)	5.92
copper additive to fodder	0.016	refrigerant R22	0.166	PP	5.88
copper in building materials	0.0159	steel (high alloyed)	0.16	hydrogen	5.53
steel (not alloyed)	0.0156	PVC	0.148	Al2O3	5.43
PUR	0.0153	Al2O3	0.131	copper additive to fodder	5.43
lead	0.0114	Rubber	0.125	copper in building materials	5.42
PVC	0.0104	vinylchloride	0.121	manganese	5.39
refrigerant R22	0.0104	chemicals organic	0.102	PE (HD)	5.39
soda	0.00835	hydrogen	0.093	phenol	4.98
Al2O3	0.00784	refrigerant R134a	0.0874	zinc additive to fodder	4.95
rubber	0.00781	HF	0.0833	zinc in building materials	4.95
vinylchloride	0.00781	zeolith	0.0804	cast iron	4.28
zeolith	0.00766	bariet	0.0711	vinylchloride	3.47
chemicals organic	0.00668	board (karton)	0.0702	Rubber	3.21
rockwool	0.00594	PP	0.0678	styrene	2.64
refrigerant R134a	0.00489	lead hard	0.0668	ethylene oxide	2.62
PP	0.00442	HCl	0.0662	zeolith	2.59
HF	0.0044	PET 0% rec	0.0662	steel (light alloyed)	2.23
HCl	0.00438	chlorine	0.0649	ethylene	2.18
chlorine	0.0043	NaOH	0.0649	explosives	2.16
NaOH	0.0043	PC	0.0556	raw iron	2.06
hydrogen	0.00417	cast iron	0.0553	paper	2.01
PET 0% rec	0.00408	PE (LD)	0.0552	"blas stahl"	1.99
PE (LD)	0.00332	PS (polystyrene)	0.0538	chemicals organic	1.9
PS (polystyrene)	0.00324	paper	0.0481	steel (not alloyed)	1.81

depletion of abiotic resources		Land use competition		climate change	
[C1] ADP (Guinee et al. 2001)		[C2] LUC (Guinee et al, 2001), m2*yr		[C3] GWP100 (Houghton et al., kg CO2 eq., 2001)	
PC	0.00303	steel (light alloyed)	0.0477	NH3	1.76
paper	0.00272	steel (not alloyed)	0.0385	HF	1.7
CaO	0.00227	PE (HD)	0.0367	lead hard	1.61
glass (coated)	0.00225	ethylene oxide	0.0346	potassium nitrate (KNO3)	1.51
PE (HD)	0.00216	H3PO4	0.0325	ureum	1.43
cement	0.00215	lead	0.032	CaO	1.38
glass (not coated)	0.0021	electro steel	0.0312	rockwool	1.29
aluminium 100% rec	0.00205	aluminium 100% rec	0.0285	calcium ammonium nitrate	1.24
electro steel	0.002	raw iron	0.0283	paraxylol	1.21
ethylene oxide	0.00199	"blas stahl"	0.0266	H3PO4	1.16
urea	0.0019	phenol	0.0242	lead	1.15
H3PO4	0.00185	rockwool	0.0224	soda	1.11
board (karton)	0.0018	TSP (triple super phosphate)	0.0219	aluminium 100% rec	1.08
Ca(OH)2	0.00172	styrene	0.0211	Ca(OH)2	1.05
TSP (triple super phoshate)	0.00147	glass (coated)	0.0195	HCl	0.892
UAN	0.00133	ethylene	0.0185	chlorine	0.874
nitro AP (52% P2O5, 8.4% N)	0.00129	SSP (single super phosphate)	0.0178	NaOH	0.874
DAP (46% P2O5)	0.00123	explosives	0.0176	animal products (meat, milk, eggs, ...)	0.857
SSP (single super phosphate)	0.0012	glass (not coated)	0.0171	glass (coated)	0.808
phenol	0.00118	ureum	0.0168	glass (not coated)	0.778
styrene	0.00109	nitro AP (52% P2O5, 8.4% N)	0.0165	biomass for human food	0.776
MAP mono ammonium phosphate	0.00108	NH3	0.0148	NPK 15-15-15 fertiliser (mixed acid route)	0.753
ethylene	0.000956	formaldehyde	0.0137	UAN	0.736
ammonium phosphate (49% P2O5, 11% N)	0.000948	soda	0.0119	MAP (mono ammonium phosphate)	0.725
calcium ammonium nitrate	0.00092	urea	0.0117	TSP (triple super phoshate)	0.724
bariet	0.000913	H2SO4	0.0115	NPK 15-15-15 fertiliser (nitrophospahate route)	0.703
ureum	0.000862	MAP (mono ammonium phosphate)	0.0113	DAP (diammonium phosphate)	0.677
explosives	0.000811	chemicals anorganic	0.0109	ammonium phosphate (49% P2O5, 11% N)	0.66
NPK 15-15-15 fertiliser (nitrophospahate route)	0.000807	PK-22-22-fertiliser	0.0109	chemicals anorganic	0.64
PK-22-22-fertiliser	0.000727	DAP (diammonium phosphate)	0.0108	HNO3	0.612
animal products (meat, milk, eggs, ...)	0.000718	paraxylol	0.0106	formaldehyde	0.592
NPK 15-15-15 fertiliser (mixed acid route)	0.000698	bentonite	0.01	board (karton)	0.52

depletion of abiotic resources		Land use competition		climate change	
[C1] ADP (Guinee et al. 2001)		[C2] LUC (Guinee et al, 2001), m2*yr		[C3] GWP100 (Houghton et al., kg CO2 eq., 2001)	
H2SO4	0.00066	FeSO4	0.00928	cement	0.402
NH3	0.000651	ammonium phosphate (49% P2O5, 11% N)	0.00921	electro steel	0.396
chemicals anorganic	0.000624	ceramic	0.0088	nitro AP (52% P2O5, 8.4% N)	0.379
biomass for human food	6.14E-04	cement	0.00859	ceramic	0.371
FeSO4	0.000609	gypsum	0.00856	PK-22-22-fertiliser	0.351
crop or grass	0.000509	UAN	0.00798	SSP (single super phosphate)	0.299
paraxylol	0.000481	CaO	0.00679	gypsum	0.258
ceramic	0.000338	concrete	0.00679	H2SO4	0.244
concrete	0.000285	NPK 15-15-15 fertiliser (nitrophospahate route)	0.00647	Sulphur (secundairy)	0.235
NaCl	0.000254	gravel (concrete)	0.0059	bariet	0.178
HNO3	0.000249	sand (construction)	0.00586	bentonite	0.14
formaldehyde	0.00022	gypsum (raw stone)	0.00579	FeSO4	0.118
gypsum	0.000121	HNO3	0.00578	NaCl	0.0995
bentonite	4.28E-05	Ca(OH)2	0.00514	concrete	0.0649
sulphur (secundairy)	2.38E-05	NPK 15-15-15 fertiliser (mixed acid route)	0.00448	gravel (concrete)	0.011
limestone	1.49E-05	calcium ammonium nitrate	0.00363	sand (construction)	0.0105
gravel (concrete)	1.11E-05	NaCl	0.00301	limestone	0.00698
sand (construction)	8.80E-06	limestone	0.00171	gypsum (raw stone)	0.00612
gypsum (raw stone)	5.96E-06	clay_loam	0.00144	clay_loam	0.00179
clay_loam	3.12E-06	Sulphur (secundairy)	0.000548	water (Demineralised)	0.000556
water (Demineralised)	2.67E-06	water (Demineralised)	4.13E-05	water (decarbonated)	1.88E-05
water (decarbonated)	4.77E-08	water (decarbonated)	1.23E-06	animal manure	0
animal manure	0	animal manure	0	calcium nitrate	0
calcium nitrate	0	calcium nitrate	0	crop or grass	0
pesticides	0	pesticides	0	pesticides	0
potassium nitrate (KNO3)	-0.00109	potassium nitrate (KNO3)	-0.0205	urea	-0.0717

Table 2 Stratospheric ozone layer depletion, human toxicity and fresh water ecotoxicity

stratospheric ozone depletion		human toxicity		fresh water ecotocicity	
[C8] ODP steady state (WMO, 1992 & 1995 & 1999)		[C16] HTP inf. (Huijbregts, 1999 & 2000)		[C17] FAETP inf. (Huijbregts, 1999 & 2000)	
rhodium	0.00254	rhodium	5.17E+04	rhodium	3.64E+03
refrigerant R22	0.00183	platinum	2.92E+04	platinum	1.95E+03
platinum	0.00136	palladium	1.78E+04	pesticides	1.31E+03
palladium	0.000664	lead	186	palladium	623
PVC	0.00041	pesticides	136	copper additive to fodder	590
vinylchloride	0.000401	zinc additive to fodder	110	zinc additive to fodder	48.5
phenol	1.14E-05	copper additive to fodder	96.3	nickel	16.3
PET 0% rec	1.05E-05	ethylene oxide	48.5	Al2O3	1.71
nickel	9.07E-06	zinc in building materials	46.4	bariet	1.27
PP	8.58E-06	PET 0% rec	36.5	zinc in building materials	1.04
PS (polystyrene)	8.49E-06	nickel	18	chromium	0.742
PE (LD)	8.32E-06	chromium	6.02	aluminium 0% rec	0.642
PC	8.30E-06	aluminium 0% rec	5.48	animal products (meat, milk, eggs, ...)	0.623
styrene	8.20E-06	PUR	4.34	biomass for human food	0.572
chromium	8.00E-06	steel (high alloyed)	4.29	crop or grass	0.521
Rubber	7.93E-06	PC	3.79	steel (high alloyed)	0.477
ethylene oxide	7.88E-06	PS (polystyrene)	3.71	PUR	0.465
PE (HD)	7.66E-06	bariet	3.52	cast iron	0.44
ethylene	7.30E-06	PE (LD)	3.49	PET 0% rec	0.355
aluminium 0% rec	6.73E-06	PP	3.46	lead	0.344
Al2O3	6.01E-06	PE (HD)	3.22	PP	0.328
paraxylol	5.97E-06	styrene	3.22	PE (LD)	0.312
PUR	4.44E-06	cast iron	2.75	PC	0.298
hydrogen	4.22E-06	phenol	2.62	raw iron	0.288
copper additive to fodder	3.35E-06	copper in building materials	2.26	PE (HD)	0.284
copper in building materials	3.35E-06	ethylene	2.12	"blas stahl"	0.268
steel (high alloyed)	2.84E-06	PVC	2.01	manganese	0.268
manganese	2.33E-06	lead hard	2	steel (light alloyed)	0.267
cast iron	2.32E-06	Rubber	2	steel (not alloyed)	0.225
zinc additive to fodder	1.66E-06	hydrogen	1.83	PS (polystyrene)	0.189
zinc in building materials	1.66E-06	vinylchloride	1.67	hydrogen	0.186
refrigerant R134a	1.49E-06	manganese	1.66	PVC	0.171
explosives	1.45E-06	steel (light alloyed)	1.63	copper in building materials	0.168
zeolith	1.43E-06	"blas stahl"	1.62	phenol	0.149
chemicals organic	1.41E-06	raw iron	1.52	Rubber	0.149
HCl	1.16E-06	refrigerant R22	1.42	refrigerant R22	0.137
chlorine	1.13E-06	HF	1.39	vinylchloride	0.122

stratospheric ozone depletion		human toxicity		fresh water ecotocicity	
[C8] ODP steady state (WMO, 1992 & 1995 & 1999)		[C16] HTP inf. (Huijbregts, 1999 & 2000)		[C17] FAETP inf. (Huijbregts, 1999 & 2000)	
NaOH	1.13E-06	steel (not alloyed)	1.37	zeolith	0.12
H3PO4	9.85E-07	refrigerant R134a	1.31	soda	0.115
lead hard	9.54E-07	Al2O3	1.25	ethylene oxide	0.101
paper	9.30E-07	zeolith	0.832	styrene	0.0896
urea	8.34E-07	explosives	0.673	ethylene	0.0865
MAP (mono ammonium phosphate)	8.11E-07	chemicals organic	0.631	chemicals organic	0.0858
DAP (diammonium phosphate)	7.85E-07	H3PO4	0.533	rockwool	0.0807
HF	7.79E-07	paper	0.498	paper	0.0796
chemicals anorganic	7.73E-07	paraxylol	0.432	refrigerant R134a	0.0663
ammonium phosphate (49% P2O5, 11% N)	7.57E-07	soda	0.427	explosives	0.0627
board (karton)	6.86E-07	rockwool	0.381	lead hard	0.0618
TSP (triple super phoshate)	6.68E-07	chemicals anorganic	0.353	HF	0.0585
ureum	6.02E-07	ceramic	0.343	H3PO4	0.0513
steel (light alloyed)	5.95E-07	HCl	0.284	HCl	0.0448
rockwool	5.24E-07	chlorine	0.279	chlorine	0.044
lead	4.62E-07	NaOH	0.279	NaOH	0.044
steel (not alloyed)	4.53E-07	ureum	0.273	board (karton)	0.0381
"blas stahl"	4.52E-07	board (karton)	0.208	chemicals anorganic	0.0353
raw iron	4.38E-07	glass (coated)	0.204	CaO	0.0312
UAN	3.95E-07	glass (not coated)	0.195	glass (coated)	0.0297
nitro AP (52% P2O5, 8.4% N)	3.41E-07	aluminium 100% rec	0.194	paraxylol	0.0295
Sulphur (secundairy)	3.36E-07	electro steel	0.19	ureum	0.0285
PK-22-22-fertiliser	3.19E-07	CaO	0.182	cement	0.0283
NPK 15-15-15 fertiliser (mixed acid route)	3.15E-07	Ca(OH)2	0.138	glass (not coated)	0.0282
potassium nitrate (KNO3)	3.03E-07	urea	0.131	aluminium 100% rec	0.0254
aluminium 100% rec	2.56E-07	cement	0.121	urea	0.0252
NH3	1.99E-07	animal products (meat, milk, eggs, ...)	0.118	formaldehyde	0.0238
SSP (single super phosphate)	1.96E-07	TSP (triple super phosphate)	0.108	Ca(OH)2	0.0236
formaldehyde	1.90E-07	biomass for human food	0.103	electro steel	0.0204
calcium ammonium nitrate	1.89E-07	Sulphur (secundairy)	0.0981	UAN	0.0171
bentonite	1.87E-07	DAP (diammonium phosphate)	0.0924	TSP (triple super phosphate)	0.0147
NPK 15-15-15 fertiliser (nitrophospahate route)	1.87E-07	crop or grass	0.0869	DAP (diammonium phosphate)	0.0143
electro steel	1.69E-07	MAP (mono ammonium phosphate)	0.0867	nitro AP (52% P2O5, 8.4% N)	0.0139
animal products (meat, milk, eggs, ...)	1.55E-07	UAN (urea ammonium nitrate)	0.0855	calcium ammonium nitrate	0.012
glass (coated)	1.43E-07	nitro AP (52% P2O5,	0.0852	MAP (mono ammonium	0.012

stratospheric ozone depletion		human toxicity		fresh water ecotocicity	
[C8] ODP steady state (WMO, 1992 & 1995 & 1999)		[C16] HTP inf. (Huijbregts, 1999 & 2000)		[C17] FAETP inf. (Huijbregts, 1999 & 2000)	
		8.4% N)		phosphate)	
soda	1.35E-07	NH3	0.0851	SSP (single super phosphate)	0.0115
glass (not coated)	1.31E-07	bentonite	0.0827	ammonium phosphate (49% P2O5, 11% N)	0.0107
biomass for human food	1.30E-07	ammonium phosphate (49% P2O5, 11% N)	0.0772	NH3	0.00986
crop or grass	1.04E-07	SSP (single super phosphate)	0.0748	NPK 15-15-15 fertiliser (nitrophospahate route)	0.00973
cement	9.91E-08	calcium ammonium nitrate	0.0563	NPK 15-15-15 fertiliser (mixed acid route)	0.00862
gypsum	9.88E-08	PK-22-22-fertiliser	0.0534	Sulphur (secundairy)	0.00848
CaO	8.09E-08	NPK 15-15-15 fertiliser (nitrophospahate route)	0.0512	bentonite	0.00785
bariet	7.44E-08	NPK 15-15-15 fertiliser (mixed acid route)	0.0487	PK-22-22-fertiliser	0.00732
HNO3	6.89E-08	H2SO4	0.0448	H2SO4	0.00668
H2SO4	6.68E-08	FeSO4	0.0369	FeSO4	0.00596
Ca(OH)2	6.13E-08	NaCl	0.0349	NaCl	0.00463
NaCl	6.12E-08	HNO3	0.0316	ceramic	0.00402
FeSO4	4.91E-08	formaldehyde	0.0298	concrete	0.00374
ceramic	4.90E-08	concrete	0.018	HNO3	0.00351
concrete	3.19E-08	gypsum	0.0154	gypsum	0.0015
gravel (concrete)	1.32E-08	limestone	0.00163	limestone	0.000202
sand (construction)	1.30E-08	gypsum (raw stone)	0.0015	gravel (concrete)	0.000152
gypsum (raw stone)	7.21E-09	gravel (concrete)	0.00145	sand (construction)	0.00013
limestone	6.07E-09	sand (construction)	0.00132	gypsum (raw stone)	8.80E-05
clay_loam	1.90E-09	clay_loam	0.000289	clay_loam	3.66E-05
water (Demineralised)	7.15E-10	water (Demineralised)	0.000176	water (Demineralised)	2.98E-05
water (decarbonated)	1.76E-11	water (decarbonated)	4.46E-06	water (decarbonated)	2.77E-06
animal manure	0	animal manure	0	animal manure	0
calcium nitrate	0	calcium nitrate	0	calcium nitrate	0
pesticides	0	potassium nitrate (KNO3)	-0.0415	potassium nitrate (KNO3)	-0.00813

Table 3 Marine ecotoxicity, terrestrial ecotoxicity and photochemical oxidant formation

marine ecotoxicity		terrestrial ecotoxicity		photochemical oxidant formation	
[C18] MAETP inf. (Huijbregts, 1999 & 2000)		[C21] TETP inf.(Huijbregts, 1999 & 2000)		[C40] POCP (Jenkin & Hayman, 1999; Derwent et al. 1998; high Nox)	
rhodium	4.02E+07	rhodium	215	rhodium	326
platinum	2.12E+07	platinum	119	platinum	185
palladium	5.42E+06	palladium	61.6	palladium	125
copper additive to fodder	1.23E+05	pesticides	52.4	nickel	0.122
aluminium 0% rec	2.98E+04	zinc additive to fodder	25.6	steel (high alloyed)	0.0177
chromium	2.63E+04	copper additive to fodder	14	PE (HD)	0.0176
nickel	2.39E+04	lead	1.64	Rubber	0.0108
zinc additive to fodder	1.27E+04	zinc in building materials	0.559	copper additive to fodder	0.00701
HF	1.13E+04	nickel	0.165	copper in building materials	0.00699
refrigerant R134a	9.23E+03	chromium	0.1	chromium	0.00504
steel (high alloyed)	7.11E+03	PE (LD)	0.0912	PE (LD)	0.00405
refrigerant R22	6.91E+03	PE (HD)	0.0845	Al2O3	0.00393
manganese	5.90E+03	aluminium 0% rec	0.0762	aluminium 0% rec	0.00378
PUR	5.80E+03	PUR	0.0716	PUR	0.00323
zinc in building materials	5.56E+03	hydrogen	0.0627	Sulphur (secundairy)	0.00297
bariet	4.76E+03	phenol	0.0561	PP	0.00292
ceramic	4.58E+03	PP	0.0542	hydrogen	0.00281
Al2O3	3.30E+03	PC	0.0532	PET 0% rec	0.00236
copper in building materials	2.85E+03	refrigerant R22	0.0499	rockwool	0.00236
PVC	2.68E+03	steel (high alloyed)	0.0441	explosives	0.00234
PE (LD)	2.64E+03	PET 0% rec	0.0426	cast iron	0.00232
cast iron	2.51E+03	cast iron	0.0408	phenol	0.00221
zeolith	2.40E+03	PVC	0.0403	PC	0.00219
Rubber	2.33E+03	PS (polystyrene)	0.0359	zinc additive to fodder	0.00219
PE (HD)	2.27E+03	vinylchloride	0.034	zinc in building materials	0.00219
PP	2.18E+03	ethylene oxide	0.0336	lead hard	0.00195
vinylchloride	2.13E+03	styrene	0.0324	manganese	0.00191
hydrogen	2.09E+03	ethylene	0.0313	HF	0.00185
PET 0% rec	1.87E+03	Rubber	0.0311	refrigerant R22	0.00179
steel (light alloyed)	1.80E+03	animal products (meat, milk, eggs, ...)	0.0261	PS (polystyrene)	0.00171
PC	1.74E+03	biomass for human food	0.0236	refrigerant R134a	0.00166
chemicals organic	1.63E+03	manganese	0.0228	PVC	0.00162
phenol	1.60E+03	explosives	0.0223	ethylene oxide	0.0016
PS (polystyrene)	1.54E+03	crop or grass	0.0211	styrene	0.00153

marine ecotoxicity		terrestrial ecotoxicity		photochemical oxidant formation	
[C18] MAETP inf. (Huijbregts, 1999 & 2000)		[C21] TETP inf.(Huijbregts, 1999 & 2000)		[C40] POCP (Jenkin & Hayman, 1999; Derwent et al. 1998; high Nox)	
H3PO4	1.50E+03	lead hard	0.021	ethylene	0.00146
raw iron	1.43E+03	HCl	0.0204	steel (light alloyed)	0.00143
"blas stahl"	1.39E+03	Al2O3	0.0201	"blas stahl"	0.0014
steel (not alloyed)	1.35E+03	chlorine	0.02	vinylchloride	0.00132
ethylene oxide	1.23E+03	NaOH	0.02	steel (not alloyed)	0.0012
glass (coated)	1.22E+03	electro steel	0.0197	raw iron	0.00109
glass (not coated)	1.19E+03	zeolith	0.019	H3PO4	0.00108
styrene	1.03E+03	copper in building materials	0.0155	zeolith	0.000997
ethylene	975	paper	0.0145	paper	0.000693
HCl	949	H3PO4	0.0144	chemicals organic	0.000683
lead hard	934	refrigerant R134a	0.0141	ureum	0.000645
chlorine	930	chemicals organic	0.0137	MAP (mono ammonium phosphate)	0.000642
NaOH	930	chemicals anorganic	0.0119	NH3	0.000628
lead	879	steel (not alloyed)	0.0113	formaldehyde	0.000601
rockwool	837	steel (light alloyed)	0.0108	ammonium phosphate (49% P2O5, 11% N)	0.000598
aluminium 100% rec	783	paraxylol	0.0104	paraxylol	0.000598
paper	779	ureum	0.00886	DAP (diammonium phosphate)	0.000586
explosives	640	HF	0.00876	lead	0.00055
electro steel	434	"blas stahl"	0.0085	TSP (triple super phoshate)	0.000506
board (karton)	427	raw iron	0.00786	soda	0.00047
paraxylol	418	board (karton)	0.0052	board (karton)	0.000459
chemicals anorganic	387	rockwool	0.00377	chemicals anorganic	0.000444
soda	379	Sulphur (secundairy)	0.00332	HCl	0.000321
ureum	352	aluminium 100% rec	0.00293	chlorine	0.000315
CaO	336	bentonite	0.00293	NaOH	0.000315
TSP (triple super phosphate)	315	NH3	0.00247	H2SO4	0.000314
Ca(OH)2	254	formaldehyde	0.00212	animal products	0.000307
SSP (single super phosphate)	253	urea	0.0017	urea	0.000264
nitro AP (52% P2O5, 8.4% N)	240	TSP (triple super phosphate)	0.00167	aluminium 100% rec	0.000252
urea	198	cement	0.00164	NPK 15-15-15 fertiliser (mixed acid route)	0.000249
MAP (mono ammonium phosphate)	173	soda	0.00142	PK-22-22-fertiliser	0.000239
DAP (diammonium	169	DAP (diammonium	0.00138	potassium nitrate	0.000231

marine ecotoxicity		terrestrial ecotoxicity		photochemical oxidant formation	
[C18] MAETP inf. (Huijbregts, 1999 & 2000)		[C21] TETP inf.(Huijbregts, 1999 & 2000)		[C40] POCP (Jenkin & Hayman, 1999; Derwent et al. 1998; high Nox)	
phosphate)		phosphate)		(KNO3)	
NH3	158	MAP (mono ammonium phosphate)	0.00137	HNO3	0.00022
PK-22-22-fertiliser	156	nitro AP (52% P2O5, 8.4% N)	0.00124	SSP (single super phosphate)	0.000202
animal products (meat, milk, eggs, ...)	149	CaO	0.00123	glass (coated)	0.000198
ammonium phosphate (49% P2O5, 11% N)	143	ammonium phosphate (49% P2O5, 11% N)	0.00121	glass (not coated)	0.000188
H2SO4	142	glass (coated)	0.00108	UAN	0.000183
cement	135	SSP (single super phosphate)	0.00106	biomass for human food	0.000182
UAN	134	UAN	0.00101	CaO	0.000161
FeSO4	132	glass (not coated)	0.000957	electro steel	0.000146
biomass for human food	124	Ca(OH)2	0.000929	calcium ammonium nitrate	0.000145
NPK 15-15-15 fertiliser (nitrophospahate route)	101	PK-22-22-fertiliser	0.00085	nitro AP (52% P2O5, 8.4% N)	0.000143
crop or grass	99	HNO3	0.000805	Ca(OH)2	0.000122
Sulphur (secundairy)	79.3	bariet	0.000759	cement	0.000116
NPK 15-15-15 fertiliser (mixed acid route)	74.1	NaCl	0.000737	NPK 15-15-15 fertiliser (nitrophospahate route)	0.000112
bentonite	73.3	NPK 15-15-15 fertiliser (mixed acid route)	0.000642	bentonite	0.000105
calcium ammonium nitrate	67.7	NPK 15-15-15 fertiliser (nitrophospahate route)	0.000641	gypsum	8.95E-05
HNO3	58.1	H2SO4	0.000614	ceramic	8.49E-05
NaCl	55.6	calcium ammonium nitrate	0.000565	bariet	6.25E-05
formaldehyde	34	FeSO4	0.000505	crop or grass	5.74E-05
gypsum	31.8	ceramic	0.000447	NaCl	4.63E-05
pesticides	31.6	gypsum	0.000268	FeSO4	4.14E-05
concrete	22.2	concrete	0.000245	concrete	2.22E-05
limestone	3.27	limestone	2.49E-05	gravel (concrete)	3.54E-06
gravel (concrete)	2.8	gravel (concrete)	2.21E-05	gypsum (raw stone)	3.40E-06
sand (construction)	2.29	sand (construction)	2.02E-05	sand (construction)	3.38E-06
gypsum (raw stone)	1.48	gypsum (raw stone)	1.45E-05	limestone	2.25E-06

marine ecotoxicity		terrestrial ecotoxicity		photochemical oxidant formation	
[C18] MAETP inf. (Huijbregts, 1999 & 2000)		[C21] TETP inf.(Huijbregts, 1999 & 2000)		[C40] POCP (Jenkin & Hayman, 1999; Derwent et al. 1998; high Nox)	
clay_loam	0.698	water (Demineralised)	1.23E-05	clay_loam	8.81E-07
water (Demineralised)	0.578	clay_loam	4.24E-06	water (Demineralised)	2.11E-07
water (decarbonated)	0.0108	water (decarbonated)	9.19E-08	water (decarbonated)	1.48E-08
animal manure	0	animal manure	0	animal manure	0
calcium nitrate	0	calcium nitrate	0	calcium nitrate	0
potassium nitrate (KNO3)	-282	potassium nitrate (KNO3)	-0.00644	pesticides	0

Table 4 Acidification and eutrophication

acidification		eutrophication	
[C45] AP (Huijbregts, 1999; average Europe total, A&B)		[C47] EP (Heijungs et al. 1992))	
rhodium	8.12E+03	rhodium	6.73
platinum	4.59E+03	platinum	3.53
palladium	3.13E+03	palladium	0.925
nickel	3.03	MAP (mono ammonium phosphate)	0.75
steel (high alloyed)	0.416	DAP (diammonium phosphate)	0.688
copper additive to fodder	0.167	TSP (triple super phosphate)	0.645
copper in building materials	0.167	PK-22-22-fertiliser	0.307
chromium	0.105	SSP (single super phosphate)	0.276
Al2O3	0.0893	NPK 15-15-15 fertiliser (mixed acid route)	0.262
aluminium 0% rec	0.0795	NPK 15-15-15 fertiliser (nitrophosphate route)	0.262
Sulphur (secundairy)	0.074	urea	0.198
PUR	0.0675	animal products (meat, milk, eggs, ...)	0.166
hydrogen	0.055	biomass for human food	0.157
PP	0.0496	NH3	0.149
lead hard	0.0464	crop or grass	0.143
zinc additive to fodder	0.0435	UAN	0.139
zinc in building materials	0.0435	calcium ammonium nitrate	0.114
HF	0.0433	calcium nitrate	0.0651
manganese	0.0415	potassium nitrate (KNO3)	0.0594
refrigerant R22	0.04	animal manure	0.0308
refrigerant R134a	0.0379	PP	0.00594
explosives	0.0368	explosives	0.00502
phenol	0.036	nickel	0.00447
cast iron	0.0346	chromium	0.00375
PC	0.0298	aluminium 0% rec	0.00296
PVC	0.0287	zinc additive to fodder	0.00203
PE (LD)	0.0276	zinc in building materials	0.00203
PET 0% rec	0.0275	hydrogen	0.00195
Rubber	0.0269	PUR	0.00165
PS (polystirol)	0.0259	steel (high alloyed)	0.00157
H3PO4	0.025	PC	0.00156
PE (HD)	0.0228	ureum	0.00155
vinylchloride	0.0227	phenol	0.00151
ethylene oxide	0.0222	manganese	0.00145
styrene	0.0218	PET 0% rec	0.00137
ethylene	0.0195	Rubber	0.00124
zeolith	0.0171	PS (polystyrene)	0.00118
MAP (mono ammonium phosphate)	0.015	copper additive to fodder	0.00116
chemicals organic	0.0148	copper in building materials	0.00115
paper	0.0144	cast iron	0.00111
ammonium phosphate (49% P2O5, 11% N)	0.014	PVC	0.00109
DAP (diammonium phosphate)	0.0137	Al2O3	0.00104
ureum	0.0128	styrene	0.00104
animal products (meat, milk, eggs,)	0.0117	PE (LD)	0.00103
TSP (triple super phosphate)	0.0116	zeolith	0.000959
lead	0.0105	rockwool	0.000939
NH3	0.0104	ethylene oxide	0.000898

acidification		eutrophication	
[C45] AP (Huijbregts, 1999; average Europe total, A&B)		[C47] EP (Heijungs et al. 1992))	
chemicals anorganic	0.00997	PE (HD)	0.000893
steel (light alloyed)	0.00911	vinylchloride	0.000835
rockwool	0.00891	refrigerant R22	0.00083
paraxylol	0.00886	ethylene	0.000775
board (karton)	0.00775	board (karton)	0.000723
urea	0.00749	soda	0.000714
H2SO4	0.00748	nitro AP (52% P2O5, 8.4% N)	0.000664
raw iron	0.00743	HNO3	0.000658
steel (not alloyed)	0.00714	paraxylol	0.000653
HCl	0.0069	lead	0.000602
"blas stahl"	0.00682	steel (light alloyed)	0.000561
chlorine	0.00676	raw iron	0.00055
NaOH	0.00676	refrigerant R134a	0.000527
biomass for human food	0.0064	paper	0.000526
PK-22-22-fertiliser	0.00546	"blas stahl"	0.000501
soda	0.00544	HF	0.000485
NPK 15-15-15 fertiliser (mixed acid route)	0.00535	chemicals organic	0.000481
aluminium 100% rec	0.00471	steel (not alloyed)	0.00046
single super phosphate	0.00468	formaldehyde	0.000385
potassium nitrate (KNO3)	0.00422	lead hard	0.000364
HNO3	0.00379	H3PO4	0.000331
UAN	0.00322	cement	0.000287
electro steel	0.00311	ammonium phosphate (49% P2O5, 11% N)	0.000274
nitro AP (52% P2O5, 8.4% N)	0.00302	glass (coated)	0.000269
CaO	0.00283	glass (not coated)	0.000262
calcium ammonium nitrate	0.00268	aluminium 100% rec	0.000261
formaldehyde	0.00245	HCl	0.000227
glass (coated)	0.00245	chlorine	0.000223
bentonite	0.00236	NaOH	0.000223
glass (not coated)	0.00222	chemicals anorganic	0.000198
Ca(OH)2	0.00214	ceramic	0.00016
NPK 15-15-15 fertiliser (nitrophospahate route)	0.00201	CaO	0.000152
cement	0.0018	electro steel	0.000127
ceramic	0.00146	Ca(OH)2	0.000115
bariet	0.00137	gypsum	7.49E-05
gypsum	0.00108	Sulphur (secundairy)	6.45E-05
crop or grass	0.00105	H2SO4	6.05E-05
FeSO4	0.000909	concrete	4.73E-05
NaCl	0.000838	bentonite	4.48E-05
concrete	0.000317	bariet	4.40E-05
gravel (concrete)	5.35E-05	NaCl	3.76E-05
sand (construction)	5.00E-05	FeSO4	2.88E-05
gypsum (raw stone)	4.91E-05	gypsum (raw stone)	8.54E-06
limestone	4.02E-05	gravel (concrete)	6.93E-06
clay_loam	1.35E-05	sand (construction)	6.82E-06
water (Demineralised)	4.43E-06	limestone	2.83E-06
water (decarbonated)	2.63E-07	clay_loam	2.05E-06
animal manure	0	water (Demineralised)	1.56E-07

acidification		eutrophication	
[C45] AP (Huijbregts, 1999; average Europe total, A&B)		[C47] EP (Heijungs et al. 1992))	
calcium nitrate	0	water (decarbonated)	1.50E-08
pesticides	0	pesticides	0

Table 5 Radiation and final solid waste production

radiation		final solid waste	
[C49] (Frischknecht et al., 1999)		[C88] final solid waste	
rhodium	1.28E-05	rhodium	4.65E+03
platinum	6.93E-06	platinum	2.42E+03
palladium	4.40E-06	palladium	416
nickel	1.98E-08	MAP (mono ammonium phosphate)	9.11
mangane	1.80E-08	ammonium phosphate (49% P2O5, 11% N)	8.61
chromium	1.35E-08	DAP (diammonium phosphate)	8.11
aluminium 0% rec	1.31E-08	TSP (triple super phosphate)	7.72
PUR	9.89E-09	nitro AP (52% P2O5, 8.4% N)	6.53
copper additive to fodder	8.32E-09	PK-22-22-fertiliser	3.54
copper in building materials	8.32E-09	copper in building materials	3.35
zinc additive to fodder	7.77E-09	NPK 15-15-15 fertiliser (mixed acid route)	2.65
zinc in building materials	7.77E-09	SSP (single super phosphate)	2.65
refrigerant R22	6.65E-09	nickel	2.45
PVC	5.84E-09	chromium	2.4
steel (high alloyed)	5.58E-09	copper additive to fodder	2.35
Al2O3	5.24E-09	NPK 15-15-15 fertiliser (nitrophospahate route)	1.89
Rubber	5.07E-09	zinc in building materials	1.7
vinylchloride	5.07E-09	manganese	1.49
chemicals organic	4.40E-09	aluminium 0% rec	1.38
refrigerant R134a	3.13E-09	rockwool	1.16
HCl	2.82E-09	glass (coated)	1.09
HF	2.81E-09	glass (not coated)	1.09
chlorine	2.76E-09	cement	1.06
NaOH	2.76E-09	bariet	1.01
PP	2.62E-09	ceramic	1.01
PET 0% rec	2.49E-09	concrete	1.01
lead hard	2.48E-09	clay_loam	1
hydrogen	2.47E-09	gravel (concrete)	1
zeolith	2.18E-09	gypsum	1
PE (LD)	2.11E-09	gypsum (raw stone)	1
polystyrol	2.04E-09	limestone	1
PC	1.74E-09	sand (construction)	1
cast iron	1.42E-09	cast iron	0.772
steel (light alloyed)	1.38E-09	steel (high alloyed)	0.77
PE (HD)	1.33E-09	zinc additive to fodder	0.717
electro steel	1.31E-09	lead hard	0.657
ethylene oxide	1.24E-09	lead	0.611
paper	1.23E-09	raw iron	0.537
H3PO4	1.19E-09	steel (light alloyed)	0.487
steel (not alloyed)	1.15E-09	"blas stahl"	0.48
aluminium 100% rec	1.03E-09	PUR	0.465
lead	1.02E-09	biomass for human food	0.434
board	1.01E-09	steel (not alloyed)	0.427
TSP (48% P2O5)	8.91E-10	zeolith	0.358
SSP (21% P2O5)	7.61E-10	PVC	0.353
rockwool	7.08E-10	refrigerant R22	0.351
nitro AP (52% P2O5, 8.4% N)	6.78E-10	soda	0.307
phenol	6.66E-10	CaO	0.251
styrol	6.40E-10	Al2O3	0.247

radiation		final solid waste	
[C49] (Frischknecht et al., 1999)		[C88] final solid waste	
bariet	6.03E-10	Rubber	0.233
ethylene	5.59E-10	HF	0.227
ureum	5.33E-10	refrigerant R134a	0.22
raw iron	5.29E-10	vinylchloride	0.202
"blas stahl"	5.24E-10	hydrogen	0.199
explosives	4.87E-10	Ca(OH)2	0.19
PK 22-22	4.43E-10	paper	0.152
H2SO4	4.26E-10	PET 0% rec	0.15
animal products (meat, milk, eggs, ...)	4.14E-10	PC	0.149
FeSO4	4.02E-10	electro steel	0.144
chemicals anorganic	3.99E-10	PP	0.142
MAP (52% P2O5)	3.99E-10	chemicals organic	0.134
NH3	3.82E-10	HCl	0.13
urea (chalmers)	3.73E-10	chlorine	0.127
DAP (46% P2O5)	3.70E-10	NaOH	0.127
glass (coated)	3.67E-10	PS (polystyrene)	0.116
biomass for human food	3.49E-10	PE (LD)	0.115
ammonium phosphate (49% P2O5, 11% N)	3.13E-10	animal products (meat, milk, eggs, ...)	0.109
crop or grass	2.85E-10	board (karton)	0.102
UAN	2.73E-10	phenol	0.0945
glass (not coated)	2.67E-10	crop or grass	0.0932
paraxylol	2.59E-10	PE (HD)	0.0895
NPK 15-15-15 (via nitrophosphate route)	2.45E-10	ethylene oxide	0.0873
ceramic	2.13E-10	styrene	0.0724
cement	2.11E-10	H3PO4	0.0687
soda	1.98E-10	ethylene	0.0642
CaO	1.48E-10	aluminium 100% rec	0.0626
HNO3	1.46E-10	urea	0.0583
NPK 15-15-15 (via the mixed acid route)	1.46E-10	NaCl	0.0482
Ca(OH)2	1.12E-10	paraxylol	0.0469
calcium ammonium nitrate (CAN)	1.10E-10	explosives	0.0435
gypsum	7.68E-11	UAN	0.0382
NaCl	6.41E-11	formaldehyde	0.0372
formaldehyde	4.46E-11	ureum	0.0317
concrete	4.05E-11	NH3	0.0285
bentonite	2.49E-11	calcium ammonium nitrate	0.0264
Sulphur (secundairy)	1.25E-11	H2SO4	0.0248
gravel (concrete)	7.60E-12	chemicals anorganic	0.0214
limestone	7.43E-12	HNO3	0.0137
sand (construction)	6.09E-12	FeSO4	0.0117
gypsum (raw stone)	3.15E-12	bentonite	0.00322
clay_loam	1.88E-12	Sulphur (secundairy)	0.00257
water (demineralised)	1.71E-12	water (Demineralised)	0.00029
water (decarbonated)	2.75E-14	water (decarbonated)	0.000201
animal manure	0	animal manure	0
calcium nitrate	0	calcium nitrate	0
pesticides	0	pesticides	0

radiation [C49] (Frischknecht et al., 1999) potassium nitrate (KNO3)	-9.63E-10	final solid waste [C88] final solid waste potassium nitrate (KNO3)	-0.0234

Appendix 3 Estimate of the emissions during use of the selected materials

1 Metals

Lead
Main sources of direct emission of lead to the environment are shot and ammunition, corrosion of lead exposed to the environment, and leaded petrol. The last source is not present in Europe in significant amounts anymore.
Corrosion of water pipes used to be a large source of lead, but due to the phasing out of this application is now small in comparison with the other uses. About 150-200 tonnes are estimated to leach out of roofs and buildings per year in the Netherlands. The Dutch consumption of lead in roofs and buildings is around 80 ktonnes/y . The leaching therefore constitutes some 0.25% of the total input. All of these emissions are assumed to go to surface water.
Lead shot and ammunition together constitute about 4% of the total inflow (3) These emissions are directly to the soil.

Rhodium
Used in very specific applications, the most common one is in car catalysts. Never used in open-air applications. Very high resistance to oxidation. No expected emissions during use.

Platinum
Similar considerations as for Rhodium.

Palladium
Similar considerations as for Rhodium.

Nickel and Iron
In case of Nickel and Iron the corrosion and leaching rates depend on the alloy and the environment. Exact composition of the alloy can reduce the corrosion rate several orders of magnitute. Presence of electro chemical environment can increase it in the same scale.
The difficulty is estimating the area exposed to corrodants, since the corrosion rates are given in mm/year or g/m^2. Furthermore they are heavily depend on the alloy.
Often cited values range from 0.1mm/year up to 1 mm/year.
Emissions during use are estimated to be similar to those of chromium considering very frequent alloying of these three metals.

Aluminium
Estimates from (2.)(corrosion losses divided by total input) 0.04% Therefore considered to be 0.

Barite
Largest use as drilling mud component. Nearly 90% of the barite sold in the United States was used as a weighing agent in oil- and gas-well-drilling. Most drilling mud in the Netherlands is recycled. We estimate a emission of 1% due to other more dissipative uses, mainly medical and coating.
http://www.inchem.org/documents/ehc/ehc/ehc107.htm

Copper
Estimates of corrosion rates for copper are available for use in building (2) The estimated corrosion of copper is around 70 tons on the total input of copper of 22000 tons. This makes a total corrosion of 0.3% of the inflow (70 +- 10 tons/year). From this, an estimate is made for all applications to be 0.1%, since households are expected to be high corrosion environments. Other uses are in electrical applications and similar that do not corrode at all. Therefore, since the estimates is only for the building sector, it is likely to be a overestimation.

Zinc
From the same publication, zinc emissions during use are estimated to be some 220 tons (+-10%) that make a total of 1.5% of the inflow in the building applications.
From (4 .) an estimate can be made of 4000 tons of zinc corroded from the total inflow of 210000, which results in 2% emissions during use. We will therefore use a corrosion fraction of 2%

Chromium
From (1.) one can estimate an emission during use to be around 1 - 1.7% The value is calculated from losses during application and production systems as defined in the publication. We use a conservative estimate of 1%.

Manganese
90% of production used in steel. The assumption is that it will corrode in the same rate as steel, and contribute likewise to the heavy metal load in sewage. This leads to a corrosion estimate of 1%. The rest is used for producing dry cell batteries, as an ingredient in plant fertilisers and animal feed, and as a colorant for brick. Around 3% is estimated to end up as fertiliser and feed, which is assumed to be emitted as a whole.
From http://minerals.usgs.gov/minerals/pubs/commodity/manganese/420397.pdf

2 Minerals and Chemicals

Refrigerant R22
Estimate leakage of 5% refrigerant per year from:
http://www.fluorocarbons.org/documents/Fluorocarbons_env.pdf

Al2O3
Main compound of ceramic, used to harden surfaces. No leaching expected.

Zeolith
Natural zeolith used in building and agriculture (proportion 6:4) and Synthetic used mainly in washing powders and as catalyst (1:1). Therefore 50% emitted estimate.

Refrigerant R134a
Idem as R22

Vinylchloride
chemicals organic
HF
HCl
Chlorine
NaOH
Hydrogen
CaO
Ethylene oxide
Are all considered to be industrial chemical with hardly any use outside the processing. Emissions estimated to be 0.

H3PO4
From http://scifun.chem.wisc.edu/CHEMWEEK/H3PO4/H3PO4.html
Mostly used in fertiliser and food. Estimate 90 % emitted.

Ca(OH)2
Agriculture and Waste water use are the main dissipative uses
http://minerals.usgs.gov/minerals/pubs/commodity/lime/stat/tbl4.txt
Estimate 20% emissions

Ureum
Mainly used as a fertiliser
http://www.fertilizer.org/ifa/publicat/PDF/1999_biblio_106.pdf. In the data UAN refers to Urea-Ammonium-Nitrate . See page 11of the report. Calculated dissipative uses 75%, which ends up entirely as an emissions.

NH3
Idem source as ammonia. Calculated dissipative uses 20%. Assumption is that all goes to waste water treatment. The other 80% ends up in fertiliser, which is emitted entirely.

Chemicals anorganic
Too diverse to say anything, ignored. Most important ones are covered separately.

FeSO4
Some use as fertiliser, which percentage, unknown. Total world production unknown, it is a by product of many processes. Estimated 1%.

Paraxylol
Used as base chemical for some polymers. Emissions during use estimated to be 0%.

NaCl
Non food application is 97% of salt. Road spraying data are missing
http://www.people.virginia.edu/~jtd/iccidd/iodman/iodman5.htm
Assuming all eaten salt enters the environment, emissions during use 3%. This allows for some spraying as well.

HNO3
Very difficult to obtain data. It is mainly used in production of fertilisers (80%) and other (20%) The other uses involve polymers and explosives. There are no significant uses with direct emissions. Estimated is therefore 0 % emission during use.

Formaldehyde
About 20% of formaldehyde is used in non-resis and plastic application. An educated guess is that about 10 % of formaldehyde is used in applications with direct emissions (biocides/desinfectants, textile, emissions from carpeting etc…)
From : http://www.atsdr.cdc.gov/toxprofiles/tp111-c4.pdf

Bentonite.
Use as cat litter, drilling clay. The world production of all types of bentonite was estimated by the USGS to be 10,226,119 tons, in 2001. Roughly 2 mil tons are used in dissipative applications. Accounts for 20 % emissions during use.
From http://www.iied.org/mmsd/mmsd_pdfs/064_murray.pdf

Sulphur
Sulphur is not used in direct applications. Estimated emissions during use of elementary sulphur are 0%

Fertilisers
Fertilisers are assumed to be emitted during use for 100%. This is due to the system definition: agricultural soil is part of the environment. Crops then extract minerals from the environment.

3 Building Materials

Theoretically, there is a probability of leaching of heavy metals out of bricks and mortar. However, these streams are extremely small and are already covered in the heavy metal emissions further in the list. There is no other expected emission during use of building materials.

4 Plastics

PUR
Emission of blowing agent during use *not yet done*

PVC
Emission of additives, mainly phthalates, during use *not yet done*

PP
No emissions during use

PET 0% rec
No emissions during use

PE (LD)
No emissions during use

Polystyrol
No emissions during use

PC
No emissions during use

PE (HD)
No emissions during use

5 Biomass

The biomass use system is typified as follows:

- Biomass
  - Wood
    - Burning
      - CO2 Emissions
      - Ash emissions
    - Construction
    - Paper
  - Plant
    - Waste (GFT)
    - Animal feed
    - Human food
      - CO_2 emissions
      - Waste Water emission
    - Fibre
  - Animal
    - Waste (GFT)
    - Human food
      - CO_2 emissions
      - Waste Water emission

- Other (Bone, horn, wool etc.)

The assumptions made to estimate emissions during use are the following:

- We assume that all biomass is decomposable.
- The standard biomass composition is assumed to be : $C_{106}H_{263}O_{110}N_{16}P_1$. The mass ratios are:
  C : 0.358
  H : 0.074
  O : 0.496
  N : 0.063
  P : 0.009
- All biomass used as human food is emitted partly as CO_2 and partly as biomass. The ratio is: Total biomass input into a household is split into 1/3 waste and 2/3 food. Per kilogram of food eaten there will be 0.338 kg of CO_2 net output. For this emissions 0.283 kg of O_2 -input is needed in addition. The remaining difference between food consumed plus oxygen for combustion minus carbon dioxide expired represents other outputs of the human metabolism refering to food consumption like evaporation by breathing and from the skin, faeces and urine. This rest mass is assumed to be entering the waste stage with the waste water.
  Thus 1 kg food + 0.283 kg O_2 - 0.338 kg of CO_2 = 0.945 kg emitted biomass.
  (source Economy-wide Material Flow Accounting (MFA), MFA-Workshop, 2-5 June 1998, Wiesbaden, Germany, Technical Documentation prepared by Wuppertal Institute, Division for Material Flows and Structural Change, Helmut Schütz and Stefan Bringezu, 29 May 1998.)

We assume that humans eat equal amounts of plant and animal food. We assume that for each kilogram eaten, 1.3 kilograms of foodstuff needs to be bought, since 1/3 is thrown away as GF waste.

6 Others

Paper
Al paper emissions during use are either handled by household waste or waste water treatment plants. Estimated emissions during use therefore are 0%

Glass (coated)
No emissions during use

Glass (not coated)
No emissions during use

Board
No emissions during use

Water (demineralised)
n.a.

Water (decarbonated)
n.a.

Appendix 4 Waste water treatment

All waste water is assumed to be treated in Waste Water Treatment Plants (WWTP). The input of the WWTP proces are the materials flowing in with waste water, an energy to process it. The outflows of this process are emissions and sludge. More specifically CO2 and N2 to air, NOx to air, remaining elements and compounds to surface water with the effluent, and P and some metals to sludge. The sludge is assumed to be landfilled.

The assumptions in designing the waste water treatment process are the following:

- The economic inputs are allocated in ratio to all inputs. The total mass input is considered and the materials have their share allocated to weight ratio.
- There is no energy input defined for the WWTP because of impossibility to convert the total average energy use to the kilograms of inflow material.
- There are two main types of materials entering the waste water treatment process: degradable and non-degradable. The non-degradable materials - mainly metals - distrubute themselves in the WWTP between the sludge and the effluent. For these a Removal Fraction (RF) is estimated. The RF is defined as (1 - Total outflow) / Total inflow. The total inflow multiplied by the RF is the amount of material that enters the sludge. For biodegreadable materials, we assume that the total inflow multiplied by the RF has been transformed into CO2, N2, NOx and P, and that the rest is emitted. In the table below, the RF are given for a number of materials.

Waste water treatment plant efficiencies in NL in 1996
All data in1000 Kg/day

Species	In	Out	Removal Fraction
COD	2522	262	0.90
BOD	949	40	0.96
Total N	227	96	0.58
Total P	36.9	9.2	0.75
Total IE	26162	2560	0.90
Copper	152	18	0.88
Chromium	22	5	0.77
Zink	405	109	0.73
Lead	52	8	0.85
Cadmium	1.6	0.4	0.75
Nikkel	30	14	0.53
Mercury	0.6	0.2	0.67
Arsenicum	4.6	2.2	0.52

Additional assumptions are made for a number of specific materials.

Metals
Metals enter the waste water system through corrosion.
For Barium we estimate a RF of 50 %
For Manganese we estimate a RF of 50 %
Iron is not taken as an inflow of the WWTP yet. WWTP accounts do not have a removal percentage of Iron.

Minerals and chemicals
Most minerals and chemicals end up in other materials, and therefore do not enter the waste stage. Some however have an end-use of their own, such as ammonia for cleaning and cooling. The inflow of ammonia is assumed to have an effect only on the N concentration in the effluent, with an RF of 58% removal.

Building materials
Building materials do not enter the waste water treatment, but are either recycled or landfilled.

Plastics
Plastics do not enter the waste water treatment, but are incinerated.

Biomass
We assume that 90% of the biomass entering the waste water treatment is mineralised in the WWTP. Of the total inflow of P, 25% stays in the effluent. If P is 0.9% of the biomass inflow, then per kilogram biomass 0.009 kg * 0.25 = 0.00225 kg P is emitted in the effluent. This assumes that all P in the effluent comes from biomass.
Of the total N entering the WWTP 42% stays in the effluent. N is 6.3 % of the biomass, therefore per kilogram biomass 0.0063 kg * 0.42 = 0.02646 kg N is emitted as N-total.
Of the total COD inflow 10% is found in the effluent. That means that from 1 kg of biomass entering the WWTP, 0.1 kg enters the effluent, assuming that all COD originates from biomass. The removed carbon is then 0.9*0.358 = 0.3222 kg C per kg biomass.
RMM of CO_2 is 16+16+14= 46 Kg/Kmol. 30.43 % of the mass of CO_2 is Carbon. The total emitted CO_2 is then 0.322 /0.3043 = 1.06 Kg CO_2.

Others
None of the "other" materials end up in waste water treatment. Of course this is untrue, since one of the largest materials, water itself, ends up in waste water treatment for a large part. However, we have assumed water not to contribute to any environmental problem when emitted. It may be argued that large waste water flows cause the WWTP to use energy, but this is ignored as well (see above).

Appendix 5 Flows of materials in, out and through the Netherlands, in kg/year, mostly for the year 2000. Data sources are described and discussed in Appendix 6. A full overview is available as an Excel file.

	Production in NL [kg/year]	Import in NL [kg/year]	Export fromNL [kg/year]	Consumption in NL [kg/year]
Material				
[A1] CAN (calcium ammonium nitrate)	2.486E+09	2.641E+08	1.660E+09	8.603E+08
[A2] urea (chalmers)	2.142E+08	3.212E+07	3.212E+08	2.142E+06
[A3] UAN				
[A4] SSP (21% P2O5)	9.524E+07	3.333E+08	1.905E+08	2.381E+07
[A5] TSP (48% P2O5)				
[A6] PK 22-22				
[A7] MAP (52% P2O5)				
[A8] DAP (46% P2O5)				
[A9] NPK 15-15-15 (mixed acid route)	2.769E+08	3.702E+08	7.472E+08	2.869E+08
[A10] NPK 15-15-15 (nitrophosphate route)				
[A11] nitro AP (52% P2O5, 8.4% N)				
[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	0.000E+00	6.380E+07	1.723E+07	3.796E+07
[A13] KNO3 (NK14-44)	7.143E+08	1.429E+07	7.857E+08	7.857E+07
[A14] zinc additive to fodder for animal production (incl .production of zinc)		7.290E+05		
[A15] copper additive to fodder for animal production (incl. production of copper)		6.350E+05		
[A16] pesticides for crop production				6111432
[A17] calcium nitrate for crop production (incl. production fert.				
[A18] lead soft	2.000E+07	6.720E+07	5.802E+07	
[A19] lead hard				
[A20] aluminium 0% Rec.	3.000E+08	1.311E+09	1.144E+09	
[A21] aluminium 100% Rec.				
[A22] nickel		6.905E+07	3.239E+07	
[A23] chromium		2.010E+07	1.330E+07	
[A24] zinc	2.150E+08	2.114E+08	2.828E+08	
[A25] manganese		1.507E+06	1.253E+07	
[A26] copper	0.000E+00	4.247E+08	2.777E+08	

	Production in NL [kg/year]	Import in NL [kg/year]	Export fromNL [kg/year]	Consumption in NL [kg/year]
[A27] bariet		9.835E+07	7.092E+07	
[A28] refrigerant R22				
[A29] refrigerant R134a				
[A30] ammonia	2.700E+09	1.000E+08	5.000E+08	0.000E+00
[A31] PE (HD)	1.580E+09	8.740E+08	2.040E+09	4.130E+08
[A32] PC	1.968E+08	3.097E+06	1.999E+08	
[A33] PS	5.563E+08	2.794E+08	6.417E+08	1.940E+08
[A34] PE (LD)				
[A35] PET 0% Rec.	7.964E+07	1.235E+08	2.031E+08	
[A36] PP	8.762E+08	3.055E+08	9.747E+08	2.070E+08
[A37] PVC	6.302E+08	2.692E+08	5.764E+08	3.230E+08
[A38] PUR	2.757E+07	2.795E+07	5.553E+07	
[A39] water (demineralised)				
[A40] water (decarbonated)	7.500E+11			7.500E+11
[A41] board (karton)				
[A42] paper	3.332E+09	3.517E+09	2.938E+09	
[A43] glas (not coated)	9.800E+08	4.792E+08	3.622E+08	
[A44] glas (coated)				
[A45] rockwool	2.450E+08	1.198E+08	1.474E+08	2.174E+08
[A46] cement	3.301E+09	3.228E+09	5.309E+08	
[A47] ceramic	4.724E+09	9.296E+08	1.562E+09	
[A48] concrete	3.458E+10	8.558E+08	1.112E+09	
[A49] gypsum		5.531E+08	5.557E+06	
[A50] limestone				
[A51] gravel (concrete)	6.855E+09	1.985E+10	9.327E+08	
[A52] sand (construction)	1.132E+11	1.083E+10	1.025E+10	
[A53] gypsum (raw stone)				
[A54] clay_loam				
[A55] steel (high alloyed)				
[A56] cast iron				
[A57] raw iron	1.064E+10	1.149E+10	1.292E+10	
[A58] steel (light alloyed)				
[A59] "blas stahl"				
[A60] electro steel				
[A61] steel (not alloyed)				
[A62] animal products (meat, milk, eggs, ...)	1.524E+10	5.347E+09	9.709E+09	1.086E+10
[A63] crop or grass	1.328E+11	6.911E+10	2.491E+10	1.307E+11
[A64] AlO3		9.493E+08	3.212E+08	
[A65] Bentonite				

	Production in NL [kg/year]	Import in NL [kg/year]	Export fromNL [kg/year]	Consumption in NL [kg/year]
[A66] Ca(OH)2				
[A67] CaO		1.272E+09	5.466E+07	
[A68] chemicals anorganic		5.122E+09	4.439E+09	
[A69] chemicals organic		9.529E+09	1.259E+10	
[A70] chlorine	6.540E+08	1.100E+07	1.500E+06	
[A71] ethylene				
[A72] ethylene oxide				
[A73] explosives				
[A74] FeSO4				
[A75] formaldehyde				
[A76] H2SO4	1.000E+09			
[A77] H3PO4	0.000E+00	2.597E+08	1.083E+08	0.000E+00
[A78] HCl	1.330E+08			
[A79] HF				
[A80] HNO3				
[A81] hydrogen				
[A82] NaCl	5.000E+09	2.819E+08	2.911E+09	
[A83] NaOH				
[A84] palladium				1.740E+03
[A85] paraxylol				
[A86] phenol				
[A87] platina				1.690E+03
[A88] rhodium				8.500E+01
[A89] rubber				
[A90] soda				
[A91] styrene				
[A92] sulphur (secondary)	5.120E+08	4.172E+06	9.045E+07	
[A93] ureum				
[A94] vinylchloride				
[A95] zeolith				
[A96] wood (massive)	818650000	2853550000	296100000	
[A97] wood (board)				

Appendix 6 Assumptions, considerations and limitations of the materials inventory

The comments in this appendix apply to the data found in the Import_export_productie_met_CBS_codes.xls file.

Description of the data layout

The materials are placed in the rows of the table. Rows coloured in yellow denote that data is available for that material. Rows crossed out my a red dashed line denotes a material that is not accounted for separately, but lumped with another material.

The colums are divided in a number of sections.

Column Letter	Description
A	The name of the material
	Light Blue section: CBS product codes
B	CBS product category number for Ore
C	CBS product category number for Basic material
D	CBS product category number for Products from material
	Yellow section: Import/Export/Production/Consumption figures for NL
E	Total annual Production in the NL in kg/year
F	Total annual Import to the NL in kg /year
G	Total annual Export from the NL in kg /year
H	Total annual Consumption of the NL in kg /year
	Light green section: Data for calculations of impacts per material
I	System II : National Consumption, Unless known directly, calculated as Production + Import - Export [kg/year] (E+F-G). If the row is coloured purple, the given consumption figure is used instead of the calculated value. Otherwise the value is calculated.
J	System I : National Region . The national regios system needs to have the Import, Export and Production treated separately. This is done in columns L, M and N. This empty column is a legacy remainder of the database development. It must not be removed, since the data references will become incorrect in other sheets.
K	System III : National Production. Here the Production figure is used [kg/year]
L	System I : National Region. Export [kg/year]. The export figure is used here.
M	System I : National Region . Here the Production - Export is calculated. [kg/year]
N	System I : National Region Here the Import figure is used [kg/year].
Dark green section: Data for calculations of total system impacts	
O	System I : National Region, Export [kg/year]
P	System I : National Region, Production - Export [kg/year]
Q	System I : National Region, Import [kg/year]
R	System II : National Consumption, Production + Import - Export [kg/year]
S	System III : National Production, Production[kg/year]
	White section: References and Comments
T	Class of material. Main use type denoted.
U	Year the data relate to.
V	Source of the data. FAO : UN Food and Agriculture organisation website.(www.fao.org) . CBS : Central Bureau voor Statistiek (www.cbs.nl) USGS : United States geological Survey (www.usgs.gov) Other references, please see reference list.

W	Which CBS codes are included in the account.
X	Which CBS codes are excluded from the account.

Data from the columns I - S are used in the results sheets to calculate the impact per material or per system total by multiplying the mass flow figures with the impacts per kilogram material.

Comments per material

[A1] CAN (calcium ammonium nitrate)

The value in column I is given, not calculated. In columns P and R the value is set to 0 in order to avoid counting the impact twice when we calculate the total impact of the system, since the material is used in crop production and its impact is accounted there. In column S, instead of production, export is used : I + P = C + E. This is done to avoid counting the fertilisers that are produced in NL and used in NL (they are already in biomass) but to include that ones that are produced for export. See extended discussion on this issue in the report 7.2.3

Data on production, import export and consumption of fertilizesr are all based on the fertilizer balance sheets of FAO (www.fao.org)

[A2] urea (chalmers)

Idem as above.

[A3] UAN

No data available.

[A4] SSP (21% P2O5)

Idem as above.

[A5] TSP (48% P2O5)

No data available.

[A6] PK 22-22

No data available.

[A7] MAP (52% P2O5)

No data available.

[A8] DAP (46% P2O5)

No data available.

[A9] NPK 15-15-15 (mixed acid route)

Idem as above.

[A10] NPK 15-15-15 (nitrophosphate route)

No data available.

[A11] nitro AP (52% P2O5, 8.4% N)

No data available.

[A12] AP (ammonium phosphate) (49% P2O5, 11% N)

Idem as above.

[A13] KNO3 (NK14-44)

Idem as above.

[A14] zinc additive to fodder for animal production (incl .production of zinc)

The import of zinc for the use as an additive to fodder is taken from Annema et al., 1995.

[A15] copper additive to fodder for animal production (incl. production of copper)

The import of copper for the use as an additive to fodder is taken from Annema et al., 1995.

[A16] pesticides for crop production

No production data available. In column M , the (production - export) (= consumption – import) data are estimated with the consumption. Since this column denotes the impacts within the NL , this estimate might be plausible.

[A17] calcium nitrate for crop production (incl. production fert.)

No data available.

[A18] lead soft

The NL consumption of lead is unknown. Therefore, values for column M and P and negative. This means that the impacts for Lead in system I, (production-Export) are incorrect. The value in column H (consumption) is unknown.

[A19] lead hard

Hard lead is lumped with soft lead. Data on Bullet use (main use of hard lead) are not available (secret).

[A20] aluminium 0% Rec.

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A21] aluminium 100% Rec.

No data available.

[A22] nickel

Including Raw Nickel, "Andere werken van nikkel". Excluding : CBS code 750101 (tussenprodukten), 750301 (resten/afval) and 759901 (producten). These categories were not available. The value in column H (consumption) is unknown.

[A23] chromium

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A24] zinc

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A25] manganese

The value in column H (consumption) is unknown.

[A26] copper

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A27] bariet

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A28] refrigerant R22

No data available.

[A29] refrigerant R134a

No data available.

[A30] ammonia

In columns P and R the value is set to 0 in order to avoid counting the impact twice. See [A1] CAN. The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A31] PE (HD)

Column E, Production is estimated by P = C + E - I. The value for consumption in column I is given, not calculated. The following CBS codes are included : 3901 + 391610 + 391721 + 392010 + 392321

[A32] PC

Column E, Production is estimated by P = C + E - I. The value for consumption in column I is given, not calculated. Included are the CBS codes : 390740+392061. The value in column H (consumption) is unknown.

[A33] PS

Column E, Production is estimated by P = C + E - I. The value for consumption in column I is given, not calculated. Included are the CBS codes : 3903+392030+392111

[A34] PE (LD)

Is lumped with PE(HD) because no separate data are available, and the production process, and thus impact are very similar.

[A35] PET 0% Rec.

All PET is included, not only virgin material. Column E, Production is estimated by P = C + E - I. The value in column H (consumption) is unknown. Includes CBS codes : 390760 Basismateriaal en werken van 392062

[A36] PP

Column E, Production is estimated by P = C + E - I. The value for consumption in column I is given, not calculated. Includes CBS codes : 3902 Basismateriaal + werken van 39169051 + 391722 + 392020

[A37] PVC

Column E, Production is estimated by P = C + E - I. The value for consumption in column I is given, not calculated. Includes CBS codes : 3904 Basismateriaal en werken van 391620 + 391723 + 391810 + 392041 + 392042 + 392112

[A38] PUR

Column E, Production is estimated by P = C + E - I. The value in column H (consumption) is unknown. Includes CBS codes 390950 Basismateriaal + werken van 392113

[A39] water (demineralised)

Lumped with water (decarbonated)

[A40] water (decarbonated)

No CBS codes for water. Columns F and G (Import and Export) are unknown.

[A41] board (karton)

Lumped with paper.

[A42] paper

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A43] glas (not coated)

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export. Includes CBS codes: 700301, 701901, 701902,701903,709901, 709902 , 709903, 709904. Excluding units in m2 and pieces (700781, 700881, 700981, 701081, 701082, 701381, 701681, 709981)

[A44] glas (coated)

Lumped with Glass (not coated)

[A45] rockwool

No special comment.

[A46] cement

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A47] ceramic

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A48] concrete

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A49] gypsum

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A50] limestone

No available data.

[A51] gravel (concrete)

In columns P and R the value is set to 0 in order to avoid counting the impact twice. Already accounted for in concrete.

[A52] sand (construction)

In columns P and R the value is set to 0 in order to avoid counting the impact twice. Already accounted for in concrete. Lumped with 'ophoogzand', extraction in 1994 is 55.1E+6 m3 (= 88160000000 kg); source: CBS milieustatistieken

[A53] gypsum (raw stone)

Lumped with Gypsum

[A54] clay_loam

No data available.

[A55] steel (high alloyed)

Lumped with Iron.

[A56] cast iron

Lumped with Iron.

[A57] raw iron

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export. Raw Iron includes all Iron & Steel Imports and Exports. Includes CBS codes : 72 and 73. P includes the sum of raw iron USGS and steel (not alloyed) . Categories 732582 & 731501 are secret

[A58] steel (light alloyed)

Lumped with Iron.

[A59] "blas stahl"

[A60] electro steel

Lumped with Iron.

[A61] steel (not alloyed)

Lumped with Iron.

[A62] animal products (meat, milk, eggs, ...)

For specific issues around Biomass, please refer to section 4.4. of the main report. Production figures for biomass are based on the food balance sheets from FAO (www.fao.org).

[A63] crop or grass

Production figures for biomass are based on the food balance sheets from FAO (www.fao.org) with additional estimates for the production of fodder and grass. Import and export of crops are based on eurostat trade statistics. These trade statistics are more complete then the food balance sheets because they also include vegetal products that are processed.

In columns P and R the value is set to 0 in order to avoid counting the impact twice, since the vast majority of biomass is used in production of animal products.

[A64] AlO3

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A65] Bentonite

No data available.

[A66] Ca(OH)2

Lumped with CaO

[A67] CaO

The value in columns E (production) and H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A68] chemicals anorganic

The value in columns E (production) and H (consumption) is unknown. Excluding substaces 280482, 280483, 284481, 284482, 284483. And exluding the secret values of I: 284301, E: 283601, E: 283502, E: 280981

[A69] chemicals organic

The value in columns E (production) and H (consumption) is unknown. Excluding substance 292181. Also excluding secret values of E: 290216, I: 291801, E:292601, E: 293302, E: 293303, I:299909.

[A70] chlorine

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A71] ethylene

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A72] ethylene oxide

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A73] explosives

No data available

[A74] $FeSO_4$

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A75] formaldehyde

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A76] H_2SO_4

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A77] H_3PO_4

The value in columns E (production) and H (consumption) is unknown. The value in column I is given, not calculated. In columns P and R the value is set to 0 in order to avoid counting the impact twice. See [A1] CAN.

[A78] HCl

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A79] HF

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A80] HNO_3

No data available. In columns P and R the value is set to 0 in order to avoid counting the impact twice in the case when data becomes available. See [A1] CAN.

[A81] hydrogen

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A82] NaCl

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A83] NaOH

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A84] palladium

Columns E , F and G (production, import and export) are unknown. The value in column I is given, not calculated. Consumption is based on 1% of world extraction (source: USGS) (GDPnl/GDPworld=0.01). In column M , the (production - export) data are estimated with the consumption. Since this column denotes the impacts within the NL , this estimate might be plausible.

[A85] paraxylol

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A86] phenol

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A87] platina

Columns E , F and G (production, import and export) and unknown. The value in column I is given, not calculated. Consumption is based on 1% of world extraction (source: USGS) (GDPnl/GDPworld=0.01). In column M , the (production - export) data are estimated with the consumption. Since this column denotes the impacts within the NL , this estimate might be plausible.

[A88] rhodium

Columns E , F and G (production, import and export) and unknown. The value in column I is given, not calculated. Consumption is based on 1% of world extraction (source: USGS) (GDPnl/GDPworld=0.01). In column M , the (production - export) data are estimated with the consumption. Since this column denotes the impacts within the NL , this estimate might be plausible.

[A89] rubber

No data available. Rubber is not a very wel defined category, since it includes a very wide range of materials.

[A90] soda

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A91] styrene

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A92] sulphur (secondary)

Includes all sulphur, not only secondary. The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A93] ureum

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A94] vinylchloride

Not taken in consideration because it is a industrial intermediate. It is never used on its own, only to produce other materials.

[A95] zeolith

No data available.

[A96] wood (massive)

The value in column H (consumption) is unknown. Calculated consumption (column I) is derived by import + production – export.

[A97] wood (board)

Lumped with wood (massive)

Appendix 7 Origins of Contribution to three selected environmental problems of Palladium and Platinum

Table 1 Origins of Palladium contribution to Global Warming
(in German because the ETH database is in German)

Process	Environmental flow	Value (kg CO2 eq.)	Contribution (%)
[P427] Erdgas in Industriefeuerung >100kW Euro	[E25] CO2 Kohlendioxid[air]	1.16E+03	30
[P580] Stk Kraftwerk in D	[E25] CO2 Kohlendioxid[air]	613	16
[P522] Brk Kraftwerk in D	[E25] CO2 Kohlendioxid[air]	256	7
[P541] Industriekohlefeuerung 1-10 MW	[E25] CO2 Kohlendioxid[air]	273	7
[P581] Stk Kraftwerk in E	[E25] CO2 Kohlendioxid[air]	213	5
[P577] Stk aus Untertagbau ab UCPTE-Bergwerk	[E21] CH4 Methan[air]	107	3
[P400] Strom oelthermisch I	[E25] CO2 Kohlendioxid[air]	114	3
[P585] Stk Kraftwerk in NL	[E25] CO2 Kohlendioxid[air]	101	3
[P509] Strom ab Brenngas-Kraftwerk I	[E25] CO2 Kohlendioxid[air]	81.1	2
[P579] Stk Kraftwerk in B	[E25] CO2 Kohlendioxid[air]	74.5	2
[P583] Stk Kraftwerk in F	[E25] CO2 Kohlendioxid[air]	95.7	2
[P584] Stk Kraftwerk in I	[E25] CO2 Kohlendioxid[air]	86.6	2
[P464] Leckage produziertes Erdgas GUS	[E21] CH4 Methan[air]	41	1
[P495] Output Gasturbine Pipeline GUS	[E25] CO2 Kohlendioxid[air]	49.6	1
[P511] Strom ab Brenngas-Kraftwerk NL	[E25] CO2 Kohlendioxid[air]	41.9	1
[P513] Strom ab Brenngas-Kraftwerk W-D	[E25] CO2 Kohlendioxid[air]	39.6	1
[P526] Brk Kraftwerk in GR	[E25] CO2 Kohlendioxid[air]	53.9	1
[P586] Stk Kraftwerk in P	[E25] CO2 Kohlendioxid[air]	45.7	1
All	All	3.45E+03	89

Table 2 Origins of Palladium contribution to Aquatic ecotoxicity
(in German because the ETH database is in German)

Process	Environmental flow	Value (kg 1,4-dichlorobenzene eq.)	Contribution (%)
[P183] Palladium ab Anreicherung	[E44] Ni Nickel[air]	239	38
[P183] Palladium ab Anreicherung	[E27] Cu Kupfer[air]	162	26
[P928] Steinkohleberge-Deponie	[E191] Ion Vanadium[fresh water]	76.6	12
[P928] Steinkohleberge-Deponie	[E76] Ion Barium[fresh water]	31.3	5
[P928] Steinkohleberge-Deponie	[E172] Ion Nickel[fresh water]	27.2	4
[P928] Steinkohleberge-Deponie	[E174] Ion Selen[fresh water]	24.7	4
[P183] Palladium ab Anreicherung	[E172] Ion Nickel[fresh water]	16	3
[P928] Steinkohleberge-Deponie	[E83] Ion Kupfer[fresh water]	10.2	2
[P928] Steinkohleberge-Deponie	[E171] Ion Kobalt[fresh water]	11.6	2
All	All	599	96

Table 3 Origins of Palladium contribution to Eutrophication
(in German because the ETH database is in German)

Process	Environmental flow	Value (kg PO4 eq.)	%
[P427] Erdgas in Industriefeuerung >100kW Euro	[E46] NOx Stickoxide als NO2[air]	0.127	14
[P928] Steinkohleberge-Deponie	[E92] Phosphate[fresh water]	0.0991	11
[P541] Industriekohlefeuerung 1-10 MW	[E46] NOx Stickoxide als NO2[air]	0.0776	8
[P580] Stk Kraftwerk in D	[E46] NOx Stickoxide als NO2[air]	0.0603	7
[P581] Stk Kraftwerk in E	[E46] NOx Stickoxide als NO2[air]	0.0606	7
[P248] Transport Frachter Uebersee	[E46] NOx Stickoxide als NO2[air]	0.0435	5
[P522] Brk Kraftwerk in D	[E46] NOx Stickoxide als NO2[air]	0.045	5
[P583] Stk Kraftwerk in F	[E46] NOx Stickoxide als NO2[air]	0.0335	4
[P400] Strom oelthermisch I	[E46] NOx Stickoxide als NO2[air]	0.0273	3
[P584] Stk Kraftwerk in I	[E46] NOx Stickoxide als NO2[air]	0.0287	3
[P258] Diesel in Baumaschine	[E46] NOx Stickoxide als NO2[air]	0.0148	2
[P495] Output Gasturbine Pipeline GUS	[E46] NOx Stickoxide als NO2[air]	0.0228	2
[P509] Strom ab Brenngas-Kraftwerk I	[E46] NOx Stickoxide als NO2[air]	0.0192	2
[P579] Stk Kraftwerk in B	[E46] NOx Stickoxide als NO2[air]	0.0144	2
[P586] Stk Kraftwerk in P	[E46] NOx Stickoxide als NO2[air]	0.0158	2
[P454] Leckage Erdgas frei UCPTE	[E299] N2 Stickstoff[air]	0.0146	2
[P459] Leckage Foerdergas GUS	[E299] N2 Stickstoff[air]	0.0202	2
[P466] Leckage produziertes Erdgas NL	[E299] N2 Stickstoff[air]	0.0171	2
[P316] Diesel in Dieselaggregat Onshore	[E46] NOx Stickoxide als NO2[air]	0.0134	1
[P513] Strom ab Brenngas-Kraftwerk W-D	[E46] NOx Stickoxide als NO2[air]	0.0104	1
[P526] Brk Kraftwerk in GR	[E46] NOx Stickoxide als NO2[air]	0.0137	1
All	All	0.779	84

Table 4 Origins of Platinum contribution to Global Warming
(in German because the ETH database is in German)

Process	Environmental flow	Value (kg CO2 eq.)	Contribution (%)
[P580] Stk Kraftwerk in D	[E25] CO2 Kohlendioxid[air]	4.21E+03	30
[P427] Erdgas in Industriefeuerung >100kW Euro	[E25] CO2 Kohlendioxid[air]	1.68E+03	12
[P581] Stk Kraftwerk in E	[E25] CO2 Kohlendioxid[air]	1.47E+03	11
[P541] Industriekohlefeuerung 1-10 MW	[E25] CO2 Kohlendioxid[air]	952	7
[P577] Stk aus Untertagbau ab UCPTE-Bergwerk	[E21] CH4 Methan[air]	665	5
[P585] Stk Kraftwerk in NL	[E25] CO2 Kohlendioxid[air]	701	5
[P579] Stk Kraftwerk in B	[E25] CO2 Kohlendioxid[air]	513	4
[P583] Stk Kraftwerk in F	[E25] CO2 Kohlendioxid[air]	595	4
[P584] Stk Kraftwerk in I	[E25] CO2 Kohlendioxid[air]	563	4
[P522] Brk Kraftwerk in D	[E25] CO2 Kohlendioxid[air]	403	3
[P586] Stk Kraftwerk in P	[E25] CO2 Kohlendioxid[air]	323	2
[P201] Roheisen	[E25] CO2 Kohlendioxid[air]	149	1
[P248] Transport Frachter Uebersee	[E25] CO2 Kohlendioxid[air]	141	1
[P400] Strom oelthermisch I	[E25] CO2 Kohlendioxid[air]	180	1
All	All	1.25E+04	90

Table 5 Origins of Platinum contribution to Aquatic Ecotoxicity
(in German because the ETH database is in German)

Process	Environmental flow	Value (kg 1,4 -di-chloroben-zene eq.)	Contribution (%)
[P928] Steinkohleberge-Deponie	[E191] Ion Vanadium[fresh water]	473	24
[P192] Platin ab Anreicherung	[E44] Ni Nickel[air]	334	17
[P192] Platin ab Anreicherung	[E27] Cu Kupfer[air]	224	12
[P928] Steinkohleberge-Deponie	[E76] Ion Barium[fresh water]	193	10
[P928] Steinkohleberge-Deponie	[E172] Ion Nickel[fresh water]	168	9
[P192] Platin ab Anreicherung	[E172] Ion Nickel[fresh water]	154	8
[P928] Steinkohleberge-Deponie	[E174] Ion Selen[fresh water]	152	8
[P928] Steinkohleberge-Deponie	[E171] Ion Kobalt[fresh water]	71.4	4
[P928] Steinkohleberge-Deponie	[E83] Ion Kupfer[fresh water]	63	3
[P192] Platin ab Anreicherung	[E83] Ion Kupfer[fresh water]	22.8	1
All	All	1.86E+03	95

Table 6 Origins of Platinum contribution to Eutrophication
(in German because the ETH database is in German)

Process	Environmental flow	Value (kg PO4 eq.)	Contribution (%)
[P928] Steinkohleberge-Deponie	[E92] Phosphate[fresh water]	0.611	17
[P580] Stk Kraftwerk in D	[E46] NOx Stickoxide als NO2[air]	0.414	12
[P581] Stk Kraftwerk in E	[E46] NOx Stickoxide als NO2[air]	0.417	12
[P541] Industriekohlefeuerung 1-10 MW	[E46] NOx Stickoxide als NO2[air]	0.271	8
[P248] Transport Frachter Uebersee	[E46] NOx Stickoxide als NO2[air]	0.258	7
[P583] Stk Kraftwerk in F	[E46] NOx Stickoxide als NO2[air]	0.208	6
[P427] Erdgas in Industriefeuerung >100kW Euro	[E46] NOx Stickoxide als NO2[air]	0.183	5
[P584] Stk Kraftwerk in I	[E46] NOx Stickoxide als NO2[air]	0.187	5
[P579] Stk Kraftwerk in B	[E46] NOx Stickoxide als NO2[air]	0.0992	3
[P586] Stk Kraftwerk in P	[E46] NOx Stickoxide als NO2[air]	0.112	3
[P258] Diesel in Baumaschine	[E46] NOx Stickoxide als NO2[air]	0.0737	2
[P522] Brk Kraftwerk in D	[E46] NOx Stickoxide als NO2[air]	0.0708	2
[P585] Stk Kraftwerk in NL	[E46] NOx Stickoxide als NO2[air]	0.0539	2
[P400] Strom oelthermisch I	[E46] NOx Stickoxide als NO2[air]	0.043	1
All	All	3	85

Appendix 8 Total score of materials, impact per kg x flows, Regional system, list-of-materials variant.

Table 1 Abiotic depletion, land use and global warming

Material	***Abiotic Depletion***	***Material***	***Land use***	***Material***	***Global Warming***
[A57] raw iron	**2.15E+08**	[A62] animal products (meat, milk, eggs, ...)	**1.90E+10**	[A63] crop or grass	**1.45E+11**
[A20] aluminium 0% Rec.	**1.17E+07**	[A63] crop or grass	**1.06E+10**	[A62] animal products (meat, milk, eggs, ...)	**2.94E+10**
[A48] concrete	**9.84E+06**	[A52] sand (construction)	**6.64E+08**	[A57] raw iron	**2.19E+10**
[A62] animal products (meat, milk, eggs, ...)	**9.39E+06**	[A57] raw iron	**3.12E+08**	[A42] paper	**7.63E+09**
[A42] paper	**9.10E+06**	[A48] concrete	**2.34E+08**	[A31] PE (HD)	**5.17E+09**
[A63] crop or grass	**9.04E+06**	[A42] paper	**1.60E+08**	[A30] ammonia	**4.74E+09**
[A46] cement	**7.11E+06**	[A20] aluminium 0% Rec.	**1.19E+08**	[A20] aluminium 0% Rec.	**3.94E+09**
[A37] PVC	**6.12E+06**	[A37] PVC	**9.05E+07**	[A36] PP	**3.47E+09**
[A24] zinc	**5.96E+06**	[A51] gravel (concrete)	**6.32E+07**	[A96] wood (massive)	**3.32E+09**
[A36] PP	**3.62E+06**	[A36] PP	**5.89E+07**	[A37] PVC	**3.29E+09**
[A31] PE (HD)	**3.36E+06**	[A31] PE (HD)	**5.77E+07**	[A1] CAN (calcium ammonium nitrate)	**3.16E+09**
[A70] chlorine	**2.81E+06**	[A70] chlorine	**4.24E+07**	[A33] PS	**2.31E+09**
[A1] CAN (calcium ammonium nitrate)	**2.55E+06**	[A24] zinc	**4.24E+07**	[A48] concrete	**2.25E+09**
[A43] glas (not coated)	**2.06E+06**	[A47] ceramic	**4.08E+07**	[A47] ceramic	**1.75E+09**
[A33] PS	**1.79E+06**	[A30] ammonia	**3.99E+07**	[A46] cement	**1.33E+09**
[A30] ammonia	**1.76E+06**	[A46] cement	**3.16E+07**	[A52] sand (construction)	**1.19E+09**
[A47] ceramic	**1.60E+06**	[A33] PS	**2.99E+07**	[A32] PC	**1.10E+09**
[A45] rockwool	**1.46E+06**	[A96] wood (massive)	**2.37E+07**	[A24] zinc	**1.06E+09**
[A82] NaCl	**1.27E+06**	[A1] CAN (calcium ammonium nitrate)	**1.89E+07**	[A43] glas (not coated)	**7.63E+08**
[A52] sand (construction)	**9.92E+05**	[A43] glas (not coated)	**1.69E+07**	[A70] chlorine	**5.72E+08**
[A76] H2SO4	**6.60E+05**	[A82] NaCl	**1.50E+07**	[A82] NaCl	**4.97E+08**
[A78] HCl	**5.83E+05**	[A76] H2SO4	**1.15E+07**	[A38] PUR	**3.79E+08**
[A32] PC	**5.67E+05**	[A32] PC	**1.08E+07**	[A45] rockwool	**3.15E+08**
[A38] PUR	**4.20E+05**	[A78] HCl	**8.81E+06**	[A35] PET 0% Rec.	**2.98E+08**
[A2] urea (chalmers)	**4.08E+05**	[A38] PUR	**6.59E+06**	[A76] H2SO4	**2.44E+08**
[A35] PET 0% Rec.	**3.12E+05**	[A45] rockwool	**5.47E+06**	[A9] NPK 15-15-15 (mixed acid route)	**2.40E+08**
[A96] wood (massive)	**2.82E+05**	[A35] PET 0% Rec.	**5.20E+06**	[A92] sulphur (secondary)	**1.20E+08**
[A18] lead soft	**2.28E+05**	[A9] NPK 15-15-15 (mixed acid route)	**3.68E+06**	[A78] HCl	**1.19E+08**

Material	*Abiotic Depletion*	*Material*	*Land use*	*Material*	*Global Warming*
[A9] NPK 15-15-15 (mixed acid route)	**2.27E+05**	[A2] urea (chalmers)	**2.50E+06**	[A51] gravel (concrete)	**8.57E+07**
[A87] platina	**1.54E+05**	[A4] SSP (21% P2O5)	**2.28E+06**	[A13] KNO3 (NK14-44)	**4.04E+07**
[A4] SSP (21% P2O5)	**1.21E+05**	[A40] water (decarbonated)	**8.12E+05**	[A4] SSP (21% P2O5)	**3.67E+07**
[A51] gravel (concrete)	**7.79E+04**	[A18] lead soft	**6.65E+05**	[A87] platina	**2.36E+07**
[A40] water (decarbonated)	**3.36E+04**	[A49] gypsum	**6.59E+05**	[A18] lead soft	**2.30E+07**
[A84] palladium	**2.93E+04**	[A87] platina	**3.66E+05**	[A40] water (decarbonated)	**1.27E+07**
[A88] rhodium	**1.74E+04**	[A92] sulphur (secondary)	**2.81E+05**	[A84] palladium	**6.78E+06**
[A13] KNO3 (NK14-44)	**1.46E+04**	[A13] KNO3 (NK14-44)	**2.14E+05**	[A88] rhodium	**2.25E+06**
[A92] sulphur (secondary)	**1.22E+04**	[A84] palladium	**1.95E+05**	[A49] gypsum	**3.03E+05**
[A49] gypsum	**6.08E+01**	[A26] copper	**1.60E+05**	[A69] chemicals organic	**5.82E+04**
[A23] chromium	**6.94E+00**	[A22] nickel	**4.34E+04**	[A27] bariet	**1.53E+04**
[A27] bariet	**5.82E+00**	[A88] rhodium	**3.43E+04**	[A22] nickel	**1.50E+04**
[A25] manganese	**1.54E+00**	[A27] bariet	**3.27E+04**	[A23] chromium	**5.03E+03**
[A67] CaO	**1.22E+00**	[A23] chromium	**8.10E+03**	[A68] chemicals anorganic	**3.62E+03**
[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**7.92E-01**	[A67] CaO	**6.09E+01**	[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**1.86E+01**
[A21] aluminium 100% Rec.	0.00E+00	[A68] chemicals anorganic	**6.83E+00**	[A21] aluminium 100% Rec.	0.00E+00
[A3] UAN	0.00E+00	[A21] aluminium 100% Rec.	0.00E+00	[A3] UAN	0.00E+00
[A5] TSP (48% P2O5)	0.00E+00	[A3] UAN	0.00E+00	[A5] TSP (48% P2O5)	0.00E+00
[A6] PK 22-22	0.00E+00	[A5] TSP (48% P2O5)	0.00E+00	[A6] PK 22-22	0.00E+00
[A7] MAP (52% P2O5)	0.00E+00	[A6] PK 22-22	0.00E+00	[A7] MAP (52% P2O5)	0.00E+00
[A8] DAP (46% P2O5)	0.00E+00	[A7] MAP (52% P2O5)	0.00E+00	[A8] DAP (46% P2O5)	0.00E+00
[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00	[A8] DAP (46% P2O5)	0.00E+00	[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00
[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00	[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A14] zinc additive to fodder for animal production (incl .production of zinc)	0.00E+00	[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A14] zinc additive to fodder for animal production (incl .production of zinc)	0.00E+00
[A15] copper additive to fodder for	0.00E+00	[A14] zinc additive to fodder for	0.00E+00	[A15] copper additive to fodder for animal	0.00E+00

Material	Abiotic Depletion	Material	Land use	Material	Global Warming
animal production (incl. production of copper)		animal production (incl .production of zinc)		production (incl. production of copper)	
[A16] pesticides for crop production	0.00E+00	[A15] copper additive to fodder for animal production (incl. production of copper)	0.00E+00	[A16] pesticides for crop production	0.00E+00
[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00	[A16] pesticides for crop production	0.00E+00	[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00
[A19] lead hard	0.00E+00	[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00	[A19] lead hard	0.00E+00
[A28] refrigerant R22	0.00E+00	[A19] lead hard	0.00E+00	[A28] refrigerant R22	0.00E+00
[A29] refrigerant R134a	0.00E+00	[A28] refrigerant R22	0.00E+00	[A29] refrigerant R134a	0.00E+00
[A34] PE (LD)	0.00E+00	[A29] refrigerant R134a	0.00E+00	[A34] PE (LD)	0.00E+00
[A39] water (demineralised)	0.00E+00	[A34] PE (LD)	0.00E+00	[A39] water (demineralised)	0.00E+00
[A41] board (karton)	0.00E+00	[A39] water (demineralised)	0.00E+00	[A41] board (karton)	0.00E+00
[A44] glas (coated)	0.00E+00	[A41] board (karton)	0.00E+00	[A44] glas (coated)	0.00E+00
[A50] limestone	0.00E+00	[A44] glas (coated)	0.00E+00	[A50] limestone	0.00E+00
[A53] gypsum (raw stone)	0.00E+00	[A50] limestone	0.00E+00	[A53] gypsum (raw stone)	0.00E+00
[A54] clay_loam	0.00E+00	[A53] gypsum (raw stone)	0.00E+00	[A54] clay_loam	0.00E+00
[A55] steel (high alloyed)	0.00E+00	[A54] clay_loam	0.00E+00	[A55] steel (high alloyed)	0.00E+00
[A56] cast iron	0.00E+00	[A55] steel (high alloyed)	0.00E+00	[A56] cast iron	0.00E+00
[A58] steel (light alloyed)	0.00E+00	[A56] cast iron	0.00E+00	[A58] steel (light alloyed)	0.00E+00
[A59] "blas stahl"	0.00E+00	[A58] steel (light alloyed)	0.00E+00	[A59] "blas stahl"	0.00E+00
[A60] electro steel	0.00E+00	[A59] "blas stahl"	0.00E+00	[A60] electro steel	0.00E+00
[A61] steel (not alloyed)	0.00E+00	[A60] electro steel	0.00E+00	[A61] steel (not alloyed)	0.00E+00
[A65] Bentonite	0.00E+00	[A61] steel (not alloyed)	0.00E+00	[A65] Bentonite	0.00E+00
[A66] Ca(OH)2	0.00E+00	[A65] Bentonite	0.00E+00	[A66] Ca(OH)2	0.00E+00
[A71] ethylene	0.00E+00	[A66] Ca(OH)2	0.00E+00	[A71] ethylene	0.00E+00
[A72] ethylene oxide	0.00E+00	[A69] chemicals organic	0.00E+00	[A72] ethylene oxide	0.00E+00
[A73] explosives	0.00E+00	[A71] ethylene	0.00E+00	[A73] explosives	0.00E+00
[A74] FeSO4	0.00E+00	[A72] ethylene ox.	0.00E+00	[A74] FeSO4	0.00E+00

Material	***Abiotic Depletion***	***Material***	***Land use***	***Material***	***Global Warming***
[A75] formaldehyde	0.00E+00	[A73] explosives	0.00E+00	[A75] formaldehyde	0.00E+00
[A79] HF	0.00E+00	[A74] FeSO4	0.00E+00	[A79] HF	0.00E+00
[A80] HNO3	0.00E+00	[A75] formaldehyde	0.00E+00	[A80] HNO3	0.00E+00
[A81] hydrogen	0.00E+00	[A79] HF	0.00E+00	[A81] hydrogen	0.00E+00
[A83] NaOH	0.00E+00	[A80] HNO3	0.00E+00	[A83] NaOH	0.00E+00
[A85] paraxylol	0.00E+00	[A81] hydrogen	0.00E+00	[A85] paraxylol	0.00E+00
[A86] phenol	0.00E+00	[A83] NaOH	0.00E+00	[A86] phenol	0.00E+00
[A89] rubber	0.00E+00	[A85] paraxylol	0.00E+00	[A89] rubber	0.00E+00
[A90] soda	0.00E+00	[A86] phenol	0.00E+00	[A90] soda	0.00E+00
[A91] styrene	0.00E+00	[A89] rubber	0.00E+00	[A91] styrene	0.00E+00
[A93] ureum	0.00E+00	[A90] soda	0.00E+00	[A93] ureum	0.00E+00
[A94] vinylchloride	0.00E+00	[A91] styrene	0.00E+00	[A94] vinylchloride	0.00E+00
[A95] zeolith	0.00E+00	[A93] ureum	0.00E+00	[A95] zeolith	0.00E+00
[A97] wood (board)	0.00E+00	[A94] vinylchloride	0.00E+00	[A97] wood (board)	0.00E+00
[A68] chemicals anorganic	**-1.37E-01**	[A95] zeolith	0.00E+00	[A64] AlO3	**-2.51E+03**
[A77] H3PO4	**-8.93E+00**	[A97] wood (board)	0.00E+00	[A67] CaO	**-4.87E+03**
[A22] nickel	**-1.43E+01**	[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**-1.72E+00**	[A25] manganese	**-5.12E+03**
[A64] AlO3	**-1.27E+02**	[A77] H3PO4	**-4.39E+01**	[A77] H3PO4	**-8.02E+03**
[A69] chemicals organic	**-1.81E+02**	[A64] AlO3	**-1.26E+02**	[A26] copper	**-1.27E+06**
[A26] copper	**-1.47E+04**	[A25] manganese	**-1.27E+04**	[A2] urea (chalmers)	**-1.53E+07**

Table 2 Ozone layer depletion, human toxicity and aquatic ecotoxicity

Material	***Ozone layer depletion***	***Material***	***Human toxicity***	***Material***	***Aquatic ecotoxicity***
[A37] PVC	**2.58E+05**	[A57] raw iron	**1.62E+10**	[A63] crop or grass	**9.00E+09**
[A31] PE (HD)	**1.21E+04**	[A24] zinc	**9.98E+09**	[A16] pesticides for crop production	**8.03E+09**
[A36] PP	**7.55E+03**	[A31] PE (HD)	**4.00E+09**	[A62] animal products (meat, milk, eggs, ...)	**7.79E+09**
[A33] PS	**4.72E+03**	[A35] PET 0% Rec.	**2.75E+09**	[A57] raw iron	**3.07E+09**
[A57] raw iron	**4.66E+03**	[A33] PS	**1.92E+09**	[A22] nickel	**5.51E+08**
[A42] paper	**3.10E+03**	[A36] PP	**1.74E+09**	[A15] copper additive to fodder for animal production (incl. production of copper)	**3.75E+08**
[A62] animal products (meat, milk, eggs, ...)	**2.10E+03**	[A42] paper	**1.67E+09**	[A42] paper	**2.72E+08**
[A20] aluminium 0% Rec.	**2.02E+03**	[A20] aluminium 0% Rec.	**1.64E+09**	[A31] PE (HD)	**2.38E+08**
[A63] crop or grass	**1.94E+03**	[A47] ceramic	**1.62E+09**	[A20] aluminium 0% Rec.	**1.94E+08**
[A32] PC	**1.64E+03**	[A62] animal products (meat, milk, eggs, ...)	**1.54E+09**	[A24] zinc	**1.89E+08**
[A52] sand (construction)	**1.47E+03**	[A63] crop or grass	**1.54E+09**	[A36] PP	**1.70E+08**
[A48] concrete	**1.10E+03**	[A37] PVC	**1.21E+09**	[A48] concrete	**1.29E+08**
[A35] PET 0% Rec.	**8.37E+02**	[A18] lead soft	**1.09E+09**	[A37] PVC	**9.81E+07**
[A70] chlorine	**7.41E+02**	[A16] pesticides for crop production	**8.29E+08**	[A46] cement	**9.34E+07**
[A30] ammonia	**5.38E+02**	[A48] concrete	**6.23E+08**	[A33] PS	**7.74E+07**
[A1] CAN (calcium ammonium nitrate)	**5.35E+02**	[A46] cement	**4.00E+08**	[A14] zinc additive to fodder for animal production (incl .production of zinc)	**3.50E+07**
[A24] zinc	**3.57E+02**	[A32] PC	**3.67E+08**	[A27] bariet	**3.47E+07**
[A46] cement	**3.29E+02**	[A30] ammonia	**2.30E+08**	[A1] CAN (calcium ammonium nitrate)	**3.34E+07**
[A82] NaCl	**3.06E+02**	[A43] glas (not coated)	**1.91E+08**	[A70] chlorine	**2.87E+07**
[A47] ceramic	**2.31E+02**	[A70] chlorine	**1.82E+08**	[A43] glas (not coated)	**2.76E+07**
[A2] urea (chalmers)	**1.79E+02**	[A82] NaCl	**1.75E+08**	[A30] ammonia	**2.66E+07**
[A92] sulphur (secondary)	**1.72E+02**	[A1] CAN (calcium ammonium nitrate)	**1.68E+08**	[A32] PC	**2.42E+07**
[A78] HCl	**1.54E+02**	[A52] sand (construction)	**1.49E+08**	[A82] NaCl	**2.32E+07**
[A9] NPK 15-15-15 (mixed acid route)	**1.30E+02**	[A27] bariet	**9.50E+07**	[A45] rockwool	**1.98E+07**
[A43] glas (not coated)	**1.28E+02**	[A45] rockwool	**9.33E+07**	[A47] ceramic	**1.90E+07**

Material	*Ozone layer depletion*	*Material*	*Human toxicity*	*Material*	*Aquatic ecotoxicity*
[A45] rockwool	**1.28E+02**	[A38] PUR	**6.65E+07**	[A96] wood (massive)	**1.50E+07**
[A38] PUR	**1.23E+02**	[A15] copper additive to fodder for animal production (incl. production of copper)	**5.97E+07**	[A52] sand (construction)	**1.47E+07**
[A51] gravel (concrete)	**1.05E+02**	[A22] nickel	**5.68E+07**	[A35] PET 0% Rec.	**1.44E+07**
[A76] H2SO4	**6.68E+01**	[A96] wood (massive)	**5.20E+07**	[A38] PUR	**7.98E+06**
[A96] wood (massive)	**6.56E+01**	[A92] sulphur (secondary)	**5.02E+07**	[A76] H2SO4	**6.68E+06**
[A4] SSP (21% P2O5)	**3.01E+01**	[A87] platina	**4.93E+07**	[A78] HCl	**5.96E+06**
[A13] KNO3 (NK14-44)	**1.64E+01**	[A14] zinc additive to fodder for animal production (incl .production of zinc)	**4.67E+07**	[A2] urea (chalmers)	**5.39E+06**
[A40] water (decarbonated)	**1.55E+01**	[A76] H2SO4	**4.50E+07**	[A92] sulphur (secondary)	**4.34E+06**
[A18] lead soft	**9.25E+00**	[A78] HCl	**3.78E+07**	[A87] platina	**3.29E+06**
[A87] platina	**2.30E+00**	[A84] palladium	**3.10E+07**	[A9] NPK 15-15-15 (mixed acid route)	**3.07E+06**
[A84] palladium	**1.15E+00**	[A2] urea (chalmers)	**2.81E+07**	[A40] water (decarbonated)	**1.90E+06**
[A49] gypsum	**4.10E-01**	[A9] NPK 15-15-15 (mixed acid route)	**2.29E+07**	[A18] lead soft	**1.71E+06**
[A88] rhodium	**2.16E-01**	[A51] gravel (concrete)	**1.08E+07**	[A4] SSP (21% P2O5)	**1.27E+06**
[A22] nickel	**2.57E-02**	[A4] SSP (21% P2O5)	**9.63E+06**	[A51] gravel (concrete)	**1.11E+06**
[A27] bariet	**2.02E-02**	[A88] rhodium	**4.40E+06**	[A84] palladium	**1.08E+06**
[A69] chemicals organic	**6.13E-03**	[A13] KNO3 (NK14-44)	**1.70E+06**	[A88] rhodium	**3.10E+05**
[A23] chromium	**5.11E-03**	[A64] AlO3	**1.48E+05**	[A13] KNO3 (NK14-44)	**2.22E+05**
[A67] CaO	**1.81E-03**	[A69] chemicals organic	**9.75E+04**	[A23] chromium	**1.08E+05**
[A68] chemicals anorganic	**1.37E-04**	[A23] chromium	**3.01E+04**	[A26] copper	**6.24E+04**
[A21] aluminium 100% Rec.	0.00E+00	[A68] chemicals anorganic	**1.20E+04**	[A49] gypsum	**1.76E+03**
[A3] UAN	0.00E+00	[A49] gypsum	**1.06E+04**	[A69] chemicals organic	**1.10E+03**
[A5] TSP (48% P2O5)	0.00E+00	[A25] manganese	**2.27E+03**	[A64] AlO3	**6.28E+02**
[A6] PK 22-22	0.00E+00	[A21] aluminium 100% Rec.	0.00E+00	[A68] chemicals anorganic	**3.42E+02**
[A7] MAP (52% P2O5)	0.00E+00	[A3] UAN	0.00E+00	[A25] manganese	**3.64E+01**

Material	*Ozone layer depletion*	*Material*	*Human toxicity*	*Material*	*Aquatic ecotoxicity*
[A8] DAP (46% P2O5)	0.00E+00	[A5] TSP (48% P2O5)	0.00E+00	[A21] aluminium 100% Rec.	0.00E+00
[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00	[A6] PK 22-22	0.00E+00	[A3] UAN	0.00E+00
[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A7] MAP (52% P2O5)	0.00E+00	[A5] TSP (48% P2O5)	0.00E+00
[A14] zinc additive to fodder for animal production (incl .production of zinc)	0.00E+00	[A8] DAP (46% P2O5)	0.00E+00	[A6] PK 22-22	0.00E+00
[A15] copper additive to fodder for animal production (incl. production of copper)	0.00E+00	[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00	[A7] MAP (52% P2O5)	0.00E+00
[A16] pesticides for crop production	0.00E+00	[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A8] DAP (46% P2O5)	0.00E+00
[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00	[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00	[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00
[A19] lead hard	0.00E+00	[A19] lead hard	0.00E+00	[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A28] refrigerant R22	0.00E+00	[A28] refrigerant R22	0.00E+00	[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00
[A29] refrigerant R134a	0.00E+00	[A29] refrigerant R134a	0.00E+00	[A19] lead hard	0.00E+00
[A34] PE (LD)	0.00E+00	[A34] PE (LD)	0.00E+00	[A28] refrigerant R22	0.00E+00
[A39] water (demineralised)	0.00E+00	[A39] water (demineralised)	0.00E+00	[A29] refrigerant R134a	0.00E+00
[A41] board (karton)	0.00E+00	[A41] board (karton)	0.00E+00	[A34] PE (LD)	0.00E+00
[A44] glas (coated)	0.00E+00	[A44] glas (coated)	0.00E+00	[A39] water (demineralised)	0.00E+00
[A50] limestone	0.00E+00	[A50] limestone	0.00E+00	[A41] board (karton)	0.00E+00
[A53] gypsum (raw stone)	0.00E+00	[A53] gypsum (raw stone)	0.00E+00	[A44] glas (coated)	0.00E+00
[A54] clay_loam	0.00E+00	[A54] clay_loam	0.00E+00	[A50] limestone	0.00E+00
[A55] steel (high alloyed)	0.00E+00	[A55] steel (high alloyed)	0.00E+00	[A53] gypsum (raw stone)	0.00E+00
[A56] cast iron	0.00E+00	[A56] cast iron	0.00E+00	[A54] clay_loam	0.00E+00
[A58] steel (light alloyed)	0.00E+00	[A58] steel (light alloyed)	0.00E+00	[A55] steel (high alloyed)	0.00E+00
[A59] "blas stahl"	0.00E+00	[A59] "blas stahl"	0.00E+00	[A56] cast iron	0.00E+00
[A60] electro steel	0.00E+00	[A60] electro steel	0.00E+00	[A58] steel (light alloyed)	0.00E+00
[A61] steel (not alloyed)	0.00E+00	[A61] steel (not alloyed)	0.00E+00	[A59] "blas stahl"	0.00E+00
[A65] Bentonite	0.00E+00	[A65] Bentonite	0.00E+00	[A60] electro steel	0.00E+00

Material	*Ozone layer depletion*	*Material*	*Human toxicity*	*Material*	*Aquatic ecotoxicity*
[A66] Ca(OH)2	0.00E+00	[A66] Ca(OH)2	0.00E+00	[A61] steel (not alloyed)	0.00E+00
[A71] ethylene	0.00E+00	[A71] ethylene	0.00E+00	[A65] Bentonite	0.00E+00
[A72] ethylene oxide	0.00E+00	[A72] ethylene oxide	0.00E+00	[A66] Ca(OH)2	0.00E+00
[A73] explosives	0.00E+00	[A73] explosives	0.00E+00	[A71] ethylene	0.00E+00
[A74] FeSO4	0.00E+00	[A74] FeSO4	0.00E+00	[A72] ethylene oxide	0.00E+00
[A75] formaldehyde	0.00E+00	[A75] formaldehyde	0.00E+00	[A73] explosives	0.00E+00
[A79] HF	0.00E+00	[A79] HF	0.00E+00	[A74] FeSO4	0.00E+00
[A80] HNO3	0.00E+00	[A80] HNO3	0.00E+00	[A75] formaldehyde	0.00E+00
[A81] hydrogen	0.00E+00	[A81] hydrogen	0.00E+00	[A79] HF	0.00E+00
[A83] NaOH	0.00E+00	[A83] NaOH	0.00E+00	[A80] HNO3	0.00E+00
[A85] paraxylol	0.00E+00	[A85] paraxylol	0.00E+00	[A81] hydrogen	0.00E+00
[A86] phenol	0.00E+00	[A86] phenol	0.00E+00	[A83] NaOH	0.00E+00
[A89] rubber	0.00E+00	[A89] rubber	0.00E+00	[A85] paraxylol	0.00E+00
[A90] soda	0.00E+00	[A90] soda	0.00E+00	[A86] phenol	0.00E+00
[A91] styrene	0.00E+00	[A91] styrene	0.00E+00	[A89] rubber	0.00E+00
[A93] ureum	0.00E+00	[A93] ureum	0.00E+00	[A90] soda	0.00E+00
[A94] vinylchloride	0.00E+00	[A94] vinylchloride	0.00E+00	[A91] styrene	0.00E+00
[A95] zeolith	0.00E+00	[A95] zeolith	0.00E+00	[A93] ureum	0.00E+00
[A97] wood (board)	0.00E+00	[A97] wood (board)	0.00E+00	[A94] vinylchloride	0.00E+00
[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**-9.31E-06**	[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**-2.27E+03**	[A95] zeolith	0.00E+00
[A77] H3PO4	**-7.12E-04**	[A77] H3PO4	**-4.85E+04**	[A97] wood (board)	0.00E+00
[A64] AlO3	**-3.14E-03**	[A67] CaO	**-5.13E+04**	[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**-2.10E+01**
[A25] manganese	**-7.89E-03**	[A26] copper	**-1.71E+05**	[A67] CaO	**-1.07E+03**
[A26] copper	**-1.52E+00**	[A40] water (decarbonated)	**-8.59E+06**	[A77] H3PO4	**-1.36E+03**

Table 3 Marine ecotoxicity, terrestrial ecotoxicity, photochemical oxidant formation

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A47] ceramic	**2.16E+13**	[A63] crop or grass	**3.66E+08**	[A31] PE (HD)	**2.78E+07**
[A57] raw iron	**1.52E+13**	[A62] animal products (meat, milk, eggs, ...)	**3.29E+08**	[A57] raw iron	**1.16E+07**
[A20] aluminium 0% Rec.	**8.93E+12**	[A16] pesticides for crop production	**3.20E+08**	[A62] animal products (meat, milk, eggs, ...)	**4.39E+06**
[A42] paper	**2.59E+12**	[A24] zinc	**1.20E+08**	[A36] PP	**2.52E+06**
[A31] PE (HD)	**2.43E+12**	[A57] raw iron	**8.36E+07**	[A42] paper	**2.34E+06**
[A62] animal products (meat, milk, eggs, ...)	**1.97E+12**	[A31] PE (HD)	**7.52E+07**	[A30] ammonia	**1.69E+06**
[A63] crop or grass	**1.77E+12**	[A42] paper	**4.89E+07**	[A92] sulphur (secondary)	**1.52E+06**
[A36] PP	**1.72E+12**	[A36] PP	**4.15E+07**	[A20] aluminium 0% Rec.	**1.12E+06**
[A37] PVC	**1.62E+12**	[A37] PVC	**2.46E+07**	[A63] crop or grass	**1.07E+06**
[A24] zinc	**1.19E+12**	[A20] aluminium 0% Rec.	**2.28E+07**	[A37] PVC	**9.83E+05**
[A43] glas (not coated)	**1.16E+12**	[A33] PS	**1.96E+07**	[A33] PS	**9.43E+05**
[A33] PS	**8.47E+11**	[A14] zinc additive to fodder for animal production (incl .production of zinc)	**1.82E+07**	[A48] concrete	**7.66E+05**
[A48] concrete	**7.68E+11**	[A70] chlorine	**1.31E+07**	[A45] rockwool	**5.78E+05**
[A70] chlorine	**6.08E+11**	[A15] copper additive to fodder for animal production (incl. production of copper)	**8.89E+06**	[A24] zinc	**4.71E+05**
[A46] cement	**4.45E+11**	[A32] PC	**8.71E+06**	[A32] PC	**4.24E+05**
[A30] ammonia	**4.26E+11**	[A48] concrete	**8.45E+06**	[A47] ceramic	**4.00E+05**
[A22] nickel	**3.79E+11**	[A30] ammonia	**6.67E+06**	[A1] CAN (calcium ammonium nitrate)	**3.87E+05**
[A32] PC	**3.00E+11**	[A18] lead soft	**6.32E+06**	[A52] sand (construction)	**3.87E+05**
[A82] NaCl	**2.78E+11**	[A46] cement	**5.42E+06**	[A46] cement	**3.82E+05**
[A52] sand (construction)	**2.61E+11**	[A82] NaCl	**3.68E+06**	[A76] H2SO4	**3.16E+05**
[A1] CAN (calcium ammonium nitrate)	**2.24E+11**	[A78] HCl	**2.71E+06**	[A87] platina	**3.12E+05**
[A45] rockwool	**2.05E+11**	[A35] PET 0% Rec.	**2.68E+06**	[A82] NaCl	**2.32E+05**
[A38] PUR	**1.54E+11**	[A52] sand (construction)	**2.30E+06**	[A84] palladium	**2.18E+05**
[A76] H2SO4	**1.42E+11**	[A47] ceramic	**2.11E+06**	[A70] chlorine	**2.06E+05**

Material	*Marine ecotoxicity*	*Material*	*Terrestrial ecotoxicity*	*Material*	*Photo chemical ox.form.*
[A35] PET 0% Rec.	**1.32E+11**	[A38] PUR	**1.72E+06**	[A43] glas (not coated)	**1.86E+05**
[A78] HCl	**1.26E+11**	[A1] CAN (calcium ammonium nitrate)	**1.71E+06**	[A35] PET 0% Rec.	**1.86E+05**
[A27] bariet	**1.25E+11**	[A92] sulphur (secondary)	**1.70E+06**	[A9] NPK 15-15-15 (mixed acid route)	**9.20E+04**
[A15] copper additive to fodder for animal production (incl. production of copper)	**7.62E+10**	[A43] glas (not coated)	**9.39E+05**	[A38] PUR	**8.81E+04**
[A96] wood (massive)	**6.64E+10**	[A96] wood (massive)	**9.36E+05**	[A96] wood (massive)	**6.34E+04**
[A2] urea (chalmers)	**4.25E+10**	[A45] rockwool	**9.23E+05**	[A2] urea (chalmers)	**5.66E+04**
[A92] sulphur (secondary)	**4.06E+10**	[A76] H2SO4	**6.15E+05**	[A78] HCl	**4.26E+04**
[A87] platina	**3.59E+10**	[A2] urea (chalmers)	**3.64E+05**	[A51] gravel (concrete)	**2.92E+04**
[A9] NPK 15-15-15 (mixed acid route)	**2.92E+10**	[A9] NPK 15-15-15 (mixed acid route)	**3.23E+05**	[A88] rhodium	**2.78E+04**
[A4] SSP (21% P2O5)	**2.61E+10**	[A87] platina	**2.01E+05**	[A4] SSP (21% P2O5)	**2.57E+04**
[A51] gravel (concrete)	**1.99E+10**	[A51] gravel (concrete)	**1.66E+05**	[A18] lead soft	**1.10E+04**
[A18] lead soft	**1.70E+10**	[A4] SSP (21% P2O5)	**1.42E+05**	[A13] KNO3 (NK14-44)	**7.81E+03**
[A84] palladium	**9.44E+09**	[A84] palladium	**1.07E+05**	[A64] AlO3	**1.22E+03**
[A40] water (decarbonated)	**6.82E+09**	[A40] water (decarbonated)	**5.11E+04**	[A69] chemicals organic	**7.17E+02**
[A14] zinc additive to fodder for animal production (incl .production of zinc)	**5.25E+09**	[A13] KNO3 (NK14-44)	**2.50E+04**	[A26] copper	**2.50E+02**
[A88] rhodium	**3.42E+09**	[A88] rhodium	**1.83E+04**	[A68] chemicals anorganic	**7.91E+01**
[A13] KNO3 (NK14-44)	**2.15E+09**	[A49] gypsum	**4.50E+02**	[A27] bariet	**2.07E+01**
[A16] pesticides for crop production	**1.93E+08**	[A68] chemicals anorganic	**6.83E+01**	[A49] gypsum	**2.02E+01**
[A49] gypsum	**1.73E+07**	[A69] chemicals organic	**6.13E+01**	[A25] manganese	**1.67E+01**
[A23] chromium	**1.39E+07**	[A27] bariet	**3.07E+01**	[A97] wood (board)	0.00E+00
[A68] chemicals anorganic	**3.42E+06**	[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**3.63E+00**	[A95] zeolith	0.00E+00
[A69] chemicals organic	**3.07E+06**	[A25] manganese	**3.31E-01**	[A94] vinylchloride	0.00E+00
[A25] manganese	**5.62E+05**	[A21] aluminium 100% Rec.	0.00E+00	[A93] ureum	0.00E+00

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A21] aluminium 100% Rec.	0.00E+00	[A3] UAN	0.00E+00	[A91] styrene	0.00E+00
[A3] UAN	0.00E+00	[A5] TSP (48% P2O5)	0.00E+00	[A90] soda	0.00E+00
[A5] TSP (48% P2O5)	0.00E+00	[A6] PK 22-22	0.00E+00	[A89] rubber	0.00E+00
[A6] PK 22-22	0.00E+00	[A7] MAP (52% P2O5)	0.00E+00	[A86] phenol	0.00E+00
[A7] MAP (52% P2O5)	0.00E+00	[A8] DAP (46% P2O5)	0.00E+00	[A85] paraxylol	0.00E+00
[A8] DAP (46% P2O5)	0.00E+00	[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00	[A83] NaOH	0.00E+00
[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00	[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A81] hydrogen	0.00E+00
[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00	[A80] HNO3	0.00E+00
[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00	[A19] lead hard	0.00E+00	[A8] DAP (46% P2O5)	0.00E+00
[A19] lead hard	0.00E+00	[A28] refrigerant R22	0.00E+00	[A79] HF	0.00E+00
[A28] refrigerant R22	0.00E+00	[A29] refrigerant R134a	0.00E+00	[A75] formaldehyde	0.00E+00
[A29] refrigerant R134a	0.00E+00	[A34] PE (LD)	0.00E+00	[A74] FeSO4	0.00E+00
[A34] PE (LD)	0.00E+00	[A39] water (demineralised)	0.00E+00	[A73] explosives	0.00E+00
[A39] water (demineralised)	0.00E+00	[A41] board (karton)	0.00E+00	[A72] ethylene oxide	0.00E+00
[A41] board (karton)	0.00E+00	[A44] glas (coated)	0.00E+00	[A71] ethylene	0.00E+00
[A44] glas (coated)	0.00E+00	[A50] limestone	0.00E+00	[A7] MAP (52% P2O5)	0.00E+00
[A50] limestone	0.00E+00	[A53] gypsum (raw stone)	0.00E+00	[A66] Ca(OH)2	0.00E+00
[A53] gypsum (raw stone)	0.00E+00	[A54] clay_loam	0.00E+00	[A65] Bentonite	0.00E+00
[A54] clay_loam	0.00E+00	[A55] steel (high alloyed)	0.00E+00	[A61] steel (not alloyed)	0.00E+00
[A55] steel (high alloyed)	0.00E+00	[A56] cast iron	0.00E+00	[A60] electro steel	0.00E+00
[A56] cast iron	0.00E+00	[A58] steel (light alloyed)	0.00E+00	[A6] PK 22-22	0.00E+00
[A58] steel (light alloyed)	0.00E+00	[A59] "blas stahl"	0.00E+00	[A59] "blas stahl"	0.00E+00
[A59] "blas stahl"	0.00E+00	[A60] electro steel	0.00E+00	[A58] steel (light alloyed)	0.00E+00

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A60] electro steel	0.00E+00	[A61] steel (not alloyed)	0.00E+00	[A56] cast iron	0.00E+00
[A61] steel (not alloyed)	0.00E+00	[A65] Bentonite	0.00E+00	[A55] steel (high alloyed)	0.00E+00
[A65] Bentonite	0.00E+00	[A66] Ca(OH)2	0.00E+00	[A54] clay_loam	0.00E+00
[A66] Ca(OH)2	0.00E+00	[A71] ethylene	0.00E+00	[A53] gypsum (raw stone)	0.00E+00
[A71] ethylene	0.00E+00	[A72] ethylene oxide	0.00E+00	[A50] limestone	0.00E+00
[A72] ethylene oxide	0.00E+00	[A73] explosives	0.00E+00	[A5] TSP (48% P2O5)	0.00E+00
[A73] explosives	0.00E+00	[A74] FeSO4	0.00E+00	[A44] glas (coated)	0.00E+00
[A74] FeSO4	0.00E+00	[A75] formaldehyde	0.00E+00	[A41] board (karton)	0.00E+00
[A75] formaldehyde	0.00E+00	[A79] HF	0.00E+00	[A39] water (demineralised)	0.00E+00
[A79] HF	0.00E+00	[A80] HNO3	0.00E+00	[A34] PE (LD)	0.00E+00
[A80] HNO3	0.00E+00	[A81] hydrogen	0.00E+00	[A3] UAN	0.00E+00
[A81] hydrogen	0.00E+00	[A83] NaOH	0.00E+00	[A29] refrigerant R134a	0.00E+00
[A83] NaOH	0.00E+00	[A85] paraxylol	0.00E+00	[A28] refrigerant R22	0.00E+00
[A85] paraxylol	0.00E+00	[A86] phenol	0.00E+00	[A21] aluminium 100% Rec.	0.00E+00
[A86] phenol	0.00E+00	[A89] rubber	0.00E+00	[A19] lead hard	0.00E+00
[A89] rubber	0.00E+00	[A90] soda	0.00E+00	[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00
[A90] soda	0.00E+00	[A91] styrene	0.00E+00	[A16] pesticides for crop production	0.00E+00
[A91] styrene	0.00E+00	[A93] ureum	0.00E+00	[A15] copper additive to fodder for animal production (incl. production of copper)	0.00E+00
[A93] ureum	0.00E+00	[A94] vinylchloride	0.00E+00	[A14] zinc additive to fodder for animal production (incl .production of zinc)	0.00E+00
[A94] vinylchloride	0.00E+00	[A95] zeolith	0.00E+00	[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A95] zeolith	0.00E+00	[A97] wood (board)	0.00E+00	[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00
[A97] wood (board)	0.00E+00	[A23] chromium	**-3.13E+01**	[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**-1.80E+01**
[A12] AP (ammonium phosphate) (49%	**-7.92E+04**	[A67] CaO	**-1.16E+02**	[A23] chromium	**-1.85E+01**

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
P2O5, 11% N)					
[A67] CaO	**-7.18E+06**	[A77] H3PO4	**-1.35E+02**	[A77] H3PO4	**-3.44E+02**
[A77] H3PO4	**-1.11E+07**	[A22] nickel	**-1.61E+02**	[A67] CaO	**-3.85E+02**
[A64] AlO3	**-1.26E+07**	[A64] AlO3	**-5.02E+02**	[A22] nickel	**-5.43E+02**
[A26] copper	**-6.54E+09**	[A26] copper	**-2.44E+03**	[A40] water (decarbonated)	**-8.48E+04**

Table 4 Acidification and eutrophication

Material	***Acidification***	***Material***	***Eutrophication***
[A62] animal products (meat, milk, eggs, ...)	**1.70E+08**	[A63] crop or grass	**2.96E+09**
[A57] raw iron	**7.85E+07**	[A62] animal products (meat, milk, eggs, ...)	**2.08E+09**
[A42] paper	**4.84E+07**	[A30] ammonia	**3.43E+08**
[A36] PP	**4.28E+07**	[A1] CAN (calcium ammonium nitrate)	**1.25E+08**
[A92] sulphur (secondary)	**3.79E+07**	[A4] SSP (21% P2O5)	**6.57E+07**
[A31] PE (HD)	**3.56E+07**	[A57] raw iron	**5.86E+06**
[A30] ammonia	**2.82E+07**	[A36] PP	**5.17E+06**
[A20] aluminium 0% Rec.	**2.36E+07**	[A42] paper	**1.78E+06**
[A63] crop or grass	**1.93E+07**	[A48] concrete	**1.63E+06**
[A37] PVC	**1.74E+07**	[A31] PE (HD)	**1.38E+06**
[A33] PS	**1.42E+07**	[A46] cement	**9.51E+05**
[A48] concrete	**1.09E+07**	[A20] aluminium 0% Rec.	**8.89E+05**
[A24] zinc	**9.37E+06**	[A52] sand (construction)	**7.73E+05**
[A87] platina	**7.76E+06**	[A47] ceramic	**7.55E+05**
[A76] H2SO4	**7.52E+06**	[A37] PVC	**6.56E+05**
[A1] CAN (calcium ammonium nitrate)	**7.04E+06**	[A33] PS	**6.48E+05**
[A47] ceramic	**6.89E+06**	[A24] zinc	**4.36E+05**
[A46] cement	**5.92E+06**	[A32] PC	**2.97E+05**
[A52] sand (construction)	**5.77E+06**	[A43] glas (not coated)	**2.57E+05**
[A32] PC	**5.75E+06**	[A45] rockwool	**2.30E+05**
[A84] palladium	**5.44E+06**	[A82] NaCl	**1.88E+05**
[A70] chlorine	**4.43E+06**	[A96] wood (massive)	**1.56E+05**
[A82] NaCl	**4.20E+06**	[A70] chlorine	**1.46E+05**
[A43] glas (not coated)	**2.22E+06**	[A35] PET 0% Rec.	**1.08E+05**
[A45] rockwool	**2.18E+06**	[A51] gravel (concrete)	**6.37E+04**
[A35] PET 0% Rec.	**2.15E+06**	[A76] H2SO4	**6.05E+04**
[A38] PUR	**1.84E+06**	[A38] PUR	**4.47E+04**
[A9] NPK 15-15-15 (mixed acid route)	**1.76E+06**	[A92] sulphur (secondary)	**3.30E+04**
[A2] urea (chalmers)	**1.61E+06**	[A78] HCl	**3.02E+04**
[A96] wood (massive)	**9.46E+05**	[A18] lead soft	**1.21E+04**
[A78] HCl	**9.14E+05**	[A40] water (decarbonated)	**1.16E+04**
[A88] rhodium	**6.91E+05**	[A87] platina	**5.97E+03**
[A4] SSP (21% P2O5)	**5.28E+05**	[A84] palladium	**1.61E+03**
[A51] gravel (concrete)	**4.20E+05**	[A88] rhodium	**5.72E+02**
[A18] lead soft	**2.11E+05**	[A49] gypsum	**4.57E+02**
[A13] KNO3 (NK14-44)	**1.49E+05**	[A64] AlO3	**8.98E+01**
[A64] AlO3	**3.01E+04**	[A69] chemicals organic	**7.63E+01**
[A69] chemicals organic	**1.77E+04**	[A27] bariet	**2.31E+01**
[A68] chemicals anorganic	**1.96E+03**	[A22] nickel	**2.14E+01**
[A25] manganese	**4.37E+02**	[A23] chromium	**7.83E+00**
[A27] bariet	**4.13E+02**	[A68] chemicals anorganic	**3.96E+00**
[A21] aluminium 100% Rec.	0.00E+00	[A21] aluminium 100% Rec.	0.00E+00
[A3] UAN	0.00E+00	[A3] UAN	0.00E+00
[A5] TSP (48% P2O5)	0.00E+00	[A5] TSP (48% P2O5)	0.00E+00

Material	*Acidification*	*Material*	*Eutrophication*
[A6] PK 22-22	0.00E+00	[A6] PK 22-22	0.00E+00
[A7] MAP (52% P2O5)	0.00E+00	[A7] MAP (52% P2O5)	0.00E+00
[A8] DAP (46% P2O5)	0.00E+00	[A8] DAP (46% P2O5)	0.00E+00
[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00	[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00
[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A14] zinc additive to fodder for animal production (incl .production of zinc)	0.00E+00	[A14] zinc additive to fodder for animal production (incl .production of zinc)	0.00E+00
[A15] copper additive to fodder for animal production (incl. production of copper)	0.00E+00	[A15] copper additive to fodder for animal production (incl. production of copper)	0.00E+00
[A16] pesticides for crop production	0.00E+00	[A16] pesticides for crop production	0.00E+00
[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00	[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00
[A19] lead hard	0.00E+00	[A19] lead hard	0.00E+00
[A28] refrigerant R22	0.00E+00	[A28] refrigerant R22	0.00E+00
[A29] refrigerant R134a	0.00E+00	[A29] refrigerant R134a	0.00E+00
[A34] PE (LD)	0.00E+00	[A34] PE (LD)	0.00E+00
[A39] water (demineralised)	0.00E+00	[A39] water (demineralised)	0.00E+00
[A41] board (karton)	0.00E+00	[A41] board (karton)	0.00E+00
[A44] glas (coated)	0.00E+00	[A44] glas (coated)	0.00E+00
[A50] limestone	0.00E+00	[A50] limestone	0.00E+00
[A53] gypsum (raw stone)	0.00E+00	[A53] gypsum (raw stone)	0.00E+00
[A54] clay_loam	0.00E+00	[A54] clay_loam	0.00E+00
[A55] steel (high alloyed)	0.00E+00	[A55] steel (high alloyed)	0.00E+00
[A56] cast iron	0.00E+00	[A56] cast iron	0.00E+00
[A58] steel (light alloyed)	0.00E+00	[A58] steel (light alloyed)	0.00E+00
[A59] "blas stahl"	0.00E+00	[A59] "blas stahl"	0.00E+00
[A60] electro steel	0.00E+00	[A60] electro steel	0.00E+00
[A61] steel (not alloyed)	0.00E+00	[A61] steel (not alloyed)	0.00E+00
[A65] Bentonite	0.00E+00	[A65] Bentonite	0.00E+00
[A66] Ca(OH)2	0.00E+00	[A66] Ca(OH)2	0.00E+00
[A71] ethylene	0.00E+00	[A71] ethylene	0.00E+00
[A72] ethylene oxide	0.00E+00	[A72] ethylene oxide	0.00E+00
[A73] explosives	0.00E+00	[A73] explosives	0.00E+00
[A74] FeSO4	0.00E+00	[A74] FeSO4	0.00E+00
[A75] formaldehyde	0.00E+00	[A75] formaldehyde	0.00E+00
[A79] HF	0.00E+00	[A79] HF	0.00E+00
[A80] HNO3	0.00E+00	[A80] HNO3	0.00E+00
[A81] hydrogen	0.00E+00	[A81] hydrogen	0.00E+00
[A83] NaOH	0.00E+00	[A83] NaOH	0.00E+00
[A85] paraxylol	0.00E+00	[A85] paraxylol	0.00E+00
[A86] phenol	0.00E+00	[A86] phenol	0.00E+00
[A89] rubber	0.00E+00	[A89] rubber	0.00E+00
[A90] soda	0.00E+00	[A90] soda	0.00E+00
[A91] styrene	0.00E+00	[A91] styrene	0.00E+00
[A93] ureum	0.00E+00	[A93] ureum	0.00E+00
[A94] vinylchloride	0.00E+00	[A94] vinylchloride	0.00E+00

Material	***Acidification***	***Material***	***Eutrophication***
[A95] zeolith	0.00E+00	[A95] zeolith	0.00E+00
[A97] wood (board)	0.00E+00	[A97] wood (board)	0.00E+00
[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**-4.44E+02**	[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**-2.11E+00**
[A23] chromium	**-5.98E+02**	[A77] H3PO4	**-5.07E+00**
[A49] gypsum	**-1.40E+03**	[A67] CaO	**-7.43E+00**
[A77] H3PO4	**-8.60E+03**	[A25] manganese	**-9.15E+00**
[A67] CaO	**-9.64E+03**	[A26] copper	**-3.23E+03**
[A22] nickel	**-1.37E+04**	[A13] KNO3 (NK14-44)	**-3.34E+06**
[A26] copper	**-3.65E+04**	[A2] urea (chalmers)	**-1.46E+07**
[A40] water (decarbonated)	**-2.20E+06**	[A9] NPK 15-15-15 (mixed acid route)	**-2.61E+07**

Table 5 Radiation and Final solid waste formation

Material	***Radiation***	***Material***	***Final solid waste formation***
[A57] raw iron	**5.63E+00**	[A52] sand (construction)	**1.14E+11**
[A62] animal products (meat, milk, eggs, ...)	**5.44E+00**	[A63] crop or grass	**6.06E+10**
[A63] crop or grass	**5.05E+00**	[A48] concrete	**3.47E+10**
[A42] paper	**4.14E+00**	[A51] gravel (concrete)	**2.58E+10**
[A20] aluminium 0% Rec.	**3.92E+00**	[A57] raw iron	**1.48E+10**
[A37] PVC	**3.78E+00**	[A46] cement	**6.18E+09**
[A36] PP	**2.30E+00**	[A62] animal products (meat, milk, eggs, ...)	**5.01E+09**
[A31] PE (HD)	**2.10E+00**	[A47] ceramic	**4.13E+09**
[A70] chlorine	**1.81E+00**	[A43] glas (not coated)	**1.18E+09**
[A24] zinc	**1.67E+00**	[A20] aluminium 0% Rec.	**8.75E+08**
[A48] concrete	**1.40E+00**	[A9] NPK 15-15-15 (mixed acid route)	**7.42E+08**
[A33] PS	**1.14E+00**	[A49] gypsum	**5.48E+08**
[A30] ammonia	**1.03E+00**	[A42] paper	**3.93E+08**
[A47] ceramic	**1.01E+00**	[A24] zinc	**2.94E+08**
[A46] cement	**6.98E-01**	[A45] rockwool	**2.56E+08**
[A52] sand (construction)	**6.98E-01**	[A4] SSP (21% P2O5)	**2.54E+08**
[A76] H2SO4	**4.26E-01**	[A82] NaCl	**2.40E+08**
[A1] CAN (calcium ammonium nitrate)	**4.13E-01**	[A37] PVC	**1.77E+08**
[A78] HCl	**3.74E-01**	[A40] water (decarbonated)	**1.51E+08**
[A32] PC	**3.43E-01**	[A26] copper	**1.47E+08**
[A82] NaCl	**3.21E-01**	[A1] CAN (calcium ammonium nitrate)	**1.23E+08**
[A38] PUR	**2.73E-01**	[A31] PE (HD)	**1.14E+08**
[A43] glas (not coated)	**2.62E-01**	[A36] PP	**1.01E+08**
[A35] PET 0% Rec.	**1.98E-01**	[A70] chlorine	**8.27E+07**
[A96] wood (massive)	**1.83E-01**	[A30] ammonia	**6.79E+07**
[A45] rockwool	**1.73E-01**	[A33] PS	**5.34E+07**
[A2] urea (chalmers)	**7.99E-02**	[A22] nickel	**3.63E+07**
[A4] SSP (21% P2O5)	**7.51E-02**	[A18] lead soft	**3.21E+07**
[A9] NPK 15-15-15 (mixed acid route)	**5.40E-02**	[A27] bariet	**2.72E+07**
[A51] gravel (concrete)	**5.32E-02**	[A76] H2SO4	**2.44E+07**
[A18] lead soft	**2.04E-02**	[A32] PC	**2.32E+07**
[A40] water (decarbonated)	**1.59E-02**	[A78] HCl	**1.72E+07**
[A87] platina	**1.17E-02**	[A2] urea (chalmers)	**1.18E+07**
[A84] palladium	**7.66E-03**	[A38] PUR	**1.09E+07**
[A92] sulphur (secondary)	**6.42E-03**	[A96] wood (massive)	**1.02E+07**
[A13] KNO3 (NK14-44)	**3.29E-03**	[A35] PET 0% Rec.	**9.36E+06**
[A88] rhodium	**1.09E-03**	[A23] chromium	**6.73E+06**
[A49] gypsum	**3.87E-05**	[A87] platina	**4.08E+06**
[A67] CaO	**3.65E-06**	[A13] KNO3 (NK14-44)	**1.30E+06**
[A27] bariet	**2.54E-06**	[A92] sulphur (secondary)	**9.46E+05**
[A23] chromium	**2.72E-07**	[A84] palladium	**7.20E+05**
[A12] AP (ammonium	**1.40E-08**	[A88] rhodium	**3.95E+05**

Material	*Radiation*	*Material*	*Final solid waste formation*
phosphate) (49% P2O5, 11% N)			
[A21] aluminium 100% Rec.	0.00E+00	[A69] chemicals organic	**3.07E+02**
[A3] UAN	0.00E+00	[A67] CaO	**1.22E+02**
[A5] TSP (48% P2O5)	0.00E+00	[A68] chemicals anorganic	**6.83E+00**
[A6] PK 22-22	0.00E+00	[A21] aluminium 100% Rec.	0.00E+00
[A7] MAP (52% P2O5)	0.00E+00	[A3] UAN	0.00E+00
[A8] DAP (46% P2O5)	0.00E+00	[A5] TSP (48% P2O5)	0.00E+00
[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00	[A6] PK 22-22	0.00E+00
[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A7] MAP (52% P2O5)	0.00E+00
[A14] zinc additive to fodder for animal production (incl .production of zinc)	0.00E+00	[A8] DAP (46% P2O5)	0.00E+00
[A15] copper additive to fodder for animal production (incl. production of copper)	0.00E+00	[A10] NPK 15-15-15 (nitrophosphate route)	0.00E+00
[A16] pesticides for crop production	0.00E+00	[A11] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00	[A14] zinc additive to fodder for animal production (incl .production of zinc)	0.00E+00
[A19] lead hard	0.00E+00	[A15] copper additive to fodder for animal production (incl. production of copper)	0.00E+00
[A28] refrigerant R22	0.00E+00	[A16] pesticides for crop production	0.00E+00
[A29] refrigerant R134a	0.00E+00	[A17] calcium nitrate for crop production (incl. production fert.)	0.00E+00
[A34] PE (LD)	0.00E+00	[A19] lead hard	0.00E+00
[A39] water (demineralised)	0.00E+00	[A28] refrigerant R22	0.00E+00
[A41] board (karton)	0.00E+00	[A29] refrigerant R134a	0.00E+00
[A44] glas (coated)	0.00E+00	[A34] PE (LD)	0.00E+00
[A50] limestone	0.00E+00	[A39] water (demineralised)	0.00E+00
[A53] gypsum (raw stone)	0.00E+00	[A41] board (karton)	0.00E+00
[A54] clay_loam	0.00E+00	[A44] glas (coated)	0.00E+00
[A55] steel (high alloyed)	0.00E+00	[A50] limestone	0.00E+00
[A56] cast iron	0.00E+00	[A53] gypsum (raw stone)	0.00E+00
[A58] steel (light alloyed)	0.00E+00	[A54] clay_loam	0.00E+00
[A59] "blas stahl"	0.00E+00	[A55] steel (high alloyed)	0.00E+00
[A60] electro steel	0.00E+00	[A56] cast iron	0.00E+00
[A61] steel (not alloyed)	0.00E+00	[A58] steel (light alloyed)	0.00E+00
[A65] Bentonite	0.00E+00	[A59] "blas stahl"	0.00E+00
[A66] Ca(OH)2	0.00E+00	[A60] electro steel	0.00E+00
[A68] chemicals anorganic	0.00E+00	[A61] steel (not alloyed)	0.00E+00
[A71] ethylene	0.00E+00	[A65] Bentonite	0.00E+00
[A72] ethylene oxide	0.00E+00	[A66] Ca(OH)2	0.00E+00
[A73] explosives	0.00E+00	[A71] ethylene	0.00E+00

Material	***Radiation***	***Material***	***Final solid waste formation***
[A74] FeSO4	0.00E+00	[A72] ethylene oxide	0.00E+00
[A75] formaldehyde	0.00E+00	[A73] explosives	0.00E+00
[A79] HF	0.00E+00	[A74] FeSO4	0.00E+00
[A80] HNO3	0.00E+00	[A75] formaldehyde	0.00E+00
[A81] hydrogen	0.00E+00	[A79] HF	0.00E+00
[A83] NaOH	0.00E+00	[A80] HNO3	0.00E+00
[A85] paraxylol	0.00E+00	[A81] hydrogen	0.00E+00
[A86] phenol	0.00E+00	[A83] NaOH	0.00E+00
[A89] rubber	0.00E+00	[A85] paraxylol	0.00E+00
[A90] soda	0.00E+00	[A86] phenol	0.00E+00
[A91] styrene	0.00E+00	[A89] rubber	0.00E+00
[A93] ureum	0.00E+00	[A90] soda	0.00E+00
[A94] vinylchloride	0.00E+00	[A91] styrene	0.00E+00
[A95] zeolith	0.00E+00	[A93] ureum	0.00E+00
[A97] wood (board)	0.00E+00	[A94] vinylchloride	0.00E+00
[A77] H3PO4	**-7.57E-07**	[A95] zeolith	0.00E+00
[A25] manganese	**-8.82E-07**	[A97] wood (board)	0.00E+00
[A69] chemicals organic	**-3.07E-06**	[A64] AlO3	**-1.26E+02**
[A22] nickel	**-7.70E-06**	[A12] AP (ammonium phosphate) (49% P2O5, 11% N)	**-2.33E+02**
[A64] AlO3	**-1.00E-05**	[A77] H3PO4	**-8.52E+02**
[A26] copper	**-3.93E-04**	[A25] manganese	**-1.06E+07**

Appendix 9 Total score of materials, impact per kg x flows, Consumption system, list-of-materials variant.

Table 1 Abiotic depletion, land use and global warming

Material	***Abiotic Depletion***	***Material***	***Land use***	***Material***	***Global Warming***
[A154] iron & steel	1.86E+08	[A160] crop and grass	1.41E+10	[A160] crop and grass	1.40E+11
[A117] aluminium 0% rec.	1.82E+07	[A159] animal products	1.36E+10	[A159] animal products	2.37E+10
[A143] cement	1.29E+07	[A149] sand (construction)	6.67E+08	[A154] iron & steel	1.90E+10
[A160] crop and grass	1.20E+07	[A154] iron & steel	2.72E+08	[A139] paper	7.88E+09
[A139] paper	1.07E+07	[A145] concrete	2.33E+08	[A117] aluminium 0% rec.	6.13E+09
[A145] concrete	9.77E+06	[A139] paper	1.88E+08	[A127] ammonia	4.04E+09
[A159] animal products	6.70E+06	[A117] aluminium 0% rec.	1.85E+08	[A161] AlO3	3.41E+09
[A161] AlO3	4.93E+06	[A148] gravel (concrete)	1.52E+08	[A143] cement	2.41E+09
[A121] zinc	3.98E+06	[A193] wood (massive)	9.53E+07	[A145] concrete	2.23E+09
[A134] PVC	3.36E+06	[A161] AlO3	8.21E+07	[A128] PE (HD)	2.22E+09
[A167] chlorine	2.85E+06	[A143] cement	5.15E+07	[A134] PVC	2.05E+09
[A164] CaO	2.76E+06	[A134] PVC	4.77E+07	[A164] CaO	1.68E+09
[A123] copper	2.32E+06	[A167] chlorine	4.31E+07	[A144] ceramic	1.52E+09
[A140] glass (not coated)	2.30E+06	[A144] ceramic	3.60E+07	[A133] PP	1.22E+09
[A119] nickel	1.98E+06	[A127] ammonia	3.40E+07	[A149] sand (construction)	1.20E+09
[A127] ammonia	1.50E+06	[A123] copper	3.33E+07	[A130] PS	1.19E+09
[A144] ceramic	1.38E+06	[A121] zinc	2.84E+07	[A98] CAN (calcium ammonium nitrate) CAN	1.09E+09
[A142] rockwool	1.29E+06	[A140] glass (not coated)	1.88E+07	[A140] glass (not coated)	8.54E+08
[A193] wood (massive)	1.10E+06	[A119] nickel	1.86E+07	[A123] copper	7.95E+08
[A149] sand (construction)	9.97E+05	[A128] PE (HD)	1.51E+07	[A121] zinc	7.11E+08
[A98] CAN (calcium ammonium nitrate) CAN	8.81E+05	[A133] PP	1.40E+07	[A167] chlorine	5.80E+08
[A128] PE (HD)	8.81E+05	[A173] H2SO4	1.15E+07	[A119] nickel	5.54E+08
[A133] PP	8.80E+05	[A130] PS	1.05E+07	[A165] chemicals anorganic	4.37E+08
[A173] H2SO4	6.60E+05	[A175] HCl	8.81E+06	[A148] gravel (concrete)	2.83E+08
[A130] PS	6.26E+05	[A164] CaO	8.27E+06	[A142] rockwool	2.80E+08
[A179] NaCl	6.02E+05	[A165] chemicals anorganic	7.44E+06	[A106] NPK 15-15-15 fertiliser (mixed acid route)	2.49E+08
[A175] HCl	5.83E+05	[A179] NaCl	7.13E+06	[A173] H2SO4	2.44E+08

Material	*Abiotic Depletion*	*Material*	*Land use*	*Material*	*Global Warming*
[A165] chemicals anorganic	4.27E+05	[A98] CAN (calcium ammonium nitrate) CAN	6.54E+06	[A179] NaCl	2.36E+08
[A115] lead soft	3.33E+05	[A142] rockwool	4.88E+06	[A146] gypsum	1.41E+08
[A120] chromium	2.89E+05	[A146] gypsum	4.69E+06	[A175] HCl	1.19E+08
[A148] gravel (concrete)	2.84E+05	[A106] NPK 15-15-15 fertiliser (mixed acid route)	3.81E+06	[A120] chromium	1.05E+08
[A106] NPK 15-15-15 fertiliser (mixed acid route)	2.35E+05	[A120] chromium	2.74E+06	[A189] sulphur (secundary)	9.99E+07
[A184] platinum	1.54E+05	[A124] bariet	1.95E+06	[A115] lead soft	3.35E+07
[A146] gypsum	6.64E+04	[A115] lead soft	9.54E+05	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	2.51E+07
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	3.60E+04	[A137] water (decarbonated)	8.12E+05	[A184] platinum	2.36E+07
[A137] water (decarbonated)	3.36E+04	[A101] SSP (single super phosphate)	5.69E+05	[A137] water (decarbonated)	1.27E+07
[A101] SSP (single super phosphate)	3.03E+04	[A184] platinum	3.66E+05	[A101] SSP (single super phosphate)	9.18E+06
[A181] palladium	2.93E+04	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	3.50E+05	[A181] palladium	6.78E+06
[A124] bariet	2.50E+04	[A189] sulphur (secundary)	2.33E+05	[A124] bariet	4.88E+06
[A111] zinc additive	2.02E+04	[A181] palladium	1.95E+05	[A110] KNO3 (potassium nitrate)	4.45E+06
[A185] rhodium	1.74E+04	[A111] zinc additive	1.43E+05	[A111] zinc additive	3.61E+06
[A189] sulphur (secundary)	1.01E+04	[A112] copper additive	1.43E+05	[A112] copper additive	3.43E+06
[A112] copper additive	1.01E+04	[A185] rhodium	3.43E+04	[A185] rhodium	2.25E+06
[A99] urea	4.08E+03	[A99] urea	2.50E+04	[A118] aluminium 100% rec.	0.00E+00
[A110] KNO3 (potassium nitrate)	1.60E+03	[A110] KNO3 (potassium nitrate)	2.35E+04	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A118] aluminium 100% rec.	0.00E+00	[A118] aluminium 100% rec.	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00
[A102] TSP (triple super phoshate)	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00

Material	*Abiotic Depletion*	*Material*	*Land use*	*Material*	*Global Warming*
[A104] MAP (mono ammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00
[A105] DAP (diammonium phosphate)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A114] calcium nitrate	0.00E+00
[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	0.00E+00	[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	0.00E+00	[A116] lead hard	0.00E+00
[A114] calcium nitrate	0.00E+00	[A114] calcium nitrate	0.00E+00	[A125] refrigerant R22	0.00E+00
[A116] lead hard	0.00E+00	[A116] lead hard	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A125] refrigerant R22	0.00E+00	[A125] refrigerant R22	0.00E+00	[A129] PC	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A126] refrigerant R134a	0.00E+00	[A131] PE (LD)	0.00E+00
[A129] PC	0.00E+00	[A129] PC	0.00E+00	[A132] PET 0% rec	0.00E+00
[A131] PE (LD)	0.00E+00	[A131] PE (LD)	0.00E+00	[A135] PUR	0.00E+00
[A132] PET 0% rec	0.00E+00	[A132] PET 0% rec	0.00E+00	[A136] water (demineralised)	0.00E+00
[A135] PUR	0.00E+00	[A135] PUR	0.00E+00	[A138] board (karton)	0.00E+00
[A136] water (demineralised)	0.00E+00	[A136] water (demineralised)	0.00E+00	[A141] glass (coated)	0.00E+00
[A138] board (karton)	0.00E+00	[A138] board (karton)	0.00E+00	[A147] limestone	0.00E+00
[A141] glass (coated)	0.00E+00	[A141] glass (coated)	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A147] limestone	0.00E+00	[A147] limestone	0.00E+00	[A151] clay_loam	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A150] gypsum (raw stone)	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A151] clay_loam	0.00E+00	[A151] clay_loam	0.00E+00	[A153] cast iron	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A152] steel (high alloyed)	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A153] cast iron	0.00E+00	[A153] cast iron	0.00E+00	[A156] blow steel	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A155] steel (light alloyed)	0.00E+00	[A157] electro steel	0.00E+00
[A156] blow steel	0.00E+00	[A156] blow steel	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A157] electro steel	0.00E+00	[A157] electro steel	0.00E+00	[A162] bentonite	0.00E+00
[A158] steel (not alloyed)	0.00E+00	[A158] steel (not alloyed)	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A162] bentonite	0.00E+00	[A162] bentonite	0.00E+00	[A168] ehtylene	0.00E+00

Material	***Abiotic Depletion***	***Material***	***Land use***	***Material***	***Global Warming***
[A163] Ca(OH)2	0.00E+00	[A163] Ca(OH)2	0.00E+00	[A169] ethylene oxide	0.00E+00
[A168] ehtylene	0.00E+00	[A168] ehtylene	0.00E+00	[A170] explosives	0.00E+00
[A169] ethylene oxide	0.00E+00	[A169] ethylene oxide	0.00E+00	[A171] FeSO4	0.00E+00
[A170] explosives	0.00E+00	[A170] explosives	0.00E+00	[A172] formaldehyde	0.00E+00
[A171] FeSO4	0.00E+00	[A171] FeSO4	0.00E+00	[A174] H3PO4	0.00E+00
[A172] formaldehyde	0.00E+00	[A172] formaldehyde	0.00E+00	[A176] HF	0.00E+00
[A174] H3PO4	0.00E+00	[A174] H3PO4	0.00E+00	[A177] HNO3	0.00E+00
[A176] HF	0.00E+00	[A176] HF	0.00E+00	[A178] hydrogen	0.00E+00
[A177] HNO3	0.00E+00	[A177] HNO3	0.00E+00	[A180] NaOH	0.00E+00
[A178] hydrogen	0.00E+00	[A178] hydrogen	0.00E+00	[A182] paraxylol	0.00E+00
[A180] NaOH	0.00E+00	[A180] NaOH	0.00E+00	[A183] phenol	0.00E+00
[A182] paraxylol	0.00E+00	[A182] paraxylol	0.00E+00	[A186] rubber	0.00E+00
[A183] phenol	0.00E+00	[A183] phenol	0.00E+00	[A187] soda	0.00E+00
[A186] rubber	0.00E+00	[A186] rubber	0.00E+00	[A188] styrene	0.00E+00
[A187] soda	0.00E+00	[A187] soda	0.00E+00	[A190] ureum	0.00E+00
[A188] styrene	0.00E+00	[A188] styrene	0.00E+00	[A191] vinylchloride	0.00E+00
[A190] ureum	0.00E+00	[A190] ureum	0.00E+00	[A192] zeolith	0.00E+00
[A191] vinylchloride	0.00E+00	[A191] vinylchloride	0.00E+00	[A194] wood (board)	0.00E+00
[A192] zeolith	0.00E+00	[A192] zeolith	0.00E+00	[A99] urea	-1.53E+05
[A194] wood (board)	0.00E+00	[A194] wood (board)	0.00E+00	[A122] manganese	-5.95E+07
[A122] manganese	-3.01E+05	[A122] manganese	-5.80E+06	[A193] wood (massive)	-1.56E+09
[A166] chemicals organic	-2.05E+07	[A166] chemicals organic	-3.14E+08	[A166] chemicals organic	-5.81E+09

Table 2 Ozone layer depletion, human toxicity and aquatic ecotoxicity

Material	***Ozone layer depletion***	***Material***	***Human toxicity***	***Material***	***Aquatic ecotoxicity***
[A134] PVC	1.32E+05	[A154] iron & steel	1.40E+10	[A160] crop and grass	1.20E+10
[A154] iron & steel	4.04E+03	[A121] zinc	6.67E+09	[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	8.03E+09
[A161] AlO3	3.77E+03	[A117] aluminium 0% rec.	2.56E+09	[A159] animal products	5.56E+09
[A139] paper	3.63E+03	[A160] crop and grass	2.05E+09	[A154] iron & steel	2.65E+09
[A128] PE (HD)	3.16E+03	[A139] paper	1.95E+09	[A161] AlO3	1.08E+09
[A117] aluminium 0% rec.	3.15E+03	[A115] lead soft	1.58E+09	[A119] nickel	5.98E+08
[A160] crop and grass	2.57E+03	[A144] ceramic	1.40E+09	[A112] copper additive	3.75E+08
[A133] PP	1.78E+03	[A128] PE (HD)	1.33E+09	[A139] paper	3.11E+08
[A130] PS	1.65E+03	[A159] animal products	1.10E+09	[A117] aluminium 0% rec.	3.02E+08
[A159] animal products	1.50E+03	[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	8.29E+08	[A143] cement	1.70E+08
[A149] sand (construction)	1.48E+03	[A161] AlO3	7.84E+08	[A121] zinc	1.50E+08
[A145] concrete	1.09E+03	[A143] cement	7.27E+08	[A145] concrete	1.29E+08
[A167] chlorine	7.52E+02	[A130] PS	7.20E+08	[A128] PE (HD)	1.17E+08
[A143] cement	5.94E+02	[A133] PP	7.16E+08	[A133] PP	6.78E+07
[A165] chemicals anorganic	5.28E+02	[A119] nickel	6.60E+08	[A134] PVC	5.52E+07
[A123] copper	4.91E+02	[A134] PVC	6.49E+08	[A164] CaO	3.80E+07
[A127] ammonia	4.59E+02	[A145] concrete	6.18E+08	[A130] PS	3.67E+07
[A148] gravel (concrete)	3.41E+02	[A123] copper	3.32E+08	[A111] zinc additive	3.54E+07
[A119] nickel	3.33E+02	[A165] chemicals anorganic	2.41E+08	[A124] bariet	3.49E+07
[A121] zinc	2.38E+02	[A164] CaO	2.22E+08	[A140] glass (not coated)	3.09E+07
[A193] wood (massive)	2.13E+02	[A140] glass (not coated)	2.14E+08	[A167] chlorine	2.92E+07
[A144] ceramic	2.01E+02	[A127] ammonia	1.96E+08	[A123] copper	2.47E+07
[A98] CAN (calcium ammonium nitrate) CAN	1.85E+02	[A167] chlorine	1.85E+08	[A165] chemicals anorganic	2.41E+07
[A175] HCl	1.54E+02	[A149] sand (construction)	1.50E+08	[A193] wood (massive)	2.33E+07
[A179] NaCl	1.45E+02	[A193] wood (massive)	1.13E+08	[A127] ammonia	2.27E+07
[A140] glass (not coated)	1.44E+02	[A124] bariet	9.66E+07	[A142] rockwool	1.75E+07

Material	*Ozone layer depletion*	*Material*	*Human toxicity*	*Material*	*Aquatic ecotoxicity*
[A189] sulphur (secundary)	1.43E+02	[A179] NaCl	8.28E+07	[A144] ceramic	1.64E+07
[A106] NPK 15-15-15 fertiliser (mixed acid route)	1.35E+02	[A142] rockwool	8.28E+07	[A149] sand (construction)	1.47E+07
[A142] rockwool	1.14E+02	[A111] zinc additive	8.05E+07	[A98] CAN (calcium ammonium nitrate) CAN	1.15E+07
[A164] CaO	9.86E+01	[A112] copper additive	6.11E+07	[A179] NaCl	1.10E+07
[A173] H2SO4	6.68E+01	[A98] CAN (calcium ammonium nitrate) CAN	5.79E+07	[A173] H2SO4	6.68E+06
[A120] chromium	5.44E+01	[A184] platinum	4.93E+07	[A175] HCl	5.96E+06
[A146] gypsum	5.41E+01	[A173] H2SO4	4.50E+07	[A120] chromium	5.04E+06
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	2.87E+01	[A189] sulphur (secundary)	4.18E+07	[A148] gravel (concrete)	3.91E+06
[A137] water (decarbonated)	1.55E+01	[A120] chromium	4.09E+07	[A189] sulphur (secundary)	3.61E+06
[A115] lead soft	1.35E+01	[A175] HCl	3.78E+07	[A184] platinum	3.29E+06
[A101] SSP (single super phosphate)	7.52E+00	[A148] gravel (concrete)	3.73E+07	[A106] NPK 15-15-15 fertiliser (mixed acid route)	3.18E+06
[A184] platinum	2.30E+00	[A181] palladium	3.10E+07	[A115] lead soft	2.44E+06
[A112] copper additive	2.12E+00	[A106] NPK 15-15-15 fertiliser (mixed acid route)	2.38E+07	[A137] water (decarbonated)	1.90E+06
[A124] bariet	2.04E+00	[A146] gypsum	8.44E+06	[A181] palladium	1.08E+06
[A110] KNO3 (potassium nitrate)	1.80E+00	[A185] rhodium	4.40E+06	[A146] gypsum	8.22E+05
[A99] urea	1.79E+00	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	2.93E+06	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	4.07E+05
[A111] zinc additive)	1.21E+00	[A101] SSP (single super phosphate)	2.41E+06	[A101] SSP (single super phosphate)	3.18E+05
[A181] palladium	1.15E+00	[A99] urea	2.81E+05	[A185] rhodium	3.10E+05
[A185] rhodium	2.16E-01	[A110] KNO3 (potassium nitrate)	1.88E+05	[A99] urea	5.39E+04
[A118] aluminium 100% rec.	0.00E+00	[A118] aluminium 100% rec.	0.00E+00	[A110] KNO3 (potassium nitrate)	2.45E+04
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00	[A118] aluminium 100% rec.	0.00E+00
[A102] TSP (triple super phoshate)	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A104] MAP (mono ammonium	0.00E+00	[A104] MAP (mono ammonium	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00

Material	***Ozone layer depletion***	***Material***	***Human toxicity***	***Material***	***Aquatic ecotoxicity***
phosphate)		phosphate)			
[A105] DAP (diammonium phosphate)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00
[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	0.00E+00	[A114] calcium nitrate	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A114] calcium nitrate	0.00E+00	[A116] lead hard	0.00E+00	[A114] calcium nitrate	0.00E+00
[A116] lead hard	0.00E+00	[A125] refrigerant R22	0.00E+00	[A116] lead hard	0.00E+00
[A125] refrigerant R22	0.00E+00	[A126] refrigerant R134a	0.00E+00	[A125] refrigerant R22	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A129] PC	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A129] PC	0.00E+00	[A131] PE (LD)	0.00E+00	[A129] PC	0.00E+00
[A131] PE (LD)	0.00E+00	[A132] PET 0% rec	0.00E+00	[A131] PE (LD)	0.00E+00
[A132] PET 0% rec	0.00E+00	[A135] PUR	0.00E+00	[A132] PET 0% rec	0.00E+00
[A135] PUR	0.00E+00	[A136] water (demineralised)	0.00E+00	[A135] PUR	0.00E+00
[A136] water (demineralised)	0.00E+00	[A138] board (karton)	0.00E+00	[A136] water (demineralised)	0.00E+00
[A138] board (karton)	0.00E+00	[A141] glass (coated)	0.00E+00	[A138] board (karton)	0.00E+00
[A141] glass (coated)	0.00E+00	[A147] limestone	0.00E+00	[A141] glass (coated)	0.00E+00
[A147] limestone	0.00E+00	[A150] gypsum (raw stone)	0.00E+00	[A147] limestone	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A151] clay_loam	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A151] clay_loam	0.00E+00	[A152] steel (high alloyed)	0.00E+00	[A151] clay_loam	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A153] cast iron	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A153] cast iron	0.00E+00	[A155] steel (light alloyed)	0.00E+00	[A153] cast iron	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A156] blow steel	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A156] blow steel	0.00E+00	[A157] electro steel	0.00E+00	[A156] blow steel	0.00E+00
[A157] electro steel	0.00E+00	[A158] steel (not alloyed)	0.00E+00	[A157] electro steel	0.00E+00

Material	*Ozone layer depletion*	*Material*	*Human toxicity*	*Material*	*Aquatic ecotoxicity*
[A158] steel (not alloyed)	0.00E+00	[A162] bentonite	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A162] bentonite	0.00E+00	[A163] Ca(OH)2	0.00E+00	[A162] bentonite	0.00E+00
[A163] Ca(OH)2	0.00E+00	[A168] ehtylene	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A168] ehtylene	0.00E+00	[A169] ethylene oxide	0.00E+00	[A168] ehtylene	0.00E+00
[A169] ethylene oxide	0.00E+00	[A170] explosives	0.00E+00	[A169] ethylene oxide	0.00E+00
[A170] explosives	0.00E+00	[A171] FeSO4	0.00E+00	[A170] explosives	0.00E+00
[A171] FeSO4	0.00E+00	[A172] formaldehyde	0.00E+00	[A171] FeSO4	0.00E+00
[A172] formaldehyde	0.00E+00	[A174] H3PO4	0.00E+00	[A172] formaldehyde	0.00E+00
[A174] H3PO4	0.00E+00	[A176] HF	0.00E+00	[A174] H3PO4	0.00E+00
[A176] HF	0.00E+00	[A177] HNO3	0.00E+00	[A176] HF	0.00E+00
[A177] HNO3	0.00E+00	[A178] hydrogen	0.00E+00	[A177] HNO3	0.00E+00
[A178] hydrogen	0.00E+00	[A180] NaOH	0.00E+00	[A178] hydrogen	0.00E+00
[A180] NaOH	0.00E+00	[A182] paraxylol	0.00E+00	[A180] NaOH	0.00E+00
[A182] paraxylol	0.00E+00	[A183] phenol	0.00E+00	[A182] paraxylol	0.00E+00
[A183] phenol	0.00E+00	[A186] rubber	0.00E+00	[A183] phenol	0.00E+00
[A186] rubber	0.00E+00	[A187] soda	0.00E+00	[A186] rubber	0.00E+00
[A187] soda	0.00E+00	[A188] styrene	0.00E+00	[A187] soda	0.00E+00
[A188] styrene	0.00E+00	[A190] ureum	0.00E+00	[A188] styrene	0.00E+00
[A190] ureum	0.00E+00	[A191] vinylchloride	0.00E+00	[A190] ureum	0.00E+00
[A191] vinylchloride	0.00E+00	[A192] zeolith	0.00E+00	[A191] vinylchloride	0.00E+00
[A192] zeolith	0.00E+00	[A194] wood (board)	0.00E+00	[A192] zeolith	0.00E+00
[A194] wood (board)	0.00E+00	[A137] water (decarbonated)	-8.59E+06	[A194] wood (board)	0.00E+00
[A122] manganese	-2.56E+01	[A122] manganese	-1.83E+07	[A122] manganese	-2.95E+06
[A166] chemicals organic	-4.31E+03	[A166] chemicals organic	-1.93E+09	[A166] chemicals organic	-2.63E+08

Table 3 Marine ecotoxicity, terrestrial ecotoxicity, photochemical oxidant formation

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A144] ceramic	1.87E+13	[A160] crop and grass	4.88E+08	[A154] iron & steel	1.00E+07
[A117] aluminium 0% rec.	1.39E+13	[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	3.20E+08	[A128] PE (HD)	7.27E+06
[A154] iron & steel	1.32E+13	[A159] animal products	2.35E+08	[A119] nickel	4.48E+06
[A139] paper	3.03E+12	[A121] zinc	8.04E+07	[A159] animal products	3.14E+06
[A160] crop and grass	2.35E+12	[A154] iron & steel	7.24E+07	[A139] paper	2.73E+06
[A161] AlO3	2.07E+12	[A139] paper	5.65E+07	[A161] AlO3	2.47E+06
[A159] animal products	1.41E+12	[A117] aluminium 0% rec.	3.56E+07	[A117] aluminium 0% rec.	1.75E+06
[A140] glass (not coated)	1.30E+12	[A128] PE (HD)	3.49E+07	[A127] ammonia	1.44E+06
[A128] PE (HD)	9.33E+11	[A111] zinc additive	1.86E+07	[A160] crop and grass	1.42E+06
[A119] nickel	8.76E+11	[A167] chlorine	1.32E+07	[A189] sulphur (secundary)	1.27E+06
[A134] PVC	8.65E+11	[A134] PVC	1.30E+07	[A123] copper	1.03E+06
[A143] cement	8.09E+11	[A161] AlO3	1.27E+07	[A145] concrete	7.61E+05
[A121] zinc	7.99E+11	[A133] PP	1.12E+07	[A143] cement	6.93E+05
[A145] concrete	7.62E+11	[A143] cement	9.84E+06	[A133] PP	5.97E+05
[A167] chlorine	6.17E+11	[A115] lead soft	9.22E+06	[A134] PVC	5.23E+05
[A133] PP	4.40E+11	[A112] copper additive	8.90E+06	[A142] rockwool	5.12E+05
[A123] copper	4.10E+11	[A145] concrete	8.39E+06	[A149] sand (construction)	3.89E+05
[A164] CaO	4.09E+11	[A165] chemicals anorganic	8.12E+06	[A144] ceramic	3.47E+05
[A127] ammonia	3.63E+11	[A130] PS	6.95E+06	[A130] PS	3.30E+05
[A130] PS	2.99E+11	[A119] nickel	6.03E+06	[A173] H2SO4	3.16E+05
[A165] chemicals anorganic	2.64E+11	[A127] ammonia	5.68E+06	[A121] zinc	3.15E+05
[A149] sand (construction)	2.62E+11	[A175] HCl	2.71E+06	[A184] platinum	3.12E+05
[A193] wood (massive)	2.45E+11	[A193] wood (massive)	2.39E+06	[A165] chemicals anorganic	3.03E+05
[A142] rockwool	1.82E+11	[A149] sand (construction)	2.31E+06	[A181] palladium	2.18E+05
[A120] chromium	1.79E+11	[A123] copper	2.28E+06	[A167] chlorine	2.09E+05
[A173] H2SO4	1.42E+11	[A144] ceramic	1.83E+06	[A140] glass (not coated)	2.08E+05
[A179] NaCl	1.32E+11	[A179] NaCl	1.75E+06	[A164] CaO	1.96E+05
[A124] bariet	1.31E+11	[A164] CaO	1.49E+06	[A193] wood (massive)	1.94E+05

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A175] HCl	1.26E+11	[A189] sulphur (secundary)	1.41E+06	[A98] CAN (calcium ammonium nitrate) CAN	1.33E+05
[A112] copper additive	7.80E+10	[A140] glass (not coated)	1.05E+06	[A179] NaCl	1.10E+05
[A98] CAN (calcium ammonium nitrate) CAN	7.76E+10	[A142] rockwool	8.19E+05	[A106] NPK 15-15-15 fertiliser (mixed acid route)	9.58E+04
[A148] gravel (concrete)	7.16E+10	[A120] chromium	6.83E+05	[A148] gravel (concrete)	9.03E+04
[A184] platinum	3.59E+10	[A173] H2SO4	6.15E+05	[A146] gypsum	4.89E+04
[A189] sulphur (secundary)	3.38E+10	[A98] CAN (calcium ammonium nitrate) CAN	5.91E+05	[A175] HCl	4.26E+04
[A106] NPK 15-15-15 fertiliser (mixed acid route)	3.03E+10	[A148] gravel (concrete)	5.69E+05	[A120] chromium	3.42E+04
[A115] lead soft	2.48E+10	[A106] NPK 15-15-15 fertiliser (mixed acid route)	3.35E+05	[A185] rhodium	2.78E+04
[A146] gypsum	1.74E+10	[A184] platinum	2.01E+05	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	2.27E+04
[A181] palladium	9.44E+09	[A146] gypsum	1.47E+05	[A115] lead soft	1.61E+04
[A111] zinc additive	9.25E+09	[A181] palladium	1.07E+05	[A101] SSP (single super phosphate)	6.40E+03
[A137] water (decarbonated)	6.82E+09	[A137] water (decarbonated)	5.11E+04	[A112] copper additive	4.44E+03
[A101] SSP (single super phosphate)	6.53E+09	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	4.61E+04	[A124] bariet	1.73E+03
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	5.43E+09	[A101] SSP (single super phosphate)	3.56E+04	[A111] zinc additive	1.60E+03
[A185] rhodium	3.42E+09	[A124] bariet	2.08E+04	[A110] KNO3 (potassium nitrate)	8.63E+02
[A99] urea	4.25E+08	[A185] rhodium	1.83E+04	[A99] urea	5.64E+02
[A110] KNO3 (potassium nitrate)	2.36E+08	[A99] urea	3.64E+03	[A118] aluminium 100% rec.	0.00E+00
[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	1.93E+08	[A110] KNO3 (potassium nitrate)	2.75E+03	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A118] aluminium 100% rec.	0.00E+00	[A118] aluminium 100% rec.	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A102] TSP (triple super phoshate)	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00
[A104] MAP (mono ammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00
[A105] DAP (diammonium phosphate)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A114] calcium nitrate	0.00E+00
[A114] calcium nitrate	0.00E+00	[A114] calcium nitrate	0.00E+00	[A116] lead hard	0.00E+00
[A116] lead hard	0.00E+00	[A116] lead hard	0.00E+00	[A125] refrigerant R22	0.00E+00
[A125] refrigerant R22	0.00E+00	[A125] refrigerant R22	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A126] refrigerant R134a	0.00E+00	[A129] PC	0.00E+00
[A129] PC	0.00E+00	[A129] PC	0.00E+00	[A131] PE (LD)	0.00E+00
[A131] PE (LD)	0.00E+00	[A131] PE (LD)	0.00E+00	[A132] PET 0% rec	0.00E+00
[A132] PET 0% rec	0.00E+00	[A132] PET 0% rec	0.00E+00	[A135] PUR	0.00E+00
[A135] PUR	0.00E+00	[A135] PUR	0.00E+00	[A136] water (demineralised)	0.00E+00
[A136] water (demineralised)	0.00E+00	[A136] water (demineralised)	0.00E+00	[A138] board (karton)	0.00E+00
[A138] board (karton)	0.00E+00	[A138] board (karton)	0.00E+00	[A141] glass (coated)	0.00E+00
[A141] glass (coated)	0.00E+00	[A141] glass (coated)	0.00E+00	[A147] limestone	0.00E+00
[A147] limestone	0.00E+00	[A147] limestone	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A150] gypsum (raw stone)	0.00E+00	[A151] clay_loam	0.00E+00
[A151] clay_loam	0.00E+00	[A151] clay_loam	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A152] steel (high alloyed)	0.00E+00	[A153] cast iron	0.00E+00
[A153] cast iron	0.00E+00	[A153] cast iron	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A155] steel (light alloyed)	0.00E+00	[A156] blow steel	0.00E+00

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A156] blow steel	0.00E+00	[A156] blow steel	0.00E+00	[A157] electro steel	0.00E+00
[A157] electro steel	0.00E+00	[A157] electro steel	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A158] steel (not alloyed)	0.00E+00	[A158] steel (not alloyed)	0.00E+00	[A162] bentonite	0.00E+00
[A162] bentonite	0.00E+00	[A162] bentonite	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A163] Ca(OH)2	0.00E+00	[A163] Ca(OH)2	0.00E+00	[A168] ehtylene	0.00E+00
[A168] ehtylene	0.00E+00	[A168] ehtylene	0.00E+00	[A169] ethylene oxide	0.00E+00
[A169] ethylene oxide	0.00E+00	[A169] ethylene oxide	0.00E+00	[A170] explosives	0.00E+00
[A170] explosives	0.00E+00	[A170] explosives	0.00E+00	[A171] FeSO4	0.00E+00
[A171] FeSO4	0.00E+00	[A171] FeSO4	0.00E+00	[A172] formaldehyde	0.00E+00
[A172] formaldehyde	0.00E+00	[A172] formaldehyde	0.00E+00	[A174] H3PO4	0.00E+00
[A174] H3PO4	0.00E+00	[A174] H3PO4	0.00E+00	[A176] HF	0.00E+00
[A176] HF	0.00E+00	[A176] HF	0.00E+00	[A177] HNO3	0.00E+00
[A177] HNO3	0.00E+00	[A177] HNO3	0.00E+00	[A178] hydrogen	0.00E+00
[A178] hydrogen	0.00E+00	[A178] hydrogen	0.00E+00	[A180] NaOH	0.00E+00
[A180] NaOH	0.00E+00	[A180] NaOH	0.00E+00	[A182] paraxylol	0.00E+00
[A182] paraxylol	0.00E+00	[A182] paraxylol	0.00E+00	[A183] phenol	0.00E+00
[A183] phenol	0.00E+00	[A183] phenol	0.00E+00	[A186] rubber	0.00E+00
[A186] rubber	0.00E+00	[A186] rubber	0.00E+00	[A187] soda	0.00E+00
[A187] soda	0.00E+00	[A187] soda	0.00E+00	[A188] styrene	0.00E+00
[A188] styrene	0.00E+00	[A188] styrene	0.00E+00	[A190] ureum	0.00E+00
[A190] ureum	0.00E+00	[A190] ureum	0.00E+00	[A191] vinylchloride	0.00E+00
[A191] vinylchloride	0.00E+00	[A191] vinylchloride	0.00E+00	[A192] zeolith	0.00E+00
[A192] zeolith	0.00E+00	[A192] zeolith	0.00E+00	[A194] wood (board)	0.00E+00
[A194] wood (board)	0.00E+00	[A194] wood (board)	0.00E+00	[A122] manganese	-2.11E+04
[A122] manganese	-6.50E+10	[A122] manganese	-2.52E+05	[A137] water (decarbonated)	-8.48E+04
[A166] chemicals organic	-4.99E+12	[A166] chemicals organic	-4.21E+07	[A166] chemicals organic	-2.09E+06

Table 4 Acidification and eutrophication

Material	***Acidification***	***Material***	***Eutrophication***
[A159] animal products	1.21E+08	[A160] crop and grass	3.78E+09
[A119] nickel	1.11E+08	[A159] animal products	1.50E+09
[A154] iron & steel	6.77E+07	[A127] ammonia	3.42E+08
[A139] paper	5.65E+07	[A98] CAN (calcium ammonium nitrate) CAN	9.81E+07
[A161] AlO3	5.61E+07	[A106] NPK 15-15-15 fertiliser (mixed acid route)	7.53E+07
[A117] aluminium 0% rec.	3.68E+07	[A101] SSP (single super phosphate)	6.58E+06
[A189] sulphur (secundary)	3.15E+07	[A154] iron & steel	5.07E+06
[A160] crop and grass	2.55E+07	[A110] KNO3 (potassium nitrate)	4.62E+06
[A123] copper	2.45E+07	[A139] paper	2.06E+06
[A127] ammonia	2.40E+07	[A143] cement	1.72E+06
[A145] concrete	1.09E+07	[A145] concrete	1.62E+06
[A143] cement	1.08E+07	[A117] aluminium 0% rec.	1.38E+06
[A133] PP	1.02E+07	[A133] PP	1.22E+06
[A128] PE (HD)	9.30E+06	[A149] sand (construction)	7.76E+05
[A134] PVC	9.28E+06	[A144] ceramic	6.54E+05
[A184] platinum	7.76E+06	[A161] AlO3	6.52E+05
[A173] H2SO4	7.52E+06	[A99] urea	4.25E+05
[A165] chemicals anorganic	6.81E+06	[A128] PE (HD)	3.65E+05
[A121] zinc	6.26E+06	[A134] PVC	3.52E+05
[A144] ceramic	5.97E+06	[A193] wood (massive)	3.03E+05
[A149] sand (construction)	5.80E+06	[A121] zinc	2.91E+05
[A181] palladium	5.44E+06	[A140] glass (not coated)	2.88E+05
[A130] PS	4.97E+06	[A130] PS	2.29E+05
[A167] chlorine	4.50E+06	[A142] rockwool	2.04E+05
[A164] CaO	3.44E+06	[A164] CaO	1.85E+05
[A193] wood (massive)	2.70E+06	[A148] gravel (concrete)	1.79E+05
[A140] glass (not coated)	2.49E+06	[A123] copper	1.65E+05
[A98] CAN (calcium ammonium nitrate) CAN	2.40E+06	[A119] nickel	1.64E+05
[A179] NaCl	2.00E+06	[A167] chlorine	1.48E+05
[A142] rockwool	1.94E+06	[A165] chemicals anorganic	1.35E+05
[A106] NPK 15-15-15 fertiliser (mixed acid route)	1.83E+06	[A179] NaCl	8.91E+04
[A148] gravel (concrete)	1.35E+06	[A173] H2SO4	6.05E+04
[A175] HCl	9.14E+05	[A146] gypsum	4.10E+04
[A120] chromium	7.11E+05	[A175] HCl	3.02E+04
[A185] rhodium	6.91E+05	[A189] sulphur (secundary)	2.75E+04
[A146] gypsum	5.88E+05	[A120] chromium	2.55E+04
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	5.32E+05	[A115] lead soft	1.76E+04
[A115] lead soft	3.10E+05	[A137] water (decarbonated)	1.16E+04
[A101] SSP (single super phosphate)	1.32E+05	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	1.04E+04
[A112] copper additive	1.06E+05	[A184] platinum	5.97E+03

Material	***Acidification***	***Material***	***Eutrophication***
[A124] bariet	3.80E+04	[A181] palladium	1.61E+03
[A111] zinc additive	3.17E+04	[A111] zinc additive	1.48E+03
[A110] KNO3 (potassium nitrate)	1.65E+04	[A124] bariet	1.21E+03
[A99] urea	1.60E+04	[A112] copper additive	7.17E+02
[A118] aluminium 100% rec.	0.00E+00	[A185] rhodium	5.72E+02
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A118] aluminium 100% rec.	0.00E+00
[A102] TSP (triple super phoshate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A104] MAP (mono ammonium phosphate)	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00
[A105] DAP (diammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00
[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A114] calcium nitrate	0.00E+00	[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	0.00E+00
[A116] lead hard	0.00E+00	[A114] calcium nitrate	0.00E+00
[A125] refrigerant R22	0.00E+00	[A116] lead hard	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A125] refrigerant R22	0.00E+00
[A129] PC	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A131] PE (LD)	0.00E+00	[A129] PC	0.00E+00
[A132] PET 0% rec	0.00E+00	[A131] PE (LD)	0.00E+00
[A135] PUR	0.00E+00	[A132] PET 0% rec	0.00E+00
[A136] water (demineralised)	0.00E+00	[A135] PUR	0.00E+00
[A138] board (karton)	0.00E+00	[A136] water (demineralised)	0.00E+00
[A141] glass (coated)	0.00E+00	[A138] board (karton)	0.00E+00
[A147] limestone	0.00E+00	[A141] glass (coated)	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A147] limestone	0.00E+00
[A151] clay_loam	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A151] clay_loam	0.00E+00
[A153] cast iron	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A153] cast iron	0.00E+00
[A156] blow steel	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A157] electro steel	0.00E+00	[A156] blow steel	0.00E+00
[A158] steel (not alloyed)	0.00E+00	[A157] electro steel	0.00E+00
[A162] bentonite	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A163] Ca(OH)2	0.00E+00	[A162] bentonite	0.00E+00
[A168] ehtylene	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A169] ethylene oxide	0.00E+00	[A168] ehtylene	0.00E+00
[A170] explosives	0.00E+00	[A169] ethylene oxide	0.00E+00
[A171] FeSO4	0.00E+00	[A170] explosives	0.00E+00

Material	*Acidification*	*Material*	*Eutrophication*
[A172] formaldehyde	0.00E+00	[A171] FeSO4	0.00E+00
[A174] H3PO4	0.00E+00	[A172] formaldehyde	0.00E+00
[A176] HF	0.00E+00	[A174] H3PO4	0.00E+00
[A177] HNO3	0.00E+00	[A176] HF	0.00E+00
[A178] hydrogen	0.00E+00	[A177] HNO3	0.00E+00
[A180] NaOH	0.00E+00	[A178] hydrogen	0.00E+00
[A182] paraxylol	0.00E+00	[A180] NaOH	0.00E+00
[A183] phenol	0.00E+00	[A182] paraxylol	0.00E+00
[A186] rubber	0.00E+00	[A183] phenol	0.00E+00
[A187] soda	0.00E+00	[A186] rubber	0.00E+00
[A188] styrene	0.00E+00	[A187] soda	0.00E+00
[A190] ureum	0.00E+00	[A188] styrene	0.00E+00
[A191] vinylchloride	0.00E+00	[A190] ureum	0.00E+00
[A192] zeolith	0.00E+00	[A191] vinylchloride	0.00E+00
[A194] wood (board)	0.00E+00	[A192] zeolith	0.00E+00
[A122] manganese	-4.57E+05	[A194] wood (board)	0.00E+00
[A137] water (decarbonated)	-2.20E+06	[A122] manganese	-1.59E+04
[A166] chemicals organic	-4.55E+07	[A166] chemicals organic	-1.47E+06

Table 5 Radiation and Final solid waste formation

Material	***Radiation***	***Material***	***Final solid waste formation***
[A160] crop and grass	6.73E+00	[A149] sand (construction)	1.14E+11
[A117] aluminium 0% rec.	6.11E+00	[A160] crop and grass	6.11E+10
[A154] iron & steel	4.87E+00	[A145] concrete	3.47E+10
[A139] paper	4.85E+00	[A148] gravel (concrete)	2.58E+10
[A159] animal products	3.88E+00	[A154] iron & steel	1.40E+10
[A161] AlO3	3.29E+00	[A143] cement	6.33E+09
[A134] PVC	1.99E+00	[A159] animal products	4.61E+09
[A167] chlorine	1.83E+00	[A144] ceramic	4.13E+09
[A145] concrete	1.39E+00	[A140] glass (not coated)	1.19E+09
[A143] cement	1.27E+00	[A117] aluminium 0% rec.	1.10E+09
[A123] copper	1.22E+00	[A106] NPK 15-15-15 fertiliser (mixed acid route)	7.69E+08
[A121] zinc	1.12E+00	[A146] gypsum	5.50E+08
[A127] ammonia	8.79E-01	[A123] copper	4.91E+08
[A144] ceramic	8.72E-01	[A139] paper	4.60E+08
[A193] wood (massive)	7.32E-01	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	3.27E+08
[A119] nickel	7.26E-01	[A164] CaO	3.05E+08
[A149] sand (construction)	7.01E-01	[A142] rockwool	2.51E+08
[A128] PE (HD)	5.49E-01	[A121] zinc	2.43E+08
[A133] PP	5.49E-01	[A137] water (decarbonated)	1.51E+08
[A173] H2SO4	4.26E-01	[A161] AlO3	1.46E+08
[A130] PS	3.99E-01	[A179] NaCl	1.14E+08
[A175] HCl	3.74E-01	[A134] PVC	1.10E+08
[A140] glass (not coated)	2.93E-01	[A119] nickel	8.89E+07
[A165] chemicals anorganic	2.73E-01	[A167] chlorine	8.39E+07
[A148] gravel (concrete)	1.97E-01	[A101] SSP (single super phosphate)	6.36E+07
[A164] CaO	1.81E-01	[A127] ammonia	5.78E+07
[A142] rockwool	1.54E-01	[A98] CAN (calcium ammonium nitrate) CAN	4.27E+07
[A179] NaCl	1.52E-01	[A115] lead soft	3.35E+07
[A98] CAN (calcium ammonium nitrate) CAN	1.43E-01	[A193] wood (massive)	3.30E+07
[A120] chromium	9.20E-02	[A128] PE (HD)	2.98E+07
[A106] NPK 15-15-15 fertiliser (mixed acid route)	5.60E-02	[A124] bariet	2.76E+07
[A146] gypsum	4.21E-02	[A133] PP	2.56E+07
[A115] lead soft	2.97E-02	[A173] H2SO4	2.44E+07
[A101] SSP (single super phosphate)	1.88E-02	[A130] PS	1.86E+07
[A124] bariet	1.65E-02	[A175] HCl	1.72E+07
[A137] water (decarbonated)	1.59E-02	[A120] chromium	1.61E+07
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	1.19E-02	[A165] chemicals anorganic	1.35E+07
[A184] platinum	1.17E-02	[A184] platinum	4.08E+06

Material	*Radiation*	*Material*	*Final solid waste formation*
[A181] palladium	7.66E-03	[A112] copper additive	1.49E+06
[A111] zinc additive	5.66E-03	[A189] sulphur (secundary)	7.86E+05
[A189] sulphur (secundary)	5.34E-03	[A181] palladium	7.20E+05
[A112] copper additive	5.28E-03	[A111] zinc additive	5.20E+05
[A185] rhodium	1.09E-03	[A185] rhodium	3.95E+05
[A99] urea	7.99E-04	[A110] KNO3 (potassium nitrate)	1.43E+05
[A110] KNO3 (potassium nitrate)	3.62E-04	[A99] urea	1.18E+05
[A118] aluminium 100% rec.	0.00E+00	[A118] aluminium 100% rec.	0.00E+00
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A102] TSP (triple super phoshate)	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00
[A104] MAP (mono ammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A105] DAP (diammonium phosphate)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	0.00E+00	[A113] pesticides for crop production (vegetables, fruits, bulbs etc)	0.00E+00
[A114] calcium nitrate	0.00E+00	[A114] calcium nitrate	0.00E+00
[A116] lead hard	0.00E+00	[A116] lead hard	0.00E+00
[A125] refrigerant R22	0.00E+00	[A125] refrigerant R22	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A129] PC	0.00E+00	[A129] PC	0.00E+00
[A131] PE (LD)	0.00E+00	[A131] PE (LD)	0.00E+00
[A132] PET 0% rec	0.00E+00	[A132] PET 0% rec	0.00E+00
[A135] PUR	0.00E+00	[A135] PUR	0.00E+00
[A136] water (demineralised)	0.00E+00	[A136] water (demineralised)	0.00E+00
[A138] board (karton)	0.00E+00	[A138] board (karton)	0.00E+00
[A141] glass (coated)	0.00E+00	[A141] glass (coated)	0.00E+00
[A147] limestone	0.00E+00	[A147] limestone	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A151] clay_loam	0.00E+00	[A151] clay_loam	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A153] cast iron	0.00E+00	[A153] cast iron	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A156] blow steel	0.00E+00	[A156] blow steel	0.00E+00
[A157] electro steel	0.00E+00	[A157] electro steel	0.00E+00
[A158] steel (not alloyed)	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A162] bentonite	0.00E+00	[A162] bentonite	0.00E+00
[A163] Ca(OH)2	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A168] ehtylene	0.00E+00	[A168] ehtylene	0.00E+00

Material	*Radiation*	*Material*	*Final solid waste formation*
[A169] ethylene oxide	0.00E+00	[A169] ethylene oxide	0.00E+00
[A170] explosives	0.00E+00	[A170] explosives	0.00E+00
[A171] FeSO4	0.00E+00	[A171] FeSO4	0.00E+00
[A172] formaldehyde	0.00E+00	[A172] formaldehyde	0.00E+00
[A174] H3PO4	0.00E+00	[A174] H3PO4	0.00E+00
[A176] HF	0.00E+00	[A176] HF	0.00E+00
[A177] HNO3	0.00E+00	[A177] HNO3	0.00E+00
[A178] hydrogen	0.00E+00	[A178] hydrogen	0.00E+00
[A180] NaOH	0.00E+00	[A180] NaOH	0.00E+00
[A182] paraxylol	0.00E+00	[A182] paraxylol	0.00E+00
[A183] phenol	0.00E+00	[A183] phenol	0.00E+00
[A186] rubber	0.00E+00	[A186] rubber	0.00E+00
[A187] soda	0.00E+00	[A187] soda	0.00E+00
[A188] styrene	0.00E+00	[A188] styrene	0.00E+00
[A190] ureum	0.00E+00	[A190] ureum	0.00E+00
[A191] vinylchloride	0.00E+00	[A191] vinylchloride	0.00E+00
[A192] zeolith	0.00E+00	[A192] zeolith	0.00E+00
[A194] wood (board)	0.00E+00	[A194] wood (board)	0.00E+00
[A122] manganese	-1.98E-01	[A122] manganese	-1.64E+07
[A166] chemicals organic	-1.35E+01	[A166] chemicals organic	-4.03E+08

Appendix 10 Total score of materials, impact per kg x flows, Production system, list-of-materials variant.

Table 1 Abiotic depletion, land use and global warming

Material	***Abiotic Depletion***	***Material***	***Land use***	***Material***	***Global Warming***
[A154] raw iron	2.15E+08	[A159] animal products	1.90E+10	[A160] crop and grass	1.05E+11
[A117] aluminium 0% rec.	1.17E+07	[A160] crop and grass	1.06E+10	[A159] animal products	3.33E+10
[A145] concrete	9.84E+06	[A149] sand (construction)	6.64E+08	[A154] raw iron	2.19E+10
[A159] animal products	9.39E+06	[A154] raw iron	3.14E+08	[A128] PE (HD)	8.51E+09
[A139] paper	9.08E+06	[A145] concrete	2.35E+08	[A139] paper	6.71E+09
[A160] crop and grass	9.03E+06	[A139] paper	1.60E+08	[A133] PP	5.15E+09
[A143] cement	7.11E+06	[A117] aluminium 0% rec.	1.19E+08	[A127] ammonia	4.74E+09
[A134] PVC	6.55E+06	[A134] PVC	9.32E+07	[A134] PVC	3.99E+09
[A121] zinc	5.96E+06	[A133] PP	5.94E+07	[A117] aluminium 0% rec.	3.94E+09
[A133] PP	3.73E+06	[A128] PE (HD)	5.78E+07	[A130] PS	3.41E+09
[A128] PE (HD)	3.37E+06	[A121] zinc	4.25E+07	[A98] CAN (calcium ammonium nitrate)	3.16E+09
[A167] chlorine	2.81E+06	[A167] chlorine	4.24E+07	[A145] concrete	2.25E+09
[A98] CAN (calcium ammonium nitrate)	2.55E+06	[A144] ceramic	4.16E+07	[A144] ceramic	1.75E+09
[A140] glass (not coated)	2.06E+06	[A148] gravel (concrete)	4.04E+07	[A129] PC	1.60E+09
[A130] PS	1.79E+06	[A127] ammonia	3.99E+07	[A143] cement	1.33E+09
[A127] ammonia	1.76E+06	[A130] PS	3.00E+07	[A149] sand (construction)	1.19E+09
[A144] ceramic	1.60E+06	[A143] cement	2.84E+07	[A121] zinc	1.06E+09
[A142] rockwool	1.46E+06	[A193] wood (massive)	2.31E+07	[A140] glass (not coated)	7.63E+08
[A179] NaCl	1.27E+06	[A98] CAN (calcium ammonium nitrate)	1.89E+07	[A167] chlorine	5.72E+08
[A149] sand (construction)	9.92E+05	[A140] glass (not coated)	1.68E+07	[A132] PET 0% rec	5.00E+08
[A173] H2SO4	6.60E+05	[A179] NaCl	1.50E+07	[A179] NaCl	4.97E+08
[A129] PC	6.05E+05	[A173] H2SO4	1.15E+07	[A135] PUR	4.49E+08
[A175] HCl	5.83E+05	[A129] PC	1.10E+07	[A142] rockwool	3.15E+08
[A135] PUR	4.22E+05	[A175] HCl	8.81E+06	[A173] H2SO4	2.44E+08
[A99] urea	4.08E+05	[A135] PUR	6.62E+06	[A106] NPK 15-15-15 fertiliser (mixed acid route)	2.40E+08
[A132] PET 0% rec	3.19E+05	[A142] rockwool	5.50E+06	[A189] sulphur (secundary)	1.20E+08
[A193] wood (massive)	2.66E+05	[A132] PET 0% rec	5.29E+06	[A175] HCl	1.19E+08

Material	*Abiotic Depletion*	*Material*	*Land use*	*Material*	*Global Warming*
[A115] lead soft	2.28E+05	[A106] NPK 15-15-15 fertiliser (mixed acid route)	3.68E+06	[A148] gravel (concrete)	7.53E+07
[A106] NPK 15-15-15 fertiliser (mixed acid route)	2.27E+05	[A99] urea	2.50E+06	[A110] KNO3 (potassium nitrate)	4.04E+07
[A101] SSP (single super phosphate)	1.21E+05	[A101] SSP (single super phosphate)	2.28E+06	[A101] SSP (single super phosphate)	3.67E+07
[A148] gravel (concrete)	7.55E+04	[A137] water (decarbonated)	8.12E+05	[A115] lead soft	2.30E+07
[A137] water (decarbonated)	3.36E+04	[A115] lead soft	6.54E+05	[A137] water (decarbonated)	1.27E+07
[A110] KNO3 (potassium nitrate)	1.46E+04	[A189] sulphur (secundary)	2.81E+05	[A118] aluminium 100% rec.	0.00E+00
[A189] sulphur (secundary)	1.22E+04	[A110] KNO3 (potassium nitrate)	2.14E+05	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A118] aluminium 100% rec.	0.00E+00	[A118] aluminium 100% rec.	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00
[A102] TSP (triple super phoshate)	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00
[A104] MAP (mono ammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophosphate route)	0.00E+00
[A105] DAP (diammonium phosphate)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A111] zinc additive	0.00E+00
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00	[A112] copper additive	0.00E+00
[A111] zinc additive	0.00E+00	[A111] zinc additive	0.00E+00	[A113] pesticides	0.00E+00
[A112] copper additive	0.00E+00	[A112] copper additive	0.00E+00	[A114] calcium nitrate	0.00E+00
[A113] pesticides	0.00E+00	[A113] pesticides	0.00E+00	[A116] lead hard	0.00E+00
[A114] calcium nitrate	0.00E+00	[A114] calcium nitrate	0.00E+00	[A119] nickel	0.00E+00
[A116] lead hard	0.00E+00	[A116] lead hard	0.00E+00	[A120] chromium	0.00E+00
[A119] nickel	0.00E+00	[A119] nickel	0.00E+00	[A122] manganese	0.00E+00

Material	***Abiotic Depletion***	***Material***	***Land use***	***Material***	***Global Warming***
[A120] chromium	0.00E+00	[A120] chromium	0.00E+00	[A123] copper	0.00E+00
[A122] manganese	0.00E+00	[A122] manganese	0.00E+00	[A124] bariet	0.00E+00
[A123] copper	0.00E+00	[A123] copper	0.00E+00	[A125] refrigerant R22	0.00E+00
[A124] bariet	0.00E+00	[A124] bariet	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A125] refrigerant R22	0.00E+00	[A125] refrigerant R22	0.00E+00	[A131] PE (LD)	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A126] refrigerant R134a	0.00E+00	[A136] water (demineralised)	0.00E+00
[A131] PE (LD)	0.00E+00	[A131] PE (LD)	0.00E+00	[A138] board (karton)	0.00E+00
[A136] water (demineralised)	0.00E+00	[A136] water (demineralised)	0.00E+00	[A141] glass (coated)	0.00E+00
[A138] board (karton)	0.00E+00	[A138] board (karton)	0.00E+00	[A146] gypsum	0.00E+00
[A141] glass (coated)	0.00E+00	[A141] glass (coated)	0.00E+00	[A147] limestone	0.00E+00
[A146] gypsum	0.00E+00	[A146] gypsum	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A147] limestone	0.00E+00	[A147] limestone	0.00E+00	[A151] clay_loam	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A150] gypsum (raw stone)	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A151] clay_loam	0.00E+00	[A151] clay_loam	0.00E+00	[A153] cast iron	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A152] steel (high alloyed)	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A153] cast iron	0.00E+00	[A153] cast iron	0.00E+00	[A156] "blas stahl"	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A155] steel (light alloyed)	0.00E+00	[A157] electro steel	0.00E+00
[A156] "blas stahl"	0.00E+00	[A156] "blas stahl"	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A157] electro steel	0.00E+00	[A157] electro steel	0.00E+00	[A161] AlO3	0.00E+00
[A158] steel (not alloyed)	0.00E+00	[A158] steel (not alloyed)	0.00E+00	[A162] bentonite	0.00E+00
[A161] AlO3	0.00E+00	[A161] AlO3	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A162] bentonite	0.00E+00	[A162] bentonite	0.00E+00	[A164] CaO	0.00E+00
[A163] Ca(OH)2	0.00E+00	[A163] Ca(OH)2	0.00E+00	[A165] chemicals anorganic	0.00E+00
[A164] CaO	0.00E+00	[A164] CaO	0.00E+00	[A166] chemicals organic	0.00E+00
[A165] chemicals anorganic	0.00E+00	[A165] chemicals anorganic	0.00E+00	[A168] ehtylene	0.00E+00
[A166] chemicals organic	0.00E+00	[A166] chemicals organic	0.00E+00	[A169] ethylene oxide	0.00E+00
[A168] ehtylene	0.00E+00	[A168] ehtylene	0.00E+00	[A170] explosives	0.00E+00
[A169] ethylene oxide	0.00E+00	[A169] ethylene oxide	0.00E+00	[A171] FeSO4	0.00E+00
[A170] explosives	0.00E+00	[A170] explosives	0.00E+00	[A172] formaldehyde	0.00E+00
[A171] FeSO4	0.00E+00	[A171] FeSO4	0.00E+00	[A174] H3PO4	0.00E+00
[A172] formaldehyde	0.00E+00	[A172] formaldehyde	0.00E+00	[A176] HF	0.00E+00

Material	Abiotic Depletion	Material	Land use	Material	Global Warming
[A174] H3PO4	0.00E+00	[A174] H3PO4	0.00E+00	[A177] HNO3	0.00E+00
[A176] HF	0.00E+00	[A176] HF	0.00E+00	[A178] hydrogen	0.00E+00
[A177] HNO3	0.00E+00	[A177] HNO3	0.00E+00	[A180] NaOH	0.00E+00
[A178] hydrogen	0.00E+00	[A178] hydrogen	0.00E+00	[A181] palladium	0.00E+00
[A180] NaOH	0.00E+00	[A180] NaOH	0.00E+00	[A182] paraxylol	0.00E+00
[A181] palladium	0.00E+00	[A181] palladium	0.00E+00	[A183] phenol	0.00E+00
[A182] paraxylol	0.00E+00	[A182] paraxylol	0.00E+00	[A184] platinum	0.00E+00
[A183] phenol	0.00E+00	[A183] phenol	0.00E+00	[A185] rhodium	0.00E+00
[A184] platinum	0.00E+00	[A184] platinum	0.00E+00	[A186] rubber	0.00E+00
[A185] rhodium	0.00E+00	[A185] rhodium	0.00E+00	[A187] soda	0.00E+00
[A186] rubber	0.00E+00	[A186] rubber	0.00E+00	[A188] styrene	0.00E+00
[A187] soda	0.00E+00	[A187] soda	0.00E+00	[A190] ureum	0.00E+00
[A188] styrene	0.00E+00	[A188] styrene	0.00E+00	[A191] vinylchloride	0.00E+00
[A190] ureum	0.00E+00	[A190] ureum	0.00E+00	[A192] zeolith	0.00E+00
[A191] vinylchloride	0.00E+00	[A191] vinylchloride	0.00E+00	[A194] wood (board)	0.00E+00
[A192] zeolith	0.00E+00	[A192] zeolith	0.00E+00	[A99] urea	-1.53E+07
[A194] wood (board)	0.00E+00	[A194] wood (board)	0.00E+00	[A193] wood (massive)	-3.78E+08

Table 2 Ozone layer depletion, human toxicity and aquatic ecotoxicity

Material	***Ozone layer depletion***	***Material***	***Human toxicity***	***Material***	***Aquatic ecotoxicity***
[A134] PVC	2.58E+05	[A154] raw iron	1.62E+10	[A160] crop and grass	9.00E+09
[A128] PE (HD)	1.21E+04	[A121] zinc	9.98E+09	[A159] animal products	7.79E+09
[A133] PP	7.54E+03	[A128] PE (HD)	5.08E+09	[A154] raw iron	3.07E+09
[A130] PS	4.73E+03	[A133] PP	3.03E+09	[A128] PE (HD)	4.48E+08
[A154] raw iron	4.66E+03	[A132] PET 0% rec	2.91E+09	[A133] PP	2.87E+08
[A139] paper	3.09E+03	[A130] PS	2.06E+09	[A139] paper	2.65E+08
[A159] animal products	2.11E+03	[A139] paper	1.66E+09	[A121] zinc	2.24E+08
[A117] aluminium 0% rec.	2.02E+03	[A117] aluminium 0% rec.	1.64E+09	[A117] aluminium 0% rec.	1.94E+08
[A160] crop and grass	1.93E+03	[A144] ceramic	1.62E+09	[A145] concrete	1.29E+08
[A129] PC	1.65E+03	[A159] animal products	1.54E+09	[A134] PVC	1.08E+08
[A149] sand (construction)	1.47E+03	[A160] crop and grass	1.54E+09	[A130] PS	1.05E+08
[A145] concrete	1.10E+03	[A134] PVC	1.27E+09	[A143] cement	9.34E+07
[A132] PET 0% rec	8.40E+02	[A115] lead soft	1.09E+09	[A129] PC	5.87E+07
[A167] chlorine	7.41E+02	[A129] PC	7.47E+08	[A98] CAN (calcium ammonium nitrate)	3.34E+07
[A127] ammonia	5.38E+02	[A145] concrete	6.23E+08	[A167] chlorine	2.87E+07
[A98] CAN (calcium ammonium nitrate)	5.35E+02	[A143] cement	4.00E+08	[A132] PET 0% rec	2.84E+07
[A121] zinc	3.57E+02	[A127] ammonia	2.30E+08	[A140] glass (not coated)	2.76E+07
[A143] cement	3.27E+02	[A140] glass (not coated)	1.91E+08	[A127] ammonia	2.66E+07
[A179] NaCl	3.06E+02	[A167] chlorine	1.82E+08	[A179] NaCl	2.32E+07
[A144] ceramic	2.32E+02	[A179] NaCl	1.75E+08	[A142] rockwool	1.98E+07
[A99] urea	1.79E+02	[A98] CAN (calcium ammonium nitrate)	1.67E+08	[A144] ceramic	1.90E+07
[A189] sulphur (secundary)	1.72E+02	[A149] sand (construction)	1.49E+08	[A149] sand (construction)	1.47E+07
[A175] HCl	1.54E+02	[A135] PUR	1.20E+08	[A135] PUR	1.28E+07
[A106] NPK 15-15-15 fertiliser (mixed acid route)	1.30E+02	[A142] rockwool	9.33E+07	[A173] H2SO4	6.68E+06
[A142] rockwool	1.28E+02	[A189] sulphur (secundary)	5.02E+07	[A175] HCl	5.96E+06
[A140] glass (not coated)	1.28E+02	[A173] H2SO4	4.50E+07	[A193] wood (massive)	5.66E+06
[A135] PUR	1.24E+02	[A175] HCl	3.78E+07	[A99] urea	5.39E+06
[A148] gravel (concrete)	9.06E+01	[A99] urea	2.81E+07	[A189] sulphur (secundary)	4.34E+06

Material	***Ozone layer depletion***	***Material***	***Human toxicity***	***Material***	***Aquatic ecotoxicity***
[A173] H2SO4	6.68E+01	[A193] wood (massive)	2.74E+07	[A106] NPK 15-15-15 fertiliser (mixed acid route)	3.07E+06
[A193] wood (massive)	5.15E+01	[A106] NPK 15-15-15 fertiliser (mixed acid route)	2.30E+07	[A137] water (decarbonated)	1.90E+06
[A101] SSP (single super phosphate)	3.01E+01	[A148] gravel (concrete)	9.91E+06	[A115] lead soft	1.67E+06
[A110] KNO3 (potassium nitrate)	1.64E+01	[A101] SSP (single super phosphate)	9.62E+06	[A101] SSP (single super phosphate)	1.27E+06
[A137] water (decarbonated)	1.55E+01	[A110] KNO3 (potassium nitrate)	1.71E+06	[A148] gravel (concrete)	1.04E+06
[A115] lead soft	9.24E+00	[A118] aluminium 100% rec.	0.00E+00	[A110] KNO3 (potassium nitrate)	2.22E+05
[A118] aluminium 100% rec.	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00	[A118] aluminium 100% rec.	0.00E+00
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A102] TSP (triple super phoshate)	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00
[A104] MAP (mono ammonium phosphate)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A105] DAP (diammonium phosphate)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00	[A111] zinc additive	0.00E+00	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00
[A111] zinc additive	0.00E+00	[A112] copper additive	0.00E+00	[A111] zinc additive	0.00E+00
[A112] copper additive	0.00E+00	[A113] pesticides	0.00E+00	[A112] copper additive	0.00E+00
[A113] pesticides	0.00E+00	[A114] calcium nitrate	0.00E+00	[A113] pesticides	0.00E+00
[A114] calcium nitrate	0.00E+00	[A116] lead hard	0.00E+00	[A114] calcium nitrate	0.00E+00
[A116] lead hard	0.00E+00	[A119] nickel	0.00E+00	[A116] lead hard	0.00E+00
[A119] nickel	0.00E+00	[A120] chromium	0.00E+00	[A119] nickel	0.00E+00

Material	***Ozone layer depletion***	***Material***	***Human toxicity***	***Material***	***Aquatic ecotoxicity***
[A120] chromium	0.00E+00	[A122] manganese	0.00E+00	[A120] chromium	0.00E+00
[A122] manganese	0.00E+00	[A123] copper	0.00E+00	[A122] manganese	0.00E+00
[A123] copper	0.00E+00	[A124] bariet	0.00E+00	[A123] copper	0.00E+00
[A124] bariet	0.00E+00	[A125] refrigerant R22	0.00E+00	[A124] bariet	0.00E+00
[A125] refrigerant R22	0.00E+00	[A126] refrigerant R134a	0.00E+00	[A125] refrigerant R22	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A131] PE (LD)	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A131] PE (LD)	0.00E+00	[A136] water (demineralised)	0.00E+00	[A131] PE (LD)	0.00E+00
[A136] water (demineralised)	0.00E+00	[A138] board (karton)	0.00E+00	[A136] water (demineralised)	0.00E+00
[A138] board (karton)	0.00E+00	[A141] glass (coated)	0.00E+00	[A138] board (karton)	0.00E+00
[A141] glass (coated)	0.00E+00	[A146] gypsum	0.00E+00	[A141] glass (coated)	0.00E+00
[A146] gypsum	0.00E+00	[A147] limestone	0.00E+00	[A146] gypsum	0.00E+00
[A147] limestone	0.00E+00	[A150] gypsum (raw stone)	0.00E+00	[A147] limestone	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A151] clay_loam	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A151] clay_loam	0.00E+00	[A152] steel (high alloyed)	0.00E+00	[A151] clay_loam	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A153] cast iron	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A153] cast iron	0.00E+00	[A155] steel (light alloyed)	0.00E+00	[A153] cast iron	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A156] "blas stahl"	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A156] "blas stahl"	0.00E+00	[A157] electro steel	0.00E+00	[A156] "blas stahl"	0.00E+00
[A157] electro steel	0.00E+00	[A158] steel (not alloyed)	0.00E+00	[A157] electro steel	0.00E+00
[A158] steel (not alloyed)	0.00E+00	[A161] AlO3	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A161] AlO3	0.00E+00	[A162] bentonite	0.00E+00	[A161] AlO3	0.00E+00
[A162] bentonite	0.00E+00	[A163] Ca(OH)2	0.00E+00	[A162] bentonite	0.00E+00
[A163] Ca(OH)2	0.00E+00	[A164] CaO	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A164] CaO	0.00E+00	[A165] chemicals anorganic	0.00E+00	[A164] CaO	0.00E+00
[A165] chemicals anorganic	0.00E+00	[A166] chemicals organic	0.00E+00	[A165] chemicals anorganic	0.00E+00
[A166] chemicals organic	0.00E+00	[A168] ehtylene	0.00E+00	[A166] chemicals organic	0.00E+00
[A168] ehtylene	0.00E+00	[A169] ethylene oxide	0.00E+00	[A168] ehtylene	0.00E+00
[A169] ethylene oxide	0.00E+00	[A170] explosives	0.00E+00	[A169] ethylene oxide	0.00E+00
[A170] explosives	0.00E+00	[A171] FeSO4	0.00E+00	[A170] explosives	0.00E+00

Material	***Ozone layer depletion***	***Material***	***Human toxicity***	***Material***	***Aquatic ecotoxicity***
[A171] FeSO4	0.00E+00	[A172] formaldehyde	0.00E+00	[A171] FeSO4	0.00E+00
[A172] formaldehyde	0.00E+00	[A174] H3PO4	0.00E+00	[A172] formaldehyde	0.00E+00
[A174] H3PO4	0.00E+00	[A176] HF	0.00E+00	[A174] H3PO4	0.00E+00
[A176] HF	0.00E+00	[A177] HNO3	0.00E+00	[A176] HF	0.00E+00
[A177] HNO3	0.00E+00	[A178] hydrogen	0.00E+00	[A177] HNO3	0.00E+00
[A178] hydrogen	0.00E+00	[A180] NaOH	0.00E+00	[A178] hydrogen	0.00E+00
[A180] NaOH	0.00E+00	[A181] palladium	0.00E+00	[A180] NaOH	0.00E+00
[A181] palladium	0.00E+00	[A182] paraxylol	0.00E+00	[A181] palladium	0.00E+00
[A182] paraxylol	0.00E+00	[A183] phenol	0.00E+00	[A182] paraxylol	0.00E+00
[A183] phenol	0.00E+00	[A184] platinum	0.00E+00	[A183] phenol	0.00E+00
[A184] platinum	0.00E+00	[A185] rhodium	0.00E+00	[A184] platinum	0.00E+00
[A185] rhodium	0.00E+00	[A186] rubber	0.00E+00	[A185] rhodium	0.00E+00
[A186] rubber	0.00E+00	[A187] soda	0.00E+00	[A186] rubber	0.00E+00
[A187] soda	0.00E+00	[A188] styrene	0.00E+00	[A187] soda	0.00E+00
[A188] styrene	0.00E+00	[A190] ureum	0.00E+00	[A188] styrene	0.00E+00
[A190] ureum	0.00E+00	[A191] vinylchloride	0.00E+00	[A190] ureum	0.00E+00
[A191] vinylchloride	0.00E+00	[A192] zeolith	0.00E+00	[A191] vinylchloride	0.00E+00
[A192] zeolith	0.00E+00	[A194] wood (board)	0.00E+00	[A192] zeolith	0.00E+00
[A194] wood (board)	0.00E+00	[A137] water (decarbonated)	-8.59E+06	[A194] wood (board)	0.00E+00

Table 3 Marine ecotoxicity, terrestrial ecotoxicity, photochemical oxidant formation

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A144] ceramic	2.16E+13	[A160] crop and grass	3.66E+08	[A128] PE (HD)	2.78E+07
[A154] raw iron	1.52E+13	[A159] animal products	3.29E+08	[A154] raw iron	1.16E+07
[A117] aluminium 0% rec.	8.93E+12	[A128] PE (HD)	1.33E+08	[A159] animal products	4.39E+06
[A128] PE (HD)	3.57E+12	[A121] zinc	1.20E+08	[A133] PP	2.53E+06
[A139] paper	2.58E+12	[A154] raw iron	8.36E+07	[A139] paper	2.32E+06
[A159] animal products	1.97E+12	[A139] paper	4.82E+07	[A127] ammonia	1.69E+06
[A133] PP	1.86E+12	[A133] PP	4.75E+07	[A189] sulphur (secundary)	1.52E+06
[A160] crop and grass	1.77E+12	[A134] PVC	2.54E+07	[A117] aluminium 0% rec.	1.12E+06
[A134] PVC	1.69E+12	[A117] aluminium 0% rec.	2.28E+07	[A160] crop and grass	1.06E+06
[A121] zinc	1.20E+12	[A130] PS	1.99E+07	[A134] PVC	1.02E+06
[A140] glass (not coated)	1.16E+12	[A167] chlorine	1.31E+07	[A130] PS	9.47E+05
[A130] PS	8.59E+11	[A129] PC	1.05E+07	[A145] concrete	7.66E+05
[A145] concrete	7.68E+11	[A145] concrete	8.45E+06	[A142] rockwool	5.78E+05
[A167] chlorine	6.08E+11	[A127] ammonia	6.67E+06	[A121] zinc	4.71E+05
[A143] cement	4.45E+11	[A115] lead soft	6.32E+06	[A129] PC	4.33E+05
[A127] ammonia	4.26E+11	[A143] cement	5.42E+06	[A144] ceramic	4.01E+05
[A129] PC	3.46E+11	[A179] NaCl	3.68E+06	[A149] sand (construction)	3.87E+05
[A179] NaCl	2.78E+11	[A132] PET 0% rec	3.41E+06	[A98] CAN (calcium ammonium nitrate)	3.84E+05
[A149] sand (construction)	2.61E+11	[A175] HCl	2.71E+06	[A143] cement	3.81E+05
[A98] CAN (calcium ammonium nitrate)	2.24E+11	[A149] sand (construction)	2.30E+06	[A173] H2SO4	3.16E+05
[A142] rockwool	2.05E+11	[A144] ceramic	2.11E+06	[A179] NaCl	2.32E+05
[A135] PUR	1.59E+11	[A135] PUR	1.98E+06	[A167] chlorine	2.06E+05
[A132] PET 0% rec	1.48E+11	[A98] CAN (calcium ammonium nitrate)	1.71E+06	[A132] PET 0% rec	1.87E+05
[A173] H2SO4	1.42E+11	[A189] sulphur (secundary)	1.70E+06	[A140] glass (not coated)	1.86E+05
[A175] HCl	1.26E+11	[A140] glass (not coated)	9.39E+05	[A106] NPK 15-15-15 fertiliser (mixed acid route)	9.25E+04
[A193] wood (massive)	5.94E+10	[A142] rockwool	9.23E+05	[A135] PUR	8.89E+04
[A99] urea	4.25E+10	[A173] H2SO4	6.15E+05	[A99] urea	5.64E+04
[A189] sulphur (secundary)	4.06E+10	[A193] wood (massive)	5.80E+05	[A193] wood (massive)	4.70E+04

Material	*Marine ecotoxicity*	*Material*	*Terrestrial ecotoxicity*	*Material*	*Photo chemical ox.form.*
[A106] NPK 15-15-15 fertiliser (mixed acid route)	2.92E+10	[A99] urea	3.64E+05	[A175] HCl	4.26E+04
[A101] SSP (single super phosphate)	2.61E+10	[A106] NPK 15-15-15 fertiliser (mixed acid route)	3.23E+05	[A101] SSP (single super phosphate)	2.56E+04
[A148] gravel (concrete)	1.90E+10	[A148] gravel (concrete)	1.51E+05	[A148] gravel (concrete)	2.40E+04
[A115] lead soft	1.70E+10	[A101] SSP (single super phosphate)	1.42E+05	[A115] lead soft	1.11E+04
[A137] water (decarbonated)	6.82E+09	[A137] water (decarbonated)	5.11E+04	[A110] KNO3 (potassium nitrate)	7.84E+03
[A110] KNO3 (potassium nitrate)	2.15E+09	[A110] KNO3 (potassium nitrate)	2.50E+04	[A118] aluminium 100% rec.	0.00E+00
[A118] aluminium 100% rec.	0.00E+00	[A118] aluminium 100% rec.	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A102] TSP (triple super phoshate)	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A104] MAP (mono ammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00
[A105] DAP (diammonium phosphate)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00	[A111] zinc additive	0.00E+00
[A111] zinc additive	0.00E+00	[A111] zinc additive	0.00E+00	[A112] copper additive	0.00E+00
[A112] copper additive	0.00E+00	[A112] copper additive	0.00E+00	[A113] pesticides	0.00E+00
[A113] pesticides	0.00E+00	[A113] pesticides	0.00E+00	[A114] calcium nitrate	0.00E+00

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A114] calcium nitrate	0.00E+00	[A114] calcium nitrate	0.00E+00	[A116] lead hard	0.00E+00
[A116] lead hard	0.00E+00	[A116] lead hard	0.00E+00	[A119] nickel	0.00E+00
[A119] nickel	0.00E+00	[A119] nickel	0.00E+00	[A120] chromium	0.00E+00
[A120] chromium	0.00E+00	[A120] chromium	0.00E+00	[A122] manganese	0.00E+00
[A122] manganese	0.00E+00	[A122] manganese	0.00E+00	[A123] copper	0.00E+00
[A123] copper	0.00E+00	[A123] copper	0.00E+00	[A124] bariet	0.00E+00
[A124] bariet	0.00E+00	[A124] bariet	0.00E+00	[A125] refrigerant R22	0.00E+00
[A125] refrigerant R22	0.00E+00	[A125] refrigerant R22	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A126] refrigerant R134a	0.00E+00	[A131] PE (LD)	0.00E+00
[A131] PE (LD)	0.00E+00	[A131] PE (LD)	0.00E+00	[A136] water (demineralised)	0.00E+00
[A136] water (demineralised)	0.00E+00	[A136] water (demineralised)	0.00E+00	[A138] board (karton)	0.00E+00
[A138] board (karton)	0.00E+00	[A138] board (karton)	0.00E+00	[A141] glass (coated)	0.00E+00
[A141] glass (coated)	0.00E+00	[A141] glass (coated)	0.00E+00	[A146] gypsum	0.00E+00
[A146] gypsum	0.00E+00	[A146] gypsum	0.00E+00	[A147] limestone	0.00E+00
[A147] limestone	0.00E+00	[A147] limestone	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A150] gypsum (raw stone)	0.00E+00	[A151] clay_loam	0.00E+00
[A151] clay_loam	0.00E+00	[A151] clay_loam	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A152] steel (high alloyed)	0.00E+00	[A153] cast iron	0.00E+00
[A153] cast iron	0.00E+00	[A153] cast iron	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A155] steel (light alloyed)	0.00E+00	[A156] "blas stahl"	0.00E+00
[A156] "blas stahl"	0.00E+00	[A156] "blas stahl"	0.00E+00	[A157] electro steel	0.00E+00
[A157] electro steel	0.00E+00	[A157] electro steel	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A158] steel (not alloyed)	0.00E+00	[A158] steel (not alloyed)	0.00E+00	[A161] AlO3	0.00E+00
[A161] AlO3	0.00E+00	[A161] AlO3	0.00E+00	[A162] bentonite	0.00E+00
[A162] bentonite	0.00E+00	[A162] bentonite	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A163] Ca(OH)2	0.00E+00	[A163] Ca(OH)2	0.00E+00	[A164] CaO	0.00E+00
[A164] CaO	0.00E+00	[A164] CaO	0.00E+00	[A165] chemicals anorganic	0.00E+00
[A165] chemicals anorganic	0.00E+00	[A165] chemicals anorganic	0.00E+00	[A166] chemicals organic	0.00E+00
[A166] chemicals organic	0.00E+00	[A166] chemicals organic	0.00E+00	[A168] ehtylene	0.00E+00
[A168] ehtylene	0.00E+00	[A168] ehtylene	0.00E+00	[A169] ethylene oxide	0.00E+00

Material	***Marine ecotoxicity***	***Material***	***Terrestrial ecotoxicity***	***Material***	***Photo chemical ox.form.***
[A169] ethylene oxide	0.00E+00	[A169] ethylene oxide	0.00E+00	[A170] explosives	0.00E+00
[A170] explosives	0.00E+00	[A170] explosives	0.00E+00	[A171] FeSO4	0.00E+00
[A171] FeSO4	0.00E+00	[A171] FeSO4	0.00E+00	[A172] formaldehyde	0.00E+00
[A172] formaldehyde	0.00E+00	[A172] formaldehyde	0.00E+00	[A174] H3PO4	0.00E+00
[A174] H3PO4	0.00E+00	[A174] H3PO4	0.00E+00	[A176] HF	0.00E+00
[A176] HF	0.00E+00	[A176] HF	0.00E+00	[A177] HNO3	0.00E+00
[A177] HNO3	0.00E+00	[A177] HNO3	0.00E+00	[A178] hydrogen	0.00E+00
[A178] hydrogen	0.00E+00	[A178] hydrogen	0.00E+00	[A180] NaOH	0.00E+00
[A180] NaOH	0.00E+00	[A180] NaOH	0.00E+00	[A181] palladium	0.00E+00
[A181] palladium	0.00E+00	[A181] palladium	0.00E+00	[A182] paraxylol	0.00E+00
[A182] paraxylol	0.00E+00	[A182] paraxylol	0.00E+00	[A183] phenol	0.00E+00
[A183] phenol	0.00E+00	[A183] phenol	0.00E+00	[A184] platinum	0.00E+00
[A184] platinum	0.00E+00	[A184] platinum	0.00E+00	[A185] rhodium	0.00E+00
[A185] rhodium	0.00E+00	[A185] rhodium	0.00E+00	[A186] rubber	0.00E+00
[A186] rubber	0.00E+00	[A186] rubber	0.00E+00	[A187] soda	0.00E+00
[A187] soda	0.00E+00	[A187] soda	0.00E+00	[A188] styrene	0.00E+00
[A188] styrene	0.00E+00	[A188] styrene	0.00E+00	[A190] ureum	0.00E+00
[A190] ureum	0.00E+00	[A190] ureum	0.00E+00	[A191] vinylchloride	0.00E+00
[A191] vinylchloride	0.00E+00	[A191] vinylchloride	0.00E+00	[A192] zeolith	0.00E+00
[A192] zeolith	0.00E+00	[A192] zeolith	0.00E+00	[A194] wood (board)	0.00E+00
[A194] wood (board)	0.00E+00	[A194] wood (board)	0.00E+00	[A137] water (decarbonated)	-8.48E+04

Table 4 Acidification and eutrophication

Material	***Acidification***	***Material***	***Eutrophication***
[A159] animal products	1.70E+08	[A160] crop and grass	2.84E+09
[A154] raw iron	7.82E+07	[A159] animal products	2.10E+09
[A139] paper	4.81E+07	[A127] ammonia	4.01E+08
[A133] PP	4.31E+07	[A98] CAN (calcium ammonium nitrate)	2.84E+08
[A189] sulphur (secundary)	3.79E+07	[A106] NPK 15-15-15 fertiliser (mixed acid route)	7.26E+07
[A128] PE (HD)	3.56E+07	[A99] urea	4.25E+07
[A127] ammonia	2.82E+07	[A110] KNO3 (potassium nitrate)	4.20E+07
[A117] aluminium 0% rec.	2.36E+07	[A101] SSP (single super phosphate)	2.63E+07
[A160] crop and grass	1.91E+07	[A154] raw iron	5.86E+06
[A134] PVC	1.81E+07	[A133] PP	5.16E+06
[A130] PS	1.42E+07	[A139] paper	1.75E+06
[A145] concrete	1.09E+07	[A145] concrete	1.63E+06
[A121] zinc	9.38E+06	[A128] PE (HD)	1.40E+06
[A173] H2SO4	7.52E+06	[A143] cement	9.48E+05
[A98] CAN (calcium ammonium nitrate)	6.95E+06	[A117] aluminium 0% rec.	8.88E+05
[A144] ceramic	6.89E+06	[A149] sand (construction)	7.72E+05
[A143] cement	5.92E+06	[A144] ceramic	7.56E+05
[A129] PC	5.90E+06	[A134] PVC	6.88E+05
[A149] sand (construction)	5.77E+06	[A130] PS	6.56E+05
[A167] chlorine	4.43E+06	[A121] zinc	4.36E+05
[A179] NaCl	4.21E+06	[A129] PC	3.07E+05
[A140] glass (not coated)	2.22E+06	[A140] glass (not coated)	2.57E+05
[A142] rockwool	2.18E+06	[A142] rockwool	2.30E+05
[A132] PET 0% rec	2.17E+06	[A179] NaCl	1.88E+05
[A135] PUR	1.85E+06	[A167] chlorine	1.46E+05
[A106] NPK 15-15-15 fertiliser (mixed acid route)	1.77E+06	[A132] PET 0% rec	1.07E+05
[A99] urea	1.60E+06	[A193] wood (massive)	7.35E+04
[A175] HCl	9.14E+05	[A173] H2SO4	6.05E+04
[A193] wood (massive)	6.55E+05	[A148] gravel (concrete)	4.76E+04
[A101] SSP (single super phosphate)	5.26E+05	[A135] PUR	4.45E+04
[A148] gravel (concrete)	3.59E+05	[A189] sulphur (secundary)	3.30E+04
[A115] lead soft	2.12E+05	[A175] HCl	3.02E+04
[A110] KNO3 (potassium nitrate)	1.50E+05	[A115] lead soft	1.21E+04
[A118] aluminium 100% rec.	0.00E+00	[A137] water (decarbonated)	1.16E+04
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A118] aluminium 100% rec.	0.00E+00
[A102] TSP (triple super phoshate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A104] MAP (mono ammonium phosphate)	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00

Material	Acidification	Material	Eutrophication
[A105] DAP (diammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A111] zinc additive	0.00E+00	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00
[A112] copper additive	0.00E+00	[A111] zinc additive	0.00E+00
[A113] pesticides	0.00E+00	[A112] copper additive	0.00E+00
[A114] calcium nitrate	0.00E+00	[A113] pesticides	0.00E+00
[A116] lead hard	0.00E+00	[A114] calcium nitrate	0.00E+00
[A119] nickel	0.00E+00	[A116] lead hard	0.00E+00
[A120] chromium	0.00E+00	[A119] nickel	0.00E+00
[A122] manganese	0.00E+00	[A120] chromium	0.00E+00
[A123] copper	0.00E+00	[A122] manganese	0.00E+00
[A124] bariet	0.00E+00	[A123] copper	0.00E+00
[A125] refrigerant R22	0.00E+00	[A124] bariet	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A125] refrigerant R22	0.00E+00
[A131] PE (LD)	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A136] water (demineralised)	0.00E+00	[A131] PE (LD)	0.00E+00
[A138] board (karton)	0.00E+00	[A136] water (demineralised)	0.00E+00
[A141] glass (coated)	0.00E+00	[A138] board (karton)	0.00E+00
[A146] gypsum	0.00E+00	[A141] glass (coated)	0.00E+00
[A147] limestone	0.00E+00	[A146] gypsum	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A147] limestone	0.00E+00
[A151] clay_loam	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A151] clay_loam	0.00E+00
[A153] cast iron	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A153] cast iron	0.00E+00
[A156] "blas stahl"	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A157] electro steel	0.00E+00	[A156] "blas stahl"	0.00E+00
[A158] steel (not alloyed)	0.00E+00	[A157] electro steel	0.00E+00
[A161] AlO3	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A162] bentonite	0.00E+00	[A161] AlO3	0.00E+00
[A163] Ca(OH)2	0.00E+00	[A162] bentonite	0.00E+00
[A164] CaO	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A165] chemicals anorganic	0.00E+00	[A164] CaO	0.00E+00
[A166] chemicals organic	0.00E+00	[A165] chemicals anorganic	0.00E+00
[A168] ehtylene	0.00E+00	[A166] chemicals organic	0.00E+00
[A169] ethylene oxide	0.00E+00	[A168] ehtylene	0.00E+00
[A170] explosives	0.00E+00	[A169] ethylene oxide	0.00E+00
[A171] FeSO4	0.00E+00	[A170] explosives	0.00E+00
[A172] formaldehyde	0.00E+00	[A171] FeSO4	0.00E+00
[A174] H3PO4	0.00E+00	[A172] formaldehyde	0.00E+00
[A176] HF	0.00E+00	[A174] H3PO4	0.00E+00

Material	*Acidification*	*Material*	*Eutrophication*
[A177] HNO3	0.00E+00	[A176] HF	0.00E+00
[A178] hydrogen	0.00E+00	[A177] HNO3	0.00E+00
[A180] NaOH	0.00E+00	[A178] hydrogen	0.00E+00
[A181] palladium	0.00E+00	[A180] NaOH	0.00E+00
[A182] paraxylol	0.00E+00	[A181] palladium	0.00E+00
[A183] phenol	0.00E+00	[A182] paraxylol	0.00E+00
[A184] platinum	0.00E+00	[A183] phenol	0.00E+00
[A185] rhodium	0.00E+00	[A184] platinum	0.00E+00
[A186] rubber	0.00E+00	[A185] rhodium	0.00E+00
[A187] soda	0.00E+00	[A186] rubber	0.00E+00
[A188] styrene	0.00E+00	[A187] soda	0.00E+00
[A190] ureum	0.00E+00	[A188] styrene	0.00E+00
[A191] vinylchloride	0.00E+00	[A190] ureum	0.00E+00
[A192] zeolith	0.00E+00	[A191] vinylchloride	0.00E+00
[A194] wood (board)	0.00E+00	[A192] zeolith	0.00E+00
[A137] water (decarbonated)	-2.20E+06	[A194] wood (board)	0.00E+00

Table 5 Radiation and Final solid waste formation

Material	***Radiation***	***Material***	***Final solid waste formation***
[A154] raw iron	5.63E+00	[A149] sand (construction)	1.13E+11
[A159] animal products	5.44E+00	[A160] crop and grass	4.59E+10
[A160] crop and grass	5.05E+00	[A145] concrete	3.49E+10
[A139] paper	4.13E+00	[A154] raw iron	1.62E+10
[A117] aluminium 0% rec.	3.92E+00	[A148] gravel (concrete)	6.86E+09
[A134] PVC	3.87E+00	[A159] animal products	6.46E+09
[A133] PP	2.32E+00	[A144] ceramic	4.76E+09
[A128] PE (HD)	2.10E+00	[A143] cement	3.48E+09
[A167] chlorine	1.81E+00	[A140] glass (not coated)	1.06E+09
[A121] zinc	1.67E+00	[A106] NPK 15-15-15 fertiliser (mixed acid route)	7.42E+08
[A145] concrete	1.40E+00	[A117] aluminium 0% rec.	7.07E+08
[A130] PS	1.14E+00	[A139] paper	3.92E+08
[A127] ammonia	1.03E+00	[A121] zinc	3.64E+08
[A144] ceramic	1.01E+00	[A142] rockwool	2.83E+08
[A143] cement	6.98E-01	[A101] SSP (single super phosphate)	2.54E+08
[A149] sand (construction)	6.97E-01	[A179] NaCl	2.40E+08
[A173] H2SO4	4.26E-01	[A134] PVC	2.15E+08
[A98] CAN (calcium ammonium nitrate)	4.13E-01	[A137] water (decarbonated)	1.51E+08
[A175] HCl	3.74E-01	[A98] CAN (calcium ammonium nitrate)	1.23E+08
[A129] PC	3.51E-01	[A128] PE (HD)	1.14E+08
[A179] NaCl	3.21E-01	[A133] PP	1.08E+08
[A135] PUR	2.74E-01	[A167] chlorine	8.27E+07
[A140] glass (not coated)	2.62E-01	[A127] ammonia	6.79E+07
[A132] PET 0% rec	2.01E-01	[A130] PS	5.35E+07
[A193] wood (massive)	1.77E-01	[A129] PC	2.55E+07
[A142] rockwool	1.73E-01	[A173] H2SO4	2.44E+07
[A99] urea	7.99E-02	[A115] lead soft	2.30E+07
[A101] SSP (single super phosphate)	7.51E-02	[A175] HCl	1.72E+07
[A106] NPK 15-15-15 fertiliser (mixed acid route)	5.40E-02	[A99] urea	1.18E+07
[A148] gravel (concrete)	5.24E-02	[A135] PUR	1.12E+07
[A115] lead soft	2.04E-02	[A132] PET 0% rec	1.03E+07
[A137] water (decarbonated)	1.59E-02	[A193] wood (massive)	8.01E+06
[A189] sulphur (secundary)	6.42E-03	[A110] KNO3 (potassium nitrate)	1.30E+06
[A110] KNO3 (potassium nitrate)	3.29E-03	[A189] sulphur (secundary)	9.46E+05
[A118] aluminium 100% rec.	0.00E+00	[A118] aluminium 100% rec.	0.00E+00
[A100] UAN (urea ammonium nitrate)	0.00E+00	[A100] UAN (urea ammonium nitrate)	0.00E+00
[A102] TSP (triple super phoshate)	0.00E+00	[A102] TSP (triple super phoshate)	0.00E+00
[A103] PK-22-22-fertiliser	0.00E+00	[A103] PK-22-22-fertiliser	0.00E+00

Material	***Radiation***	***Material***	***Final solid waste formation***
[A104] MAP (mono ammonium phosphate)	0.00E+00	[A104] MAP (mono ammonium phosphate)	0.00E+00
[A105] DAP (diammonium phosphate)	0.00E+00	[A105] DAP (diammonium phosphate)	0.00E+00
[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00	[A107] NPK 15-15-15 fertiliser (nitrophospahate route)	0.00E+00
[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00	[A108] nitro AP (52% P2O5, 8.4% N)	0.00E+00
[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00	[A109] AP (ammonium phosphate) (49% P2O5, 11% N)	0.00E+00
[A111] zinc additive	0.00E+00	[A111] zinc additive	0.00E+00
[A112] copper additive	0.00E+00	[A112] copper additive	0.00E+00
[A113] pesticides	0.00E+00	[A113] pesticides	0.00E+00
[A114] calcium nitrate	0.00E+00	[A114] calcium nitrate	0.00E+00
[A116] lead hard	0.00E+00	[A116] lead hard	0.00E+00
[A119] nickel	0.00E+00	[A119] nickel	0.00E+00
[A120] chromium	0.00E+00	[A120] chromium	0.00E+00
[A122] manganese	0.00E+00	[A122] manganese	0.00E+00
[A123] copper	0.00E+00	[A123] copper	0.00E+00
[A124] bariet	0.00E+00	[A124] bariet	0.00E+00
[A125] refrigerant R22	0.00E+00	[A125] refrigerant R22	0.00E+00
[A126] refrigerant R134a	0.00E+00	[A126] refrigerant R134a	0.00E+00
[A131] PE (LD)	0.00E+00	[A131] PE (LD)	0.00E+00
[A136] water (demineralised)	0.00E+00	[A136] water (demineralised)	0.00E+00
[A138] board (karton)	0.00E+00	[A138] board (karton)	0.00E+00
[A141] glass (coated)	0.00E+00	[A141] glass (coated)	0.00E+00
[A146] gypsum	0.00E+00	[A146] gypsum	0.00E+00
[A147] limestone	0.00E+00	[A147] limestone	0.00E+00
[A150] gypsum (raw stone)	0.00E+00	[A150] gypsum (raw stone)	0.00E+00
[A151] clay_loam	0.00E+00	[A151] clay_loam	0.00E+00
[A152] steel (high alloyed)	0.00E+00	[A152] steel (high alloyed)	0.00E+00
[A153] cast iron	0.00E+00	[A153] cast iron	0.00E+00
[A155] steel (light alloyed)	0.00E+00	[A155] steel (light alloyed)	0.00E+00
[A156] "blas stahl"	0.00E+00	[A156] "blas stahl"	0.00E+00
[A157] electro steel	0.00E+00	[A157] electro steel	0.00E+00
[A158] steel (not alloyed)	0.00E+00	[A158] steel (not alloyed)	0.00E+00
[A161] AlO3	0.00E+00	[A161] AlO3	0.00E+00
[A162] bentonite	0.00E+00	[A162] bentonite	0.00E+00
[A163] Ca(OH)2	0.00E+00	[A163] Ca(OH)2	0.00E+00
[A164] CaO	0.00E+00	[A164] CaO	0.00E+00
[A165] chemicals anorganic	0.00E+00	[A165] chemicals anorganic	0.00E+00
[A166] chemicals organic	0.00E+00	[A166] chemicals organic	0.00E+00
[A168] ehtylene	0.00E+00	[A168] ehtylene	0.00E+00
[A169] ethylene oxide	0.00E+00	[A169] ethylene oxide	0.00E+00
[A170] explosives	0.00E+00	[A170] explosives	0.00E+00
[A171] FeSO4	0.00E+00	[A171] FeSO4	0.00E+00
[A172] formaldehyde	0.00E+00	[A172] formaldehyde	0.00E+00
[A174] H3PO4	0.00E+00	[A174] H3PO4	0.00E+00

Material	*Radiation*	*Material*	*Final solid waste formation*
[A176] HF	0.00E+00	[A176] HF	0.00E+00
[A177] HNO3	0.00E+00	[A177] HNO3	0.00E+00
[A178] hydrogen	0.00E+00	[A178] hydrogen	0.00E+00
[A180] NaOH	0.00E+00	[A180] NaOH	0.00E+00
[A181] palladium	0.00E+00	[A181] palladium	0.00E+00
[A182] paraxylol	0.00E+00	[A182] paraxylol	0.00E+00
[A183] phenol	0.00E+00	[A183] phenol	0.00E+00
[A184] platinum	0.00E+00	[A184] platinum	0.00E+00
[A185] rhodium	0.00E+00	[A185] rhodium	0.00E+00
[A186] rubber	0.00E+00	[A186] rubber	0.00E+00
[A187] soda	0.00E+00	[A187] soda	0.00E+00
[A188] styrene	0.00E+00	[A188] styrene	0.00E+00
[A190] ureum	0.00E+00	[A190] ureum	0.00E+00
[A191] vinylchloride	0.00E+00	[A191] vinylchloride	0.00E+00
[A192] zeolith	0.00E+00	[A192] zeolith	0.00E+00
[A194] wood (board)	0.00E+00	[A194] wood (board)	0.00E+00