Swedish Society for Nature Conservation

Report

Home Sweet Home?

- dusty surprises under the bed

A study on the chemical cocktail in household dust from all corners of the world

Content

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Preface

In the supposed safety of the home, there are toxic surprises. Ordinary household dust, namely, acts as a reservoir for many environmental pollutants. Chemical compounds may be long lived in the indoor environment, where the air is dry, and UV light, and large amounts of degrading microbes are missing. Metals cannot be degraded, just like in the outdoor environment. Investigations of the content of chemicals in dust, have demonstrated the diversity of chemicals occurring in our homes. Involuntarily, we live in a complex cocktail of chemicals, the consequences of which are yet to be seen. Many of the chemicals in the cocktail are also likely to interact with one another. Effects may be added, or strengthened beyond added effects (i.e. synergistic effects).

In this study, just as in earlier ones, we found a large number of endocrine (hormone) disrupting chemicals. The dust samples were from 12 countries all over the globe. Hormones regulate everything from mood to gender. They are crucial to metabolism, the nervous system, and reproduction. Hormones are usually active at very low concentrations and during narrow time spans. The same goes for hormone disrupting chemicals (so called endocrine disruptors) that mimic hormones, or inhibit hormone production. Because of this, even low concentrations of endocrine disruptors in the external environment, may have adverse effects in humans and other organisms.

Apart from illustrating the diversity of chemicals in our homes (the household dust mirrors this), and the fact that many of the chemicals are endocrine disruptors, with known combination effects, the Swedish Society for Nature Conservation (SSNC) wants to highlight shortages in the current risk assessment methodology applied by authorities worldwide. The shortages are particularly remarkable when it comes to endocrine disrupters, and chemicals with combination effects. The present standardized test methodology with high exposure concentrations and short exposure times are not designed for detection of hormone disruption, which may occur at very low concentrations, and manifest itself at a completely different stage of the life cycle of the organism.

From an ethical point of view and to make it realizable to test many different chemicals in a short time, other methodologies than animal tests are required. Highest priority should be given to research aiming to improve cell-based methods, and computer simulation models. SSNC also shows that there is already a simple mathematic model available for taking combination effects from chemicals with corresponding modes of action into consideration – the “dose addition model” – a model that could immediately be adopted for risk assessments.

Furthermore, REACH needs to be modified in order to take hormone disruption into account in the evaluation of chemicals. SSNC has suggested suitable measures.

The starting point in politics must be the protection of foetuses and children – the most sensitive individuals. All risk assessments need to be based on a child perspective. Known or suspected hormone disruptors should be banned at once, in accordance with the precautionary principle.

SSNC is of the opinion that Sweden, with this as a starting point, needs to push for an ambitious chemicals politics in the EU and internationally. This will increase the pressure on other countries, and will result in adequate protection in Sweden earlier. Endocrine disruptors in notorious groups of chemicals such as brominated flame retardants, phthalates and organofluorine chemicals need to be regulated quickly. They can potentially be found in the dust under your bed – they can potentially harm your children, and their ability of getting children in the future. This is unacceptable.

Mikael Karlsson

President of the Swedish Society for Nature Conservation

Summary

Home sweet home – but is it really so sweet? This study has shown that there are dusty problems lurking under our beds. Ordinary balls of dust contain a cocktail of chemicals. Several of them are known environmental toxicants that can affect our endocrine system, as individual chemicals or in combination with one another.

The Swedish Society for Nature Conservation has shown in this study that a large number of chemicals are present in ordinary household dust around the world. The dust samples came from 12 countries: South Africa, Tanzania, Kenya, Uganda, the Philippines, Malaysia, Sweden, Belgium, Germany, the Czech Republic, Hungary and Italy. Household dust has a chemical content that varies between different sites, and also over time at the same site. However, our study is limited to providing a snapshot of the situation at the sampling sites.

On the basis of the results, we discuss deficiencies of present-day risk assessments that often fail to identify the risks and problems that exist. We therefore also present a method that provides a more true picture of the chemicals problem. The model is based on what is known as the concentration addition method, which takes greater account of combination effects of chemicals, known as cocktail effects. Using this methodology, we show that there is an evident health risk associated with the combined exposure to phthalates both in the EU (the Czech Republic) and in the Global South[1] (the Philippines). Furthermore, the results show that the level of bisphenol A (BPA) was very high in the sample from the Philippines. In this report we have taken account of the most sensitive individuals – small children.

[1] Global South is a term used in the world of development assistance and relates to developing countries and transition economies.

The report concludes with a number of recommendations and demands that principally apply to the EU's chemicals regulation REACH and how it needs to be modified to provide better protection against endocrine disruptors and other types of hazardous chemicals.

It is alarming that chemicals with negative effects on the environment and health that have long been known are present in household dust under our beds in many parts of the world. In addition, the levels of a number of chemicals exceeded those previously measured in household dust. The majority of these chemicals are potential endocrine disruptors and are produced by humans. They do not belong in the environment and should not be in the dust in bedrooms!

Introduction

Few of us reflect on the fact that our homes are full of chemicals – not just household chemicals, cosmetics and medicines, but also in building materials, paints and varnishes, carpets, wallpapers, furniture, electronic equipment, foods and much more besides. Some chemicals are deliberately added, for example flame retardants in furniture upholstery and electronics, or preservatives in foods and chemical household products and cosmetics. Other pollutants which people throughout the world unintentionally are exposed to are heavy metals in foods, all kinds of air pollutants and pollutants that have settled on hair, clothes and shoes from the outdoor environment and that enter the home with these. The diversity of chemicals and the complexity of the mixtures are increasing exponentially. Global production of chemicals increased from around one million tonnes in 1930 to four hundred million tonnes in 2001 (European Commission, 2001). Many of the chemicals that are in circulation in society have been poorly investigated, or have not been investigated at all. with respect to effects on the environment and health. We know even less about how chemicals interact in deliberate and unintentional mixtures.

The breakdown of organic chemicals is very limited indoors, because of often dry air and the absence of UV light and larger quantities of degrading microorganisms. Air turnover in present-day well insulated buildings in cool climates is also limited, which contributes to a long turnaround time for chemicals in the indoor environment. Exposure to certain chemicals indoors may therefore be thousands of times greater than outdoors (Smith, 1988). Certain chemicals whose use has been limited or banned, for example PCBs[2] , are now declining in the external environment and in foods, but may still be present in the indoor environment, which makes inhalation of polluted indoor air and polluted dust an increasingly important route of exposure (Voorhees, 2001; Harrad *et al.,* 2006).

The dust we have analysed comes from home environments and is ,in the remainder of this report, referred to as "household dust". It is a heterogeneous material made up of various size fractions, for example hair and flakes of skin (from humans and pets), viruses, bacteria, pollen, mould, mites, soot, ash, soil particles, textile fibres, abraded material from furniture and other household items or food remnants (Paustenbach *et al.,* 1997). The dust acts as a reservoir for the chemicals in the indoor environment and reflects the chemicals to which people are potentially exposed in the home (Abb *et al.,* 2009). Polluted dust can be inhaled, ingested as it is deposited on foods, and when children put

[2] Polychlorinated biphenyl ethers (there are many variants).

dusty objects in their mouths, or be deposited on our skin, through which fat-soluble chemicals from the dust may be absorbed.

Facts box: Where do the chemicals end up indoors?

A number of chemicals, for example most heavy metals, end up in the dust with particulates. Volatile organic compounds may leave the objects in which they were originally present and create equilibria between the indoor air, the objects, and dust particles. Equilibrium in this context means that the chemical reaches a balance in the rate at which it leaves the object and changes into gaseous form and is then dissolved in dust, and the rate of dissolving back from dust to air and back to the object. This equilibrium is dynamic, and over time can result in varying concentrations of the chemical in the object, the air and dust, depending on temperature, air humidity and other factors in the home. Flame retardants, PCBs, phthalates, triclosan and several other preservatives, bisphenol A, PFOS and other perfluorinated substances and alkylphenols (e.g. nonylphenol), and many pesticides belong to the group of semi-volatile organic chemicals (Wechsler and Nazaroff, 2008). The semi-volatile organic compounds have a tendency to change into gaseous form, but then readily form equilibria with dust.

Exposure to chemicals in the home is influenced by the time we spend indoors. In industrialised and rich countries, people spend up to 90% of their time indoors (Brown *et al*., 1994; Mølhave *et al*., 1997). It is unclear what the situation is like in developing countries and transition economies. Age is another factor that dictates how much time we spend indoors. Young children spend more time in the home than adults (Geens *et al.,* 2009). Other influencing factors are linked to physiology and behaviour. Children spend a lot of time close to the floor and in contact with other surfaces in the home where dust settle, and young children frequency have "hand-to-mouth contact", which means that they commonly ingest more dust than adults (Lorber, 2008, Johnson-Restrepo and Kannan, 2009; Roberts *et al*., 2009). Children's skin is also thinner and their body surface area in relation to volume is larger than that of adults (http://www.dotpharmacy.co.uk/upkids.html). The potential skin uptake of chemicals is consequently greater than for adults (Plankett *et al.,* 1999), for example from dust. Another possible factor influencing chemical exposure in the home is household economics. A correlation between income and exposure to brominated flame retardants was found in a study from California (Quirós- Alcalá *et al*., 2011). People from households with a low income were most exposed. The originators of the study explain the result as being due to the furnishings in low-income households probably being older and worn, or consisting of cheaper products of poorer quality. The furnishings would consequently disperse more flame retardants. The possibility of household articles in poor countries being of poorer quality and consequently becoming worn more quickly cannot be ruled out. The articles may be manufactured in countries with relatively weak chemicals legislation and control, and may therefore contain more hazardous chemicals.

There isa relatively large number of studies of the chemical content of household dust. The methods used for dust collection, analysed dust fractions, and analytical methods are, however, so varied that it is difficult to make direct comparisons of the results in different studies. The studies, nevertheless, give a hint to what chemicals may be found in household dust and the order of magnitude of the concentrations. Comparative studies have sometimes been made between different countries in a region (see for example Santillo *et al.*, 2003), but to our knowledge no study has been carried out

with wider global coverage in which all the samples have been collected and analysed by the same method. The purpose of this study was to illustrate the situation in countries in Africa, Asia and Europe. As individual households are included in the study, it is not possible to decide whether they are representative of the participating country or region concerned, but they can provide a snapshot of what chemicals we can be expected to be exposed to through household dust in various parts of the world. At the same time, we wish to draw attention, with this study, to the diversity – cocktail – of chemicals people are exposed to daily and describe how we could take better account of combination effects that arise in this cocktail.

Studied chemicals

A selection of chemicals hazardous to the environment and health was analysed. These chemicals are capable, or are suspected of being capable, of affecting the body's endocrine system, have known cocktail effects, or may occur in household dust according to previously published dust studies.

The chemicals can be broadly classified as follows (see Table 1):

Table 1: Grouping of studied chemicals and generalised properties

Group of chemicals	**Properties**
Brominated flame retardants (PBDEs)	Very persistent in nature. Accumulate in organisms, and many of them are capable, or are suspected of being capable, of disrupting the body's endocrine system, and consequently, among other things, affecting fertility and causing cancer.
Polychlorinated biphenyl ethers (PCBs)	Very persistent in nature and several of them are capable, or are suspected of being capable, of disrupting the body's endocrine system and, among other things, affecting fertility and causing cancer. PCBs are also classified as very toxic to aquatic organisms.
Phthalates	Break down easily in nature, but at least some of them can disrupt the body's endocrine system and consequently affect fertility. Some are classified as toxic to reproduction, and are suspected of being carcinogenic.
Bisphenol A	Accumulate in organisms due to chronic exposure and disrupt the body's endocrine system. Impairments of fertility and cancer are effects that have been seen in animal studies.
Alkylphenols	Persistent in nature and accumulate in organisms. Are to varying degrees endocrine disruptors and are capable, among other things, of affecting fertility.
Parabens	Preservatives that are rapidly broken down in the body, but which to varying degrees are endocrine disruptors and consequently, among other things, can affect fertility. The most potent endocrine disruptor parabens propyl- and butylparabens are included in this study.
Perfluorinated substances	Very persistent in nature and accumulate in organisms. Animal studies have shown that perfluorinated substances can affect the immune system, the body's endocrine system, birth weight and lead to deformities.
Pesticides	Methoxychlor, Prochloraz and Vinclozolin can disrupt the body's endocrine system, with effects such as fertility impairments and cancer.
Heavy metals, including methylated mercury	Metals are elements (cannot be broken down) and accumulate in the environment, and in organisms. Heavy metals are highly toxic, and lead and cadmium, for example, are carcinogenic. Mercury and methyl mercury damage the nervous system.

A detailed list of analysed elements and compounds is provided in Annex I. The fact boxes contain further information about the chemicals that occurred at high levels in our study and that are considered in greater detail in the discussion section.

Cocktail effect

A combination effect, popularly known as a "cocktail effect", means that all chemicals in a mixture contribute to the properties of the mixture, such as toxicity. This may appear obvious, but to date it has almost always been the toxicity of the individual substances included in the mixture that has been looked at and no attempt has been made to estimate the aggregate effect. Several of the chemicals that have been analysed in this study have known cocktail effects together with other chemicals. Read more about this in the Swedish Society for Nature Conservation's report Save the Men (Naturskyddsföreningen, 2011).

Methods and materials

Before this report was written, a review was made of data published, or otherwise made public, on household dust concentrations of the chemicals that were analysed in this study. The concentrations are presented in tabular form in Annex 2. These data form the basis for comparisons with our results.

Data collection and descriptions of locations

All the dust samples analysed in this study were collected in bedrooms, as these are one of the rooms where people spend most time during the 24-hour period, regularly and in a relatively equivalent way in a global perspective. Dust has been analysed from bedrooms in six European countries (all EU Member States), four countries in Africa and two countries in south-east Asia. Outside the EU, dust was collected with the assistance of the Swedish Society for Nature Conservation's partners CAP[3], EcoWaste Coallition[4], Envirocare[5], groundWork[6], iLima[7] and NAPE[8].

[3] CAP is a Malaysian organisation that works on consumer issues (http://consumer.org.my/index.php/homepage/about-us).
[4] EcoWaste Coallition is a Philippine network of organisations that work on chemical issues and waste management (www.ecowastecoalition.org).
[5] Envirocare is a Tanzanian environmental organisation that works on chemical issues, linked among other things to textile production (www.envirocaretz.org).
[6] groundWork is a South African environmental organisation that works on issues concerning chemical safety and implementation of international chemical conventions nationally and regionally in Africa (www.www.groundwork.org.za)
[7] iLima is a Kenyan environmental organisation that works on implementation of international chemical conventions in the country and to eliminate heavy metals and persistent organic pollutants, for instance in cosmetics (www.ilimakenya.org).
[8] NAPE is a Ugandan environmental organisation that works for the implementation of international chemical conventions in the country and offers capacity support to many other environmental organisations in Uganda (www.nape.or.ug).

The Swedish Society for Nature Conservation has collaborated with ChemSec[9] and its networks to carry out the collection of dust in Europe. Participating European organizations are: AMICA in Italy, Bund in Germany, HEAL (Health Environmental Alliance) and EPHA (European Public Health Alliance) in Belgium, Levego (Clean Air Action Group) in Hungary and SSL (Society for Sustainable living) in the Czech Republic.

The table in Annex III contains a brief description of the sampling points and Annex IV photographs of these sites.

The bedrooms had not been vacuum-cleaned for a week, and the dust was collected around and under beds, as well as on beds, using identical hand–held vacuum cleaners and identical filter bags at all sites. The filters containing the collected dust were placed in the same type of aluminium foil at all the sampling sites to prevent influence of UV light, and in identical plastic bags, and were sent to the laboratory. Three samples per bedroom were taken in each country and were then pooled to produce one sample per country, as this reduces the risk of sample loss in transport and provides more true results for the bedroom concerned. In Kenya, the collection of dust was in part carried out differently, as samples were taken in three different bedrooms in suburbs of Nairobi. These three samples were also pooled.

Analytical methods

All analyses were coordinated by Eurofins Environment in Lidköping, Sweden. Eurofins analysed flame retardants, BPA, the metals and the PCBs; the SOFIA laboratory in Berlin the phthalates, phenols, parabens and pesticides.

As well as the dust the packaging material in which the dust was transported and the filters with which the dust samples were collected, were analysed. These samples served as blank samples, used to establish whether the analysed chemicals might have been added to the dust from the filters and packaging material, and if so how much.

A list of the extraction methods and standardised analytical methods used by the laboratories follows below (see Table 2).

[9] ChemSec is a subsidiary organisation of the Swedish Society for Nature Conservation, with the EU as its principal platform. ChemSec works on political lobbying with regard to chemicals and assisting companies to anticipate legislation in the phasing-out of chemically harmful to the environment and health (www.chemsec.org).

Table 2: Chemical, standardised test, extraction method and analytical method.

Chemical(number of varieties)	***Standard test***	***Extraction method***	***Analytical method***
Phthalates (12)	SF09B	ethyl acetate & acetone	GC-MS[10]
Bisphenol (BPA)	GF059	methylbenzene followed by derivatisation	GC-MS
Flame retardants (PBDEs) (24)	CYR22	Soxhlet extraction with methylbenzene	GC-MS
Pesticides (3)	PSF03	ethyl acetate	GC-MS
PCBs (7)	PCB7_F	n-Hexane & acetone	GC-MS[11]
Alkylphenols	SF0VK	distillation followed by derivitisation	GC-MS
Methyl mercury	Me-Hg	distillation followed by aqueous phase ethylation	GC12
Parabens (2)	PSF01	ethyl acetate	GC-MS
Pb (Lead) & Cd (Cadmium)	-	Micro wave assisted extraction with nitric acid & hydrogen peroxide	ICP-MS[13]
Metallic mercury (Hg)	-	nitric acid	AFS[14]
Perfluorinated substances (14)	PFC_M	methanol	LC-MS-MS[15]

Estimation of exposure

There are plenty of estimates in the literature of the daily quantity of dust that children and adults take in through unintentional ingestion and inhalation of dust.

Table 3: Type of exposure, daily intake of dust and references

Type of exposure	**Unit [mg dust/day]**	**Reference**
Unintentional ingestion, children	20-200	See references in Oomen et al., 2008
Unintentional ingestion, adults	0.56-100	See references in Oomen et al., 2008
Inhalation, children	0.15- 0.34	Maertens *et al*., 2004
Inhalation, adults	0.81	Maertens *et al*., 2004

As can be seen from Table 3, unintentional ingestion accounts for most of the daily intake of dust. The Swedish Society for Nature Conservation therefore disregards inhalation in the analyses of our data. Information is also lacking on how much dust is deposited daily on the skin, but this exposure route is probably of less significance than ingestion and inhalation.

[10] Gas chromatograph linked to a mass spectrometer
[11] Gas chromatograph with flame ionisation detector
[12] Gas chromatograph with fluorescence detector
[13] Inductively coupled plasma mass spectrometry
[14] Atomic fluorescence spectrophotometry
[15] By what is known is triple quadrupole mass spectrometry

The exposure estimates in this report are, therefore, based on involuntarily ingested dust (around 200 mg/day). The Swedish Society for Nature Conservation chose to calculate the estimations for children and a high daily intake of dust, in order to take account of the most sensitive individuals (that is to say active toddlers crawling around close to and on the floor). A baby's organ systems are under development, and babies are therefore especially sensitive to exposure to chemicals. The Swedish Society for Nature Conservation assumes that 100% of the chemicals in the ingested dust is taken up by the body, which is a simplification of reality, but at the same time a safety factor in the calculation.

Daily exposure (daily intake (DI)) for the chemicals studied in the home environment was calculated using the following formula:

Daily exposure/Daily intake = (involuntarily ingested dust x measured concentration in dust sample)/body weight

We have chosen 7 kg as the weight of children in the calculations of daily exposure, which is equivalent to a baby around 7 months old. At this age active toddlers are starting to shuffle forwards or crawl, and are at risk of taking in large amounts of dust from floor surfaces.

Tolerable daily intake (TDI)

Tolerable daily intake (TDI) indicates the quantity of a chemical, usually in mg/kg body weight and day, that a human is deemed capable of taking in through food every day throughout life, without contracting adverse health effects. Known TDI values for the studied chemicals are listed in Annex 2. In cases where authorities have stipulated TDI values, these were primarily used for comparisons with the results in our study. Data from publications were used where no official TDIs were available. The Swedish Society for Nature Conservation is dubious about how the TDI values are set, but they serve as a basis for assessing risks according to accepted methodology in toxicological contexts. Risk indexes were calculated using the following formula:

Risk index = (daily exposure + background exposure) / TDI

According to present TDIs, there is not expected to be any evident risk to human health, when the risk index is less than 1 (Oomen *et al.,* 2008). As we do not know the background exposure through food for the studied chemicals and the individuals who live in the homes where the dust samples were taken, it is likely that risk index underestimate the real situation. As a precaution, we therefore choose to highlight all samples and chemicals that have a risk index greater than 0.8 (as Oomen *et al.,* 2008, did in their study).

Cumulative risk assessment of phthalates

For chemicals that act in the same way, Koch *et al.* (2001) have proposed a new risk assessment model based on TDIs. The risk index is calculated for each chemical with the same mode of action in a mixture. The sum of the risk indexes becomes a cumulative TDI value according to the formula below[16]:

[16] The Greek letter sigma is used in mathematical contexts to designate sum. DI is daily intake.

$$TDI_{\text{cumulatively summed}} = (\Sigma (DI/TDI))*100$$

If this exceeds 100%, the tolerable daily intake of the chemicals in the mixture has been exceeded.

In this report we have made such a calculation for the four phthalates BBP, DBP, DEHP and DINP. As for TDI, a value above 100% means that the exposure is associated with substantial health risks according to present TDIs.

Results

The emphasis here is put on the results highlighted by the Swedish Society for Nature Conservation in the discussion paragraph. A more detailed presentation of the results can be found in Annex V (running text and table of measured concentrations in the samples). The table in Annex VI contains an estimated daily exposure for a 7-month-old baby.

The concentrations of the analysed chemicals varied in the different samples (see Annex V). The individual sample that differs most from the others by consistently having high levels of chemicals is the Philippine.

The table in Annex VII lists the samples and sample results that deviate from the concentration ranges measured in other studies. The chemicals that exceed the levels in previous studies are brominated diphenyl ethers (flame retardants) and phthalates (plasticisers of plastics, principally PVC), and the greatest deviations are in dust samples from the Global South, particularly in the sample from the Philippines, but also in the sample from Uganda. DINP was found at a high level in the sample from Hungary.

The mean concentration of the studied flame retardants in the dust samples from the six countries from the South was 349.4 µg/kg, and 60.2 µg/kg in the dust samples from the six EU Member States.. The mean concentration of the studied phthalates in the dust samples from the six countries from the Global South was 684.8 mg/kg, and 934.8 mg/kg in the dust samples from the six EU Member States.

Summed concentrations (referred to below as cumulative concentrations) for the studied brominated flame retardants and the phthalates were calculated for each sample and are presented in Graphs 1A and 1B as relative values, normalised against the samples with the lowest cumulative concentrations (the sample from Malaysia for the flame retardants; from Kenya for the phthalates). The cumulative concentration of brominated flame retardant in the sample from the Philippines was more than 10 000 times greater than in the sample from Malaysia.

Graph 1: A) Summed concentrations of studied brominated flame retardants and B) summed concentrations of studied phthalates. 1 = South Africa, 2 = Tanzania, 3 = Kenya, 4 = Uganda, 5 = Philippines, 6 = Malaysia, 7 = Sweden, 8 = Germany, 9 = Belgium, 10 = Czech Republic, 11 = Hungary, 12 = Italy.

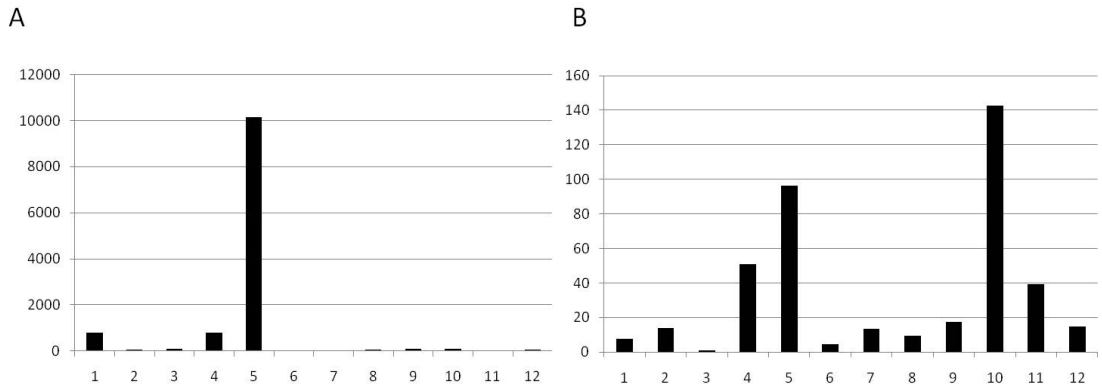

Table 4 a: Daily exposure (intake) of phthalates from dust, in relation to TDI values and cumulatively summed TDI. Relates to the Philippine sample.

Phthalate	Daily intake (DI) **(µg/kg/day),** Philippines, 7-month-old baby	Tolerable daily intake (TDI) **(µg/kg/day)**	% of TDI
BBP	0.77	500	0,15
DEHP	47.7	50	95.4
DINP	15.7	150	10,5
DBP	0.49	10	4.9
$TDI_{cumulatively\ summed}$			110.95

Table 4 b: Daily exposure (intake) of phthalates from dust, in relation to TDI values and cumulatively summed TDI. Relates to the Czech sample.

Phthalate	Daily intake (DI) **(µg/kg/day),** Czech Republic, 7-month-old baby	Tolerable daily intake (TDI) **(µg/kg/day)**	% of TDI
BBP	$13.7*10^{-3}$	500	0,0027
DEHP	13.4	50	26,8
DINP	0	150	0
DBP	8.29	10	83
$TDI_{cumulatively\ summed}$			109.8

Discussion

With this study, the Swedish Society for Nature Conservation has shown that a series of hazardous chemicals are to be found in ordinary household dust around the world. In several cases the concentrations were higher than reported previously (see the table in Annex IV). The majority of the chemicals are potential hormone disruptors, and are produced by humans. Many have documented

combination effects. They do not belong in the environment and should not to be present in the dust in our bedrooms. This shows how unsustainable our chemical-intensive society is today.

The study also points to the complexity of the chemical cocktail we are exposed to daily. The Swedish Society for Nature Conservation has only measured a small number of chemicals in dust. The dust samples probably contain far more. It is known that combination effects may exist for some of the groups of chemicals found, for example phthalates, and it can be guessed that many more chemicals in the dust might have combination effects, including effects that are not solely additive. The results provide a snapshot of the situation at the sampling sites, and have, furthermore, been used to shed light on the deficiencies in present-day risk assessment.

In the report Save the Men (Naturskyddsföreningen, 2011), which the Swedish Society for Nature Conservation presented in the spring of 2011, we discussed the key role of the endocrine system for a number of functions in the body. This applies to everything from reproduction (physiology and behaviour), the development of the nervous system (see for example Ahmed *et al.,* 2008); Nunez *et al.*, 2008) to metabolism (see for example Moller *et al*., 2009; Vijajyakumar *et al*., 2010). In addition, we gave examples of endocrine disrupting chemicals, particularly those that have an oestrogenic[17] or anti-androgenic[18] action. Studying the presence of these chemicals in household dust in different parts of the world was an important aim in this study.

Central to toxicological risk assessment since the late 1950s is the concept of TDI, or equivalent concepts such as ADI (Acceptable Daily Intake) and RfD (Reference Dose). The concept was first used systematically by the Council of Europe, and later by the UN Joint Expert Committee on Food Additives (JRCFA), the US Food and Drug Administration (FDA), the US Environmental Protection Agency (US EPA), the European Food Safety Authority (EFSA), as well as several other authorities around the world (Vettorazzi, 1987; Galli *et al.,* 2008). Tolerable daily intake (TDI) indicates the quantity of a chemical, usually in mg/kg body weight and day, which a human is deemed capable of taking in through food every day throughout their life without it acquiring any adverse health effects. Unfortunately there are no official TDI values for a large number of important chemical compounds, including brominated flame retardants which are commonly occurring environmental pollutants globally (see, for example, de Wit, 2003; de Wit *et al*., 2006; de Wit *et al.,* 2010). In 2005 an FAO/WHO expert committee concluded that the information on brominated flame retardants is too scanty to derive TDI values (Fromme *et al.,* 2009). This is remarkable, especially for a group of chemicals with such well documented harmful effects as flame retardants. The Swedish Society for Nature Conservation is, in general, very sceptical about how TDI values are set (see discussion below), but in the absence of other reference values, they have been used in our assessment of the aggregate exposure to phthalates.

Our calculations show that the exposure to individual chemicals through dust is in all cases below the respective TDI values (see the tables in Figures II and VI), although the DEHP content in the dust sample form the Philippines, and DBP in the Czech Republic. is equivalent to a daily intake with a risk index of more than 0.8 of the tolerable intake. However, the reality is far more complicated as there

[17] Oestrogen is a sex hormone with a feminising action
[18] Anti-androgenic means that the effect of the male sex hormone testosterone is counteracted

is simultaneous exposure to tens of thousands of different chemicals that can potentially interact in exercising toxic effects. Consequently,, the traditional way of deriving and interpreting TDI may lead to substantial underestimation of the risk. Based on available knowledge, the Swedish Society for Nature Conservation, therefore, wishes to propose a modified risk assessment method, exemplified here with endocrine disruptors as below.

Most of the evidence suggests that chemicals with the same mode of action in a mixture act according to the concentration addition model, where each chemical contributes to the toxicity of the mixture in proportion to its share in the mixture (Borget *et al*., 2004; Brian *et al*., 2005; Matthiessen and Johnson, 2007). There are, thus, simple methods for estimating combination effects of chemicals. It should be possible to apply a concept similar to the concentration addition model to TDI, as described in the methods section above. We exemplify this with the chemical group of phthalates. The phthalates we have chosen to collate -BBP, DBP, DEHP and DINP -all have well documented anti-androgenic effects (Boberg *et al*., 2011; Gray *et al*., 2000; Mylchreest *et al*., 1999). This means that they disrupt sex hormone regulated functions in men or male animals. Examples of such effects are hypospadias (a deformity in which the urethra is on the underside of the penis) and cryptorchidism (where the testicle has not migrated down into the scrotum from the abdominal cavity or the inguinal canal). Based on common modes of action, we have made a concentration addition calculation for the phthalates mentioned. Each phthalate contributes to the total daily exposure (the measure of cumulative TDI) in proportion to its share of the TDI of the substance, exemplified by the Philippine sample in Table 4. The total phthalate exposure of a 7-month-old baby weighing 7 kg then exceeds 100 %[19] of the TDI (in the Philippines (110.95 %, se Table 4 a), and in the Czech Republic (109.8 %, see Table 4 b). We can thus, show with this methodology, which is also described in the scientific literature (Koch *et al.*, 2011), that the level of exposure exceeds what is considered to be risk-free in a couple of the studied countries. This clearly shows not just the need for improved risk assessment methodology, but also that the presence of endocrine disruptors, especially phthalates, must be reduced. Denmark is a pioneering country in this respect. Its Minister of the Environment, Karen Ellemann, wants to prohibit the importing and production of articles containing the endocrine disrupting phthalates BBP, DBP, DEHP and DIBP, with reference to their combination effects. The Government is pursuing the requirement nationally in Denmark and through the EU's chemicals agency ECHA at EU level (see http://www.mim.dk/eng/News/Minister_plans to introduce a ban against_four_dangerous_phthalates.htm). If the ban is implemented, it would be the first time in history that chemicals have been banned because of their combination effects.

In a corresponding manner it should be possible to group brominated flame retardants and their breakdown products according to oestrogenic (see for example Legler *et al*., 2003; Stoker *et al*., 2005; Lilienthal *et al*., 2006; Liu *et al*., 2011) and thyroid hormone-disrupting (see for example Legler *et al*., 2003; Kuriyama *et al*., 2007; Tseng *et al*., 2008; Messer, 2010) mechanisms in risk assessments.

[19] If this value exceeds 100 %, the tolerable daily intake of the chemicals in the mixture has been exceeded and there is an evident risk to health

However, there are no TDI values for different PBDEs at present. It should also be possible to group bisphenols in risk assessments. Bisphenol A, F and S (with certain derivatives[20]), for example, are oestrogenic and anti-androgenic (see for example Satosh *et al*., 2004; Kuruto-Niwa *et al*., 2005). The aim in the longer term, should be to conduct a cumulative risk assessment for as many chemical substances and modes of action as possible.

There are also other problems with endocrine disruptors than cocktail effects. In our study, we have made a conservative assessment based on officially established TDI values. However, the standardised experimental animal tests that normally underlie TDI values are not designed to evaluate effects of endocrine disruptors. These methods are usually short-term experiments with high levels of exposure. Hormones are, however, active at very low concentrations (of the order of pg/l or ng/l[21]), and may have cumulative and delayed effects that are revealed in later stages of life (Liney *et al*., 2005; Matthiessen and Johnson, 2007). The relationship between dose and effect is also difficult to predict for endocrine disruptors (Ge *et al*., 2007). High priority, therefore, needs to be given to develop methods that are capable with high sensitivity to identify disruption in the various endocrine systems. It is worth pointing out that animal experiments have on many occasions not been found to be relevant for predicting effects on humans[22]. It is also highly desirable to improve the cell-based methods for toxicity tests on endocrine disruptors. This is also under way in, for example, the large project "Toxicity for the 21st century" (Shukla *et al*., 2010; Bhattacharya *et al*., 2011). As well as the ethical aspect (large-scale and generation-wide animal experiments can be avoided), such methods make it possible to test a far larger number of chemicals and in a significantly shorter time, with the ambition to provide more relevant results than animal experiments with respect to human toxicity. Cell cultures may, however, have a poorer ability to metabolise chemicals (Coecke *et al*., 2006). The substance is sometimes not an endocrine disruptor in itself, but one of its breakdown products is, which means that cell cultures may fail to detect endocrine disruptor effects. In addition, a cell culture cannot represent the complexity of the communication that takes place between different parts of an endocrine system (O'Connor and Chapin, 2003). As certain receptors in endocrine systems can bind many different types of chemicals, it is also difficult to create functioning computer-based models for endocrine systems. The ambition with the new test methods is, however, to overcome this.

We can use the chemical BPA as an example of the problems mentioned above. It is known that dose-response curves for BPA do not follow linear relations (see for example Vadenberg *et al*.,2006;

[20] A chemical derivative is a chemical that can be created from another one (parent substance) by new chemical groups being added to the latter. This can take place artificially, when new chemicals are created in the manufacturing process, or naturally when chemicals are broken down in nature.

[21] 1 pg = 1/1 000 000 000 000 gram ; 1 ng = 1/1 000 000 000 gram

[22] Small differences in kinetics (that is to say, uptake of chemicals in the body, distribution, conversion, excretion), hormone systems etc., can lead to different results in different species.

Wadia *et al*., 2007). It is, consequently, not possible based on observations of exposure to a particular dose to predict what happens at lower doses, which has long been regarded as a fundamental principle of toxicology. The EFSA and the US EPA have set the TDI for BPA at 0.05 mg/kg and day, which is a very high value in view of the fact that several studies have shown endocrine disrupting effects of BPA exposure in the order of ng/kg and day (see for example FAO/WHO, 2010; Carbaton *et al.*, 2011; Loganathan and Kannan, 2011). The daily exposure level for the dust sample from the Philippines corresponds to the concentrations that have been found to produce effects in animal experiments (see Loganathan and Kannan, 2011). Even though the daily BPA intake from dust ingestion is estimated to be less than 1% of the total BPA intake (Loganathan and Kannn, 2011), the exposure is of the same magnitude as that which affects experiments animals.

Dust ingestion, as mentioned, is only one of the many exposure routes for a chemical. All exposure routes add together to give the total daily intake of a particular chemical. We know for phthalates that dust ingestion in certain age groups, and for certain phthalates (for example DEHP and BBP), can account for a relatively large share of the daily intake, while other exposure routes (feed intake, inhalation, skin uptake etc.) are more important for other phthalates, and can also vary between age groups (Wormuth *et al.,* 2006). Young children probably take in at least as much phthalates from other sources, which adds to the total exposure.

As mentioned earlier, our calculation shows that the aggregate exposure to the phthalates DEHP, BBP, DBP and DINP from dust exceeds 100% of summed cumulative TDI at a couple of sampling sites. That is, there is a substantial risk. If account is additionally taken of all exposure routes for the studied chemicals, and of the fact that they may have combination effects across the groups of chemicals (for example phthalates with flame retardants), the picture of risk is further strengthened.

Some dust samples had a significantly higher concentration of metals or metal compounds than others. The samples from Tanzania and Kenya had high levels of lead. One may speculate on the reason for this. In many countries in the South there are no restrictions on the level of lead in paints, which has caused SAICM[23] to make ”Lead in Paint” a priority policy area (so called “emerging policy issue”). The dust sample from Tanzania comes from a room with painted walls. Calculations of daily intake of lead from these dust samples showed, however, that the TDI is not exceeded. It is interesting that the level of methyl mercury was highest in the Swedish dust sample. The dust sample was collected in an apartment in Hammarby Sjöstad, where extensive construction work that is currently in progress, churning up dust from soil layers. The land is an old lake bed in which methyl mercury may have been formed (this happens in oxygen-poor bottom sediment) from mercury dispersed by the many small-scale industrial enterprises that operated in the area, before the land was remediated and prepared for housing. It is difficult to discuss any risks in areas of housing on old industrial land based on a single sample, but this type of location close to a lake in an urban environment is now highly attractive to house-builders, despite high remediation costs. There may, possibly, be a somewhat elevated risk of exposure to chemicals from contaminated land for residents

[23] SAICM stands for Strategic Approach to International Chemicals Management, and is global policy work under the auspices of the UN. It is intended to ensure that all production and use of chemicals by 2020 takes place in such a way that harm to the environment and health is minimised. See www.saicm.org.

of such areas in conjunction with construction work. Our finding, combined with the lack of knowledge that prevails on the environmental and health effects and combination effects of many chemicals, means that the development of old industrial land for house-building instead of other land use where people are exposed to a lesser extent, can be questioned.

The Swedish Society for Nature Conservation's recommendations and demands

The Swedish Society for Nature Conservation fully supports the demands of the Danish Government to ban DEHP, DBP and BBP in articles on the EU market, both in articles produced in the EU, and in imported goods. We urge the Swedish Government to lend its full support to Denmark on the issue, and to introduce the ban in Sweden as soon as possible.

The Swedish Society for Nature Conservation proposes the following in order to improve risk assessment for endocrine disrupting chemicals in the EU (and for chemicals in general)[24]:

- Methodology must be established in REACH[25] and other chemicals legislation in the EU for the evaluation of endocrine disruptor chemicals and what levels of uncertainty are acceptable in the evaluations. In the absence of standardised tests for effects of endocrine disrupting chemicals, it is of the greatest importance that account is taken of all available knowledge. Greater emphasis must be put here on independent university research. Particular consideration needs to be given to effects of low-dose exposures, when published data on such exposures is available. With knowledge about the nature of the endocrine systems, it is particularly important to apply the precautionary principle to endocrine disrupting chemicals, which under uncertainty means worst-case classification rather than approval of substances.

- If there are data showing or suggesting that chemicals have the same mode of action (which in the case of endocrine disruptors should be interpreted as meaning that they may disrupt the same endocrine function), the concentration addition model is to be applied. If there is no such information, an extra safety factor should instead be applied for possible combination effects. This provides a better margin of safety in the risk assessments, in accordance with the precautionary principle that should always guide toxicological risk assessment.

- Evaluations of chemicals according to REACH take place in three stages: registration, assessment and authorisation. In the registration stage, toxicity data from cell culture tests

[24] See further reasoning and demands in the Swedish Society for Nature Conservation's policy on environmental toxins.
[25] REACH stands for Registration, Evaluation, Authorisation and Restriction of Chemicals and has been the EU's chemicals regulation since 2007.

may be considered sufficient, but it must be borne in mind that cell cultures may fail to reveal effects of endocrine disrupting metabolites from tested chemicals[26]. More extensive tests should be required at the assessment stage. Unfortunately in the present situation these are animal tests, and generation tests may become necessary to identify effects of endocrine disruptor chemicals. It should be remembered, however, that the animal tests are not validated with respect to their ability to predict toxicity in humans. We urge the OECD to continue to attach the greatest priority to develop standardised tests for effects of endocrine disruption, and to find alternatives to animal tests. The commitment to modern and more relevant testing methods (such as TOX 21) needs to be prioritised and strengthened. This is essential so that knowledge about the large number of chemicals that are in circulation in society and combination effects of these chemicals can be acquired in a reasonable time.

- Presently, all chemicals produced or imported to the EU in quantities in excess of one tonne have to be registered under REACH. As endocrine disrupting chemicals are active at very low concentrations, the 1-tonne limit in REACH today is far too high and needs to be adjusted downwards for these and other groups of chemicals.

In the current situation, there is no requirement for environmental monitoring for the chemicals that pass review under REACH. As there is no methodology at present for evaluating endocrine disruptors, there is a risk of such chemicals being approved under REACH. The Swedish Society for Nature Conservation is of the opinion that all chemicals approved under REACH should also be subject to environmental monitoring, to confirm that they do not pose unacceptable risks. The costs of monitoring should be borne by the companies that register chemicals in proportion to volumes of the chemicals in production or use, according to the polluter-pays principle. Research on the development of biological markers (often at cell level) should be intensified, so that they can be used as early diagnostic instruments in environmental monitoring to detect effects of the chemicals before they are manifested at individual and population level.

In the report “Save the Men” by the Swedish Society for Nature Conservation, which was presented in the spring of 2011, we account for our political demands in greater detail.

FACTS BOXES

After contact with partner organisations of the Swedish Society for Nature Conservation, it has emerged that bans and restrictions on the following chemicals are still generally lacking in large parts of the Global South. The exception is feeding bottles for babies, where bans (or proposed bans) on bisphenol A are now in place in certain parts of the world. All the participating European countries are Member States of the EU, and are consequently covered to a very great extent by common chemicals legislation.

Bisphenol A (BPA)

[26] Metabolite is a scientific term for a breakdown product.

BPA is, principally, used for the production of polycarbonate plastic and for epoxy glues. Polycarbonate plastics are widespread and are used in society, for example, in water bottles, sports equipment, CDs and DVDs and spectacle lenses.

Known environmental and health problems:

BPA has hormone-like properties, which may cause foetal damage in exposure during the foetal stage, have adverse effects on reproduction, and affect the immune system, and it is also suspected that BPA is carcinogenic. Based on laboratory experiments and observations of various organisms in the environment, BPA is considered capable of leading to feminisation of males. BPA is classified as hazardous to aquatic organisms, and can cause long-term harmful effects in the environment.

Restrictions and limit values:

The EU and Canada have banned BPA in feeding bottles. Such a ban comes into force in Malaysia in March 2012, and there is also a proposal for a ban in South Africa. The European Food Safety Agency (EFSA) has set the tolerable daily intake (TDI) of BPA at 50 µg/kg body weight/day. However, this limit is subject to considerable discussion, as far lower levels of exposure have been found to affect experimental animals. During the winter of 2010/2011 the Swedish Chemicals Agency and the Swedish National Food Administration conducted a joint investigation of BPA, focusing in particular on the exposure of children.

Phthalates

Phthalates are a group of chemicals that are produced in large quantities, and occur in a large number of everyday articles. Small/light phthalates (of low molecular weight) are found in cosmetics, while larger/heavier phthalates (of higher molecular weight) are used as plasticisers in plastics. It is, principally, the large phthalates that are associated with adverse health effects. These include dibutyl phthalate (DBP), diethylhexyl phthalate (DEHP), benzylbutyl phthalate (BBP), diisobutyl phthalate (DIBP), diisodecyl phthalate (DIDP), diisononyl phthalate (DINP) and di-n-octyl phthalate (DNOP).

Known environmental and health properties:

DBP, DEHP, BBP, DIBP, DIDP, DINP and DNOP are endocrine disruptors (to varying degrees) and can adversely affect foetal development and reproductive capacity. Certain phthalates also have environmentally hazardous properties. DBP and BBP, for example, are bioccumulative and highly toxic to aquatic organisms.

Restrictions and limit values:

Four phthalates (DEHP, DBP, BBP and DIBP) are included in the candidate list for REACH, which means that they have been identified as substances of very high concern. Their inclusion in the candidate list means that the seller of an article that contains more than 0.1% of any of these phthalates has an obligation, on request, to inform his customers of this fact. Since the spring of 2011, BBP, DBP and DEHP have been included in Annex XIV to REACH, which means that within a few years special permission will be required to use them.

Special rules limit how phthalates may be used in toys. DEHP, DBP and BBP must not be present at levels above 0.1 % in any toys or child-care articles, while DIDP, DINP and DNOP are prohibited above 0.1 % in toys or child-care articles *that can be put in the mouth.* DEHP is one of the prioritised substances in the Water Framework Directive, and is, thus, to be phased out.

The European Food Safety Agency (EFSA) has set the tolerable daily intake (TDI) for several phthalates: DEHP 50 μg/kg body weight/day, DBP 10 μg/kg body weight/day, BBP 500 μg/kg body weight/day and DINP 150 μg/kg body weight/day.

Denmark has been working since the spring of 2011 on prohibition in the EU of the phthalates DEHP, DBP, BBP and DIBP, with reference to their combination effects, in certain products.

Polybrominated diphenyl ethers (PBDEs)

Polybrominated diphenyl ethers are used as flame retardants in electronic products, furniture, vehicles, plastic articles and textiles.

Known environmental and health problems:

PBDEs are a group of around 70 different compounds, and belong to the group of brominated flame retardants. The different variants have been named after the number of bromine atoms contained in the compound. Tri-BDE, thus, has three bromine atoms, while tetra-BDE has four (and so on). PBDEs are, in varying degrees, fat-soluble and persistent, and some of them are readily taken up by organisms and dispersed in the food webs of ecosystems, where they remain for a long time. With the exception of some of the compounds, such as penta-PDE, octa-BDE and deca-BDE, there still great gaps in our knowledge of environmental and health effects. It is known, however, that many PBDEs are highly toxic to aquatic organisms, and can cause harmful long-term effects in the environment. Some damage the nervous system, and octa-BDE is classified as toxic to reproduction.

Restrictions:

PBDEs are prohibited for use in electrical and electronic products under the RoHS Directive. In the EU, penta- and octa-BDEs above a particular concentration are additionally prohibited in chemical products. The Stockholm Convention, a global agreement aimed at eliminating the most hazardous and most persistent organic environmental toxins, has placed many PBDEs on its phase-out list. This applies to tetra-BDE, penta-BDE, hexa-BDE, hepta-BDE and octa-BDE. All the countries in our study, apart from Italy and Malaysia, have ratified the Stockholm Convention. However, it is up to the individual countries to implement the Convention, and this not yet been done, for example, in Uganda.

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The concentration addition method means that the toxicity of the substances contained is combined in proportion to their concentration in the mixture.

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Annex I

A compilation is provided here of published median concentrations in household dust of the chemicals studied by the Swedish Society for Nature Conservation.

Table: Chemical, concentration (ng/g), country and reference.

Chemical	**Median concentration (ng/g)**	**Country**	**References**
Brominated diphenyl ethers			
PBDE 100	0.54[27] 84.90 (n=23)	Japan China	Takigami *et al.*, 2009 Kang *et al.*, 2011
PBDE 119	No information	No information	No information
PBDE 126	No information	No information	No information
PBDE 138	No information	No information	No information
PBDE 153	6.90 (n=31) 2.01	Singapore Japan	Tan *et al.*, 2007 Takigami *et al.*, 2009
PBDE 154	3.50 0.99	Singapore Japan	Tan *et al.*, 2007 Takigami *et al.*, 2009
PBDE 156	22.50	China	Kang *et al.*, 2011
PBDE 17	9.20	China	Kang *et al.*, 2011
PBDE 183	18.00 44.00 30.7	Singapore Canada United States	Tan *et al.*, 2007
PBDE 184	75.40	China	Kang *et al.*, 2011
PBDE 191	2.78	China	Kang *et al.*, 2011
PBDE 196	2.30 (n=45)	Belgium	D'Hollander *et al.*, 2010
PBDE 197	1.40 (n=39) 15.00	Belgium China	Ali *et al.*, 2011 Kang *et al.*, 2011
PBDE 206	50.50	China	Kang *et al.*, 2011
PBDE 207	47.30	China	Kang *et al.*, 2011
PBDE 209	425.00 420.00 7100 1000 390 1401.00	Spain France United Kingdom Singapore Japan China	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Tan *et al.*, 2007 Takigami *et al.*, 2009 Kang *et al.*, 2011
PBDE 28	0.28 0.35 0.60 37.60	France United Kingdom Singapore China	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Tan *et al.*, 2007 Kang *et al.*, 2011
PBDE 47	13.00	Spain	Santillo *et al.*, 2003

[27] Mean value of samples from two buildings.

	24.00 24.80 20.00 102.00[28]	France United Kingdom Singapore China	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Tan *et al.*, 2007 Kang *et al.*, 2011
PBDE 49	10.10	China	Kang *et al.*, 2011
PBDE 66	8.67	China	Kang *et al.*, 2011
PBDE 71	31.90[29]	China	Kang *et al.*, 2011
PBDE 77	No information	No information	Ingen information
PBDE 85	30.60	China	Kang *et al.*, 2011
PBDE 99	17.50 28.50 44.00 4.20 5.40	Spain France United Kingdom Singapore China	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Tan *et al.*, 2007[1] Kang *et al.*, 2011
Polychlorinated diphenyl ethers			
PCB 28	0.20 (n=31) 7.30 (n=10) 3.40 (n=20)	Singapore Canada United Kingdom	Tan *et al.*, 2007[2] Harrad *et al.*, 2009 Harrad *et al.*, 2009
PCB 52	7.20 (n=10) 1.80 (n=20)	Canada United Kingdom	Harrad *et al.*, 2009 Harrad *et al.*, 2009
PCB101	0.50 8.80 1.20	Singapore Canada United Kingdom	Tan *et al.*, 20072 Harrad *et al.*, 2009 Harrad *et al.*, 2009
PCB 118	0.30 8.70 0.41	Singapore Canada United Kingdom	Tan *et al.*, 20072 Harrad *et al.*, 2009 Harrad *et al.*, 2009
PCB 138	9.50 0.92	Canada United Kingdom	Harrad *et al.*, 2009 Harrad *et al.*, 2009
PCB 153	200 (n=119)	USA	Rudel *et al.* (2003)
PCB 180	0.10 6.80 0.89	Singapore Canada United Kingdom	Tan *et al.*, 20072 Harrad *et al.*, 2009 Harrad *et al.*, 2009
Ftalater			
BBP	82 200[30] 4540[31] 28 200[32] 23 600[33] 24 500[34] 97 560[35] b(n=51) 135 000[36] (n=390)	Germany Spain France Italy United Kingdom Belgium Sweden	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Al Bitar, 2004 Bornehag *et al.*, 2005

[28] Mean value of samples from two buildings
[29] Mean value of samples from two buildings
[30] Median of 5 samples
[31] Median of 22 samples
[32] Median of 58 samples
[33] Median of 5 samples
[34] Median of 100 samples
[35] Median of 51 samples
[36] Median of 436 households

	15 200[37]	Germany	Abb *et al.*, 2009
DIBP	36 500[9] 148 999[10] 118 800[11] 180 100[12] 43 200[13] 56 820[14] 45 000[8]	Germany Spain France Italy United Kingdom Belgium Sweden	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Al Bitar, 2004 Bornehag *et al.*, 2005
Di-isobutyl adipate	No information	No information	No information
DNOP	No information	No information	No information
DBP	44 100[9] 79 400[10] 55 300[11] 42 800[12] 52 800[13] 97 560[14] 150 000[8] 87 400[15]	Germany Spain France Italy United Kingdom Belgium Sweden Germany	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Al Bitar, 2004 Bornehag *et al.*, 2005 Abb *et al.*, 2009
Dibutyl adipate	No information	No information	No information
DEHP	996 000[9] 317 200[10] 504 600[11] 434 300[12] 195 400[13] 244 990[14] 770 000[8] 604 000[15]	Germany Spain France Italy United Kingdom Belgium Sweden Germany	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Al Bitar, 2004 Bornehag *et al.*, 2005 Abb *et al.*, 2009
Diethyl adipate	No information	No information	No information
DEHA	No information	No information	No information
DEP	12 900[9] 5330[10] 6870[11] 6780[12] 3500[13] 3770[14]	Germany Spain France Italy United Kingdom Belgium	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Santillo *et al.*, 2003 Al Bitar, 2004
DIDP	61 150[14] 33 600[15]	Belgium Germany	Al Bitar, 2004 Abb *et al.*, 2009
DIHP	No information	No information	No information
DINP	113 000[9] 115 300[11] 102 910[14] 41 000[8] 129 000[15]	Germany France Belgium Sweden Germany	Santillo *et al.*, 2003 Santillo *et al.*, 2003 Al Bitar, 2004 Bornehag *et al.*, 2005 Abb *et al.*, 2009
DMP	1420[9]	Germany	Santillo *et al.*, 2003

[37] Median of 30 samples

	610[14]	Belgium	Al Bitar, 2004
DINCH	120 00000[38]	Germany	Nagorka *et al.*, 2011
TBP	No information	No information	No information
Alkylphenols			
Nonylphenol	2580 (n=118)	USA	Rudel *et al.*, 2003
Nonylphenol monoethoxylates	3360 (n=118)	USA	Rudel *et al.*, 2003
Nonylphenol diethoxylate	5330 (n=118)	USA	Rudel *et al.*, 2003
Octylphenol	130 (n=118)	USA	Rudel *et al.*, 2003
Bisphenols			
Bisphenol A	2001[39]	Belgium	Geens *et al.*, 2009
Perfluorinated compounds			
PFBS	359.00 (n=39)	Australia, United Kingdom, Germany and USA	Kato *et al.*, 2009
PFDA	No information	No information	No information
PFHpA	97.3 (n=39)	Australia, United Kingdom, Germany and USA	Kato *et al.*, 2009
PFDS	No information	No information	No information
PFDoA	No information	No information	No information
PFHxS	210.00 180.00 120.00 77.00 150.00 120.00 16.00 240.00 0.1	United Kingdom Australia Canada France Germany Kazakhstan Thailand United States Belgium	D'Hollander *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 D'Hollander *et al.*, 2010
PFHxA	0.3	Belgium	D'Hollander *et al.*, 2010
PFNA	0.1	Belgium	D'Hollander *et al.*, 2010
PFOS	25.00 (n=16) 49.00 (n=48) 140.00 (n=45) 170.00 (n=20) 140.00 (n=19) 160.00 (n=10) 170.00 (n=10) 59.00 (n=9) 16.00 (n=20) 310.00 (n=10)	Japan Sweden United Kingdom Australia Canada France Germany Kazakhstan Thailand United States	Moriwaki *et al.*, 2003. Bjorklund *et al.*, 2009 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010 Goosey *et al.*, 2010

[38] Mean value of 36 households
[39] Mean value of 18 samples

PFOSA	No information	No information	No information
PFOA	165.00	Japan	Moriwaki *et al.*, 2003.
	55.00	Sweden	Bjorklund *et al.*, 2009
	190.00	United Kingdom	Goosey *et al.*, 2010
	180.00	Australia	Goosey *et al.*, 2010
	69.00	Canada	Goosey *et al.*, 2010
	31.00	France	Goosey *et al.*, 2010
	300.00	Germany	Goosey *et al.*, 2010
	18.00	Thailand	Goosey *et al.*, 2010
	240.00	United States	Goosey *et al.*, 2010
Pesticides			
Vinclozolin	No information	No information	No information
Prochloraz	No information	No information	No information
Methoxychlor	240 (n=119)	USA	Rudel *et al.*, 2003
Parabens			
Butylparaben	76	Spain	Canosa *et al.*, 2007
Propylparaben	406	Spain	Canosa *et al.*, 2007
Metals and metal compounds			
Lead	573 000.00[40]	New Zealand	Kim & Fergusson, 1993
	232 000.00[41]	Canada	Rasmussen *et al.*, 2001
	85 200.00[52]	Australia	Chattopadhyay *et al.*, 2005
Cadmium	4240.00[40]	New Zealand	Kim & Fergusson, 1993
	4400.00[41]	Canada	Rasmussen *et al.*, 2001
	1900.00[42]	Australia	Chattopadhyay *et al.*, 2005
Mercury	5000.00[41]	Canada	Rasmussen *et al.*, 2001
Methyl mercury	No information	No information	No information

[40] Mean value of 120 samples
[41] Mean value of 48 samples
[42] Mean value of 82 samples

Annex II

A compilation is presented here of official TDI values for the chemicals studied by the Swedish Society for Nature Conservation.

Table: Tolerable daily intake (mg/day/kg body weight) for the analysed substances and references.

Chemical	**TDI (mg/day/kg body weight)**	**Reference**
Brominated diphenyl ethers		
PBDE 17	No information	
PBDE 28	No information	
PBDE 47	No information	
PBDE 49	No information	
PBDE 66	No information	
PBDE 71	No information	
PBDE 77	No information	
PBDE 85	No information	
PBDE 99	No information	
PBDE 100	No information	
PBDE 119	No information	
PBDE 126	No information	
PBDE 138	No information	
PBDE 153	No information	
PBDE 154	No information	
PBDE 156	No information	
PBDE 183	No information	
PBDE 184	No information	
PBDE 191	No information	
PBDE 196	No information	
PBDE 197	No information	
PBDE 206	No information	
PBDE 207	No information	
PBDE 209	No information	
Polychlorinated diphenyl ethers		
PCB 28	0.00002	EFSA
PCB 52	0.00002	EFSA
PCB 101	0.00002	EFSA
PCB 118	0.00002	EFSA
PCB 153	0.00002	EFSA
PCB 138	0.00002	EFSA
PCB 180	0.00002	EFSA
Phthalates		
BBP	0.5	EFSA

DEHA	0.3	EFSA
DEHP	0.05	EFSA
Di-isobutyl adipate	No information	
DIDP	0.15	EFSA
DIHP	No information	
DINP	0.15	EFSA
DOP	0.037	CSTE[43]
Dibutyl adipate	No information	
DNOP	No information	
DBP	0.01	EFSA
Diethyl adipate	No information	
DEP	0.037	SCTEE[44]
DMP	No information	
DINCH	1	EFSA
TBP	No information	
Alkylphenols		
Nonylphenol	0.005	Nielsen *et al*., 2000
Nonylphenol monoethoxylates	No information	
Nonylphenol diethoxylate	No information	
Octylphenol	No information	
Bisphenols		
Bisphenol A	0.05	EFSA
Perfluorinated substances		
PFBS	No information	
PFDA	No information	
PFHpA	No information	
PFDS	No information	
PFDoA	No information	
PFHxS	No information	
PFHxA	No information	
PFNA	No information	
PFOS	No information	
PFOSA	0.00015	EFSA
PFOA	0.015	EFSA
Pesticides		
Vinclozolin	0.01	WHO
Prochloraz	0.01	WHO
Methoxychlor	0.1	WHO
Parabens		
Butylparaben	No information	
Propylparaben	10 mg[45]	EFSA
Metals and metal compounds		

[43] Council of State and Territorial Epidemiologists
[44] Scientific Committee on Toxicology Ecotoxicology and Environment
[45] Temporary group TDI for the sum of methyl-, ethyl-, propylparaben and their salts set by the predecessor of the EFSA. Obsolete.

Lead	0.0036	De Winter-Sorkina et al., 2003
Cadmium	0.0005	De Winter-Sorkina et al., 2003
Mercury	0.002	De Winter-Sorkina et al., 2003
Methyl mercury	0. 0001	De Winter-Sorkina et al., 2003

Annex III

A description is given here of the sampling sites and their surroundings.

Table 1: Sampling country, city/town, other information

Sampling country	**City/town**	**Other information**
South Africa	Durban	Second-floor apartment in the suburb of Merebank. There are no children in the household. Indoor environment. Floor covering of quarry tiles, painted walls, wooden furniture. Outdoor environment: several industrial enterprises close to the residential area, including two oil refineries and chemical production.
Tanzania	Dar-es-Salaam	Room occupied by two people in rented apartment in the suburb of Kinondoni. Indoor environment: Plastic floor, painted walls, wooden furniture and textiles. Outdoor environment: A major road outside, close to several arable fields.
Kenya	Nairobi	The dust sample consists of three sub-samples. The first sub-sample came from a four-person apartment, from a room occupied by one person. The apartment is on the ground floor. Outdoor environment: Large residential area, close to railway line and there is a major motorway a short distance away. The second sub-sample came from a room occupied by two people, in a six-person household, in a third-floor apartment. Outdoor environment: Around 15 km from the centre of Nairobi, in an area where agriculture is undertaken. The third sub-sample was taken in a room occupied by two people, in a four-person household, on the first floor. Outdoor environment: The building is located around 20

		km from the centre of Nairobi, close to a garage, a shopping centre and a church.
Uganda	Kampala	Room occupied by two people in a nine-person household in the suburb of Najjanankumbi. Indoor environment: Stone floor, painted walls, rug, wooden furniture, textiles, hygiene products and books. Outdoor environment: Close to minor road in area of individual houses.
Malaysia	George Town	Room occupied by one person on the fifth floor on the outskirts of Georgetown City. There is both a child and a dog in the household. Indoor environment: Floor covering of quarry tile, wooden furniture, textiles, mosquito nets and hygiene products. Outdoor environment: Rented flat next to busy road, directly opposite a school, and close to a car workshop.
Philippines	Manila	Room occupied by three people, six-person apartment on the 3rd floor, in the district of Malabon City. Indoor environment: Both wall and floor covering of plastic, wooden furniture, textiles, electrical appliances, toys, computer, TV and hygiene products. No ventilation. Outdoor environment: densely populated suburb of rental apartment blocks, directly opposite basketball court and at a terminal for three-wheel moped taxis.
Sweden	Stockholm	Apartment with young family, on the 2nd floor in central Stockholm (Hammarby Sjöstad), built in 2006. Indoor environment: Parquet flooring, painted plasterboard and concrete walls, textiles and computer. Outdoor environment: Proximity to Värmdöleden road, excavation work in old lake sediment right outside, in a larger area of apartments and a few parks.
Germany	Frankfurt	Apartment occupied by a couple, on the 2nd floor. Indoor environment: Wooden floor, wooden and cane furniture, textiles, books and stereo, textiles. The bedroom has a balcony. Outdoor environment: Proximity to church and hospital in an area of apartments.
Belgium	Brussels	Room on the second floor in a terraced house occupied by a young couple in central Brussels (Ixelles). Indoor environment: Wooden floor, painted walls, wooden furniture and textiles.

		Outdoor environment: The house is located next to a road, neighbouring a day nursery and school. The area is dominated by terraced houses and apartments.
Czech Republic	Pilsen	Apartment occupied by two people, on the 3rd floor in the town. Indoor environment: Painted walls, textiles, plastic mat, toys and hygiene products. Outdoor environment: Area of rental apartment blocks in industrial town,engineering and metallurgy facility. Factory pruducing railways locomotives, turbins for power plans, tramways etc.
Hungary	Budapest	Room with two people in apartment occupied by four people, on the 2nd floor, in the suburb of Törökbálint. Indoor environment: Floor covering of plastic, wallpaper and wooden furniture. Outdoor environment: Large motorway approx. 1 km from the building, sparely populated affluent suburb.
Italy	Rom	Apartment occupied by an adult, on the first floor Indoor environment: Floor covering of quarry tiles, furniture of melamine and polyurethane foam, bookshelves, textiles, TV and stereo. Bedroom with balcony. Outdoor environment: On square directly opposite a railway station, car park and with a car workshop beneath the apartment.

Annex IV

Pictures from the sampling sites are provided here.

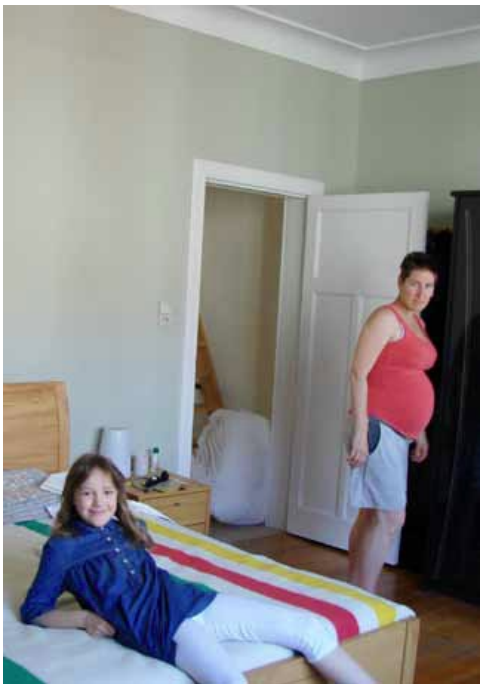

Amica, Italy


Bund, Germany

CAP, Malaysia

EcoWaste, Philippines

groundWork, South Africa




HEAL/EPHA Belgium

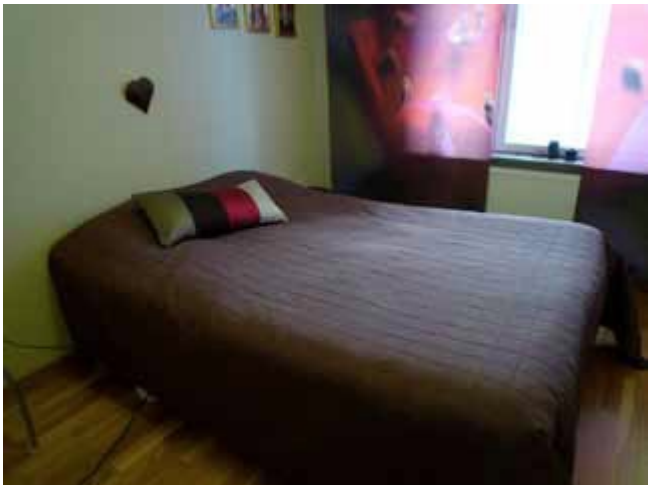
Envirocare, Tanzania

iLima, Kenya

Levego, Hungary

NAPE, Uganda

SSL, Czech Republic



Stockholm, Swedish Society for Nature Conservation

Annex V

The concentrations of the analysed chemicals varied in the different samples. The results for the analysed groups of chemicals are presented below in running text and as a table of measured values.

Flame retardants

One of the groups of chemicals that deviates from other studies is brominated diphenyl ethers (flame retardants), and the greatest differences are in dust samples from the Global South, particularly in the sample from the Philippines, but also in the sample from Uganda (see the table below).

The mean concentration (from Annex V) of the studied flame retardants in the dust samples from the six countries from the South was 349.4 µg/kg, and 60.2 µg/kg in the dust samples from the six EU Member States.

Summed concentrations of the studied brominated flame retardants were calculated for each sample and are presented in Graph 1A as relative values, normalised against the samples with the lowest cumulative concentrations (the sample from Malaysia). The cumulative concentration of brominated flame retardants in the sample from the Philippines was more than 10 000 times greater than in the sample from Malaysia.

Phthalates

Another of the chemical groups that deviates from other studies is phthalates (plasticisers of plastics, principally PVC), and the greatest deviations are in dust samples from the Global South, particularly in the sample from the Philippines. DINP was remarkably high in the sample from Hungary.

The mean concentration of the studied phthalates in the dust samples from the six countries from the Global South was 684.8 mg/kg, and in the dust samples from the six EU Member States was 934.8 mg/kg.

Summed concentrations of the studied phthalates were calculated for each sample and are presented in Graph 1B as relative values, normalised against the samples with the lowest cumulative concentrations (the sample from Kenya).

Alkylphenols

The sum of the alkylphenol levels was comparable in order of magnitude in most of the dust samples (see the table below). The dust sample from Belgium had the highest sum; the dust sample from Malaysia the lowest.

Bisphenols

The concentration of bisphenol A was highest in the Philippine dust sample (see the table below). It was more than five times higher than the concentration in the Italian dust sample, and 15-16 times higher than in the samples from Sweden, South Africa and the Czech Republic.

Parabens

Only propylbaraben was detected in a dust sample (the sample from South Africa, see the table below) and at low concentration.

Perfluorinated compounds

The summed levels for perfluorinated compounds were generally highest in the countries in the Global South (Philippines, South Africa, Tanzania) (see the table below).

Polychlorinated diphenyl ethers

None of the analysed PCBs could be detected in the dust samples.

Pesticides

None of the analysed pesticides could be detected in the dust samples.

Metals

The lead levels varied, but were high in certain dust samples (Belgium, the Philippines, Italy, Kenya, Tanzania and the Czech Republic) in relation to the other dust samples in this study (see the table below).

Mercury was only found in the dust sample from Tanzania and methylated mercury was found generally at higher levels in the European dust samples than in the dust samples from the South (see the table below). The highest methyl mercury level was found in the Swedish dust sample.

The cadmium levels varied and were highest in Germany (see the table below).

No individual daily exposure value through involuntary ingestion of dust exceeds official TDI values (see tables in Annexes II and VI).

Table: Chemical, concentration in samples from South Africa, Tanzania, Kenya, Uganda, the Philippines, Malaysia, Sweden, Germany, Belgium, the Czech Republic, Hungary and Italy. Minus signs (-) designate values that are below a reliable level of quantification or detection. These value have been excluded from calculations of daily exposure.

Chemical	Sample, South Africa (µ/kg)	Sample, Tanzania (µ/kg)	Sample, Kenya (µ/kg)	Sample, Uganda (µ/kg)	Sample, Philippines (µ/kg)	Sample, Malaysia (µ/kg)	Sample, Sweden (µ/kg)	Sample, Germany (µ/kg)	Sample, Belgium (µ/kg)	Sample, Czech Republic (µ/kg)	Sample, Hungary (µ/kg)	Sample, Italy (µ/kg)

Brominated diphenyl ethers												
PBDE 17	-	-	-	5.4	3.4	-	-	-	-	0.25	-	-
PBDE 28	-	0.14	0.29	16.9	13.1	-	-	-	-	0.5	-	-
PBDE 47	1.0	2.4	1.3	60.4	2400.0	-	10.9	1.4	5.5	3.4	1.5	3.4
PBDE 49	-	0.1	-	10.8	60.1	-	-	-	-	0.3	-	-
PBDE 66	-	0.1	-	13.3	59.4	-	-	-	-	0.3	-	-
PBDE 71	-	-	-	-	-	-	-	-	-	-	-	-
PBDE 77	-	-	-	1.3	-	-	-	-	-	-	-	-
PBDE 85	-	-	-	1.7	266.0	-	-	-	-	-	-	-
PBDE 99	0.9	2.2	1.2	30.4	4330.0	-	13.6	3.8	9.3	4.1	3.4	2.5
PDE 100	-	0.5	-	2.2	897.0	-	2.2	-	1.8	0.8	-	-
PBDE 119	-	-	-	6.0	0	-	-	-	-	-	-	-
PBDE 126	-	-	-	-	-	-	-	-	-	-	-	-
PBDE 138	-	-	-	-	64.6	-	-	-	-	-	-	-
PBDE 153	1.4	0.4	2.5	10.9	474	-	1.7	-	-	-	-	-
PBDE 154	0	0	0	2.1	369	-	0.9	-	-	-	-	-
PBDE 156	0	0	0	0	0	-	-	-	-	-	-	-
PBDE 183	4.5	0.7	43.4	2.9	17.3	-	-	-	-	-	-	-
PBDE 184	-	-	-	-	-	-	-	-	-	-	-	-
PBDE 191	-	-	-	-	-	-	-	-	-	-	-	-
PBDE196	6.7	-	4.7	3.1	-	-	3.9	-	-	-	-	-
PBDE 197	3.8	-	10.2	-	-	-	-	-	-	-	-	-
PBDE 206	50.4	2.8	-	34.9	31.8	-	-	-	-	-	-	-
PBDE 207	59.6	-	2.5	33.1	-	-	-	-	-	-	-	-
PBDE 209	660.0	29.8	51.4	567	1180.0	-	-	45.1	92.9	80.0	0	67.4
Polybrominated biphenyl ethers[46]												
PCB 28	-	-	-	-	-	-	-	-	-	-	-	-

[46] The reason why PCBs could not be detected in this study is probably that the sensitivity of the measuring method was too low. Other studies have shown that PCBs are a chemical group often found in dust.

PCB 52	-	-	-	-	-	-	-	-	-	-	-	-
PCB101	-	-	-	-	-	-	-	-	-	-	-	-
PCB 118	-	-	-	-	-	-	-	-	-	-	-	-
PCB 153	-	-	-	-	-	-	-	-	-	-	-	-
PCB 138	-	-	-	-	-	-	-	-	-	-	-	-
PCB 180	-	-	-	-	-	-	-	-	-	-	-	-
Phthalates												
BBP	1000.0	350.0	1600.0	2500.0	27000.0	1400.0	7600.0	7100.0	2000.0	480.0	-	1700.0
DEHA	4100.0	15000.0	-	16000.0	5000.0	3400.0 0	5800.0	0	3900.0	-	1800.0	3700.0
DEHP	120000. 0	289000. 0	6500.0	720000. 0	1670000. 0	65000. 0	121000. 0	213000. 0	146000. 0	470000.0	37000.0	203000. 0
Di-isobutyl adipate	-	-	-	-	-	-	11000.0	-	-	-	-	-
DIDP	10000.0	0	-	-	-	-	60000.0	3900.0	-	-	11000.0	82000.0
DIHP	-	0	-	-	-	-	-	146000. 0	-	-	-	-
DINP	33000.0	21000.0	-	460000. 0	550000.0	5600.0	102000. 0	-	59000.0	-	879000. 0	60000.0
DOP	-	-	-	-	-	-	0.4	2600	-	-	-	-
Dibutyl adipate	-	-	-	-	-	-	0	-	-	-	-	-
DBP	8000.0	3700.0	15000. 0	3900.0	17000.0	1000.0	9200.0	-	4900.0	2900000. 0	1900.0	2400.0
Diethyl adipate	-	-	-	-	-	-	-	59000.0	-	-	-	-
DEP	-	-	520.0	650.0	940.0	-	-	-	8400.0	660.0	840.0	320.0
DMP	-	-	-	-	-	-	-	-	-	-	-	-
DINCH	-	-	-	-	-	-	-	4900.0	-	-	-	-
TBP	140.0	-	-	-	-	-	-	-	-	-	-	-
Alkylphenols												
Nonylphenol	0.1	0.5	2.1	1.0	3.8	0.2	1.0	0.8	1.5	1.6	2.1	2.2
Nonylphenol monoethoxylates	-	0.2	-	0.7	0.5	$58.0*10^{-3}$	0.2	1.2	1.1	0.5	-	0.4

Nonylphenol diethoxylate	-	-	-	0.7	0.3	-	-	1.3	2.8	-	-	0.4
Octylphenol	-	-	-	-	-	-	-	-	-	-	-	-
Bisphenols												
Bisphenol A	1.5	$35.7*10^{-3}$	0.6	0.3	24.7	0.1	1.7	0.4	0.4	1.5	0.9	4.6
Perfluorinated compounds												
PFBS	-	-	-	-	-	-	-	-	-	-	-	-
PFDA	-	-	-	-	-	-	-	-	-	-	-	-
PFHpA	-	-	-	-	-	-	-	-	-	-	-	-
PFDS	-	-	-	-	-	-	-	-	-	-	-	-
PFDoA	-	-	-	-	-	-	-	-	-	-	-	-
PFHxS	-	-	-	-	-	-	-	-	-	-	-	-
PFHxA	-	-	-	-	-	-	-	-	-	-	-	-
PFNA	-	-	-	-	-	-	-	-	-	-	-	-
PFOS	7.2	1.5	-	0.7	-	7.6	1.6	-	-	-	-	-
PFOSA	-	-	-	-	-	-	-	-	-	-	-	-
PFOA	-	3.4	-	-	1.1	-	-	-	-	-	-	-
Pesticides												
Vinclozolin	-	-	-	-	-	-	-	-	-	-	-	-
Prochloraz	-	-	-	-	-	-	-	-	-	-	-	-
Methoxychlor	-	-	-	-	-	-	-	-	-	-	-	-
Parabens												
Butylparaben	-	-	-	-	-	-	-	-	-	-	-	-
Propylparaben	0.2	-	-	-	-	-	-	-	-	-	-	-
Metals and metal compounds												
Lead	3500.0	170000.0	120000.0	6000.0	29000.0	510.0	780.0	3300.0	11000.0	11000.0	4100.0	20000.0
Cadmium	170.0	390.0	79.0	310.0	500.0	-	-	650.0	170.0	290.0	77.0	90.0
Mercury	-	300.0	-	-	-	-	-	-	-	-	-	-
Methyl mercury	-	1.5	0.3	0	10.0	-	25.0	10.0	1.7	1.9	13.0	12.0

Annex VI

Table A: Chemical and daily exposure (µg/kg and day) (9-month-old baby weighing 7 kg) in South Africa, Tanzania, Kenya, Uganda, the Philippines, Malaysia, Sweden, Germany, Belgium, the Czech Republic, Hungary and Italy.

Chemical	South Africa, child, daily uptake (µg/kg * day)	Tanzania, child, daily uptake (µg/kg * day)	Kenya, child, daily uptake (µg/kg * day)	Uganda, child, daily uptake (µg/kg * day)	Philippines, child, daily uptake (µg/kg * day)	Malaysia, child, daily uptake (µg/kg * day)	Sweden, child, daily uptake (µg/kg * day)	Germany, child, daily uptake (µg/kg * day)	Belgium, child, daily uptake (µg/kg * day)	Czech Republic, child, daily uptake (µg/kg * day)	Hungary, child, daily uptake (µg/kg * day)	Italy, child, daily uptake (µg/kg * day)
Brominated diphenyl ethers												
PBDE 17	-	$4.0*10\text{-}^{6}$	$8.3*10^{-06}$	$4.8*10^{-3}$	$9.7*10^{-05}$	-	-	-	-	$7.1*10^{-06}$	-	-
PBDE 28	0	$6.9*10^{-05}$	$3.8*10^{-05}$	$1.7*10^{-3}$	3.7*10-3	-	-	-	-	$14*10^{-6}$	-	-
PBDE 47	$27.2*10^{-6}$	$3.1*10^{-6}$	-	308.6*10-6	$68.6*10^{-3}$	-	$311.4*10^{-6}$	$3.9*10^{-5}$	$158*10^{-6}$	$9.7*10^{-5}$	$4.2*10^{-5}$	$9.7*10^{-5}$
PBDE 49	-	$3.1*10^{-6}$	-	$380.0*10^{-6}$	$1.7*10^{-3}$	-	-	-	-	$8.9*10^{-6}$	-	-
PBDE 66	-	-	-	-	$1.7*10^{-3}$	-	-	-	-	$9.1*10^{-6}$	-	-
PBDE 71	-	-	-	$3.7*10^{-5}$	-	-	-	-	-	-	-	-
PBDE 77	-	-	-	$4.9*10^{-5}$	-	-	-	-	-	-	-	-
PBDE 85	.	$6.3*10^{-5}$	$3.4*10^{-5}$	$868.6*10^{-6}$	$7.6*10^{-3}$	-	-	-	-	-	-	-
PBDE 99	$2.6*10^{-5}$	$1.4*10^{-5}$	-	$62.0*10^{-6}$	0.1	-	$388.6*10^{-6}$	$108.3*10^{-6}$	$265.4*10^{-6}$	$116.6*10^{-6}$	$9.7*10^{-5}$	$7.0*10^{-5}$
PDE 100	-	-	-	$170.9*10^{-}$	$25.6*10^{-3}$	-	$7.7*10^{-5}$	-	$5.1*10^{-}$	$2.3*10^{-5}$	-	-

				^{6}					^{5}			
PBDE 119	-	-	-	-	-	-	-	-	-	-	-	-
PBDE 126	-	-	-	-	-	-	-	-	-	-	-	-
PBDE 138	-	$12*10^{-6}$	$7.1*10^{-5}$	$3.1*10^{-3}$	$1.8*10^{-3}$	-	-	-	-	-	-	-
PBDE 153	$40.0*10^{-6}$	-	-	$5.9*10^{-5}$	$13.5*10^{-3}$	-	$4.8*10E^{-5}$	-	-	-	-	-
PBDE 154	-	-	-	-	$10.5*10^{-3}$	-	$2.61*10^{-5}$	-	-	-	-	-
PBDE 156	-	$1.9*10^{-5}$	$1.2*10^{-3}$	$820.0*10^{-6}$	-	-	-	-	-	-	-	-
PBDE 183	$129.4*10^{-6}$	-	-	-	$494.3*10^{-6}$	-	-	-	-	-	-	-
PBDE 184	-	-	-	-	-	-	-	-	-	-	-	-
PBDE 191	-	-	$132.0*10^{-6}$	$9.0*10^{-5}$	-	-	-	-	-	-	-	-
PBDE 196	$190.9*10^{-6}$	-	$292.4*10^{-6}$	-	-	-	$112.0*10^{-6}$	-	-	-	-	-
PBDE 197	$108.9*10^{-6}$	$8.1*10^{-5}$	-	$997.1*10^{-6}$	-	-	-	-	-	-	-	-
PBDE 206	$1.4*10^{-3}$	$7.2*10^{-5}$	-	$945.7*10^{-6}$	$908.6*10^{-6}$	-	-	-	-	-	-	-
PBDE 207	$1.7*10^{-3}$	$1.5*10^{-3}$	$851.4*10^{-3}$	$16.2*10^{-3}$	-	-	-	-	-	-	-	-
PBDE 209	$18.3*10^{-3}$	$1.5*10^{-3}$	$851.4*10^{-6}$	$16.2*10^{-3}$	$33.7*10^{-3}$	-	-	$1.3*10^{-3}$	$2.7*10^{-3}$	$2.3*10^{-}3$	-	$1.9*10^{-3}$
Phthalates												
BBP	$28.7*10^{-3}$	$10.0*10^{-3}$	$45.7*10^{-3}$	$71.4*10^{-3}$	$771.4*10^{-3}$	$40.0*10^{-3}$	0.2	$57.1*10^{-3}$	0.2	$13.7*10^{-3}$	$51.4*10^{-3}$	$48.5*10^{-3}$
DEHA	0.1	0.4	-	0.5	0.1	1.0	0.2	0.1	-	-	1.1	0.1
DEHP	3.4	8.3	0.2	20.6	**47.7**	1.9	3.5	4.2	6.1	13.4	-	5.8
Di-isobutyl adipate	-	-	-	-	-	-	0.3	-	-	-	0.2	-
DIDP	0.3	-	-	-	-	-	1.7	-	0.7	-	-	2.3

DIHP	-	-	-	-	-	-	-	-	-	-	25.1	-
DINP	0.9	0.6	-	13.1	15.7	0.2	2.9	1.7	3.5	-	-	1.7
DOP	-	-	-	-	-	-	$1.1*10^{-5}$	-	-	-	-	-
Dibutyl adipate	-	-	-	-	-	-	-	-	-	-	$54.2*1054.2*10^{-3}$	-
DBP	0.2	0.1	0.4	0.1	0.5	$28.6*10^{-3}$	0.3	0.1	1.2	8.29	-	$68.6*10^{-3}$
Diethyl adipate	-	-	-	-	-	-	-	-	-	-	$24.0*10^{-3}$	-
DEP	-	-	$14.0*10^{-3}$	$18.6*10^{-3}$	$26.9*10^{-3}$	-	-	0.2	$94.3*10^{-3}$	$18.9*10^{-3}$	-	9.1*10-3
TBP	$4.0*10^{-3}$	-	-	-	-	-	-	-	-	-	-	-
Alkylphenols												
Isononylphenol	$2.9*10^{-5}$	$1.3*10^{-5}$	$60.0*10^{-6}$	$2.8*10^{-5}$	$108.6*10^{-6}$	$4.3*10^{-6}$	$28.0*10^{-6}$	22.0*10-6	$4.3*10^{-05}$	$22*10^{-6}$	$4.6*10^{-5}$	$6.3*10^{-5}$
Nonylphenol monoethoxylates	$8.3*10^{-5}$	$5.7*10^{-6}$	-	$2.0*10^{-5}$	$1.5*10^{-.5}$	$1.7*10^{-6}$	$6.8*10^{-6}$	$3.4*10^{-5}$	$3.1*10^{-5}$	$3.4*10^{-05}$	$1.3*10^{-5}$	$1.2*10^{-5}$
Nonylphenol diethoxylate	$3.7*10^{-5}$	-	-	$2.0*10^{-5}$	$9.5*10^{-6}$	-	-	$3.7*10^{-5}$	$80.0*10^{-6}$	$3.7*10^{-5}$	-	$10.0*10^{-6}$
Bisphenols												
Bisphenol A	$4.3*10^{-5}$	$10.2*10^{-6}$	$1.6*10^{-5}$	$7.7*10^{-6}$	$705.7*10^{-6}$	$1.9*10^{-6}$	$1.1*10^{-6}$	$1.2*10^{-5}$	$1.1*10^{-5}$	$4.3*10^{-5}$	$25.0*10^{-6}$	$131.7*10^{-6}$
Perfluorinated compounds												
PFOS	$205.7*10^{-6}$	$4.3*10^{-5}$	-	$20.0*10^{-6}$	-	$217.1*10^{-6}$	$4.6*10^{-05}$	-	-	-	-	-
PFOA	-	$9.7*10^{-5}$	-	-	$3.1*10^{-5}$	-	-	-	-	-	-	-
Parabens												
Propylparaben	$4.3*10^{-6}$	-	-	-	-	-	-	-	-	-	-	-
Metals and metal												

compounds												
Lead	0.1	4.9	3.4	0.2	0.8	$14.6*10^{-3}$	$22.2*10^{-3}$	$94.2*10^{-3}$	0.3	0.3	0.1	0.6
Cadmium	$4.9*10^{-3}$	$260.0*10^{-6}$	$2.3*10^{-3}$	$8.8*10^{-3}$	$14.3*10^{-3}$	-	-	$18.6*10^{-3}$	$4.8*10^{-3}$	$8.3*10^{-3}$	$2.2*10^{-3}$	$2.5*10^{-3}$
Mercury	-	$2000.0*10^{-6}$	-	-	-	-	-	-	-	-	-	
Methylmercury	-	$4.3*10^{-5}$	$8.6*10^{-6}$	-	$285.7*10^{-6}$	-	$714.3*10^{-6}$	$285.7*10^{-6}$	$1.1*10^{-6}$	$5.4*10^{-5}$	$371.4*10^{-6}$	$80.0*10^{-6}$

Annex VII

A compilation is presented here of the sample values that deviate from published data from other studies.

Table: Chemical, previously reported concentration range, and deviating sample values.

Chemical	Previously reported concentration range (µg/kg)	Sample, South Africa (µ/kg)	Sample, Tanzania (µ/kg)	Sample, Kenya (µ/kg)	Sample, Uganda (µ/kg)	Sample, Philippines (µ/kg)	Sample, Malaysia (µ/kg)	Sample, Sweden (µ/kg)	Sample, Germany (µ/kg)	Sample, Belgium (µ/kg)	Sample, Czech Republic (µ/kg)	Sample, Hungary (µ/kg)	Sample, Italy (µ/kg)
Brominated diphenyl ethers													
PBDE 17	9.2												
PBDE 28	37.6												
PBDE 47	13 - 102					2400							
PBDE 49	10.1				10.8	60.1							
PBDE 66	8.7				13.3								
PBDE 71	31.9												
PBDE 77	No info.												
PBDE 85	30.6					266							
PBDE 99	5.40 - 44.0					4330							
PDE 100	0.54 - 84.9					897							
PBDE 119	No info.												
PBDE 126	No info.												
PBDE 138	No info.												

PBDE 153	2.0 - 6.9				10.9	474							
PBDE 154	0.99 - 3.6					369							
PBDE 156	22.5												
PBDE 183	1.40 - 77.0												
PBDE 184	75.4												
PBDE 191	2.8												
PBDE 196	2.3	6.68		4.65	3.14			3.92					
PBDE 197	1.40 - 15.0												
PBDE 206	50.5	50.4											
PBDE 207	47.3	59.6											
PBDE 209	390 - 7100												
Phthalates													
BBP	15.2 - 135.0												
DEHA	No info.												
DEHP	195 - 996					1670							
Di-isobutyl adipate	No info.												
DIDP	33.6 - 61.2												82
DIHP	No info.												
DINP	41 - 129				460	550						879	124
DOP	No info.												
Dibutyl adipate	No info.												
DBP	No info.												
Diethyl adipate	No info.												
DEP	3.7 - 12			15		17							
DMP	0.61 - 1.42								8.4				
DINCH	1200												
TBP	No info.												
Alkylphenols													

Nonylphenol	2580 - 7500												
Nonylphenol monoethoxylates	3360												
Nonylphenol diethoxylate	5330												
Octylphenol	130												
Bisphenols													
Bisphenol A	7200												
Perfluorinated compounds													
PFOS	No info.												
PFOA	300												
Parabens													
Butylparaben	76												
Propylparaben	406												
Metals and metal compounds													
Lead	85200 - 573000												
Cadmium	1900 - 4400												
Mercury	5000												
Methylmercury	No info.												