



4FUN

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Abbreviations

As	Arsenic
CS1	Case Study 1
Pb	Lead
PDF	Probability Density Function
PBPK	Physiologically Based PharmacoKinetic

MERLIN-Expo: Lessons learned from the case studies

One of the objectives of the 4FUN project was to increase the confidence in the applicability of the MERLIN-Expo tool through targeted demonstration activities based on complex realistic case studies. In particular, we aimed at demonstrating: (i) the reliability of the modelling predictions through a comparison with actual measurements; (ii) the feasibility of building complex realistic exposure scenarios satisfying the needs of stakeholders; and (iii) how uncertainty margins can improve risk governance. The case studies can be seen as reference cases that provide guidance to future users on how to apply the tool in different situations and how to interpret the results from the assessments with the tool taking into account relevant regulatory frameworks. The three case studies are presented thoroughly in separate deliverables (D5.1, D5.2, and D5.3). Here the main features of the MERLIN-Expo tool that were explored using these case studies are summarised.

Reliability of the MERLIN-Expo predictions

One of the major achievements of the case studies was to assess the reliability of the predictions obtained by MERLIN-Expo. In most cases, a factor less than 3 was observed between the model predictions and the actual experimental data (see case studies 1 and 3, for example). Such an agreement between predictions and measurement is generally judged acceptable in a purely predictive framework, i.e., the models are sufficiently generic to be applied to a large number of substances and situations, even when the measurement data were not used to calibrate the models. Although the number of case studies is relatively low to generalize these results, our testing approach gives a quite reasonable confidence in MERLIN-Expo predictions. It is important to notice that confidence increases because some modules of the modelling chain had already been studied on their own (for example, the PBPK model has already been developed and evaluated on a separate dataset).

Unsurprisingly, MERLIN-Expo performed best when model parameters were set to values specific to the sites and the populations (see case study 1), allowing to tailor the assessment to local conditions. Most of the modules implemented in the MERLIN-Expo library are mechanistic models, so their parameters refer to physico-chemical, physical or biological processes that have already been measured or estimated. MERLIN-Expo integrates and organizes the available knowledge in order to improve exposure assessment and, subsequently, risk assessment. In the case there is no prior information, default values are provided in MERLIN-Expo and guidance on how to obtain additional, more specific data is given in the documentation of each module.

Flexibility in building complex exposure scenarios

One of the main features of MERLIN-Expo is its ability to build realistic site-specific scenarios in an intuitive fashion, making use of a library of models that covers a wide spectrum of exposure assessment contexts. MERLIN-Expo was tested on three case studies exhibiting very different characteristics in order to cover a wide range of: (i) substances (e.g. metals, persistent organic pollutants, emerging pollutants); (ii) contamination sources (water, wastes, soil, dust, air, food); (iii) environmental policy endpoints (e.g. waste, land management, water quality); (iv) spatial/temporal scales (e.g. close vicinity of industry, lagoon). The case studies offered the opportunity to explore the applicability of the tool at several levels of complexity, ranging from very simple to rather complex scenarios. The complexity depends on the description of the environment and exposure pathways (number of modules selected and their interconnections, default values or site specific values for parameterization), but also on the statistical analyses performed (deterministic or probabilistic). All these different levels of complexity were effectively handled with MERLIN-Expo. Using the same tool also allows a direct comparison of the

results obtained from different hypotheses. Moreover, MERLIN-Expo can be used to combine ecological and human exposure assessment using a single tool (see case study 2), supporting the integrated evaluation of chemical fate and effects, also for long-term scenarios.

Incorporating uncertainty in risk assessment

All the case studies performed probabilistic analyses to study the impact of uncertainty and variability in parameter values of the different modules on the final model outputs, such as a biological measure in humans. The probabilistic simulation tools implemented in MERLIN-Expo were used together with the default probability density functions (pre-)defined for model parameters. These analyses produced a mean prediction associated to an interval of confidence for the model outcomes of interest. In some cases (e.g., in case study 3), we showed that the experimental data were encompassed in the predicted interval of confidence at 95%, a result that further supports the accuracy of the tool. Sensitivity analyses were also run to identify and rank the key input parameters of the exposure, and also to assess the relative contribution of the different sources, pathways, and routes of exposure on the overall modelled exposure (e.g., in case study 1).

The availability of different options for uncertainty and sensitivity analysis in MERLIN-Expo, from simple local methods to more computational expensive non-local methods, is targeted to a wide range of end-users and should facilitate the incorporation of such issues in future decision making. Such analyses then provide valuable information for both risk assessors and decision-makers by supporting decisions to conduct additional analyses or prioritise resource allocations for additional research and/or data collection efforts. This is also in line with the recommendations of international agencies (EFSA, 2015; BFR 2015; WHO 2008) and makes MERLIN-Expo an appealing tool for advanced exposure assessment.

An evolving tool

Modelling tools are usually in constant evolution. At the beginning of the 4FUN project, the MERLIN-Expo tool was not suitable to implement all the case study specificities. All along the project, there were discussions with the model and software developers to make some adjustments in order to improve the tool. Few examples of functionalities and features included in MERLIN-Expo and used in the case studies are: capability of modelling larger populations, performing simulation for several individuals at the same time; including individual time-activity patterns (e.g. individual moving between areas with varying levels of contamination); developing a food web model to describe the transfer of contamination between species and across trophic levels (prey and predator model, implemented for the aquatic environment); adding a module ("human intake") to combine the human intakes from several sources; allowing time-varying intake (e.g., food consumption evolves with the age of the individual), including and parametrizing new substances originally not included in the database.

MERLIN-Expo is now ready to be used for various exposure scenarios but will need to be maintained and updated to include new models and/or features that could further facilitate scenario building and/or the interpretation of the results. For instance, the tool could be linked to databases or *in silico* models (QSARs) to ease the parameterization of the models. End-users with not all the required information at hand find guidance in the model documentation supplemented to the tool. Extending this guidance and documentation may be particularly relevant for physico-chemical parameters specific to the contaminants (e.g., the partition coefficients between two media, or between blood and tissue in humans), or for the integration of default values for food consumption of predefined products (e.g., referencing the database developed by the European Food Safety Authority).

1 Introduction

This report aims to present the achievements obtained in the case studies of the 4FUN project. The main objective of the case studies is to increase the confidence in the applicability of MERLIN-Expo through targeted demonstration activities based on complex realistic case studies. In particular, these activities aim at

- improving the reliability of modelling calculations through a systematic comparison with actual measurements;
- demonstrating how uncertainty margins can improve risk governance;
- demonstrating the feasibility of building complex realistic scenarios satisfying the needs of stakeholders.

As described in the document of work of the 4FUN project, the process of model demonstration applied in each case study entails the same following steps:

- Parameterisation of the exposure and PBPK models, in order to overcome the shift from a generic to a site-specific assessment. For each case study, the selected modules of MERLIN-Expo will be parameterised according to the substances of interest and the characteristics of the investigated context;
- Comparison between the model outcomes and actual monitoring data for the full chain of models.
- The propagation of uncertainty and variability in the full chain of model will be determined. The tiered approach recommended by WHO for uncertainty analysis will be followed to anticipate on future regulatory guidelines at European level.
- Sensitivity analysis will be performed for the three case studies in order to identify the key parameters of the exposure and human models, and to assess the contribution of the different relative pathways, sources and routes of exposure on a model outcome.

Case study 1 of the 4FUN project focuses on lead (Pb) and arsenic (As) exposure in preschool children and adults, respectively, living in the Northern Campine region of Belgium. This region - located in the north-east of Belgium (Figure 1) - has a long history harbouring polluting zinc smelting industry. Most of the smelters have closed down in the last decades and the remaining factories have modernised their production processes resulting in a significant reduction of heavy metals emissions. Despite these measures, exposure of the inhabitants of the polluted area continues. The soil is still contaminated with heavy metals such as Pb and As due to high emissions over the past century. The residues (ashes, slags and muffles) from the smelting operations were used in the hardening of roads and industrial terrains and the discharge of waste water into the surface water has led to the contamination of groundwater (Van Holderbeke et al., 2009). Following a scientific publication on the increased incidence of lung cancer in the region (Nawrot et al., 2006), the Flemish Government launched the so-called Cadmium Action Plan (Schauvliege, 2009). One of the actions defined in this Plan was the implementation of a large-scale monitoring campaign (further referred to as "monitoring campaign" in this document) to investigate the following set of research questions: a) is there a significant difference in body burden of heavy metals in the population compared to the biomonitoring studies of the 1990s?; b) what are the actual exposure pathways in the population? This monitoring campaign was eventually conducted between 2006 and 2008 in participation with stakeholders from the local community and locally active environmental health workers and involved a population sample of 337 preschool children (2-6 years old) and 1,220 adults (19-79 years old). The polluted study area consisted of districts of the municipalities

of Mol, Balen, Lommel, Overpelt and Neerpelt. The low exposure reference study area was located more than 10 km south-east of the smelters and included districts of the municipalities of Hechtel and Eksel (Figure 1) (Vlaamse Overheid, 2008).



Figure 1: Geographic overview of the Belgian Northern Campine region and the municipalities investigated during the large-scale monitoring campaign of 2006-2008.

Within the context of the 4FUN project, exposure scenarios for the local populations are constructed using the datasets obtained in the above mentioned monitoring campaign. A conceptual model integrating the different exposure pathways is built as well. The objectives of Case study 1 are 1) to estimate the total internal and external Pb and As exposure and 2) to characterize and rank the different exposure pathways according to their contribution to the measured concentrations in the population.

Lead (Pb) is probably the most intensively biomonitored chemical with continued concern about its potential health impact. Pb is an ubiquitous environmental pollutant with a long history in human biomonitoring (HBM) programs. Probably, it was and continuous to be one of the first pollutants to receive widespread attention as a causative agent for health-related effects. Human biomonitoring has historically focused on determining Pb concentrations in blood as this parameter has played an important role in the elucidation of the link between Pb in the environment and health effects such as loss of IQ or neurological disorders (Bierkens et al., 2011).

Arsenic (As) is an element of which the various forms are differing in toxicity. Inorganic arsenic forms (As (III) and As (V)) are toxic whereas organic arsenic compounds are non-toxic or at least far less toxic. Speciation analysis is therefore essential when evaluating risks from arsenic exposure. In exposure assessments, inorganic arsenic is of most interest and all collected data in this study refer therefore to inorganic As.

2 Construction of exposure scenarios and available datasets

Several pathways are considered to predict human exposure to Pb and inorganic As (further referred to as "As"), namely the inhalation of air (indoor and outdoor) and the oral ingestion of food products (both locally produced and purchased), dust and soil. To do these predictions with MERLIN-Expo, three types of datasets are basically needed: time activity data, environmental data and human data. The majority of these data are coming from the monitoring campaign (Van Deun et al., 2008a; 2008b and confidential, unpublished results). Of the 337 preschool children and 1220 adults that participated in this campaign. Valid and complete data to be used in this project are available for 334 and 1214 participants, respectively.

2.1 Time activity datasets

Based on the distance and wind direction from the former locations of the smelters, the investigated region is divided into four different areas (Figure 2). A first distinction is made between study area (blue; i.e. where the smelters are located), reference area (green; i.e. the control area) and external area (yellow; i.e. all locations outside the study and reference area). A second distinction of the study area is made between industrial area (deep blue) and surrounding area (pale blue).

For all participants of the monitoring campaign, data are available regarding the average number of hours they spent yearly indoors and outdoors in these four areas (confidential, unpublished results). These data are converted to time fractions (i.e. the hours spent divided by 8760 hours/year) to be used as input for the MERLIN-Expo model to predict exposure by inhalation of indoor and outdoor air and by oral ingestion of soil and dust.



Figure 2: Geographic overview of the four different areas considered in case study 1, namely industrial (deep blue), surrounding (pale blue), reference (green) and external (yellow) area.

2.2 Environmental datasets

During the monitoring campaign, environmental measurements were carried out at the homes of 100 individual adult participants and at 14 public places (Van Deun et al., 2008a; 2008b). The locations of these homes and public places are indicated on Figure 3 in red and black, respectively. At the home locations, samples of garden soil, indoor dust and indoor air among others were taken. A few samples of locally produced vegetables were collected as well. At the public places (e.g. schools, day nurseries, shops and offices), only indoor and outdoor air samples were collected. The concentrations of Pb and As determined in all the above mentioned samples (with the exception of the concentrations in locally produced vegetables for which the available data are not of sufficient quality) are used as input for the MERLIN-Expo model. Hereto, descriptive statistic data (averages, medians, minima and maxima) are calculated for all the considered media per area.

As can be noticed from Figure 3, not that many environmental samples were available from the monitoring campaign to calculate descriptive statistic data of good quality for the external area. Therefore, the environmental dataset for the external area is extended with information from other studies (Bierkens et al., 2010a; 2010b; Cornelis et al., 2013a).



Figure 3: Geographic overview of the environmental measurements collected during the monitoring campaign at 100 home (red) and 14 public (black) locations.

For the prediction of dietary exposure to Pb and As, the following external/purchased food products are considered: breakfast cereals, bread, bread rolls, cakes, rusks, pasta, rice, other cereals, liver, kidney, horsemeat, poultry, coffee, tea, tap water, bottled water, soup, other drinks, potato, carrot, scorzonera, radish, spinach, endive, celery, celeriac, lettuce, leek, onion, Belgian endive, Brussels sprouts, cabbage, savoy cabbage, cauliflower, broccoli, bean, tomato, pea and fish (only for As). Concentrations of Pb and As in these products are taken from literature (EFSA, 2012; 2014; FAVV, 2009; Leblanc et al., 2005; Van Holderbeke et al., 2008) as input for the model. Locally produced food products (i.e. root crops, potatoes and leafy vegetables produced in the considered industrial, surrounding and reference area) are predicted by models in MERLIN-Expo. So, for these products, concentrations of Pb and As do not need to be provided as input in the model.

Besides concentrations of Pb and As in soil, outdoor air, indoor air, dust and purchased food products, MERLIN-Expo also needs data of Pb and As for the following input parameters: surface dry deposition flux ($F_{p,dry}$; in mg/m²/day), surface wet deposition flux ($F_{p,wet}$; in mg/m²/day) and quantity in soil (Q_{soil} ; in mg). As no measurement data for these parameters are available as such, area specific values are calculated according to the following equations:

$F_{p,dry} = C_{p,a} \times V_d$	(Meneses et al., 2002)
$F_{p,wet} = C_{p,a} \times R_n \times R_w \times W_p$	(Meneses et al., 2002)
$Q_{soil} = C_{soil} \times h_{root} \times S_{field} \times \rho_{soil,dry}$	(MERLIN-Expo)

where:

 $C_{p,a}$ is the concentration of Pb/As in air particles in mg/m³ (monitoring campaign)

 V_d is the dry particle deposition rate of 865 m/day (Cornelis et al., 2013b)

R_n is the annual rainfall of 2.34E-03 m/yr (WeatherOnline Ltd, 2015)

 R_w is the fraction retained after rainfall of 1 (Cornelis et al., 2013b)

 W_p is the volumetric washout factor for particles of 5E+05 (Cornelis et al., 2013b)

 C_{soil} is the concentration of Pb/As in soil in mg/kg dw (monitoring campaign)

 h_{root} is the depth of the root zone in m (MERLIN-Expo or Fierens et al., 2014)

 S_{field} is the soil surface in m² (MERLIN-Expo or monitoring campaign)

 $\rho_{soil,dry}$ is the soil dry density in kg dw/m³ (MERLIN-Expo or Fierens et al., 2014)

Lastly, various area, plant and/or chemical specific parameter data are needed in order to be able to use the plant (leaf, potato and root; see Section 3.1) modules of MERLIN-Expo. Some examples of such parameters are: air temperature, relative humidity, actual evapotranspiration and transfer factors from soil to leaf, potato, and root. For some of these parameters (e.g. relative humidity), default values are available in MERLIN-Expo. As input for the other parameters and to overwrite the default values in some scenarios (see Section 3.2), data are taken from the monitoring campaign or from literature (Allen et al., 1998; ClimaTemps, 2015; Cornelis et al., 2013a; Fierens et al., 2014; WeatherOnline Ltd, 2015).

2.3 Human datasets

All participants from the monitoring campaign filled out a questionnaire inquiring about current and past home locations, consumption patterns, birth date, body weight and gender among others (confidential, unpublished results). The reported current home locations are used to divide the participants in the four considered areas. A geographic overview of this division can be found in Figure 4. In this figure, the pink and orange circles are representing the home locations of the preschool children and adults, respectively.



Figure 4: Geographic overview of the home locations of the preschool children (pink) and adults (orange) that participated in the monitoring campaign.

With respect to the consumption patterns, information was available about the number of glasses, table spoons, slices, etc. of various food products (see Section 2.2 for complete list) the participants consume during an average week. In order to be able to calculate oral exposure with these values, the reported cooking units are converted to kilograms or litres per day by using the report of the Belgian Superior Health Council (2005). Since the participants were also asked to report if the vegetables they consume are originating from a shop, from local production or from both (for the latter, the percentage shop/local origin was additionally asked), it is possible to make a distinction between exposure via local and external/purchased vegetable consumption in some of the scenarios (see Section 3.2) of this project as well. Consumption figures that were not available from the questionnaires, but necessary to calculate oral exposure in CS1, are the consumption of fish, and the ingestion of soil and dust. For these items, general consumption figures reported by Van Holderbeke et al. (2008) are used.

The reported birth dates from the questionnaires are used to calculate the (average, minimal, etc.) initial ages (in yr) of the participants per considered area. These values are used in MERLIN-Expo as input for the population module and are calculated as follows:

$Initial age = Date_{monitoring} - Date_{birth} - 1$

where:

Date_{monitoring} is the date the urine/blood sample of a participant was taken in yr

Datebirth is the birth date of the participant in yr

1 is the number of simulation years that is considered in the scenarios of CS1

One of the key features of the MERLIN-Expo tool is that – when sufficient information is available – it can link environmental fate modelling to Physiologically Based PharmacoKinetic (PBPK) modelling. By doing so, external exposures can be converted to internal exposures. For Pb, this conversion (from mg Pb per day to mg Pb per liter blood) is done by using the PBPK model that is implemented in MERLIN-Expo. For As, the PBPK

model of MERLIN-Expo unfortunately does not contain all required information. So here, an external PBPK model is used. For this external model, the reported gender and body weight of the participants is used among others (see Section 3.1). Since measurements of Pb in blood and As in urine were available for all preschool children and adults that participated in the monitoring campaign, respectively, the predicted internal Pb and As exposures of this project can be validated.

3 The conceptual model implemented in MERLIN-Expo

3.1 The conceptual model

In order to be able to simulate exposure scenarios for CS1, several modifications had to be made to MERLIN-Expo during the 4FUN project. First of all, a new module (i.e. human intake) was developed in order to consider time activity (indoors versus outdoors), exposure via the inhalation of indoor and outdoor air and exposure via the ingestion of dust and consumption of purchased food products. Furthermore, given the large and varied number of individuals included in CS1, a new tab (i.e. context) was added to the tool to include purchased food products and individuals in exposure scenarios *ad libitum*. Lastly, two new modules, i.e. population and population intake, were developed as extended versions of the man and human intake modules, respectively. With these two extended modules, exposure can be predicted simultaneously for a large number of individuals.

The following modules of MERLIN-Expo are used in CS1: leaf, potato, root (for locally produced vegetables), population intake and population. The way these modules are linked to each other, is illustrated in Figure 5. As can be noticed, all considered modules (with the exception of the population module) have to be duplicated and linked to the population module for each of the four considered areas (i.e. industrial, surrounding, reference and external). All purchased food products are originating from the external area. Because none of the participants cultivate vegetables in the external area, the linkage of a leaf, potato and root module is not necessary in this area. In the scenarios where the consumption of locally produced vegetables is not considered (see Section 3.2), only the population intake and population module have to be used (indicated with dotted lines in Figure 5). Because the PBPK model in MERLIN-Expo does not contain all required information for As, the population module was used to link the different exposure pathways to the population module without converting external exposures to internal exposures.



Figure 5: Linkage of the different MERLIN-Expo modules used in CS1. The leaf, potato and root modules are only linked in scenarios where local vegetable consumption is considered (indicated with dotted lines).

To assess the relevance of the external exposures estimated by MERLIN-Expo for As and link them to the measured urine concentrations from the monitoring campaign, a simplified calculation of the body burdens of As as elaborated during the monitoring campaign (Van Holderbeke et al., 2008) is programmed in Microsoft Excel 2010:

 $DABS_{AIR} = F_{AIR} \times D_{AIR}$ $DABS_{FOOD} = F_{FOOD} \times D_{FOOD}$ $DABS_{WATER} = F_{WATER} \times D_{WATER}$ $DABS_{SOIL/DUST} = F_{SOIL/DUST} \times D_{SOIL/DUST}$

$$ABS = \sum DABS_i$$
$$As_{tox,urine} = \frac{ABS \times 1000}{Cr_{ur}}$$

where:

DABS is the absorbed dose of air, food, water or soil/dust in μ g/day *F* is the absorption factor of air, food, water or soil/dust (Table 1) *D* is the external exposure dose via air, food, water or soil/dust in μ g/day *ABS* is the total absorbed dose in μ g/day *As*_{tox.urine} is the urinary excretion of arsenic in μ g/g creatinine

The creatinine excretion rate Cr_{ur} (in mg/day) can be calculated as follows:

IF gender = *female THEN*
$$Cr_{ur} = \left(22 - \frac{age}{9}\right) \times BW$$

IF gender = *male THEN* $Cr_{ur} = \left(28 - \frac{age}{6}\right) \times BW$

where:

age is the age of the participant in y BW is the body weight of the participant in kg

Table 1: Absorption factors for As (Van Holderbeke et al., 2008)

Absorption factor (-)	Value
Air	0.5
Food	1.0
Water	1.0
Soil/dust	0.3

-

3.2 Scenarios

During CS1, ten different scenarios – seven for Pb and three for As – are built with the conceptual model described in Section 3.1. An overview of the differences between these scenarios is given in Table 2. Principally, the distinction between these scenarios is based on the following topics:

- The chemical and population group under consideration (Pb in preschool children *vs.* As in adults);
- Deterministic vs. probabilistic (100; 1,000 and/or 10,000 simulation runs) exposure modelling;
- With vs. without considering the correlation between soil and dust ingestion figures;
- With vs. without considering the consumption of locally produced vegetables;
- Using default vs. own parameter values as input for the plant modules;
- Considering simple vs. complex time activity patterns;
- Using human dependent input data at population *vs.* individual level for exposure modelling;
- With vs. without considering the consumption of fish;
- Calculating internal exposure with the PBPK model implemented in MERLIN-Expo or a simplified calculation of the body burdens of As programmed in MS Excel 2010.

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Scenario (Scen.)	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6	Scen. 7	Scen. 8	Scen. 9	Scen. 10
Chemical	Pb	Pb	Pb	Pb	Pb	Pb	Pb	As	As	As
Population	Children	Children	Children	Children	Children	Children	Children	Adults	Adults	Adults
Deterministic (Det.)/	Det.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.
Probabilistic (Prob.)										
100/1,000/10,000 simulation runs	n/a	100-1,000- 10,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Correlation between soil and dust ingestion	n/a	No-Yes	Yes	Yes	Yes	Yes	n/a	Yes	n/a	n/a
Consumption of locally produced vegetables	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Default/Own parameter values for plant modules	n/a	n/a	Default	Own	n/a	Own	Own	Own	Own	Own
Simple/Complex time activity patterns	Simple	Simple	Simple	Simple	Complex	Complex	Complex	Complex	Complex	Complex
Population/Individual level	Population	Population	Population	Population	Population	Population	Individual	Population	Individual	Individual
Consumption of fish	No	No	No	No	No	No	No	No	No	Yes
PBPK model	MERLIN- Expo	MERLIN- Expo	MERLIN- Expo	MERLIN- Expo	MERLIN- Expo	MERLIN- Expo	MERLIN- Expo	MS Excel 2010 ¹	MS Excel 20101	MS Excel 20101

Table 2: Overview of the different scenarios considered in CS1 to predict Pb and As exposure in preschool children and adults, respectively.

n/a: not applicable.

¹ a simplified calculation of the body burdens of As

In the deterministic scenario (i.e. scenario 1), only fixed, average parameter values are used to calculate exposure to Pb and As. However, input data are not always known with a sufficient degree of certainty. Therefore, in the other scenarios (i.e. scenario 2-10), it is chosen to replace the average values of some parameters by probability density functions (PDFs). Depending on the relevance of the scenario and if possible, PDFs are provided for the concentrations of Pb/As in soil, dust, indoor air and outdoor air; the consumption figures of locally produced leafy vegetables, potatoes and roots crops; the consumption figures of the five external/purchased food products contributing most to dietary Pb/As exposure; the ingestion figures of dust and soil and the initial age of the participants. Based on the results of a small sample survey with data from the monitoring campaign (data not shown), the Log-Normal distribution was chosen for all parameter PDFs as the distribution with the best fit. In all cases except for the concentration of Pb/As in outdoor air, the PDFs of the parameters comprise the calculated average, standard deviation, minimum and maximum value of the corresponding datasets. For the outdoor air levels of Pb and As, the PDFs consist of the calculated average and the 5th and 95th percentiles.

In CS1, the added ingestion figures of soil and dust are related to each other, i.e. the correlation coefficient and the R² value amount to 1 (Van Holderbeke et al., 2008). This means that an individual that ingests high/low amounts of soil also ingests high/low amounts of dust and vice versa. If exposure via soil and/or dust ingestion is an important exposure pathway for Pb in preschool children and/or for As in adults, this correlation might have an important effect on the calculated exposure results of CS1. This effect is investigated by performing the simulation of scenario 2 once without and once with considering a correlation between soil and dust ingestion figures.

The soil of the considered industrial and surrounding areas of CS1 is historically polluted with heavy metals. As a consequence, vegetables that are cultivated in these areas might contain higher Pb and As levels than vegetables cultivated in the reference area or purchased from a shop. To investigate this hypothesis, oral exposure via vegetable consumption is considered in two different ways: in scenario 1, 2 and 5, it is assumed that all consumed vegetables are purchased (i.e. originating from the external area) whereas in the other scenarios, a part of the consumed vegetables is considered to originate from local production (i.e. cultivated in the areas the participants are living). The consumption proportions shop/local are calculated for each area and are based on the data obtained during the monitoring campaign (see Section 2.3). The default parameter values available in the plant modules of MERLIN-Expo are used to predict metal concentrations in locally produced vegetables in scenario 3. In the other scenarios (4, 6, 7, 8, 9 and 10), these default values are replaced by values that are typically valid for the considered CS1 areas (see Section 2.2).

People do not stay constantly at the same location; they are going to school/work, on holiday, to their weekly hobbies, etc. Furthermore, at a certain location, they can be present indoors or outdoors. Such time activity patterns are considered in a simple and a complex way in CS1. Scenarios 1 till 4 consider a simple time activity pattern. Here, the participants of the monitoring campaign are assumed to spend 50% indoors and 50% outdoors in the area where their home location is situated. More complex time activity patterns are considered in scenarios 5 till 10. Here, "real" time fractions based on the data from the monitoring campaign (see Section 2.1) are used.

Scenarios 1-6 and 8 are performed at population level. This means that in these scenarios, parameter (e.g. initial age and food consumption figures) values valid for the total population of the considered areas are used as input for the model and thus that average exposures for the population living in the industrial, surrounding and reference area are calculated. Scenarios 7, 9 and 10 on the contrary, are performed at individual level. Here, exposures are calculated each time for ten individuals living in the industrial, surrounding

and reference area by making use of their own reported initial age, food consumption figures, and so on. For each area, the child/adult with the highest measured Pb/As biomonitoring concentration is firstly included in the scenario. Subsequently, six children/adults per area that reported to consume locally produced vegetables are randomly chosen from the monitoring database. Lastly, the scenario is extended by choosing three additional children/adults per area that reported only to consume purchased/external food products.

Scenario 10 is the only scenario in which the consumption of fish is taken into account because fish can be an important source of arsenic in the human diet. Although the fish consumption was not questioned during the monitoring campaign, an average consumption for men and woman respectively and an average As concentration (Van Holderbeke et al., 2008) is taken into account in the MERLIN-Expo model.

The external exposure is converted to internal exposure by using the MERLIN-Expo model for scenarios 1-7 (Pb). The calculation of the internal body burden for scenarios 8-10 (As) is programmed in MS 2010.

All scenarios are performed with version 2.0.3 of MERLIN-Expo (i.e. the most recent version available at the beginning of the CS1 simulations) and are run for 1 year (i.e. starting from day 0 till day 365). The probabilistic scenarios (i.e. scenario 2-10) are performed by doing 1,000 Monte Carlo (seed 10021) simulations; scenario 2 is additionally performed with 100 and 10,000 Monte Carlo (seed 10021) simulations. Probabilistic sensitivity analyses are performed with scenario 6 and 8 for Pb and As, respectively.

3.3 Input data

Several datasets (time activity, environmental and human; see Section 2) are available to perform exposure calculations with MERLIN-Expo for CS1. In this Section, an overview is given of all the data that are actually used in MERLIN-Expo to perform the simulations for the ten considered scenarios.

3.3.1 Time activity data inputs

In all CS1 scenarios, time fractions are entered as constant values in MERLIN-Expo. Depending on the scenario, different assumptions regarding time activity are made (see Section 3.2) resulting in five different input datasets. An overview of these five datasets can be found in Table 8-Table 12 of Section 7 (Appendices).

3.3.2 Environmental data inputs

The constant concentrations of Pb and As (average and PDF when available) in soil, dust, indoor and outdoor air particles that are used as input for MERLIN-Expo are listed in Table 13 and Table 14 of Section 7, respectively. The concentrations of these two chemicals in external/ purchased food products on the other hand, can be found in Table 15 of Section 7. Furthermore, in the scenarios where the consumption of locally produced vegetables is considered (i.e. scenarios 3-4 and 6-10), additional area, plant and/or chemical specific time series and parameter data are necessary. An overview of these data is given in Table 16 and Table 17 of Section 7, respectively.

3.3.3 Human data inputs

The ingestion rates of soil, dust, external/purchased food products and – depending on the scenario (see Section 3.2) – locally produced vegetables that are used as input for the MERLIN-Expo model are listed in Table 18-Table 22 of Section 7. As can be noticed from these Tables, constant, average ingestion figures are entered for all the considered media. For the "population level" scenarios (i.e. scenarios 1-6 and 8), PDFs for the ingestions rates of soil, dust, locally produced vegetables and the top five contributing purchased food items are added to MERLIN-Expo as well. Table 23 and Table 24 of Section 7 on the other hand,

represent the initial age data that are used as input for the population (i.e. scenarios 1-6 and 8) and individual (i.e. scenarios 7 and 9-10) level scenarios, respectively. Also here, PDFs are additionally considered for the population level scenarios. Lastly, Table 25 and Table 26 of Section 7 summarise the data that are additionally needed for the PBPK model programmed in MS Excel 2010 for the As scenarios (i.e. scenarios 8-10).

3.4 Model simulations

In this Section, the simulation results of the ten considered CS1 scenarios are presented. The first seven scenarios are dealing with Pb exposure in Belgian preschool children and are varying from very simple (i.e. a deterministic scenario with no local food consumption, simple time activity patterns and calculations done at population level) to rather complex (i.e. a probabilistic scenario with local food consumption, complex time activity patterns and calculations done at individual level). The last three scenarios are dealing with As exposure in Belgian adults and are built based on the expertise developed during the Pb scenario calculations. For each scenario, the topics considered (e.g. consideration of local food consumption), the differences towards previous scenarios and the major simulation results are described.

3.4.1 Scenario 1

Scenario 1 is the only deterministic scenario of CS1. This scenario is mainly built to check if all the modules used are linked correctly to each other and if all necessary input parameter data are added properly to MERLIN-Expo. It is also used for the determination of the five external/purchased food products that are contributing the most to dietary Pb exposure in children living in the three considered areas. This in order to know for which food products it is useful to add PDFs for the food consumption figures in the other (probabilistic) scenarios.

The average Pb concentrations in blood of the children living in the three considered areas as predicted by MERLIN-Expo for one year are depicted in Figure 6. As can be noticed from this figure, the highest average Pb concentration is predicted for children living in the industrial area (blue line), followed by children living in the surrounding area (red line) and the reference area (green line).



Figure 6: Average one year predictions of Pb concentrations in blood of children living in the industrial (blue), surrounding (red) and reference (green) area (in mg/L).

After finishing the simulation of scenario 1, the average predicted levels of Pb in blood are compared with the concentrations of Pb measured during the monitoring campaign (Bruckers, 2008a). This comparison is illustrated in Figure 7. For all three areas, it can be observed that the predicted levels are lying within the range (average \pm standard deviation) of the measured Pb concentrations.



Figure 7: Measured (average \pm standard deviation) versus predicted concentrations of Pb in blood (in μ g/dL) of children living in the three considered areas.

Based on the output gathered from MERLIN-Expo, the contribution of the different exposure pathways to internal Pb exposure is additionally calculated in a MS Excel 2010

spreadsheet (Figure 8). For children living in the industrial area, dust ingestion is the most important exposure pathway (43% of total internal Pb exposure), followed by the consumption of external/purchased food products (41%) and the ingestion of contaminated soil (14%). The contribution of the inhalation routes (i.e. via indoor and outdoor air) is rather negligible, namely 0.6% and 1.6%, respectively. For children living in the surrounding and reference area, the consumption of external/purchased food products is the most important exposure pathway. The contribution of this route amounts to 49% in the surrounding area and to 65% in the reference area. Dust and soil ingestion are the next highest contributing routes with contribution percentages of 39% and 8% for the surrounding area and 27% and 7% for the reference area, respectively. Just like observed in the industrial area, the inhalation of contaminated indoor and outdoor air is negligible in these two areas.



Figure 8: Average contribution of the different exposure pathways to internal Pb exposure in children living in the three considered areas.

Table 3 summarises the five food products contributing most to the dietary exposure to Pb via the consumption of external/purchased food products. For all three areas, soup, bread, tap water and lettuce are the four main food sources. The fifth most important food product is bread rolls for the industrial and reference area and breakfast cereals for the surrounding area.

Table 3: Top five of external/purchased food products contributing most to Pb exposure in children living in the three considered areas. The contribution percentages are listed between parentheses.

	Industrial area	Surrounding area	Reference area
Food N° 1	Soup (39.4%)	Soup (39.9%)	Soup (44.4%)
Food N° 2	Bread (10.6%)	Bread (10.2%)	Bread (9.3%)
Food N° 3	Tap water (8.9%)	Tap water (10.1%)	Tap water (6.1%)
Food N° 4	Lettuce (5.3%)	Lettuce (5.9%)	Lettuce (5.3%)
Food N° 5	Bread rolls (4.7%)	Breakfast cereals (4.4%)	Bread rolls (4.5%)

3.4.2 Scenario 2

To simulate scenario 2, PDFs are added to the first scenario (see Section 3.4.1) for the following parameters: concentrations of Pb in soil, dust, indoor air and outdoor air; the consumption values of soup, bread, tap water, lettuce and bread rolls; the ingestion values of dust and soil and the initial age of the participants. A correlation of 1 between soil and dust ingestion is added to the scenario as well. Subsequently, this probabilistic scenario is simulated once with 100; 1,000 and 10,000 simulation runs in order to determine the adequate number of simulations (i.e., the minimal number of simulations that is required to obtain a stable result). Afterwards, a fourth simulation of scenario 2 is performed with 1,000 simulation runs but without considering the correlation between soil and dust ingestion.

The results of these four runs in comparison with the measured Pb concentrations in blood from the monitoring campaign are summarised in Figure 9 (average ± standard deviation) and Figure 10 (minimum-median-maximum). When looking to the average results presented in Figure 9, it can be concluded that the predictions of the four simulations are more or less comparable to each other: the predicted concentrations of Pb in blood are about 1.5 times higher than the corresponding measured levels in the industrial and reference area whereas predictions almost similar to the measured concentrations are obtained for children living in the surrounding area. We also observed that the four different simulations all captured the variability of the data and the numbers of simulations are noticed when looking at the minimum-median-maximum predictions (Figure 10). Here, 100 simulations seem not sufficient to reproduce the data variability suggesting to use a higher number of simulations (e.g., 1,000). Integrating the correlation between soil and dust ingestion has no impact on the results in the surrounding and reference areas, but reduces the variability on the industrial area.



Figure 9: Measured versus predicted (no/with correlation; 100/1,000/10,000 iterations) concentrations of Pb in blood (average \pm standard deviation; in µg/dL) of children living in the three considered areas.



Figure 10: Measured versus predicted (no/with correlation; 100/1,000/10,000 iterations) concentrations of Pb in blood (minimum-median-maximum; in μ g/dL) of children living in the three considered areas.

For the scenario 2 simulation with 1,000 simulation runs including the correlation between soil and dust ingestion, the average, minimum, median and maximum contribution of the different exposure pathways to internal Pb exposure are calculated for each of the three considered areas. These contributions are shown in Figure 11. For all three areas, average and median contributions are quite similar to each other. Comparing minimum with maximum contributions reveals that exposure via food consumption and inhalation via indoor air are of less importance for the upper end compared to the lower end of the internal Pb exposure distribution. The opposite is observed for exposure via dust ingestion and inhalation via outdoor air.











3.4.3 Scenario 3

Compared to scenario 2 (see Section 3.4.2), the consumption of locally produced vegetables is additionally considered in scenario 3. To do this, three plant modules (i.e. leaf, potato and root) are linked to the population intake module of the industrial, surrounding and reference area of scenario 2. In this scenario, the default parameter values of the plant modules in MERLIN-Expo are not overwritten.

Figure 12 and Figure 13 illustrate the predicted average and minimum-median-maximum concentrations of Pb in blood, respectively, in comparison with the monitoring results and

the scenario 2 predictions. As can be noticed from Figure 12, the average predictions of scenario 2 (i.e. without local food consumption) and scenario 3 (i.e. with local food consumption) are nearly the same. On the other hand, the min-max concentrations are narrower in scenario 3 than in scenario 2 (Figure 13). Moreover, the concentration ranges of scenario 3 are more comparable to the measured concentration ranges than those of scenario 2. Based on these observations, it can be concluded that the consideration of local food consumption is valuable for the prediction of Pb exposure in Belgian preschool children with MERLIN-Expo during CS1.



Figure 12: Measured versus predicted (without/with local food consumption) concentrations of Pb in blood (average \pm standard deviation; in µg/dL) of children living in the three considered areas.



Figure 13: Measured versus predicted (without/with local food consumption) concentrations of Pb in blood (minimum-median-maximum; in μ g/dL) of children living in the three considered areas.

Figure 14 present the average, minimum, median and maximum contribution of the different exposure pathways to internal Pb exposure that are calculated for each of the three considered areas. As can be noticed, the average contribution of local food consumption amounts to 2.6%, 5.9% and 8.4% for preschool children living in the industrial, surrounding and reference area, respectively. Furthermore, it can be concluded that in all areas, this exposure route is especially relevant for the upper end of the internal Pb exposure distribution as maximum contributions of 16% in the industrial area, 23% in the surrounding area and even 47% in the reference area are obtained.



Industrial area

Surrounding area

Minimum



Median

Maximum

Figure 14: Average, minimum, median and maximum contribution of the different exposure pathways to internal Pb exposure in children living in the industrial, surrounding and reference areas.

The minimum, median and maximum concentrations of Pb in leafy vegetables, potatoes and root crops that are predicted by MERLIN-Expo for the industrial, surrounding and reference area are depicted in Figure 15. For all three types of vegetables, predictions are the highest for the industrial area, followed by the surrounding and the reference area. This is in line with the fact that the soil of the industrial area is higher polluted with heavy metals than the soils of the surrounding and reference area (Van Deun et al., 2008a; 2008b).

0%

Average



Figure 15: Predicted concentrations of Pb in food cultivated in the three considered areas (minimummedian-maximum; in mg/kg fw).

3.4.4 Scenario 4

In contrast to scenario 3 (see Section 3.4.3), default parameter values provided in MERLIN-Expo for the plant modules are overwritten with own values in scenario 4. By doing this, its effect on the prediction of Pb concentrations in blood and vegetables can be investigated.

As can be observed from Figure 16 and Figure 17, replacing default values only affects the predicted maximum concentrations of Pb in blood. For children living in the industrial area, higher maximum levels are predicted in scenario 4 (i.e. with own parameter values) than in scenario 3 (i.e. with default parameter values) whereas the opposite is seen for children living in the surrounding and reference area.



Figure 16: Measured versus predicted (default/own parameter values) concentrations of Pb in blood (average \pm standard deviation; in µg/dL) of children living in the three considered areas.



Figure 17: Measured versus predicted (default/own parameter values) concentrations of Pb in blood (minimum-median-maximum; in μ g/dL) of children living in the three considered areas.

With respect to plant levels, remarkably lower and narrower concentration ranges of Pb in leafy vegetables, potatoes and root crops are predicted when own instead of default parameter values are used in MERLIN-Expo (Figure 18). Monitoring data of Pb in vegetables cultivated in the industrial, surrounding and reference area of sufficient quality are lacking. So, the Pb levels predicted in scenario 3 and 4 can unfortunately not be validated. Comparing the plant levels predicted in scenario 3 and 4 for the reference area with the Pb levels that are added to MERLIN-Expo for external/purchased food products (Table 15) might give an idea of the relevance of replacing default by own parameter values. Of course, this only holds true if it is assumed that vegetables cultivated in the reference area contain Pb in the same concentrations as vegetables that are cultivated in other external (non-polluted) areas. Concentrations of Pb in purchased leafy vegetables are varying between 0.010 and 0.083 mg/kg fw, in purchased potatoes amounts to 0.012 mg/kg fw (Table 15). Based on these values, the concentrations predicted in scenario 4 (i.e. with using own parameter values) seems to give the best results.



Figure 18: Predicted concentrations of Pb in food cultivated in the three considered areas (minimummedian-maximum; in mg/kg fw) by making use of default (pale colours) and own (dark colours) parameter values as input for the plant modules.

3.4.5 Scenario 5

Scenario 5 is based on the conceptual model of scenario 2 (i.e. probabilistic, but without considering local food consumption; see Section 3.4.2). The only difference between these two scenarios is that in scenario 2, a simple time activity pattern is considered while a more complex pattern is considered in scenario 5.

Figure 19 and Figure 20 show the predicted Pb concentrations in blood of both scenario 2 and scenario 5 in comparison with the measured blood levels from the monitoring campaign. Notwithstanding the fact that the time fractions used in scenario 5 are more realistic since they are based on the questionnaire data from the monitoring campaign itself, better predictions seems to be obtained for scenario 2 (i.e. with a simple time activity pattern) than for scenario 5 (i.e. with a complex time activity pattern).



Figure 19: Measured versus predicted (without/with time activity) concentrations of Pb in blood (average \pm standard deviation; in µg/dL) of children living in the three considered areas.



Figure 20: Measured versus predicted (without/with time activity) concentrations of Pb in blood (minimum-median-maximum; in μ g/dL) of children living in the three considered areas.

Dust ingestion becomes a more important exposure route in relation to total internal Pb exposure in scenario 5 compared to scenario 2 (see Figure 11). The opposite on the other hand, is observed for soil ingestion. For instance, in scenario 2, the average dust and soil ingestion represents 45% and 13% of the total internal Pb exposure in children living in the industrial area compared to 59% and 4% in scenario 5, respectively. This observation can simply be explained by the fact that scenario 5 makes use of the real indoor (i.e. where dust ingestion is considered) and outdoor (i.e. where soil ingestion is considered) time fractions that are reported by the children of the monitoring campaign, which are higher and lower, respectively, than the 50% indoors and 50% outdoors that are assumed in scenario 2.

3.4.6 Scenario 6

Scenario 6 combines the considerations made in scenario 4 (see Section 3.4.4) and scenario 5 (see Section 3.4.5). This means that local food consumption (predicted by using own parameter values for the plant modules) as well as complex time activity patterns are considered in this scenario. So, in fact, scenario 6 can be considered as the most complex scenario of CS1 to investigate Pb exposure in preschool children at population level.

The concentrations of Pb in blood predicted in scenario 6 in comparison with the measured values from the monitoring campaign are depicted in Figure 21 (average values \pm standard deviation) and Figure 22 (minimum, median and maximum values). As can be noticed from these Figures, the predicted average and maximum blood concentrations are about 1.5 times higher than the corresponding monitoring data (exception: maximum Pb

concentration in blood of children living in industrial area) while median and minimum predictions are similar to the related monitoring data.



Figure 21: Measured versus predicted concentrations of Pb in blood (average \pm standard deviation; in μ g/dL) of children living in the three considered areas.



Figure 22: Measured versus predicted concentrations of Pb in blood (minimum-median-maximum; in μ g/dL) of children living in the three considered areas.

The average, minimum, median and maximum contributions of the different exposure pathways to internal Pb exposure in children living in the three considered areas are shown in Figure 23. In general, dust ingestion and the consumption of external/purchased food products are the two main exposure routes. Depending on the area and the statistical value (average, minimum, median or maximum) considered, the contribution percentages are varying between 24% and 72% for dust ingestion and between 12% and 73% for external food consumption. The relevance of local food consumption as exposure pathway for Pb in children seems to be area dependent as children from the reference area are higher
exposed to Pb via locally produced vegetables than children from the surrounding and industrial area. For instance, the maximum contribution of local food consumption to internal Pb exposure amounts to 30% in the reference area, 15% in the surrounding area and 7.9% in the industrial area. This is in accordance with the local food consumption values reported by the participants from the monitoring campaign (Bruckers, 2008a).



Surrounding area



Reference area



Figure 23: Average, minimum, median and maximum contribution of the different exposure pathways to internal Pb exposure in children living in the industrial, surrounding and reference area.

Because scenario 6 is the most complex scenario at population level regarding Pb exposure in preschool children, probabilistic sensitivity analyses are performed with this

scenario. By doing this, the linearity of the implemented MERLIN-Expo modules is investigated and correlations (i.e. standardised regression coefficients) and first order indices (i.e. EASI² values) of the most relevant input parameters in relation to their corresponding output parameters are obtained.

High R² values are observed for the outputs of the leaf and potato modules of scenario 6. For instance, with regard to the industrial area (surrounding and reference area are analogous), the R² value amounts to 0.74 for the concentration in leaf and to 1 for the concentration in potato. This means that both leaf and potato modules are considered to be linear. In the leaf modules, the weathering (wash-off) loss rate from leaf to soil has the highest correlation coefficient, namely -0.86 for the industrial leaf module and -0.87 for the surrounding and reference leaf modules. Regarding the potato modules, a correlation coefficient of -1 is observed between the water content of the potato (input) and the Pb concentration of the potato (output).

In the population module, the R² value amounts to 0.94 for Pb in blood of children living in the industrial and reference area and to 0.95 for children living in the surrounding area. So, just like the plant modules, the population module seems to be linear. With regard to the predicted concentration of Pb in blood, an overview of its relationship with the top five input parameters is given in Table 4. For all three considered population groups, the highest correlation is found between the predicted Pb concentration in blood and the added (measured) concentration of Pb in dust of the corresponding area. The standardised regression coefficients amount to 0.84, 0.83 and 0.65 for dust levels of the industrial, surrounding and reference area, respectively. Other important, but not significant correlations are found between the Pb concentration in blood and the bodyweight variability, initial age, consumption figures of soup, tap water and lettuce and the ingestion figure of dust. The bodyweight variability and the initial age are negatively correlated while the other input parameters are positively correlated with the predicted concentration of Pb in blood.

	Industrial population	Surrounding population	Reference population
Parameter N° 1	Concentration of Pb in dust of industrial area (0.84)	Concentration of Pb in dust of surrounding area (0.83)	Concentration of Pb in dust of reference area (0.65)
Parameter N° 2	Bodyweight variability (-0.33)	Bodyweight variability (-0.38)	Bodyweight variability (-0.51)
Parameter N° 3	Initial age (-0.23)	Initial age (-0.29)	Initial age (-0.41)
Parameter N° 4	Consumption figure of soup (0.16)	Concentration of Pb in dust of industrial area (0.23)	Consumption figure of tap water (0.11)
Parameter N° 5	Consumption figure of tap water (0.06)	Ingestion figure of dust (0.10)	Consumption figure of lettuce (0.08)

 Table 4: Top five of the input parameters with the highest relationships with output parameter "Pb concentration in blood". The correlation coefficients are listed between parentheses.

The effect of the added input parameter values of the population module on the predicted Pb concentration in blood is investigated by calculating EASI first order indices. Figure 24 for instance, presents a pie chart with EASI values for the concentration of Pb predicted in preschool children living in the reference area. As can be noticed, the initial age of the children living in the reference area is the most influential parameter. It represents 42% of

² Effective Algorithm for computing global Sensitivity Indices (Plischke, 2010).

the variability of the Pb blood concentration. The second and third most influent parameters are the bodyweight variability and the concentration of dust in the external area. EASI values for these input parameters amount to 28% and 20%, respectively. So, using the actual individual data (i.e., age and bodyweight) for the children will allow reducing the uncertainty in the model predictions.



Figure 24: Pie chart of the EASI first order indices for the concentration of Pb in blood of children living in the reference area.

3.4.7 Scenario 7

Unlike the previous six scenarios about Pb exposure in preschool children, scenario 7 predicts concentrations of Pb in blood at an individual level. To do this, the conceptual model of scenario 6 (see Section 3.4.6) is used and all "population level" input data like time fractions and food consumption figures are replaced by individual reported data. For each of the three considered areas, data of ten preschool children are added to MERLIN-Expo.

In Figure 25, the average predicted concentrations of Pb in blood for the 30 chosen individuals are plotted in function of their corresponding measured blood concentrations. As can be noticed from this plot, the predicted values are mostly higher than the corresponding measured values (as already observed in the previous scenario). For children living in the industrial and surrounding area, an overestimation factor of about 2 on average is observed. For children from the reference area, the overestimation factor amounts to 1.5 on average. These factors are thus more or less equal to the overestimations that are observed at population level in scenario 6 (Figure 21).



Figure 25: Measured vs. predicted (average) concentrations of Pb in blood (in µg/dL) of 30 preschool children living in the industrial (blue), surrounding (red) or reference (green) area.

3.4.8 Scenario 8

Scenario 8, 9 and 10 consider the exposure to As in adults living in the Northern Campine region of Belgium. Scenario 8 is similar to scenario 6 for Pb (Table 2), but due to the absence of a built-in PBPK module for As, a simplified calculation of the body burdens of As as elaborated during the monitoring campaign (Van Holderbeke et al., 2008) is programmed in Microsoft Excel 2010 in order to validate the external exposures calculated by the MERLIN-Expo model with the measured urine concentrations from the monitoring campaign. The consumption of locally produced vegetables (leaf, root and potato) was taken into consideration by including the plant modules in MERLIN-Expo. Similar to scenarios 4, 6 and 7, default parameters in the plant modules were overwritten with own parameter (verified) values. Complex time activity patterns were taken into account and calculations were performed at population level.

In a first step, scenario 8 was run in a deterministic way in order to determine the five external/purchased food products that are contributing the most to dietary As exposure in adults living in the three considered areas (Table 5).

Table 5: Top five of external/purchased food products contributing most to As exposure in adults living in the three considered areas. The contribution percentages are listed between parentheses.

	Industrial area	Surrounding area	Reference area
Food N° 1	Bottled water (26.46%)	Bottled water (27.74%)	Bottled water (29.61%)
Food N° 2	Bread (17.97%)	Coffee (18.95%)	Bread (17.53%)
Food N° 3	Coffee (16.55%)	Bread (17.82%)	Coffee (17.38%)
Food N° 4	Soup (10.02%)	Soup (9.32%)	Soup (9.90%)
Food N° 5	Tap Water (7.70%)	Tap Water (6.65%)	Tap Water (5.34%)

Table 5 summarises the five food products contributing most to the dietary exposure to As via the consumption of external/purchased food products. For all three areas, bottled water, bread, coffee, soup and tap water are the five main food sources.

In a second step, PDFs are added to the consumption figures of bottled water, bread, coffee, soup and tap water; the concentrations of As in soil, dust, indoor air and outdoor air; the ingestion rates of dust and soil and the initial age of the participants (all input data are given in section 3.3). A correlation of 0.9 between soil and dust ingestion is added to the scenario as well. Subsequently, this probabilistic scenario is executed using Monte carlo simulations with 1,000 iterations.

The output gathered from MERLIN-Expo is exported to MS Excel 2010 in order to calculate the As concentration in urine and the contribution of the different exposure pathways to the internal As exposure.

The average predicted levels of As in urine are compared with the concentrations of As measured during the monitoring campaign (Bruckers, 2008b). This comparison is shown in Figure 26 for female adults and in Figure 27 for male adults. For all three areas, it can be observed that the predicted average levels are slightly lower (max 12%) than the measured average levels (with the exception of males living in the reference area – 5% overprediction), but within the range (average \pm standard deviation) of the measured As concentrations.



Figure 26: Measured versus predicted concentrations of As in urine (average \pm standard deviation; in μ g/g creatinine) of female adults living in the three considered areas.



Figure 27: Measured versus predicted concentrations of As in urine (average \pm standard deviation; in μ g/g creatinine) of male adults living in the three considered areas.

Median As concentrations measured in urine are 1.4-2.6 times lower than median predicted As concentrations in urine for female (Figure 28) and male adults (Figure 29). Although the deviation of the median values from observed values is larger than for the average As urine levels, the modelled concentrations (minimum-median-maximum) still lie within the range of the measured As concentrations.



Figure 28: Measured versus predicted concentrations of As in urine (minimum-median-maximum; in µg/g creatinine) of female adults living in the three considered areas.



Figure 29: Measured versus predicted concentrations of As in urine (minimum-median-maximum; in $\mu g/g$ creatinine) of male adults living in the three considered areas.

The average, minimum, median and maximum contribution of the different exposure pathways to internal As exposure are calculated for each of the three considered areas. In order to have a clear view of all the exposure pathways, additional graphs are made excluding the contribution of external food. The contributions are shown in Figure 30 and Figure 31.

The main exposure pathway contributing to the final human exposure for all three areas is ingestion of external or purchased food. Values for average and median contributions are quite similar. Exposure via external food as the major exposure pathway is followed by local food and indoor air. Comparing minimum with maximum contributions reveals that exposure via external food consumption, inhalation via indoor and outdoor air and ingestion of soil and dust are of less importance for the upper end of exposure as compared to the lower end of the internal As exposure distribution. The opposite is observed for exposure via local food consumption.



Surrounding area







100% 90% 80% 70%



Industrial area







Figure 31: Contribution of the different exposure pathways (exclusive of exposure via external food) to internal As exposure in adults living in the industrial, surrounding and reference area.

Figure 32 shows the exposure via the consumption of the top five of external/purchased food products and local food (leaf, root and potato) for adults living in the industrial, surrounding or reference area. The exposure via external/purchased food is dominant over local food, which is also shown in Figure 30. Bottled water, followed by bread, coffee, soup and tap water are the most important contributors.



Figure 32: Contribution of the top five of external/purchased food products and local food products to internal As exposure via food in adults living in the industrial, surrounding or reference area (average values).

During the measurement campaign (Van Deun et al., 2008b), some samples were analysed of locally produced lettuce and (peeled) carrots. Because not enough data are available for the industrial and surrounding area separately, the results of this analysis are further combined and referred to as "study area". The model results show an average overprediction of 1.5 for the carrots, and a nearly 1:1 prediction for lettuce (Figure 33).





A sensitivity analysis was performed using the methods available in MERLIN-Expo. Because the model does not have a built-in PBPK module for As, the sensitivity analysis focusses on the output parameters i.e. As concentration in locally produced vegetables and As ingestion rates of the population in the external, industrial, surrounding and reference area. The linearity of the implemented MERLIN-Expo modules is investigated and correlations (i.e. standardised regression coefficients) and first order indices (i.e. EASI³ values) of the most relevant input parameters in relation to their corresponding output parameters are obtained.

High coefficient of determination (R^2) values are observed for the outputs of the leaf and potato modules of scenario 8. For instance, with regard to the industrial area (surrounding and reference area are analogous), the R^2 value amounts to 0.72 for the concentration in leaf and to 1 for the concentration in potato. This means that both leaf and potato modules are considered to be linear. In the leaf modules, the weathering (wash-off) loss rate from leaf to soil has the highest correlation coefficient, namely -0.85 for the industrial leaf module, -0.86 for the reference leaf module and -0.87 for the surrounding leaf module. Regarding the potato modules, a correlation coefficient of -1 is observed between the water content of the potato (input) and the As concentration of the potato (output).

In the ingestion rate module for the external area (this module was added in order to take the consumption of external/purchased food into account), the R² value amounts to 1 for the three population groups living in the industrial, surrounding or reference area. So, just like the plant modules, the ingestion rate for the external area module seems to be linear. With regard to the predicted As ingestion rate caused by the consumption of purchased or external food, an overview of its relationship with the top five input parameters is given in Table 6. For all three considered population groups, the highest correlation is found between the predicted ingestion rate and the consumption of bottled water, bread, coffee, tap water and soup.

	industrial population	surrounding population	reference population		
Parameter N° 1	Consumption of bottled water (0.71)	Consumption of bottled water (0.74)	Consumption of bottled water (0.73)		
Parameter N° 2	Consumption of bread (0.45)	Consumption of coffee (0.46)	Consumption of coffee (0.45)		
Parameter N° 3	Consumption of coffee (0.38)	Consumption of bread (0.37)	Consumption of bread (0.35)		
Parameter N° 4	Consumption of tap water (0.32)	Consumption of tap water (0.30)	Consumption of tap water (0.26)		
Parameter N° 5	Consumption of soup (0.21)	Consumption of soup (0.18)	Consumption of soup (0.19)		

Table 6: Top five of the input parameters with the highest relationships with output parameter "As ingestion rate caused by the consumption of purchased or external food". The correlation coefficients are listed between parentheses.

The effect of the added input parameter values of the ingestion rate module on the predicted As ingestion of purchased food is investigated by calculating EASI first order indices. Figure 34, for instance, presents a pie chart with EASI values for the predicted As ingestion via purchased or external food for adults living in the industrial area. As can be noticed, the consumption of bottled water is the most influential parameter. It represents

³ Effective Algorithm for computing global Sensitivity Indices (Plischke, 2010).

47% of the variability of the ingestion of As via purchased food. The second and third most influent parameters are the consumption of coffee and the consumption of bread. EASI values for these input parameters amount to 15% and 13%, respectively.



Figure 34: Pie chart of the EASI first order indices for the predicted As ingestion due to the consumption of purchased or external food by adults living in the industrial area.

In the ingestion rate module for the industrial area (= consumption of local food and ingestion of soil and dust by the adult population living in the industrial, surrounding or reference area during their residence time in the industrial area), the R² value amounts to 0.9 for the population living in the industrial area and 1 for the population living in the reference and surrounding area. Just like the ingestion rate module for the external area, the ingestion rate module for the industrial area seems to be linear. With regard to the predicted ingestion rate, an overview of its relationship with the top five input parameters is given in Table 7.

For all three considered population groups, the highest correlation is found between the predicted ingestion rate and the measured concentration of As in dust in the industrial area. The standardised regression coefficients amount to 0.71, 1 and 0.97 for dust levels of the industrial, surrounding and reference area, respectively. For people living in the industrial area, other important correlations are found between the predicted ingestion rate of As and the consumption of locally produced vegetables and the ingestion rate of dust. For people living in the surrounding and reference area, additional important correlations are found between the predicted ingestion rate of As in soil and the ingestion rate of dust and soil.

	industrial area	surrounding area	reference area			
Parameter N° 1	Concentration in dust (0.71)	Concentration in dust (1.0)	Concentration in dust (0.97)			
Parameter N° 2	Consumption of locally produced leaf vegetables(0.58)	Concentration in soil (0.06)	Concentration in soil (0.22)			
Parameter N° 3	Consumption of locally produced root crops(0.17)	Ingestion rate of dust(0.04)	Ingestion rate of dust(0.05)			
Parameter N° 4	Consumption of locally produced potatoes (0.06)	Ingestion rate of soil(0.01)	Ingestion rate of soil(0.01)			
Parameter N° 5	Ingestion rate of dust(0.05)					

 Table 7: Top five of the input parameters with the highest relationships with output parameter "As ingestion in the industrial area". The correlation coefficients are listed between parentheses.

The effect of the input parameter values of the ingestion rate module on the predicted As ingestion during the residence time of the populations in the industrial area is investigated by calculating EASI first order indices.

Figure 35, for instance, presents a pie chart with EASI values for the As ingestion predicted for adults living in the industrial area during their residence time in the industrial area. As can be noticed, the measured concentration of As in dust is the most influential parameter. It represents 51% of the variability of the As ingestion in the industrial area. The second and third most influent parameters are the consumption of locally produced leafy vegetables and root crops. EASI values for these input parameters amount to 14% and 3%, respectively. 32% Of the module output cannot be explained.



Figure 35: Pie chart of the EASI first order indices for the As ingestion of adults living in the industrial area, during their residence time in the industrial area.

Figure 36 presents a pie chart with EASI values for the As ingestion predicted for adults living in the reference area during their residence time in the industrial area. As can be noticed, the measured concentration of As in dust is the most influential parameter. It represents 94% of the variability of the As ingestion in the industrial area. The next influent parameters are the measured concentration of As in soil and the ingestion rates for soil and dust. EASI values for these input parameters amount to 5% and 1%, respectively. Results for the population living in the surrounding area are similar and not shown.



Figure 36: Pie chart of the EASI first order indices for the As ingestion of adults living in the reference area during their residence time in the industrial area.

3.4.9 Scenario 9

In contrast to scenario 8 for As, the human dependent data are now at individual level instead of at population level. This scenario is analogous to scenario 7 for Pb. Exposures are calculated each time for ten individuals living in the industrial, surrounding and reference area by making use of their own reported initial age, food consumption figures, and so on (input data are described in section 3.3). For each area, the adult with the highest measured As biomonitoring concentration is firstly included in the scenario. Subsequently, six adults per area that reported to consume locally produced vegetables are randomly chosen from the monitoring database. Lastly, the scenario is extended by choosing three additional adults per area that reported only to consume purchased/external food products.



Figure 37: Measured vs. predicted (average) concentrations of As in urine (in µg/g creatinine) of 30 adults living in the industrial (blue), surrounding (red) or reference (green) area.

Figure 37 shows the measured versus the predicted average concentration of As in urine of the 30 individual adults living in the three study areas. The results show an average model overprediction of a factor 1.4 (0.1-9.3), compared to 1.1 on a population basis.

3.4.10 Scenario 10

Scenario 10 takes the consumption of fish into account because fish can be an important source of arsenic in the human diet. Because the fish consumption was not questioned during the study, an average consumption for men and woman of 25.9 and 22.6 g/day respectively (Van Holderbeke et al., 2008) is taken into account in the MERLIN-Expo model.



Figure 38: Measured vs. predicted (average) concentrations of As in urine (in µg/g creatinine) of 30 adults living in the industrial (blue), surrounding (red) or reference (green) area.

The results of scenario 10 are shown in Figure 38. Scenario 9 and scenario 10 produce almost the same results.

4 Conclusions

This section summarises the most important conclusions drawn for the CS1 predictions done with MERLIN-Expo. A distinction is made between conclusions about Pb exposure in preschool children and about As exposure in adults. At the end of this section, some recommendations to further improve the MERLIN-Expo tool are given as well.

4.1 Pb in preschool children

Seven scenarios were built and simulated in CS1 to investigate the exposure of Belgian preschool children to Pb. The scenarios are varying from very simple to rather complex in order to study the effect of several items (i.e. deterministic *vs.* probabilistic, with *vs.* without considering local food consumption, population *vs.* individual level, and so on) on the model outcomes (i.e. predicted concentrations of Pb in leaf, potato, root and blood).

The best predictions of Pb in locally produced leafy vegetables, potatoes and root crops are obtained when default plant input parameter values are replaced by own parameter data. By doing so, the predicted levels of Pb in vegetables cultivated in the reference area are comparable to measured concentrations of Pb in food products reported in literature. Predicted concentrations of Pb in vegetables from the industrial area are higher than those from the surrounding and reference area. This is line with the environmental (i.e. soil and outdoor air particles) concentrations of Pb added as input to the model. The sensitivity analysis performed in scenario 6 reveals that all the implemented leaf and potato modules are linear. In the leaf modules, the highest (positive) correlation is found between the weathering (wash-off) loss rate from leaf to soil and the predicted Pb concentration in leaf. In the potato and the predicted Pb concentration in the vater content of the potato and the predicted Pb concentration in the potato.

With regard to internal Pb exposure, we showed that 1,000 simulation runs were sufficient to obtain a stable result and that the inclusion of the correlation between soil and dust ingestion enables to improve the predictability of the model. Predicted Pb levels in blood also agree better with monitoring data when local food consumption (predicted by using own input parameter values) and a simple time activity pattern are considered. Predicted blood levels are higher for children from the industrial area than for children from the surrounding and reference area. The same trend is observed during the monitoring campaign. At population as well as at individual level, predicted concentrations of Pb in blood are - on average - 1.5-2 times higher than the measured concentrations of the monitoring campaign. Based on the results of the sensitivity analysis, the population module in CS1 seems to be linear as well. Relevant (but not all significant) relationships between the predicted concentration of Pb in blood and the following input parameters are observed: the measured Pb concentration in dust (positive correlation), the body weight variability (negative correlation), the initial age (negative correlation), the consumption figures of soup, tap water and lettuce (positive correlations) and the ingestion value of dust (positive correlation).

The contribution of the different exposure pathways to internal Pb exposure are calculated additionally in a MS Excel 2010 spreadsheet. In general, dust ingestion and the consumption of external/purchased food products are the two main exposure routes. When considering a complex time activity pattern, dust ingestion becomes an even more important exposure route. This can be explained by the fact that, in reality, children spend more time indoors than the 50% that is considered in the simple time activity pattern. With regard to the consumption of external/purchased food products, the main contributors to internal Pb exposure are soup, bread, tap water, lettuce, bread rolls and breakfast cereals. Local food consumption is especially relevant for the upper end of the internal Pb exposure distribution. Moreover, this exposure route is observed to be more important for children living in the reference area than for children living in the surrounding and industrial area.

Compared to the other pathways, the contribution of the inhalation routes (i.e. via indoor and outdoor air) is rather negligible.

Based on all these observations, the conclusion can be made that MERLIN-Expo may be considered as a suitable tool for the prediction of internal Pb exposure in children.

4.2 As in adults

Three complex scenarios in CS1 investigate the exposure of Belgian adults to As. The scenarios are built based on the expertise developed during the Pb scenario calculations. Due to the absence of a built-in PBPK model for As, a simplified calculation of the body burdens of As is programmed in Microsoft Excel 2010.

The plant module over predicts the concentration in locally produced carrots slightly (factor 1.5), the prediction of the As concentration in lettuce is very good (1:1). The sensitivity analysis performed in scenario 8 shows that the implemented leaf and potato modules are linear with the highest correlation between the weathering (wash-off) loss rate from leaf to soil and the predicted As concentration in leaf and the water content of the potato and the predicted As concentration in the potato.

With regard to internal As exposure, good predictions in comparison with biomonitoring data are obtained at population level. Predicted average concentrations of As in urine are slightly lower (max 12%) than the measured average levels. Median As concentrations measured in urine are 1.4-2.6 times lower than median predicted As concentrations in urine. At individual level, predicted concentrations of As in urine are – on average – 1.4 times higher than measured urinary concentrations. For some individuals however, the model shows an under- or over prediction of 0.1-9.3 times the measured As concentration in urine. Taking the average consumption of fish into account does not improve the modelling results. Probably more detailed data e.g. personalised fish consumption data are needed to improve the modelling results on an individual basis.

The exposure of the adults living in the study area is largely determined by external factors (external or purchased food), region specific contamination (local food, soil and dust ingestion, indoor and outdoor air) is less important for adults living in the study area.

A sensitivity analysis was performed on the ingestion rate module for the three populations in the different areas. The highest EASI first order indices were found for the top five external/purchased food products (external area); ingestion and concentration of dust and soil and consumption of locally produced vegetables (own area, e.g. As ingestion of adults living in the industrial area, during their residence time in the industrial area); and dust and soil concentrations and ingestion (other areas e.g. As ingestion of adults living in the surrounding area, during their residence time in the industrial area).

All this leads to the conclusion that MERLIN-Expo, provided a PBPK-model for As is included, may be a suitable tool for the prediction of As exposure in adults on a population level.

4.3 Suggestions to further improve MERLIN-expo

Within CS1, a conceptual model was built with MERLIN-Expo (version 2.0.3) in order to investigate the exposure of Belgian preschool children and adults to Pb and As, respectively. This conceptual model comprises 14 different modules (or five if local food consumption is not considered), which all need their specific data inputs. During this building process and data search, the following suggestions came up to further improve the MERLIN-Expo tool:

• Default consumption figures for predefined food products (e.g. leaf, fish and milk) could be extracted from general food consumption databases (e.g. the database of the European Food Safety Authority (EFSA, 2015)) and be implemented in MERLIN-Expo;

- The plant modules (e.g. the leaf module) of MERLIN-Expo require the contaminant quantity in the soil and the surface dry and wet deposition flux as an input. The calculations to obtain these inputs automatically could be included in the MERLIN-Expo tool;
- It is suggested to implement the MERLIN-Expo tool with a built-in PBPK model to convert external inorganic As exposures to toxic relevant As concentrations in urine;
- The calculations to obtain the contribution of the different exposure pathways to Pb and As could be performed directly by MERLIN-Expo in order to construct the final overview histograms as for example depicted in Figure 8. In this way valuable information would be given to users performing risk assessments

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7 Appendices

Table 8: Average time fractions used in scenarios 1-4.

Average time fraction (-)	Children living in industrial area	Children living in surrounding area	Children living in reference area
Industrial area (indoors)	0.5	0	0
Industrial area (outdoors)	0.5	0	0
Surrounding area (indoors)	0	0.5	0
Surrounding area (outdoors)	0	0.5	0
Reference area (indoors)	0	0	0.5
Reference area (outdoors)	0	0	0.5
External area (indoors)	0	0	0
External area (outdoors)	0	0	0

Table 9: Average time fractions used in scenarios 5 and 6 (Reference: confidential, unpublished results from the monitoring campaign).

Average time fraction (-)	Children living in industrial area	Children living in surrounding area	Children living in reference area
Industrial area (indoors)	0.7848	0.1337	0.0038
Industrial area (outdoors)	0.1698	0.0234	0.0013
Surrounding area (indoors)	0.0087	0.6791	0.0030
Surrounding area (outdoors)	0.0093	0.1372	0.0029
Reference area (indoors)	0.0006	0.0030	0.7870
Reference area (outdoors)	0.0002	0.0003	0.1640
External area (indoors)	0.0188	0.0180	0.0299
External area (outdoors)	0.0078	0.0053	0.0081

GA-No.: 308440

Average time fraction (-)	Child_1	Child_2	Child_3	Child_4	Child_5	Child_6	Child_7	Child_8	Child_9	Child_10
Children living in industrial area										
Industrial area (indoors)	0.8767	0.8827	0.8136	0.6346	0.6514	0.8505	0.8568	0.8847	0.8136	0.8034
Industrial area (outdoors)	0.1233	0.1153	0.1864	0.2295	0.3446	0.1495	0.1432	0.1153	0.1864	0.1230
Surrounding area (indoors)	0	0	0	0	0.0040	0	0	0	0	0
Surrounding area (outdoors)	0	0	0	0	0	0	0	0	0	0
Reference area (indoors)	0	0	0	0	0	0	0	0	0	0
Reference area (outdoors)	0	0	0	0	0	0	0	0	0	0
External area (indoors)	0	0.0020	0	0.1199	0	0	0	0	0	0.0491
External area (outdoors)	0	0	0	0	0	0	0	0	0	0.0245
Children living in surrounding area										
Industrial area (indoors)	0.2759	0.1109	0.3171	0.1109	0.1109	0.1109	0.1109	0.1109	0.1109	0
Industrial area (outdoors)	0.1065	0.0170	0.1656	0.0170	0.0170	0.0170	0.0170	0.0170	0.0170	0
Surrounding area (indoors)	0.4962	0.7443	0.3595	0.7387	0.6444	0.7227	0.7659	0.6996	0.6996	0.6658
Surrounding area (outdoors)	0.0640	0.1279	0.1578	0.1334	0.2277	0.1494	0.1063	0.1726	0.1726	0.1604
Reference area (indoors)	0	0	0	0	0	0	0	0	0	0.1569
Reference area (outdoors)	0	0	0	0	0	0	0	0	0	0.0170
External area (indoors)	0.0384	0	0	0	0	0	0	0	0	0
External area (outdoors)	0.0192	0	0	0	0	0	0	0	0	0
Children living in reference area										
Industrial area (indoors)	0	0	0.0020	0	0	0	0	0	0	0
Industrial area (outdoors)	0	0	0	0	0	0.0287	0	0	0	0

Table 10: Average time fractions used in scenario 7 (Reference: confidential, unpublished results from the monitoring campaign).

GA-No.: 308440

Average time fraction (-)	Child_1	Child_2	Child_3	Child_4	Child_5	Child_6	Child_7	Child_8	Child_9	Child_10
Surrounding area (indoors)	0	0	0.0020	0	0	0	0	0	0	0
Surrounding area (outdoors)	0	0	0	0	0	0.0287	0	0	0	0
Reference area (indoors)	0.7768	0.8707	0.8775	0.7901	0.8768	0.7305	0.7705	0.9543	0.8292	0.8396
Reference area (outdoors)	0.1167	0.1133	0.1186	0.0862	0.1233	0.1272	0.2296	0.0378	0.1668	0.1604
External area (indoors)	0.0710	0.0160	0	0.0825	0	0.0566	0	0.0080	0.0040	0
External area (outdoors)	0.0355	0	0	0.0413	0	0.0283	0	0	0	0

Average time fraction (-)	Adults living in industrial area	Adults living in surrounding area	Adults living in reference area
Industrial area (indoors)	0.8699	0.0023	0.0082
Industrial area (outdoors)	0.0370	0.0003	0.0039
Surrounding area (indoors)	0.0181	0.8838	0.0174
Surrounding area (outdoors)	0.0007	0.0365	0.0040
Reference area (indoors)	0.0009	0.0004	0.8527
Reference area (outdoors)	0.00001	0.0002	0.0348
External area (indoors)	0.0631	0.0665	0.0683
External area (outdoors)	0.0104	0.0101	0.0109

Table 11: Average time fractions used in scenario 8 (Reference: confidential, unpublished results from the monitoring campaign).

GA-No.: 308440

Average time fraction (-)	Adult_1	Adult_2	Adult_3	Adult_4	Adult_5	Adult_6	Adult_7	Adult_8	Adult_9	Adult_10
Adults living in industrial area										
Industrial area (indoors)	0.8045	0.9170	0.9095	0.9872	0.9388	0.7991	0.7598	1	0.7910	0.7818
Industrial area (outdoors)	0.0128	0.0830	0.0577	0.0128	0.0064	0.0183	0	0	0.0154	0.0219
Surrounding area (indoors)	0.1826	0	0	0	0	0	0.1826	0	0	0
Surrounding area (outdoors)	0	0	0	0	0	0	0	0	0	0
Reference area (indoors)	0	0	0	0	0	0	0	0	0	0
Reference area (outdoors)	0	0	0	0	0	0	0	0	0	0
External area (indoors)	0	0	0.0219	0	0.0365	0.1826	0.0384	0	0.1900	0.1918
External area (outdoors)	0	0	0.0110	0	0.0183	0	0.0192	0	0.0037	0.0046
Adults living in surrounding area										
Industrial area (indoors)	0	0	0	0	0	0	0	0	0	0
Industrial area (outdoors)	0	0	0	0	0	0	0	0	0	0
Surrounding area (indoors)	0.8127	0.7328	0.5955	1	0.9526	0.9790	0.9559	0.8494	0.8998	0.9122
Surrounding area (outdoors)	0.0046	0.0207	0	0	0.0474	0.0210	0.0057	0.1233	0.1002	0.0686
Reference area (indoors)	0	0	0	0	0	0	0	0	0	0
Reference area (outdoors)	0	0	0	0	0	0	0	0	0	0
External area (indoors)	0.1826	0.2100	0.3525	0	0	0	0.0256	0.0183	0	0.0128
External area (outdoors)	0	0.0365	0.0520	0	0	0	0.0128	0.0091	0	0.0064
Adults living in reference area										
Industrial area (indoors)	0	0	0.0913	0	0	0	0	0.0014	0	0
Industrial area (outdoors)	0	0	0.0171	0	0	0	0.0117	0.0014	0	0

Table 12: Average time fractions used in scenarios 9 and 10 (Reference: confidential, unpublished results from the monitoring campaign).

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Average time fraction (-)	Adult_1	Adult_2	Adult_3	Adult_4	Adult_5	Adult_6	Adult_7	Adult_8	Adult_9	Adult_10
Surrounding area (indoors)	0	0	0.0913	0	0	0	0	0.0014	0	0
Surrounding area (outdoors)	0	0	0.0171	0	0	0	0.0117	0.0014	0	0
Reference area (indoors)	0.7925	0.5172	0.7255	0.7214	0.9358	0.9726	0.7304	0.9211	0.8055	0.1622
Reference area (outdoors)	0.0249	0	0.0193	0.0432	0.0642	0	0.0499	0.0321	0.0119	0.0022
External area (indoors)	0.1826	0.4349	0.0256	0.1753	0	0.0183	0.1918	0.0274	0.1826	0.6689
External area (outdoors)	0	0.0479	0.0128	0.0600	0	0.0091	0.0046	0.0137	0	0.1667

Medium	Unit	Average Pb conc.	PDF
Industrial area			
Soil ¹	mg/kg	143.5	logn(mean=143.5,sd=88.1,trmin=18,trmax=340)
Dust ¹	mg/g	0.366	logn(mean=0.366,sd=0.383,trmin=0.051,trmax=2.085)
Indoor air particles ¹	mg/m³	1.12E-05	logn(mean=1.12E-05,sd=2.72E-06,trmin=9.3E-
Outdoor air particles ¹	mg/m³	3.10E-05	logn(p1=5.0,x1=6.7E-06,p2=95.0,x2=6.88E-05)
Surrounding area			
Soil ¹	mg/kg	74.1	logn(mean=74.1,sd=39.6,trmin=22,trmax=200)
Dust ¹	mg/g	0.2805	logn(mean=0.2805,sd=0.3491,trmin=0.0506,trmax=1.8798)
Indoor air particles ¹	mg/m³	1.51E-05	logn(mean=1.51E-05,sd=1.39E-05,trmin=9.50E-
Outdoor air particles ¹	mg/m³	3.15E-05	logn(p1=5.0,x1=6.9E-06,p2=95.0,x2=8.65E-05)
Reference area			
Soil ¹	ma/ka	15 7	logn/mean-15.7 sd-21.6 trmin-23 trmay-83)
Duct ¹	mg/g	-0.151	$\log ((1 - 1)^{-1}) = 100 + 100$
Dusi	iiig/g	0.151	logn(mean=0.151,su=0.144,umin=0.0501,umiax=0.050)
Indoor air particles	mg/m³	1.05E-05	logn(mean=1.05E-05,sd=3.65E-07,trmin=1.01E-
Outdoor air particles	mg/m³	1.42E-05	logn(p1=5.0,x1=4.6E-06,p2=95.0,x2=3.16E-05)
External area			
Soil ²	mg/kg	20.3	logn(mean=20.3,sd=10.7,trmin=0,trmax=72)
Dust ¹	mg/g	0.151	logn(mean=0.151,sd=0.144,trmin=0.0561,trmax=0.5636)
Indoor air particles ³	mg/m³	4.40E-05	
Outdoor air particles ³	mg/m ³	4.40E-05	<u>.</u>

Table 13: Concentrations of Pb in soil, dust, indoor and outdoor air particles (average and PDF) used in scenarios 1-7.

¹ Van Deun et al. (2008a; 2008b) – ² Bierkens et al. (2010a) – ³ Cornelis et al. (2013a).

Table 14: Concentrations of As in soil, dust, indoor and outdoor air particles (average and PDF) used in scenarios 8-10.

Medium	Unit	Average As conc.	PDF
Industrial area			
Soil ¹	mg/kg	7.3	logn(mean=7.3,sd=3.6,trmin=2.0,trmax=16.0)
Dust ¹	mg/g	0.0109	logn(mean=0.0109,sd=0.0065,trmin=0.0023,trmax=0.0263)
Indoor air particles ¹	mg/m³	1.90E-06	logn(mean=1.90E-06,sd=1.70E-07,trmin=1.70E-
Outdoor air particles ¹	mg/m³	4.00E-07	logn(p1=5.0,x1=2.00E-07,p2=95.0,x2=1.40E-06)
Surrounding area			
Soil ¹	mg/kg	5.9	logn(mean=5.9,sd=2.0,trmin=2.4,trmax=12.0)
Dust ¹	mg/g	0.0075	logn(mean=0.0075,sd=0.0038,trmin=0.0026,trmax=0.0206)
	-		

Medium	Unit	Average As conc.	PDF
Indoor air particles ¹	mg/m³	2.20E-06	logn(mean=2.20E-06,sd=7E-07,trmin=1.70E-06,trmax=4E-
Outdoor air particles ¹	mg/m³	7.00E-07	logn(p1=5.0,x1=2.00E-07,p2=95.0,x2=2.80E-06)
Reference area			
Soil ¹	mg/kg	4.4	logn(mean=4.4,sd=0.7,trmin=3.1,trmax=5.3)
Dust ¹	mg/g	0.0058	logn(mean=0.0058,sd=0.0028,trmin=0.0028,trmax=0.0124)
Indoor air particles ¹	mg/m³	1.90E-06	logn(mean=1.90E-06,sd=5.70E-08,trmin=1.80E-
Outdoor air particles ¹	mg/m³	4.0E-07	logn(p1=5.0,x1=2.00E-07,p2=95.0,x2=1.2E-06)
External area			
Soil ²	mg/kg	4.2	logn(mean=4.2,sd=1.5,trmin=1.8,trmax=7)
Dust ¹	mg/g	0.0058	logn(mean=0.0058,sd=0.0028,trmin=0.0028,trmax=0.0124)
Indoor air particles ³	mg/m³	4.8E-06	-
Outdoor air particles ³	mg/m³	4.8E-06	-

¹ Van Deun et al. (2008a; 2008b) - ² Bierkens et al. (2010b) - ³ Cornelis et al. (2013a).

Table 15: Concentrations of Pb and As in external/purchased food products (in mg/kg fw) used in scenarios 1-10.

Food product	Average Pb conc. (Reference)	Average As conc. (Reference)
Breakfast cereals	0.025 (EFSA, 2012)	0.0124 (Van Holderbeke et al., 2008)
Bread	0.012 (FAVV, 2009)	0.0124 (Van Holderbeke et al., 2008)
Bread rolls	0.029 (EFSA, 2012)	0.0124 (Van Holderbeke et al., 2008)
Cakes	0.026 (EFSA, 2012)	0.0124 (Van Holderbeke et al., 2008)
Rusks	0.026 (Leblanc et al., 2005)	0.0124 (Van Holderbeke et al., 2008)
Pasta	0.012 (FAVV, 2009)	0.0124 (Van Holderbeke et al., 2008)
Rice	0.012 (FAVV, 2009)	0.01587 (Van Holderbeke et al., 2008)
Other cereals	0.012 (FAVV, 2009)	0.0117 (Van Holderbeke et al., 2008)
Liver	0.045 (FAVV, 2009)	0.0005 (Van Holderbeke et al., 2008)
Kidney	0.102 (FAVV, 2009)	0.0005 (Van Holderbeke et al., 2008)
Horsemeat	0.013 (FAVV, 2009)	0.000044 (Van Holderbeke et al., 2008)
Poultry	0.012 (FAVV, 2009)	0.00044 (Van Holderbeke et al., 2008)
Coffee	0.004 (EFSA, 2012)	0.002725 (EFSA, 2014)
Теа	0.007 (FAVV, 2009)	0.0001 (EFSA, 2014)
Tap water	0.005 (FAVV, 2009)	0.00256 (Van Holderbeke et al., 2008)
Bottled water	0.001 (FAVV, 2009)	0.00382 (Van Holderbeke et al., 2008)
Soup	0.019 (Leblanc et al., 2005)	0.004 (Leblanc et al., 2005)
Other drinks	0.001 (FAVV, 2009)	0.0069 (Van Holderbeke et al., 2008)
Potato	0.012 (FAVV, 2009)	0.00331 (Van Holderbeke et al., 2008)
Carrot	0.018 (FAVV, 2009)	0.01374 (Van Holderbeke et al., 2008)

Food product	Average Pb conc. (Reference)	Average As conc. (Reference)
Scorzonera	0.036 (FAVV, 2009)	0.01339 (Van Holderbeke et al., 2008)
Radish	0.014 (FAVV, 2009)	0.00744 (Van Holderbeke et al., 2008)
Spinach	0.083 (FAVV, 2009)	0.01046 (Van Holderbeke et al., 2008)
Endive	0.019 (FAVV, 2009)	0.00807 (Van Holderbeke et al., 2008)
Celery	0.017 (FAVV, 2009)	0.00807 (Van Holderbeke et al., 2008)
Celeriac	0.017 (FAVV, 2009)	0.01786 (Van Holderbeke et al., 2008)
Lettuce	0.185 (FAVV, 2009)	0.00872 (Van Holderbeke et al., 2008)
Leek	0.011 (FAVV, 2009)	0.01935 (Van Holderbeke et al., 2008)
Onion	0.011 (FAVV, 2009)	0.0108 (Van Holderbeke et al., 2008)
Belgian endive	0.019 (FAVV, 2009)	0.00893 (Van Holderbeke et al., 2008)
Brussels sprouts	0.010 (FAVV, 2009)	0.0253 (Van Holderbeke et al., 2008)
Cabbage	0.010 (FAVV, 2009)	0.01339 (Van Holderbeke et al., 2008)
Savoy cabbage	0.010 (FAVV, 2009)	0.01339 (Van Holderbeke et al., 2008)
Cauliflower	0.010 (FAVV, 2009)	0.01633 (Van Holderbeke et al., 2008)
Broccoli	0.010 (FAVV, 2009)	0.01488 (Van Holderbeke et al., 2008)
Bean	0.027 (EFSA, 2012)	0.0147 (Van Holderbeke et al., 2008)
Tomato	0.013 (FAVV, 2009)	0.00049 (Van Holderbeke et al., 2008)
Pea	0.010 (FAVV, 2009)	0.02679 (Van Holderbeke et al., 2008)
Fish	-	0.00075 (Van Holderbeke et al., 2008)

Table 16: Area, plant and/or chemical specific time series data used in scenarios 3-4 and 6-10.

Parameter	Unit	Time (day) Average value	Reference
Valid for industrial, surrounding	g and referen	ce area	
Actual evapotranspiration_leaf	mm/day	0.0 0.985714	(Allen et al., 1998)
		29.28571 0.985714]
		71.42857 1.585714	
		109.2857143 1.585714286	
		125.0 1.392857143	3
Actual evapotranspiration_root	mm/day	0.0 0.875	(Allen et al., 1998)
		20.0 0.875	
		48.33333 1.575	
		90.0 1.575	
		115.0 1.25	
Temperature of air	°C	0 11.56	(WeatherOnline Ltd, 2015)
Relative humidity	-	Default (scenario 3):	

Parameter	Unit	Time (day) Average value	Reference
		0 0.50	MERLIN-Expo
		Own (scenario 4 & 6-10):	(ClimaTemps, 2015)
Only valid for industrial area			
Surface dry deposition flux_Pb	mg/m²/day	0 2.68E-02	Calculated (see Section 2.2)
Surface wet deposition flux_Pb	mg/m²/day	0 3.63E-02	Calculated (see Section 2.2)
Quantity in soil_leaf/potato_Pb	mg	Default (scenario 3):	Calculated (see Section 2.2)
		0 1.84E+08	Coloulated (and Costian 2.2)
		Own (scenario 4, 6 & 7):	Calculated (see Section 2.2)
Quantity in soil_root_Pb	mg	Default (scenario 3):	Calculated (see Section 2.2)
		0 9.20E+07	Coloulated (and Costian 2.2)
		Own (scenario 4, 6 & 7):	Calculated (see Section 2.2)
Surface dry deposition flux. As	ma/m²/day	0 2.81E+06	Calculated (see Section 2.2)
Surface wet deposition flux As	mg/m²/day	0 3.64E-04	Calculated (see Section 2.2)
Quantity in soil leaf/potato As	ma	0 2 455 - 05	Calculated (see Section 2.2)
Quantity in soil_root As	ma	0 3.45E+05	Calculated (see Section 2.2)
	mg	0 3.43=+05	
Only valid for surrounding area			
Surface dry deposition flux_Pb	mg/m²/day	0 2.72E-02	Calculated (see Section 2.2)
Surface wet deposition flux_Pb	mg/m²/day	0 3.69E-02	Calculated (see Section 2.2)
Quantity in soil_leaf/potato_Pb	mg	Default (scenario 3):	Calculated (see Section 2.2)
		0 8.75E+07	Colculated (see Section 2.2)
		Own (scenario 4, 6 & 7):	Calculated (See Section 2.2)
Quantity in soil_root_Pb	mg	Default (scenario 3):	Calculated (see Section 2.2)
		0 4.37E+07	Calculated (see Section 2.2)
		Own (scenario 4, 6 & 7):	Calculated (SEC CECHOIT 2.2)
Surface dry deposition flux_As	mg/m²/day	0 6.06E-04	Calculated (see Section 2.2)
Surface wet deposition flux_As	mg/m²/day	0 8.19E-04	Calculated (see Section 2.2)

Parameter	Unit	Time (day) Average value	Reference
Quantity in soil_leaf/potato_As	mg	0 2.79E+05	Calculated (see Section 2.2)
Quantity in soil_root_As	mg	02.79E+05	Calculated (see Section 2.2)
Only valid for reference area			
Surface dry deposition flux_Pb	mg/m²/day	0 1.23E-02	Calculated (see Section 2.2)
Surface wet deposition flux_Pb	mg/m²/day	0 1.66E-02	Calculated (see Section 2.2)
Quantity in soil_leaf/potato_Pb	mg	Default (scenario 3):	Calculated (see Section 2.2)
		0 8.32E+07 Own (scenario 4, 6 & 7): 0 3.27E+06	Calculated (see Section 2.2)
Quantity in soil_root_Pb	mg	Default (scenario 3):	Calculated (see Section 2.2)
		0 4.16E+07 Own (scenario 4, 6 & 7): 0 3.27E+06	Calculated (see Section 2.2)
Surface dry deposition flux_As	mg/m²/day	0 3.46E-04	Calculated (see Section 2.2)
Surface wet deposition flux_As	mg/m²/day	0 4.68E-04	Calculated (see Section 2.2)
Quantity in soil_leaf/potato_As	mg	0 2.83E+05	Calculated (see Section 2.2)
Quantity in soil_root_As	mg	0 2.83E+05	Calculated (see Section 2.2)

Table 17: Area, plant and/or chemical specific parameter data used in scenarios 3-4 and 6-10.

Parameter	Unit	Default value in MERLIN-Expo	Own value (Reference)
Valid for industrial, surrounding and r	reference area		
Depth of the root zone	m	0.50	0.34 (Fierens et al., 2014)
Dry density of soil	kg dw/m³	1290.0	1474.7 (Fierens et al., 2014)
Carbohydrates content in potato	L/kg fw	0.086	0.19 (Fierens et al., 2014)
Fraction of organic carbon in soil	g/g	0.05	0.0168 (Fierens et al., 2014)
Lipid content of leaf	kg/kg fw	0.02	0.0006 (Fierens et al., 2014)
Lipid content of root	kg/kg fw	0.025	0.0015 (Fierens et al., 2014)
Water content of potato	L/kg fw	0.8	0.778 (Fierens et al., 2014)
Water content of leaf	L/kg fw	0.9	0.913 (Fierens et al., 2014)
water content of root	L/kg fw	0.8	0.890 (Fierens et al., 2014)
Only valid for industrial area			
Surface area of field_leaf/potato_Pb	m²	2000	39.25 (monitoring campaign ¹)

Parameter	Unit	Default value in MERLIN-Expo	Own value (Reference)
Surface area of field_root_Pb	m²	1000	39.25 (monitoring campaign ¹)
Transfer factor from soil to leaf_Pb	kg dw/kg dw	0.018	0.0095 (Cornelis et al., 2013a)
Transfer factor from soil to potato_Pb	kg dw/kg dw	0.018	0.00126 (Cornelis et al., 2013a)
Transfer factor from soil to root_Pb	kg dw/kg dw	0.018	0.00473 (Cornelis et al., 2013a)
Surface area of field_leaf/potato_As	m²	2000	102.68 (monitoring campaign ¹)
Surface area of field_root_As	m²	1000	102.68 (monitoring campaign ¹)
Transfer factor from soil to leaf_As	kg dw/kg dw	0.01	0.033 (Cornelis et al., 2013a)
Transfer factor from soil to potato_As	kg dw/kg dw	0.01	0.003 (Cornelis et al., 2013a)
Transfer factor from soil to root_As	kg dw/kg dw	0.01	0.0131 (Cornelis et al., 2013a)
Only valid for surrounding area			
Surface area of field_leaf/potato_Pb	m²	2000	74.38 (monitoring campaign ¹)
Surface area of field_root_Pb	m²	1000	74.38 (monitoring campaign ¹)
Transfer factor from soil to leaf_Pb	kg dw/kg dw	0.018	0.0095 (Cornelis et al., 2013a)
Transfer factor from soil to potato_Pb	kg dw/kg dw	0.018	0.00235 (Cornelis et al., 2013a)
Transfer factor from soil to root_Pb	kg dw/kg dw	0.018	0.00887 (Cornelis et al., 2013a)
Surface area of field_leaf/potato_As	m²	2000	113.46 (monitoring campaign ¹)
Surface area of field_root_As	m²	1000	113.46 (monitoring campaign ¹)
Transfer factor from soil to leaf_As	kg dw/kg dw	0.01	0.033 (Cornelis et al., 2013a)
Transfer factor from soil to potato_As	kg dw/kg dw	0.01	0.003 (Cornelis et al., 2013a)
Transfer factor from soil to root_As	kg dw/kg dw	0.01	0.01774 (Cornelis et al., 2013a)
Only valid for reference area			
Surface area of field_leaf/potato_Pb	m²	2000	101 (monitoring campaign ¹)
Surface area of field_root_Pb	m²	1000	101 (monitoring campaign ¹)
Transfer factor from soil to leaf_Pb	kg dw/kg dw	0.018	0.0095 (Cornelis et al., 2013a)
Transfer factor from soil to potato_Pb	kg dw/kg dw	0.018	0.00245 (Cornelis et al., 2013a)
Transfer factor from soil to root_Pb	kg dw/kg dw	0.018	0.00676 (Cornelis et al., 2013a)
Surface area of field_leaf/potato_As	m²	2000	120.16 (monitoring campaign ¹)
Surface area of field_root_As	m²	1000	120.16 (monitoring campaign ¹)
Transfer factor from soil to leaf_As	kg dw/kg dw	0.01	0.033 (Cornelis et al., 2013a)
Transfer factor from soil to potato_As	kg dw/kg dw	0.01	0.003 (Cornelis et al., 2013a)
Transfer factor from soil to root_As	kg dw/kg dw	0.01	0.01589 (Cornelis et al., 2013a)

¹ Confidential, unpublished results.

Table 18: Ingestion rates of soil, dust and external/purchased food products (average and PDF) used in scenarios 1, 2 and 5.

Medium	Unit	Average	PDF
Children living in in	dustrial a	rea	
Soil ¹	mg/day	45.009	logn(mean=45.009,sd=4.894,trmin=40.95,trmax=50.85)
Dust ¹	mg/day	55.011	logn(mean=55.011,sd=5.981,trmin=50.05,trmax=62.15)
Breakfast cereals ²	kg/day	0.0138	-
Bread ²	kg/day	0.083	logn(mean=0.083,sd=0.039,trmin=0.01,trmax=0.223)
Bread rolls ²	kg/day	0.0151	logn(mean=0.0151,sd=0.0154,trmin=0,trmax=0.0771)
Cakes ²	kg/day	0.0091	-
Rusks ²	kg/day	0.0019	-
Pasta ²	kg/day	0.0183	-
Rice ²	kg/day	0.0041	-
Other cereals ²	kg/day	0.0007	-
Liver ²	kg/day	3.33E-05	-
Kidney ²	kg/day	0	-
Horsemeat ²	kg/day	0.0010	-
Poultry ²	kg/day	0.0338	-
Coffee ²	kg/day	0.015	-
Tea ²	kg/day	0.0145	-
Tap water ²	L/day	0.1670	logn(mean=0.1670,sd=0.343,trmin=0,trmax=1.6)
Bottled water ²	L/day	0.2873	-
Soup ²	kg/day	0.1954	logn(mean=0.1954,sd=0.1539,trmin=0,trmax=1)
Other drinks ²	kg/day	0.1656	-
Potato ²	kg/day	0.0178	-
Carrot ²	kg/day	0.0060	-
Scorzonera ²	kg/day	0.0008	-
Radish ²	kg/day	0.0003	-
Spinach ²	kg/day	0.0018	-
Endive ²	kg/day	0.0002	-
Celery ²	kg/day	0.0024	-
Celeriac ²	kg/day	0.0003	-
Lettuce ²	kg/day	0.0027	logn(mean=0.0027,sd=0.0039,trmin=0,trmax=0.0214)
Leek ²	kg/day	0.0019	-
Onion ²	kg/day	0.0019	-
Belgian endive ²	kg/day	0.0008	-
Brussels sprouts ²	kg/day	0.0009	-
Cabbage ²	kg/day	0.0022	-
Savoy cabbage ²	kg/day	0.0005	-
Cauliflower ²	kg/day	0.0024	-
Broccoli ²	kg/day	0.0025	-
Bean ²	kg/day	0.0027	

Medium	Unit	Average	PDF
Tomato ²	kg/day	0.0157	-
Pea ²	kg/day	0.0029	-
Children living in s	urroundin	g area	
Soil ¹	mg/day	43.615	logn(mean=43.615,sd=4.434,trmin=40.95,trmax=50.85)
Dust ¹	mg/day	53.308	logn(mean=53.308,sd=5.419,trmin=50.05,trmax=62.15)
Breakfast cereals ²	kg/day	0.0165	-
Bread ²	kg/day	0.0798	logn(mean=0.0798,sd=0.0400,trmin=0.0214,trmax=0.2229)
Bread rolls ²	kg/day	0.0139	logn(mean=0.0139,sd=0.0151,trmin=0,trmax=0.0743)
Cakes ²	kg/day	0.0048	-
Rusks ²	kg/day	0.0019	-
Pasta ²	kg/day	0.0138	-
Rice ²	kg/day	0.0031	-
Other cereals ²	kg/day	0.0007	-
Liver ²	kg/day	0	-
Kidney ²	kg/day	0	-
Horsemeat ²	kg/day	0.0008	-
Poultry ²	kg/day	0.0277	-
Coffee ²	kg/day	0.0115	-
Tea ²	kg/day	0.0115	-
Tap water ²	L/day	0.1904	logn(mean=0.1904,sd=0.2600,trmin=0,trmax=1)
Bottled water ²	L/day	0.2813	-
Soup ²	kg/day	0.1977	logn(mean=0.1977,sd=0.1034,trmin=0,trmax=0.2596)
Other drinks ²	kg/day	0.1486	-
Potato ²	kg/day	0.0170	-
Carrot ²	kg/day	0.0065	-
Scorzonera ²	kg/day	0.0006	-
Radish ²	kg/day	0.0002	-
Spinach ²	kg/day	0.0022	-
Endive ²	kg/day	0.0002	-
Celery ²	kg/day	0.0012	-
Celeriac ²	kg/day	0.0004	-
Lettuce ²	kg/day	0.0030	logn(mean=0.0030,sd=0.0036,trmin=0,trmax=0.0171)
Leek ²	kg/day	0.0026	-
Onion ²	kg/day	0.0029	-
Belgian endive ²	kg/day	0.0006	-
Brussels sprouts ²	kg/day	0.0006	-
Cabbage ²	kg/day	0.0020	-
Savoy cabbage ²	kg/day	0.0006	-
Medium	Unit	Average	PDF
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Cauliflower ²	kg/day	0.0029	-
Broccoli ²	kg/day	0.0025	-
Bean ²	kg/day	0.0029	-
Tomato ²	kg/day	0.0204	-
Pea ²	kg/day	0.0024	-
Children living in re	ference a	rea	
Soil ¹	mg/day	43.80	logn(mean=43.804,sd=4.497,trmin=40.95,trmax=50.85)
Dust ¹	mg/day	53.54	logn(mean=53.538,sd=5.497,trmin=50.05,trmax=62.15)
Breakfast cereals ²	kg/day	0.0120	-
Bread ²	kg/day	0.0760	logn(mean=0.0760,sd=0.0421,trmin=0.002,trmax=0.2786)
Bread rolls ²	kg/day	0.0153	logn(mean=0.0153,sd=0.0149,trmin=0,trmax=0.1286)
Cakes ²	kg/day	0.0091	-
Rusks ²	kg/day	0.0029	-
Pasta ²	kg/day	0.0161	-
Rice ²	kg/day	0.0044	-
Other cereals ²	kg/day	0.0015	-
Liver ²	kg/day	8.36E-5	-
Kidney ²	kg/day	0	-
Horsemeat ²	kg/day	0.0007	-
Poultry ²	kg/day	0.0318	-
Coffee ²	kg/day	0.0104	-
Tea ²	kg/day	0.0153	-
Tap water ²	L/day	0.1200	logn(mean=0.1200,sd=0.2076,trmin=0,trmax=0.8)
Bottled water ²	L/day	0.3022	-
Soup ²	kg/day	0.2296	logn(mean=0.2296,sd=0.1260,trmin=0,trmax=1)
Other drinks ²	kg/day	0.1970	-
Potato ²	kg/day	0.0171	-
Carrot ²	kg/day	0.0064	-
Scorzonera ²	kg/day	0.0004	-
Radish ²	kg/day	0.0003	-
Spinach ²	kg/day	0.0019	-
Endive ²	kg/day	0.0001	-
Celery ²	kg/day	0.0022	-
Celeriac ²	kg/day	0.0006	-
Lettuce ²	kg/day	0.0028	logn(mean=0.0028,sd=0.0045,trmin=0,trmax=0.0386)
Leek ²	kg/day	0.0032	-
Onion ²	kg/day	0.0028	-
Belgian endive ²	kg/day	0.0004	-

Medium	Unit	Average	PDF
Brussels sprouts ²	kg/day	0.0009	-
Cabbage ²	kg/day	0.0022	-
Savoy cabbage ²	kg/day	0.0005	
Cauliflower ²	kg/day	0.0024	-
Broccoli ²	kg/day	0.0026	-
Bean ²	kg/day	0.0026	-
Tomato ²	kg/day	0.0209	-
Pea ²	kg/day	0.0030	-

¹ Van Holderbeke et al. (2008) $-^{2}$ confidential, unpublished results from the monitoring campaign.

Table 19: Ingestion rates of soil, dust, local and external/purchased food products (average and PDF) used in scenarios 3, 4 and 6.

Medium	Unit	Average	PDF
Children living in in	dustrial a	rea	
Soil ¹	mg/day	45.009	logn(mean=45.009,sd=4.894,trmin=40.95,trmax=50.85)
Dust ¹	mg/day	55.011	logn(mean=55.011,sd=5.981,trmin=50.05,trmax=62.15)
Local leaf ²	kg/day	0.0015	logn(mean=0.0015,sd=0.0051,trmin=0,trmax=0.0336)
Local root ²	kg/day	0.0002	logn(mean=0.0002,sd=0.0009,trmin=0,trmax=0.0079)
Local potato ²	kg/day	0.0007	logn(mean=0.0007,sd=0.0033,trmin=0,trmax=0.0231)
Breakfast cereals ²	kg/day	0.0138	-
Bread ²	kg/day	0.083	logn(mean=0.083,sd=0.039,trmin=0.01,trmax=0.223)
Bread rolls ²	kg/day	0.0151	logn(mean=0.0151,sd=0.0154,trmin=0,trmax=0.0771)
Cakes ²	kg/day	0.0091	-
Rusks ²	kg/day	0.0019	-
Pasta ²	kg/day	0.0183	-
Rice ²	kg/day	0.0041	-
Other cereals ²	kg/day	0.0007	-
Liver ²	kg/day	3.33E-05	-
Kidney ²	kg/day	0	-
Horsemeat ²	kg/day	0.0010	-
Poultry ²	kg/day	0.0338	-
Coffee ²	kg/day	0.015	-
Tea ²	kg/day	0.0145	-
Tap water ²	L/day	0.1670	logn(mean=0.1670,sd=0.343,trmin=0,trmax=1.6)
Bottled water ²	L/day	0.2873	-
Soup ²	kg/day	0.1954	logn(mean=0.1954,sd=0.1539,trmin=0,trmax=1)
Other drinks ²	kg/day	0.1656	-
Potato ²	kg/day	0.0171	-
Carrot ²	kg/day	0.0059	-

Medium	Unit	Average	PDF
Scorzonera ²	kg/day	0.0008	-
Radish ²	kg/day	0.0003	
Spinach ²	kg/day	0.0018	-
Endive ²	kg/day	0.0002	-
Celery ²	kg/day	0.0021	-
Celeriac ²	kg/day	0.0003	-
Lettuce ²	kg/day	0.0026	logn(mean=0.0026,sd=0.0037,trmin=0,trmax=0.0214)
Leek ²	kg/day	0.0017	-
Onion ²	kg/day	0.0018	-
Belgian endive ²	kg/day	0.0008	-
Brussels sprouts ²	kg/day	0.0009	-
Cabbage ²	kg/day	0.0021	-
Savoy cabbage ²	kg/day	0.0005	-
Cauliflower ²	kg/day	0.0024	-
Broccoli ²	kg/day	0.0025	-
Bean ²	kg/day	0.0026	-
Tomato ²	kg/day	0.0152	-
Pea ²	kg/day	0.0029	-
Children living in s	urroundin	g area	
Soil ¹	mg/day	43.615	logn(mean=43.615,sd=4.434,trmin=40.95,trmax=50.85)
Dust ¹	mg/day	53.308	logn(mean=53.308,sd=5.419,trmin=50.05,trmax=62.15)
Local leaf ²	kg/day	0.0046	logn(mean=0.0046,sd=0.0129,trmin=0,trmax=0.0550)
Local root ²	kg/day	0.0004	logn(mean=0.0004,sd=0.0009,trmin=0,trmax=0.0047)
Local potato ²	kg/day	0.0015	logn(mean=0.0015,sd=0.0041,trmin=0,trmax=0.0193)
Breakfast cereals ²	kg/day	0.0165	-
Bread ²	kg/day	0.0798	logn(mean=0.0798,sd=0.0400,trmin=0.0214,trmax=0.2229)
Bread rolls ²	kg/day	0.0139	logn(mean=0.0139,sd=0.0151,trmin=0,trmax=0.0743)
Cakes ²	kg/day	0.0048	-
Rusks ²	kg/day	0.0019	-
Pasta ²	kg/day	0.0138	-
Rice ²	kg/day	0.0031	-
Other cereals ²	kg/day	0.0007	-
Liver ²	kg/day	0	-
Kidney ²	kg/day	0	-
Horsemeat ²	kg/day	0.0008	-
Poultry ²	kg/day	0.0277	-
Coffee ²	kg/day	0.0115	-

Tea²

kg/day 0.0115 -

Medium	Unit	Average	PDF
Tap water ²	L/day	0.1904	logn(mean=0.1904,sd=0.2600,trmin=0,trmax=1)
Bottled water ²	L/day	0.2813	-
Soup ²	kg/day	0.1977	logn(mean=0.1977,sd=0.1034,trmin=0,trmax=0.2596)
Other drinks ²	kg/day	0.1486	-
Potato ²	kg/day	0.0155	-
Carrot ²	kg/day	0.0062	-
Scorzonera ²	kg/day	0.0006	-
Radish ²	kg/day	0.0002	-
Spinach ²	kg/day	0.0021	-
Endive ²	kg/day	0.0002	-
Celery ²	kg/day	0.0011	-
Celeriac ²	kg/day	0.0004	-
Lettuce ²	kg/day	0.0028	logn(mean=0.0028,sd=0.0035,trmin=0,trmax=0.0171)
Leek ²	kg/day	0.0024	-
Onion ²	kg/day	0.0026	-
Belgian endive ²	kg/day	0.0006	-
Brussels sprouts ²	kg/day	0.0006	-
Cabbage ²	kg/day	0.0019	-
Savoy cabbage ²	kg/day	0.0005	-
Cauliflower ²	kg/day	0.0028	-
Broccoli ²	kg/day	0.0024	-
Bean ²	kg/day	0.0026	-
Tomato ²	kg/day	0.0209	-
Pea ²	kg/day	0.0023	-

Children living in reference area

Soil ¹	mg/day	43.80	logn(mean=43.804,sd=4.497,trmin=40.95,trmax=50.85)
Dust ¹	mg/day	53.54	logn(mean=53.538,sd=5.497,trmin=50.05,trmax=62.15)
Local leaf ²	kg/day	0.0073	logn(mean=0.0073,sd=0.0183,trmin=0,trmax=0.1196)
Local root ²	kg/day	0.0012	logn(mean=0.0012,sd=0.0035,trmin=0,trmax=0.0206)
Local potato ²	kg/day	0.0024	logn(mean=0.0024,sd=0.0071,trmin=0,trmax=0.0557)
Breakfast cereals ²	kg/day	0.0120	-
Bread ²	kg/day	0.0760	logn(mean=0.0760,sd=0.0421,trmin=0.002,trmax=0.2786)
Bread rolls ²	kg/day	0.0153	logn(mean=0.0153,sd=0.0149,trmin=0,trmax=0.1286)
Cakes ²	kg/day	0.0091	-
Rusks ²	kg/day	0.0029	-
Pasta ²	kg/day	0.0161	-
Rice ²	kg/day	0.0044	-
Other cereals ²	kg/day	0.0015	-

Medium	Unit	Average	PDF
Liver ²	kg/day	8.36E-5	-
Kidney ²	kg/day	0	-
Horsemeat ²	kg/day	0.0007	-
Poultry ²	kg/day	0.0318	-
Coffee ²	kg/day	0.0104	-
Tea ²	kg/day	0.0153	-
Tap water ²	L/day	0.1200	logn(mean=0.1200,sd=0.2076,trmin=0,trmax=0.8)
Bottled water ²	L/day	0.3022	-
Soup ²	kg/day	0.2296	logn(mean=0.2296,sd=0.1260,trmin=0,trmax=1)
Other drinks ²	kg/day	0.1970	-
Potato ²	kg/day	0.0146	-
Carrot ²	kg/day	0.0052	-
Scorzonera ²	kg/day	0.0004	-
Radish ²	kg/day	0.0002	-
Spinach ²	kg/day	0.0016	-
Endive ²	kg/day	0.0001	-
Celery ²	kg/day	0.0015	-
Celeriac ²	kg/day	0.0004	-
Lettuce ²	kg/day	0.0024	logn(mean=0.0024,sd=0.0038,trmin=0,trmax=0.0241)
Leek ²	kg/day	0.0018	-
Onion ²	kg/day	0.0025	-
Belgian endive ²	kg/day	0.0004	-
Brussels sprouts ²	kg/day	0.0008	-
Cabbage ²	kg/day	0.0019	-
Savoy cabbage ²	kg/day	0.0004	-
Cauliflower ²	kg/day	0.0022	-
Broccoli ²	kg/day	0.0025	-
Bean ²	kg/day	0.0023	-
Tomato ²	kg/day	0.0181	-
Pea ²	kg/day	0.0028	-

¹ Van Holderbeke et al. (2008) -² confidential, unpublished results from the monitoring campaign.

Table 20: Average ingestion rates of soil, dust, local and external/purchased food products used in scenario 7.

Medium	Unit	Child_1	Child_2	Child_3	Child_4	Child_5	Child_6	Child_7	Child_8	Child_9	Child_10
Children living in industrial area											
Soil ¹	mg/day	40.95	50.85	50.85	40.95	40.95	50.85	40.95	40.95	50.85	50.85
Dust ¹	mg/day	50.05	62.15	62.15	50.05	50.05	62.15	50.05	50.05	62.15	62.15
Local leaf ²	kg/day	0.0000	0.0073	0.0073	0.0276	0.0025	0.0000	0.0000	0.0336	0.0000	0.0059
Local root ²	kg/day	0.0000	0.0000	0.0029	0.0079	0.0014	0.0000	0.0000	0.0011	0.0000	0.0003
Local potato ²	kg/day	0.0000	0.0231	0.0154	0.0077	0.0000	0.0000	0.0000	0.0000	0.0000	0.0139
Breakfast cereals ²	kg/day	0.0000	0.0057	0.0000	0.0143	0.0257	0.0000	0.0000	0.0257	0.0371	0.0000
Bread ²	kg/day	0.0836	0.0557	0.0836	0.0579	0.0557	0.0557	0.0557	0.0193	0.0557	0.0836
Bread rolls ²	kg/day	0.0000	0.0013	0.0286	0.0057	0.0057	0.0286	0.0114	0.0114	0.0114	0.0114
Cakes ²	kg/day	0.1393	0.0000	0.0000	0.0063	0.0696	0.0000	0.0025	0.0000	0.0000	0.0000
Rusks ²	kg/day	0.0071	0.0000	0.0000	0.0000	0.0014	0.0003	0.0071	0.0000	0.0000	0.0000
Pasta ²	kg/day	0.0357	0.0118	0.0179	0.0118	0.0107	0.0118	0.0057	0.0214	0.0321	0.0000
Rice ²	kg/day	0.0171	0.0034	0.0020	0.0034	0.0069	0.0020	0.0051	0.0030	0.0043	0.0010
Other cereals ²	kg/day	0.0000	0.0008	0.0008	0.0000	0.0000	0.0000	0.0051	0.0000	0.0010	0.0000
Liver ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kidney ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Horsemeat ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000
Poultry ²	kg/day	0.0268	0.0214	0.0964	0.0643	0.0268	0.0158	0.0268	0.0482	0.0143	0.0214
Coffee ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tea ²	kg/day	0.0000	0.1500	0.0000	0.1500	0.0000	0.0000	0.0000	0.3000	0.0000	0.0000
Tap water ²	L/day	0.4327	0.4000	0.0000	0.0000	0.0000	0.0000	0.2000	0.2000	0.2000	0.0000
Bottled water ²	L/day	0.4260	0.0000	0.6000	1.2000	0.0000	0.0000	0.2000	0.0000	0.0000	0.2000
Soup ²	kg/day	0.2500	0.2500	0.0000	0.0000	0.0000	0.2596	0.2500	0.2500	0.0000	0.2500

Medium	Unit	Child_1	Child_2	Child_3	Child_4	Child_5	Child_6	Child_7	Child_8	Child_9	Child_10
Other drinks ²	kg/day	0.8000	0.0000	0.0000	0.0000	0.6000	0.0000	0.0000	0.8000	0.0000	0.6000
Potato ²	kg/day	0.0171	0.0000	0.0000	0.0077	0.0231	0.0077	0.0154	0.0043	0.0051	0.0084
Carrot ²	kg/day	0.0057	0.0054	0.0029	0.0079	0.0041	0.0023	0.0051	0.0011	0.0086	0.0010
Scorzonera ²	kg/day	0.0000	0.0008	0.0000	0.0020	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000
Radish ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0000	0.0000
Spinach ²	kg/day	0.0040	0.0020	0.0000	0.0030	0.0000	0.0010	0.0008	0.0010	0.0034	0.0000
Endive ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000
Celery ²	kg/day	0.0000	0.0010	0.0000	0.0231	0.0008	0.0000	0.0004	0.0000	0.0004	0.0000
Celeriac ²	kg/day	0.0000	0.0026	0.0000	0.0000	0.0004	0.0000	0.0008	0.0000	0.0000	0.0000
Lettuce ²	kg/day	0.0020	0.0000	0.0064	0.0214	0.0034	0.0020	0.0008	0.0030	0.0034	0.0000
Leek ²	kg/day	0.0000	0.0000	0.0000	0.0034	0.0000	0.0020	0.0008	0.0000	0.0004	0.0000
Onion ²	kg/day	0.0000	0.0004	0.0005	0.0000	0.0004	0.0000	0.0043	0.0000	0.0111	0.0020
Belgian endive ²	kg/day	0.0004	0.0004	0.0000	0.0028	0.0000	0.0000	0.0008	0.0007	0.0002	0.0003
Brussels sprouts ²	kg/day	0.0000	0.0004	0.0000	0.0069	0.0030	0.0030	0.0000	0.0000	0.0000	0.0020
Cabbage ²	kg/day	0.0004	0.0000	0.0000	0.0010	0.0026	0.0010	0.0030	0.0010	0.0010	0.0001
Savoy cabbage ²	kg/day	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000
Cauliflower ²	kg/day	0.0129	0.0015	0.0003	0.0030	0.0023	0.0010	0.0020	0.0010	0.0000	0.0020
Broccoli ²	kg/day	0.0129	0.0026	0.0000	0.0171	0.0019	0.0010	0.0034	0.0010	0.0017	0.0020
Bean ²	kg/day	0.0020	0.0051	0.0002	0.0030	0.0018	0.0000	0.0030	0.0009	0.0010	0.0005
Tomato ²	kg/day	0.0696	0.0115	0.0000	0.0979	0.0000	0.0050	0.0631	0.0283	0.0015	0.0015
Pea ²	kg/day	0.0000	0.0020	0.0020	0.0026	0.0045	0.0000	0.0037	0.0022	0.0004	0.0020
Children living in surrounding area											
Soil ¹	mg/day	40.95	50.85	40.95	50.85	40.95	40.95	50.85	40.95	40.95	40.95
Dust ¹	mg/day	50.05	62.15	50.05	62.15	50.05	50.05	62.15	50.05	50.05	50.05

Medium	Unit	Child_1	Child_2	Child_3	Child_4	Child_5	Child_6	Child_7	Child_8	Child_9	Child_10
Local leaf ²	kg/day	0.0057	0.0175	0.0000	0.0031	0.0000	0.0021	0.0000	0.0541	0.0540	0.0064
Local root ²	kg/day	0.0020	0.0020	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000
Local potato ²	kg/day	0.0021	0.0019	0.0000	0.0000	0.0000	0.0154	0.0000	0.0039	0.0039	0.0039
Breakfast cereals ²	kg/day	0.0286	0.0057	0.0033	0.0371	0.0143	0.0057	0.0114	0.0000	0.0000	0.0371
Bread ²	kg/day	0.0579	0.0836	0.2229	0.0214	0.0557	0.0964	0.0836	0.0557	0.0557	0.0836
Bread rolls ²	kg/day	0.0114	0.0057	0.0114	0.0514	0.0027	0.0114	0.0286	0.0114	0.0114	0.0114
Cakes ²	kg/day	0.0063	0.0063	0.0107	0.0000	0.0025	0.0050	0.0000	0.0000	0.0000	0.0000
Rusks ²	kg/day	0.0017	0.0007	0.0003	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000
Pasta ²	kg/day	0.0214	0.0107	0.0083	0.0118	0.0295	0.0118	0.0179	0.0143	0.0086	0.0118
Rice ²	kg/day	0.0050	0.0020	0.0051	0.0034	0.0034	0.0034	0.0034	0.0016	0.0016	0.0000
Other cereals ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000
Liver ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kidney ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Horsemeat ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Poultry ²	kg/day	0.0158	0.0089	0.0004	0.0268	0.0964	0.0395	0.0214	0.0143	0.0143	0.0214
Coffee ²	kg/day	0.0000	0.1500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tea ²	kg/day	0.0000	0.1500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tap water ²	L/day	L/day	0.6000	0.0000	0.0000	0.4000	0.4000	0.6000	0.0000	0.2000	0.2000
Bottled water ²	L/day	L/day	0.0000	0.6000	0.8000	0.0000	0.2000	0.2000	0.2000	0.0000	0.0000
Soup ²	kg/day	kg/day	0.2500	0.2500	0.2500	0.0000	0.2500	0.2500	0.2500	0.0000	0.0000
Other drinks ²	kg/day	kg/day	0.0000	0.0000	0.0000	0.0000	0.6000	0.0000	0.0000	0.8000	1.0000
Potato ²	kg/day	0.0064	0.0058	0.0223	0.0043	0.0386	0.0000	0.0043	0.0116	0.0116	0.0116
Carrot ²	kg/day	0.0033	0.0059	0.0088	0.0044	0.0334	0.0019	0.0018	0.0035	0.0053	0.0043
Scorzonera ²	kg/day	0.0000	0.0017	0.0000	0.0004	0.0000	0.0000	0.0000	0.0008	0.0008	0.0030
Radish ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0034	0.0000	0.0000	0.0000	0.0000	0.0000

Medium	Unit	Child_1	Child_2	Child_3	Child_4	Child_5	Child_6	Child_7	Child_8	Child_9	Child_10
Spinach ²	kg/day	0.0023	0.0003	0.0040	0.0008	0.0040	0.0040	0.0000	0.0000	0.0000	0.0020
Endive ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015
Celery ²	kg/day	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000
Celeriac ²	kg/day	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000
Lettuce ²	kg/day	0.0015	0.0043	0.0000	0.0000	0.0086	0.0000	0.0020	0.0005	0.0000	0.0018
Leek ²	kg/day	0.0000	0.0008	0.0004	0.0011	0.0214	0.0000	0.0017	0.0000	0.0000	0.0000
Onion ²	kg/day	0.0000	0.0016	0.0000	0.0000	0.0111	0.0009	0.0017	0.0008	0.0008	0.0032
Belgian endive ²	kg/day	0.0021	0.0004	0.0010	0.0002	0.0000	0.0000	0.0000	0.0002	0.0002	0.0002
Brussels sprouts ²	kg/day	0.0000	0.0000	0.0004	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008
Cabbage ²	kg/day	0.0000	0.0010	0.0020	0.0020	0.0016	0.0020	0.0000	0.0008	0.0008	0.0020
Savoy cabbage ²	kg/day	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cauliflower ²	kg/day	0.0020	0.0010	0.0034	0.0015	0.0016	0.0020	0.0004	0.0020	0.0030	0.0030
Broccoli ²	kg/day	0.0008	0.0010	0.0069	0.0020	0.0069	0.0015	0.0004	0.0010	0.0030	0.0000
Bean ²	kg/day	0.0006	0.0000	0.0012	0.0008	0.0040	0.0013	0.0010	0.0020	0.0020	0.0009
Tomato ²	kg/day	0.0006	0.0043	0.0031	0.0229	0.1091	0.0283	0.0120	0.0536	0.0537	0.0015
Pea ²	kg/day	0.0027	0.0002	0.0015	0.0005	0.0240	0.0020	0.0022	0.0024	0.0036	0.0030
Children living in reference area											
Soil ¹	mg/dav	50.85	50.85	40 95	40 95	40 95	40 95	40 95	40 95	40 95	40 95
Dust ¹	mg/day	62 15	62 15	50.05	50.05	50.05	50.05	50.05	50.05	50.05	50.05
Local leaf ²	kg/dav	0.0000	0.0248	0.0720	0.0186	0 0000	0 0000	0 0764	0,0000	0.0213	0.0320
Local root ²	kg/dav	0.0000	0.0079	0.0022	0.0023	0.0000	0.0000	0.0060	0.0000	0.0153	0.0057
Local potato ²	kg/dav	0.0000	0.0000	0.0231	0.0039	0.0058	0.0000	0.0000	0.0000	0.0116	0.0077
Breakfast cereals ²	kg/dav	0.0143	0.0000	0.0000	0.0000	0.0257	0.0143	0.0143	0.0257	0.0057	0.0033
Bread ²	kg/day	0.0557	0.0836	0.1114	0.0386	0.1114	0.0386	0.0836	0.1114	0.0557	0.1114

Medium	Unit	Child_1	Child_2	Child_3	Child_4	Child_5	Child_6	Child_7	Child_8	Child_9	Child_10
Bread rolls ²	kg/day	0.0114	0.0057	0.0143	0.0143	0.0057	0.0067	0.0067	0.0114	0.0171	0.0286
Cakes ²	kg/day	0.0268	0.0000	0.0000	0.0000	0.0000	0.0107	0.0000	0.0025	0.0000	0.0000
Rusks ²	kg/day	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0017	0.0007	0.0014
Pasta ²	kg/day	0.0295	0.0179	0.0268	0.0118	0.0268	0.0118	0.0071	0.0143	0.0536	0.0295
Rice ²	kg/day	0.0034	0.0030	0.0034	0.0012	0.0040	0.0008	0.0086	0.0086	0.0034	0.0008
Other cereals ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000
Liver ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kidney ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Horsemeat ²	kg/day	0.0000	0.0000	0.0000	0.0063	0.0000	0.0000	0.0125	0.0000	0.0000	0.0000
Poultry ²	kg/day	0.0214	0.0107	0.0711	0.0214	0.0107	0.0536	0.0214	0.0395	0.0536	0.0143
Coffee ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.1500	0.0000	0.0000	0.0000	0.0000
Tea ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tap water ²	L/day	0.4000	0.0000	0.2000	0.0000	0.4000	0.0000	0.0000	0.2000	0.4327	0.0000
Bottled water ²	L/day	0.0000	0.4000	0.4000	0.4000	0.4000	0.8000	0.2000	0.2000	1.0000	0.2000
Soup ²	kg/day	0.2500	0.2500	0.2500	0.2500	0.0000	0.2500	0.2500	0.0000	0.0000	0.2500
Other drinks ²	kg/day	0.2000	0.0000	0.2000	0.0000	0.4000	0.0000	0.6000	0.8000	0.0000	0.0000
Potato ²	kg/day	0.0231	0.0223	0.0000	0.0116	0.0174	0.0154	0.0086	0.0154	0.0039	0.0077
Carrot ²	kg/day	0.0071	0.0026	0.0022	0.0000	0.0049	0.0015	0.0000	0.0092	0.0000	0.0019
Scorzonera ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000
Radish ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Spinach ²	kg/day	0.0040	0.0045	0.0015	0.0000	0.0051	0.0004	0.0008	0.0030	0.0005	0.0004
Endive ²	kg/day	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Celery ²	kg/day	0.0000	0.0019	0.0000	0.0000	0.0077	0.0000	0.0000	0.0000	0.0000	0.0000
Celeriac ²	kg/day	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Lettuce ²	kg/day	0.0000	0.0015	0.0010	0.0013	0.0000	0.0034	0.0017	0.0034	0.0000	0.0017

Medium	Unit	Child_1	Child_2	Child_3	Child_4	Child_5	Child_6	Child_7	Child_8	Child_9	Child_10
Leek ²	kg/day	0.0000	0.0008	0.0015	0.0000	0.0077	0.0004	0.0000	0.0012	0.0000	0.0000
Onion ²	kg/day	0.0000	0.0004	0.0000	0.0006	0.0077	0.0000	0.0010	0.0004	0.0000	0.0021
Belgian endive ²	kg/day	0.0000	0.0034	0.0004	0.0000	0.0000	0.0004	0.0000	0.0004	0.0000	0.0000
Brussels sprouts ²	kg/day	0.0051	0.0008	0.0000	0.0000	0.0000	0.0004	0.0000	0.0008	0.0000	0.0008
Cabbage ²	kg/day	0.0051	0.0030	0.0015	0.0020	0.0051	0.0020	0.0000	0.0000	0.0005	0.0010
Savoy cabbage ²	kg/day	0.0000	0.0008	0.0000	0.0004	0.0012	0.0020	0.0000	0.0000	0.0000	0.0000
Cauliflower ²	kg/day	0.0051	0.0026	0.0026	0.0000	0.0051	0.0008	0.0000	0.0030	0.0010	0.0008
Broccoli ²	kg/day	0.0000	0.0030	0.0026	0.0000	0.0051	0.0010	0.0000	0.0030	0.0000	0.0010
Bean ²	kg/day	0.0012	0.0030	0.0000	0.0008	0.0051	0.0020	0.0015	0.0012	0.0000	0.0000
Tomato ²	kg/day	0.0000	0.0089	0.0490	0.0290	0.0237	0.0110	0.0540	0.0293	0.0000	0.0174
Pea ²	kg/day	0.0026	0.0011	0.0000	0.0034	0.0092	0.0029	0.0018	0.0045	0.0000	0.0002

¹ Van Holderbeke et al. (2008) $-^{2}$ confidential, unpublished results from the monitoring campaign.

Table 21: Ingestion	rates of soil,	dust and	external/purchased	food products	(average and	I PDF)	used in
scenario 8.							

Medium	Unit	Average	PDF
Adults living in indu	ustrial are	a	
Soil ¹	mg/day	22.68	logn(mean=22.68,sd=0.838,trmin=22.5,trmax=26.55)
Dust ¹	mg/day	27.72	logn(mean=27.72,sd=1.024,trmin=27.5,trmax=32.45)
Local leaf ²	kg/day	0.0156	logn(mean=0.0156,sd=0.0419,trmin=0,trmax=0.3954)
Local root ²	kg/day	0.0012	logn(mean=0.0012,sd=0.0043,trmin=0,trmax=0.0505)
Local potato ²	kg/day	0.0041	logn(mean=0.0041,sd=0.0103,trmin=0,trmax=0.0669)
Breakfast cereals ²	kg/day	0.0069	-
Bread ²	kg/day	0.1368	logn(mean=0.1368,sd=0.1078,trmin=0,trmax=1.17)
Bread rolls ²	kg/day	0.0166	-
Cakes ²	kg/day	0.0070	-
Rusks ²	kg/day	0.0020	-
Pasta ²	kg/day	0.0212	-
Rice ²	kg/day	0.0065	-
Other cereals ²	kg/day	0.0006	-
Liver ²	kg/day	0.0003	-
Kidney ²	kg/day	0.00003	-
Horsemeat ²	kg/day	0.0028	-
Poultry ²	kg/day	0.0341	-
Coffee ²	kg/day	0.6150	logn(mean=0.6150,sd=0.4965,trmin=0,trmax=2.5)
Tea ²	kg/day	0.2150	-
Tap water ²	L/day	0.2934	logn(mean=0.2934,sd=0.4801,trmin=0,trmax=3)
Bottled water ²	L/day	0.6539	logn(mean=0.6539,sd=0.6341,trmin=0,trmax=3.6)
Soup ²	kg/day	0.2423	logn(mean=0.2423,sd=0.1440,trmin=0,trmax=1.75)
Other drinks ²	kg/day	0.0544	-
Potato ²	kg/day	0.0209	-
Carrot ²	kg/day	0.0069	-
Scorzonera ²	kg/day	0.0007	-
Radish ²	kg/day	0.0003	-
Spinach ²	kg/day	0.0020	-
Endive ²	kg/day	0.0003	-
Celery ²	kg/day	0.0028	-
Celeriac ²	kg/day	0.0009	-
Lettuce ²	kg/day	0.0056	-
Leek ²	kg/day	0.0049	-
Onion ²	kg/day	0.0067	-
Belgian endive ²	kg/day	0.0040	-
Brussels sprouts ²	kg/day	0.0014	-

Medium	Unit	Average	PDF
Cabbage ²	kg/day	0.0028	-
Savoy cabbage ²	kg/day	0.0008	-
Cauliflower ²	kg/day	0.0031	-
Broccoli ²	kg/day	0.0030	-
Bean ²	kg/day	0.0031	-
Tomato ²	kg/day	0.0298	-
Pea ²	kg/day	0.0041	-
Adults living in surr	ounding a	area	
Soil ¹	mg/day	22.64	logn(mean=22.64,sd=0.735,trmin=22.5,trmax=26.55)
Dust ¹	mg/day	27.67	logn(mean=27.67,sd=0.898,trmin=27.5,trmax=32.45)
Local leaf ²	kg/day	0.0150	logn(mean=0.0150,sd=0.0288,trmin=0,trmax=0.2013)
Local root ²	kg/day	0.0013	logn(mean=0.0013,sd=0.0032,trmin=0,trmax=0.022)
Local potato ²	kg/day	0.0058	logn(mean=0.0058,sd=0.0114,trmin=0,trmax=0.0557)
Breakfast cereals ²	kg/day	0.0046	-
Bread ²	kg/day	0.1406	logn(mean=0.1406,sd=0.1045,trmin=0,trmax=0.975)
Bread rolls ²	kg/day	0.0179	-
Cakes ²	kg/day	0.0076	-
Rusks ²	kg/day	0.0026	-
Pasta ²	kg/day	0.0217	-
Rice ²	kg/day	0.0069	-
Other cereals ²	kg/day	0.0010	-
Liver ²	kg/day	0.0002	-
Kidney ²	kg/day	0.00001	-
Horsemeat ²	kg/day	0.0024	-
Poultry ²	kg/day	0.0353	-
Coffee ²	kg/day	0.7053	logn(mean=0.7053,sd=0.6015,trmin=0,trmax=3.2219)
Tea ²	kg/day	0.1726	-
Tap water ²	L/day	0.2611	logn(mean=0.2611,sd=0.4862,trmin=0,trmax=3.6)
Bottled water ²	L/day	0.7023	logn(mean=0.7023,sd=0.6252,trmin=0,trmax=4.8)
Soup ²	kg/day	0.2286	logn(mean=0.2286,sd=0.1380,trmin=0,trmax=1.25)
Other drinks ²	kg/day	0.0405	-
Potato ²	kg/day	0.0190	-
Carrot ²	kg/day	0.0061	-
Scorzonera ²	kg/day	0.0005	-
Radish ²	kg/day	0.0003	-
Spinach ²	kg/day	0.0017	-
Endive ²	kg/day	0.0004	-
Celery ²	kg/day	0.0024	-

Medium	Unit	Average	PDF
Celeriac ²	kg/day	0.0009	-
Lettuce ²	kg/day	0.0053	-
Leek ²	kg/day	0.0037	-
Onion ²	kg/day	0.0069	-
Belgian endive ²	kg/day	0.0041	-
Brussels sprouts ²	kg/day	0.0014	-
Cabbage ²	kg/day	0.0027	-
Savoy cabbage ²	kg/day	0.0008	-
Cauliflower ²	kg/day	0.0029	-
Broccoli ²	kg/day	0.0029	-
Bean ²	kg/day	0.0027	-
Tomato ²	kg/day	0.0314	-
Pea ²	kg/day	0.0033	-
Adults living in refe	rence are	a	
Soil ¹	mg/day	22.70	logn(mean=22.70,sd=0.886,trmin=22.5,trmax=26.55)
Dust ¹	mg/day	27.75	logn(mean=27.75,sd=1.083,trmin=27.5,trmax=32.45)
Local leaf ²	kg/day	0.0270	logn(mean=0.0270,sd=0.0541,trmin=0,trmax=0.3808)
Local root ²	kg/day	0.0026	logn(mean=0.0026,sd=0.0072,trmin=0,trmax=0.1149)
Local potato ²	kg/day	0.0062	logn(mean=0.0062,sd=0.0129,trmin=0,trmax=0.0669)
Breakfast cereals ²	kg/day	0.0052	-
Bread ²	kg/day	0.1311	logn(mean=0.1311,sd=0.079,trmin=0,trmax=0.6964)
Bread rolls ²	kg/day	0.0180	
Cakes ²	kg/day	0.0080	-
Rusks ²	kg/day	0.0022	
Pasta ²	kg/day	0.0245	
Rice ²	kg/day	0.0068	
Other cereals ²	kg/day	0.0013	
Liver ²	kg/day	0.0002	-
Kidney ²	kg/day	7E-06	
Horsemeat ²	kg/day	0.0017	-
Poultry ²	kg/day	0.0364	-
Coffee ²	kg/day	0.6262	logn(mean=0.6262,sd=0.5262,trmin=0,trmax=3.75)
Tea ²	kg/day	0.1357	-
Tap water ²	L/day	0.2240	logn(mean=0.2240,sd=0.4437,trmin=0,trmax=3.6)
Bottled water ²	L/day	0.7441	logn(mean=0.7441,sd=0.6327,trmin=0,trmax=4)
Soup ²	kg/day	0.2417	logn(mean=0.2417,sd=0.1372,trmin=0,trmax=1.5)
Other drinks ²	kg/day	0.0452	-
Potato ²	kg/day	0.0178	<u>.</u>

Medium	Unit	Average	PDF
Carrot ²	kg/day	0.0060	-
Scorzonera ²	kg/day	0.0006	-
Radish ²	kg/day	0.0002	-
Spinach ²	kg/day	0.0016	-
Endive ²	kg/day	0.0003	-
Celery ²	kg/day	0.0025	-
Celeriac ²	kg/day	0.0010	-
Lettuce ²	kg/day	0.0047	-
Leek ²	kg/day	0.0044	-
Onion ²	kg/day	0.0066	-
Belgian endive ²	kg/day	0.0040	-
Brussels sprouts ²	kg/day	0.0012	-
Cabbage ²	kg/day	0.0028	-
Savoy cabbage ²	kg/day	0.0009	-
Cauliflower ²	kg/day	0.0030	-
Broccoli ²	kg/day	0.0028	-
Bean ²	kg/day	0.0027	-
Tomato ²	kg/day	0.0293	-
Pea ²	kg/day	0.0032	-

¹ Van Holderbeke et al. (2008) – ² confidential, unpublished results from the monitoring campaign.

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Medium	Unit	Adult_1	Adult _2	Adult _3	Adult _4	Adult _5	Adult _6	Adult _7	Adult _8	Adult _9	Adult _10
Adults living in industrial area											
Soil ¹	mg/day	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Dust ¹	mg/day	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
Local leaf ²	kg/day	0.0000	0.0655	0.0237	0.0000	0.0000	0.0031	0.0407	0.0119	0.0000	0.0094
Local root ²	kg/day	0.0000	0.0062	0.0059	0.0000	0.0000	0.0022	0.0047	0.0040	0.0000	0.0000
Local potato ²	kg/day	0.0000	0.0231	0.0000	0.0000	0.0000	0.0145	0.0129	0.0223	0.0000	0.0129
Breakfast cereals ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0143	0.0000	0.0371	0.0000
Bread ²	kg/day	0.1671	0.2786	0.2786	0.2786	0.1671	0.1114	0.0771	0.0557	0.1114	0.2229
Bread rolls ²	kg/day	0.0229	0.0171	0.0100	0.0229	0.0114	0.0100	0.0229	0.0286	0.0114	0.0714
Cakes ²	kg/day	0.0000	0.0000	0.0000	0.0107	0.0000	0.0268	0.0025	0.0000	0.0000	0.0214
Rusks ²	kg/day	0.0107	0.0000	0.0000	0.0093	0.0000	0.0010	0.0000	0.0000	0.0000	0.0000
Pasta ²	kg/day	0.0100	0.0000	0.0536	0.0197	0.0042	0.0286	0.0143	0.0000	0.0197	0.0214
Rice ²	kg/day	0.0086	0.0069	0.0040	0.0016	0.0030	0.0086	0.0016	0.0040	0.0069	0.0103
Other cereals ²	kg/day	0.0000	0.0000	0.0016	0.0000	0.0000	0.0020	0.0012	0.0000	0.0000	0.0051
Liver ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0041	0.0000	0.0000
Kidney ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Horsemeat ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Poultry ²	kg/day	0.0286	0.0214	0.0214	0.0220	0.0357	0.0214	0.0536	0.0220	0.0551	0.0286
Coffee ²	kg/day	0.7500	0.1500	0.7500	0.0000	0.6000	0.7500	0.5000	0.2500	0.2500	0.5000
Tea ²	kg/day	0.0000	0.4500	0.3000	0.0000	0.5000	0.1500	0.0000	0.0000	0.7500	0.0000
Tap water ²	L/day	1.2000	0.6000	0.6000	0.0000	1.8000	0.8000	0.0000	0.4000	0.0000	0.0000
Bottled water ²	L/day	0.0000	0.0000	0.8000	1.6000	0.0000	0.0000	1.2000	0.0000	0.4000	0.4000
Soup ²	kg/day	0.5000	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500

Table 22: Average ingestion rates of soil, dust, local and external/purchased food products used in scenarios 9 and 10.

Medium	Unit	Adult_1	Adult _2	Adult _3	Adult _4	Adult _5	Adult _6	Adult _7	Adult _8	Adult _9	Adult _10
Other drinks ²	kg/day	0.4000	0.0000	0.0000	0.8000	0.0000	0.4000	0.0000	0.0000	0.0000	0.0000
Potato ²	kg/day	0.0309	0.0000	0.0386	0.0223	0.0043	0.0087	0.0000	0.0000	0.0043	0.0000
Carrot ²	kg/day	0.0115	0.0000	0.0059	0.0029	0.0206	0.0013	0.0000	0.0000	0.0049	0.0074
Scorzonera ²	kg/day	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0004	0.0012	0.0012
Radish ²	kg/day	0.0000	0.0000	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000
Spinach ²	kg/day	0.0012	0.0012	0.0016	0.0016	0.0020	0.0020	0.0040	0.0008	0.0051	0.0003
Endive ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000
Celery ²	kg/day	0.0000	0.0000	0.0006	0.0008	0.0111	0.0000	0.0000	0.0000	0.0000	0.0000
Celeriac ²	kg/day	0.0000	0.0008	0.0040	0.0000	0.0008	0.0000	0.0016	0.0000	0.0000	0.0012
Lettuce ²	kg/day	0.0069	0.0000	0.0086	0.0069	0.0129	0.0008	0.0000	0.0000	0.0020	0.0069
Leek ²	kg/day	0.0040	0.0000	0.0006	0.0040	0.0010	0.0000	0.0000	0.0000	0.0000	0.0011
Onion ²	kg/day	0.0017	0.0000	0.0008	0.0043	0.0043	0.0020	0.0000	0.0004	0.0000	0.0017
Belgian endive ²	kg/day	0.0075	0.0000	0.0099	0.0024	0.0064	0.0004	0.0052	0.0000	0.0072	0.0008
Brussels sprouts ²	kg/day	0.0024	0.0000	0.0016	0.0016	0.0000	0.0000	0.0016	0.0008	0.0000	0.0000
Cabbage ²	kg/day	0.0040	0.0016	0.0020	0.0016	0.0030	0.0000	0.0000	0.0008	0.0012	0.0030
Savoy cabbage ²	kg/day	0.0000	0.0012	0.0020	0.0016	0.0030	0.0000	0.0016	0.0000	0.0000	0.0000
Cauliflower ²	kg/day	0.0016	0.0012	0.0040	0.0016	0.0030	0.0012	0.0000	0.0012	0.0012	0.0040
Broccoli ²	kg/day	0.0016	0.0012	0.0040	0.0016	0.0012	0.0051	0.0016	0.0000	0.0008	0.0040
Bean ²	kg/day	0.0016	0.0000	0.0013	0.0008	0.0051	0.0011	0.0000	0.0000	0.0020	0.0032
Tomato ²	kg/day	0.0158	0.0000	0.0051	0.0055	0.2100	0.0140	0.0033	0.0000	0.0237	0.0176
Pea ²	kg/day	0.0032	0.0000	0.0010	0.0026	0.0018	0.0045	0.0000	0.0006	0.0025	0.0032
Fish ^{1,3}	kg/day	0.0259	0.0259	0.0259	0.0259	0.0226	0.0259	0.0226	0.0259	0.0259	0.0259
Adults living in surrounding area											
Soil ¹	mg/day	22.5	22.5	26.6	22.5	22.5	22.5	22.5	22.5	22.5	22.5

Medium	Unit	Adult_1	Adult _2	Adult _3	Adult _4	Adult _5	Adult _6	Adult _7	Adult _8	Adult _9	Adult _10
Dust ¹	mg/day	27.5	27.5	32.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
Local leaf ²	kg/day	0.0000	0.0011	0.0000	0.0673	0.0244	0.0000	0.0117	0.0383	0.0169	0.0308
Local root ²	kg/day	0.0000	0.0001	0.0000	0.0063	0.0129	0.0000	0.0000	0.0092	0.0036	0.0000
Local potato ²	kg/day	0.0000	0.0000	0.0000	0.0154	0.0000	0.0000	0.0463	0.0077	0.0174	0.0000
Breakfast cereals ²	kg/day	0.0000	0.0000	0.0143	0.0033	0.0000	0.0057	0.0000	0.0000	0.0000	0.0000
Bread ²	kg/day	0.1114	0.1114	0.0836	0.1671	0.1114	0.0418	0.1114	0.1671	0.1114	0.6686
Bread rolls ²	kg/day	0.0100	0.0114	0.0114	0.0571	0.0429	0.0114	0.0057	0.0114	0.0067	0.0571
Cakes ²	kg/day	0.0000	0.0000	0.0063	0.0063	0.0268	0.0000	0.0000	0.0107	0.0268	0.0000
Rusks ²	kg/day	0.0000	0.0000	0.0257	0.0008	0.0013	0.0000	0.0000	0.0000	0.0029	0.0075
Pasta ²	kg/day	0.0083	0.0357	0.0536	0.0214	0.0143	0.0286	0.0197	0.0115	0.0115	0.0197
Rice ²	kg/day	0.0040	0.0050	0.0040	0.0000	0.0069	0.0020	0.0016	0.0040	0.0040	0.0069
Other cereals ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0051	0.0000
Liver ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kidney ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Horsemeat ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.1393	0.0000	0.0000
Poultry ²	kg/day	0.0804	0.0214	0.0214	0.0357	0.0536	0.0001	0.0214	0.0050	0.0220	0.0125
Coffee ²	kg/day	1.0000	0.0000	0.0000	0.9000	3.0000	1.0000	0.7500	1.2500	1.0000	1.1500
Tea ²	kg/day	0.0000	0.0000	0.2500	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000
Tap water ²	L/day	0.6000	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2000	0.0000
Bottled water ²	L/day	0.0000	1.2000	0.8000	0.4000	1.2000	0.0000	1.4000	0.4000	0.0000	0.0000
Soup ²	kg/day	0.2500	0.2500	0.2500	0.2500	0.0000	0.2500	0.0000	0.0000	0.2500	0.2500
Other drinks ²	kg/day	0.0000	0.0000	0.0000	0.6000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2000
Potato ²	kg/day	0.0154	0.0231	0.0386	0.0000	0.0223	0.0086	0.0000	0.0231	0.0058	0.0077
Carrot ²	kg/day	0.0024	0.0043	0.0051	0.0000	0.0074	0.0036	0.0136	0.0051	0.0022	0.0066
Scorzonera ²	kg/day	0.0016	0.0000	0.0000	0.0000	0.0020	0.0016	0.0016	0.0000	0.0000	0.0012

Medium	Unit	Adult_1	Adult _2	Adult _3	Adult _4	Adult _5	Adult _6	Adult _7	Adult _8	Adult _9	Adult _10
Radish ²	kg/day	0.0000	0.0009	0.0000	0.0000	0.0003	0.0000	0.0000	0.0003	0.0000	0.0000
Spinach ²	kg/day	0.0000	0.0012	0.0040	0.0000	0.0030	0.0050	0.0000	0.0002	0.0006	0.0020
Endive ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0009	0.0016
Celery ²	kg/day	0.0000	0.0000	0.0016	0.0000	0.0030	0.0000	0.0060	0.0000	0.0003	0.0040
Celeriac ²	kg/day	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0024	0.0000	0.0003	0.0008
Lettuce ²	kg/day	0.0171	0.0026	0.0034	0.0000	0.0064	0.0171	0.0030	0.0000	0.0000	0.0034
Leek ²	kg/day	0.0020	0.0000	0.0016	0.0000	0.0030	0.0000	0.0050	0.0000	0.0000	0.0040
Onion ²	kg/day	0.0309	0.0012	0.0086	0.0000	0.0309	0.0010	0.0064	0.0011	0.0020	0.0000
Belgian endive ²	kg/day	0.0088	0.0038	0.0030	0.0048	0.0217	0.0019	0.0050	0.0000	0.0015	0.0011
Brussels sprouts ²	kg/day	0.0016	0.0000	0.0012	0.0000	0.0020	0.0020	0.0040	0.0000	0.0030	0.0016
Cabbage ²	kg/day	0.0012	0.0012	0.0016	0.0030	0.0086	0.0040	0.0012	0.0051	0.0020	0.0000
Savoy cabbage ²	kg/day	0.0012	0.0000	0.0000	0.0008	0.0069	0.0000	0.0000	0.0000	0.0008	0.0040
Cauliflower ²	kg/day	0.0030	0.0012	0.0069	0.0012	0.0040	0.0086	0.0040	0.0012	0.0008	0.0000
Broccoli ²	kg/day	0.0012	0.0020	0.0069	0.0000	0.0030	0.0000	0.0016	0.0000	0.0012	0.0171
Bean ²	kg/day	0.0050	0.0006	0.0016	0.0000	0.0021	0.0086	0.0050	0.0000	0.0015	0.0040
Tomato ²	kg/day	0.0214	0.0147	0.0113	0.0574	0.2837	0.0536	0.0128	0.0000	0.0075	0.0000
Pea ²	kg/day	0.0004	0.0045	0.0008	0.0035	0.0321	0.0023	0.0030	0.0000	0.0014	0.0020
Fish ^{1,3}	kg/day	0.0259	0.0259	0.0226	0.0226	0.0259	0.0226	0.0259	0.0259	0.0259	0.0226
Adults living in reference area											
Soil ¹	mg/day	22.5	26.6	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Dust ¹	mg/day	27.5	32.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
Local leaf ²	kg/day	0.0000	0.0408	0.0000	0.0574	0.2416	0.0000	0.0642	0.0362	0.0000	0.0135
Local root ²	kg/day	0.0000	0.0109	0.0000	0.0151	0.0074	0.0000	0.0135	0.0025	0.0000	0.0000
Local potato ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0129	0.0000	0.0000	0.0064	0.0000	0.0000

Medium	Unit	Adult_1	Adult _2	Adult _3	Adult _4	Adult _5	Adult _6	Adult _7	Adult _8	Adult _9	Adult _10
Breakfast cereals ²	kg/day	0.0000	0.0371	0.0743	0.0000	0.0000	0.0114	0.0000	0.0000	0.0057	0.0000
Bread ²	kg/day	0.0771	0.0836	0.1671	0.2786	0.1114	0.0771	0.2786	0.0771	0.0964	0.1671
Bread rolls ²	kg/day	0.0171	0.0114	0.0114	0.0229	0.0114	0.0114	0.0229	0.0429	0.0229	0.0286
Cakes ²	kg/day	0.0214	0.0025	0.0214	0.0000	0.0000	0.0000	0.0063	0.0063	0.0804	0.0050
Rusks ²	kg/day	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0036	0.0007	0.0000	0.0010
Pasta ²	kg/day	0.0104	0.0179	0.0286	0.0214	0.0115	0.0197	0.0197	0.0197	0.0179	0.0357
Rice ²	kg/day	0.0060	0.0086	0.0103	0.0171	0.0069	0.0008	0.0069	0.0069	0.0000	0.0069
Other cereals ²	kg/day	0.0000	0.0012	0.0034	0.0000	0.0000	0.0000	0.0000	0.0000	0.0334	0.0012
Liver ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kidney ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Horsemeat ²	kg/day	0.0000	0.0000	0.0169	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000
Poultry ²	kg/day	0.1857	0.0143	0.0571	0.0357	0.0128	0.0536	0.0214	0.0536	0.0357	0.0000
Coffee ²	kg/day	0.7500	0.0000	0.7500	0.6000	0.6000	0.0000	0.7500	0.9000	0.5000	0.1500
Tea ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000
Tap water ²	L/day	0.0000	0.0000	0.8000	0.0000	0.8000	0.0000	0.0000	0.0000	0.0000	1.4000
Bottled water ²	L/day	0.0000	0.8000	0.0000	0.6000	0.0000	1.2000	1.2000	0.4000	0.0000	0.0000
Soup ²	kg/day	0.0000	0.2500	0.2500	0.2500	0.2500	0.2500	0.5000	0.2500	0.2500	0.2500
Other drinks ²	kg/day	0.0000	0.0000	0.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Potato ²	kg/day	0.0231	0.0017	0.0129	0.0463	0.0000	0.0154	0.0386	0.0021	0.0446	0.0129
Carrot ²	kg/day	0.0073	0.0000	0.0028	0.0000	0.0000	0.0051	0.0000	0.0015	0.0066	0.0053
Scorzonera ²	kg/day	0.0024	0.0000	0.0000	0.0012	0.0000	0.0008	0.0002	0.0008	0.0030	0.0000
Radish ²	kg/day	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010
Spinach ²	kg/day	0.0050	0.0000	0.0012	0.0000	0.0030	0.0008	0.0002	0.0000	0.0016	0.0004
Endive ²	kg/day	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000
Celery ²	kg/day	0.0008	0.0000	0.0051	0.0000	0.0000	0.0008	0.0034	0.0043	0.0016	0.0004

Medium	Unit	Adult_1	Adult _2	Adult _3	Adult _4	Adult _5	Adult _6	Adult _7	Adult _8	Adult _9	Adult _10
Celeriac ²	kg/day	0.0000	0.0000	0.0012	0.0034	0.0000	0.0008	0.0000	0.0004	0.0012	0.0000
Lettuce ²	kg/day	0.0008	0.0000	0.0051	0.0000	0.0000	0.0043	0.0021	0.0021	0.0034	0.0000
Leek ²	kg/day	0.0012	0.0000	0.0012	0.0000	0.0000	0.0012	0.0039	0.0032	0.0012	0.0004
Onion ²	kg/day	0.0043	0.0000	0.0034	0.0000	0.0000	0.0017	0.0021	0.0021	0.0043	0.0034
Belgian endive ²	kg/day	0.0006	0.0000	0.0015	0.0000	0.0038	0.0041	0.0035	0.0004	0.0000	0.0000
Brussels sprouts ²	kg/day	0.0024	0.0000	0.0012	0.0012	0.0000	0.0012	0.0000	0.0008	0.0012	0.0000
Cabbage ²	kg/day	0.0050	0.0000	0.0012	0.0030	0.0000	0.0030	0.0050	0.0026	0.0069	0.0020
Savoy cabbage ²	kg/day	0.0016	0.0000	0.0012	0.0012	0.0000	0.0012	0.0000	0.0000	0.0030	0.0000
Cauliflower ²	kg/day	0.0020	0.0008	0.0012	0.0030	0.0000	0.0030	0.0015	0.0015	0.0030	0.0020
Broccoli ²	kg/day	0.0020	0.0034	0.0012	0.0000	0.0016	0.0034	0.0040	0.0015	0.0040	0.0020
Bean ²	kg/day	0.0050	0.0000	0.0012	0.0000	0.0000	0.0020	0.0020	0.0008	0.0030	0.0017
Tomato ²	kg/day	0.0015	0.0099	0.0109	0.0056	0.0000	0.0561	0.0089	0.0147	0.0000	0.0033
Pea ²	kg/day	0.0025	0.0000	0.0020	0.0000	0.0000	0.0000	0.0033	0.0035	0.0045	0.0030
Fish ^{1,3}	kg/day	0.0259	0.0226	0.0259	0.0259	0.0259	0.0226	0.0259	0.0226	0.0259	0.0259

¹ Van Holderbeke et al. (2008) – ² confidential, unpublished results from the monitoring campaign – ³ only considered in scenario 10.

Table 23: Initial ages (average and PDF) used in scenarios 1-6 and 8 (reference: confidential, unpublished results from the monitoring campaign).

	Unit	Average initial age	PDF
Industrial area			
Preschool children	у	3.03	logn(mean=3.03,sd=1.11,trmin=1.0,trmax=5.0)
Adults	у	48.36	logn(mean=48.36,sd=15.41,trmin=18,trmax=77)
Surrounding area			
Preschool children	у	3.12	logn(mean=3.12,sd=1.02,trmin=1.0,trmax=5.0)
Adults	у	48.35	logn(mean=48.35,sd=15.33,trmin=18,trmax=78)
Reference area			
Preschool children	у	3.14	logn(mean=3.14,sd=1.11,trmin=1.0,trmax=5.0)
Adults	у	47.91	logn(mean=47.91,sd=15.85,trmin=18,trmax=77)

Table 24: Initial ages used in scenarios 7, 9 and 10 (reference: confidential, unpublished results from the monitoring campaign).

Initial age (y)	N° 1	N° 2	N° 3	N° 4	N° 5	N° 6	N° 7	N° 8	N° 9	N° 10
Industrial area										
Preschool children	3	2	2	5	4	1	3	3	2	2
Adults	45	71	71	41	65	39	29	45	48	33
Surrounding area										
Preschool children	4	2	3	2	4	4	1	3	3	3
Adults	49	40	19	62	35	48	61	63	71	47
Reference area										
Preschool children	2	2	3	3	4	3	3	4	5	4
Adults	41	20	45	52	68	27	28	47	23	21

Table 25: Input parameter data for the external PBPK model used in scenario 8 (reference: confidential, unpublished results from the monitoring campaign).

Parameter	Unit	Average value for male population	Average value for female population
Adults living in industrial area			
Gender distribution	%	49.88	50.12
Age	у	49.26	49.46
Body weight	kg	81.32	69.13

Adults living in surrounding

area

Parameter	Unit	Average value for male population	Average value for female population
Gender distribution	%	50.74	49.26
Age	у	50.53	47.89
Body weight	kg	80.39	67.89
Adults living in reference area			
Gender distribution	%	45.84	54.16
Age	у	50.14	47.95
Body weight	kg	82.57	68.43

Parameter	Unit	Adult_1	Adult_2	Adult_3	Adult_4	Adult_5	Adult_6	Adult_7	Adult_8	Adult_9	Adult_10
Adults living in industrial area											
Gender	-	man	man	man	man	woman	man	woman	man	man	man
Age	у	46	72	72	42	66	40	30	46	49	34
Body weight	kg	77	54	69	105	66	80	64	121	116	92
Adults living in surrounding area											
Gender distribution	-	man	man	woman	woman	man	woman	man	man	man	woman
Age	у	50	41	20	63	36	49	62	64	72	48
Body weight	kg	68	80	56	82	105	64.5	70	88	80	73.5
Adults living in reference area											
Gender distribution	-	man	woman	man	man	man	woman	man	woman	man	man
Age	у	42	21	46	53	69	28	29	48	24	22
Body weight	kg	79.5	59	64	99	85	81	86	72	74	76

Table 26: Input parameter data for the external PBPK model used in scenarios 9 and 10 (reference: confidential, unpublished results from the monitoring campaign).