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EnviRisk

Report providing an economic assessment of protocols looking at available options

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Preface

This report is a deliverable of a project ENVIRISK (Assessing the Risks of Environmental Stressors: Contribution to Development of Integrating Methodology). ENVIRISK is funded under the EU 6th Framework Programme for R & D Priority 8.1 Policy-oriented research, Contract No. SSPE-CT-2005-044232. The aim of ENVIRISK is to develop an integrated methodological framework for identification of health risks caused by exposure to environmental factors, with a view to provide useful information for prevention and targeted policy measures. The framework include the development and piloting of protocols and methodologies for exposure assessment and health impact assessment in specified areas relevant to the implementation of the European Environment & Health Action Plan (EHAP).

The ENVIRISK contains seven partners:

- Norwegian Institute for Air Research (NILU), Dr. Alena Bartonova, Project Coordinator
- National Institute for Health and Welfare (THL), Prof. Matti Jantunen, Principal Investigator
- Institute of Experimental Medicine, Academy of Science of the Czech Republic (IEM), Dr. Radim Sram, Principal Investigator
- Slovak Medical University, Research Base (SMU), Prof. Tomas Trnovec, Principal Investigator
- Regional Institute of Public Health, Kolin (ZUKOLIN), Dr. Eva Rychlikova, Principal Investigator
- Technion Israel Institute of Technology, Dr. David Broday, Principal Investigator
- University of Hertfordshire, Prof. Ranjeet Sokhi, Principal Investigator

ENVIRISK has three scientific work packages:

- WP 1-Data and techniques for realistic exposure assessment
- WP 2-Relations between exposure and health
- WP 3-Dissemination and contribution to EHIS

This report is one of WP 1 tasks. It includes three chapters. First, define the exposure scenarios, methods and protocols for both PAHs and PCBs. Second, summarize the data needs and describe the available data. Third, analyze the cost for data and information gathering relevant for methods and protocols in several countries. The aim is to provide the relevant information for assessing the available options for protocols in the view of providing a cost-benefit recommendation for exposure and health impact assessment.

For more information, please visit ENVIRISK website at http://envirisk.nilu.no or contact the coordinator Dr. Alena Bartonova, E-mail: aba@nilu.no.

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1 Introduction

This report includes three chapters. First, define the exposure scenarios, methods and protocols for both PAHs and PCBs. Second, summarize the data needs and describe the available data. Third, analyze the cost for data and information gathering relevant for methods and protocols in several countries. The aim is to provide the relevant information for assessing the available options for protocols in the view of providing a cost-benefit recommendation for exposure and health impact assessment.

2 Exposure scenarios and relevant methods and protocols

2.1 Exposure scenarios

It is well known that the effects of exposure to any hazardous substance depend on the dose (how much), the duration (how long), how you are exposed (breathing, eating, drinking, or skin contact), personal traits (such as age, sex, nutritional status, family traits, lifestyle, and state of health) and habits, and whether other chemicals are present. Figure 1 illustrates the scope and elements for the exposure assessment to any hazardous substance.

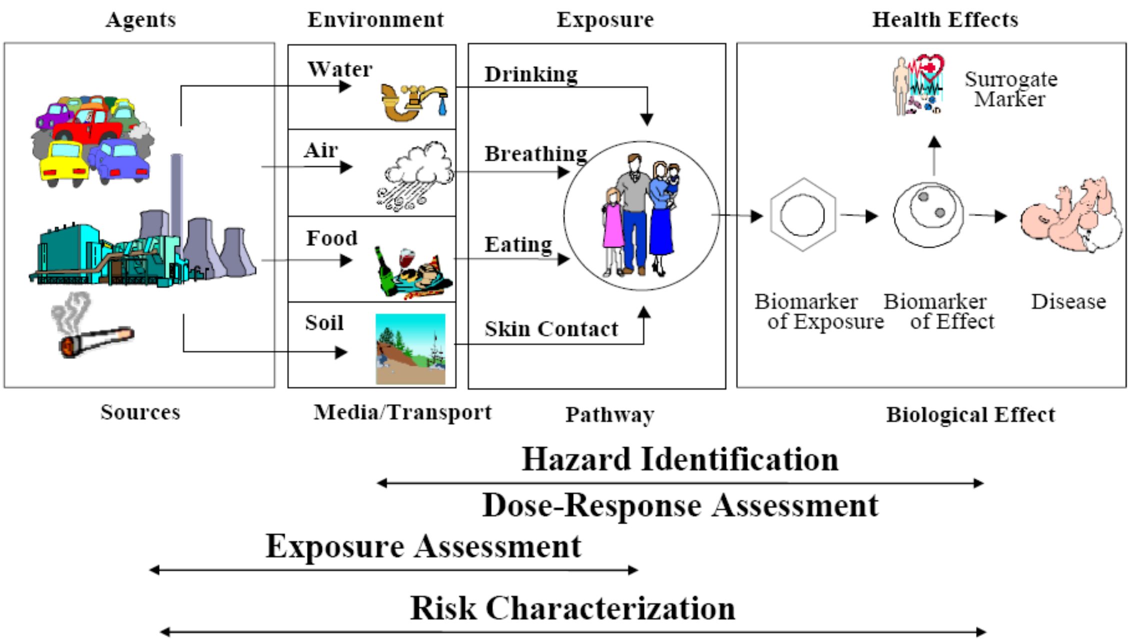

Figure 1 Environmental health risk assessment (Robb 2006)

In the following two parts, we summarized the factors which may determine whether harmful health effects will occur and what the type of those health effects will be for both PAHs and PCBs.

2.1.1 Exposure scenarios for PAHs

Based on the input from D1.1, D1.2 and D1.3 and exposure scenario platform from KTL (http://www.ktl.fi/expoplatform/home_ui). We scoped a general exposure scenario for PAHs, without specifying the time, place/area and geographical scale (Table 1).

Table 1: Scope and elements for general exposure scenario to PAHs.

Agent	✓ **PAHs (all relevant compounds)**
Source /Activity	✓ Traffic ✓ Residential heating ✓ Long-range transport ✓ Industrial ✓ Agricultural ✓ Natural ✓ Environmental tobacco smoke (ETS)
Time Scale	✓ Long term ✓ Short Term
Place /Area	✓ Any (home, outside, workplace)
Geographical Scale	✓ Any local, urban and rural
Population	✓ All ✓ Occupational exposure (e.g. police men) ✓ Pregnant women ✓ Children
Release Media	✓ Air ✓ Water ✓ Soil
Route/pathway of Exposure	✓ Inhalation (breathing) ✓ Ingestion (drinking and eating) ✓ Dermal contact (skin contact)
Contact Media/transport	✓ Air ✓ Water ✓ Soil ✓ Food
Contact Duration Frequency	✓ Time activity data (in different microenvironments)
Associated Health Effects	✓ Cancer ✓ Genotoxicity ✓ Bronchitis ✓ Enhance of Alergic Inflammation ✓ Increase Risk of Cardiopulmonary mortality ✓ Intrauterine growth retardation ✓ Short term exposure symptoms: irritation, nausea, vomiting, diarrhea and confusion

2.1.2 Exposure scenarios for PCBs

Based on the input from D1.1, D1.2 and D1.3, and exposure scenario platform from KTL (http://www.ktl.fi/expoplatform/home_ui). We scoped a general exposure scenario for PCBs, without specifying the time, place/area and geographical scale (Table 2).

Table 2. Scope and elements for general exposure scenario to PCBs.

Agent	✓ **PCBs (all relevant compounds)**
Source /Activity	✓ Electrical equipment (capacitors and transformers) ✓ Waste incineration ✓ Metal smelting (open-health, converter, electric) ✓ Coal combustion
Time Scale	✓ Long term ✓ Short term
Place /Area	✓ Any
Geographical scale	✓ Any local, urban and rural
Population	✓ All ✓ Children ✓ Fishermen ✓ Groups using home grown foods
Release Media	✓ Soil ✓ Sediment ✓ Water ✓ Air
Route of Exposure	✓ Ingestion ✓ Dermal routes ✓ Inhalation
Contact Media	✓ Food ✓ Air ✓ Water ✓ Soil ✓ Equipment
Contact Duration Frequency	✓ Exposure frequency: days/year ✓ Exposure duration: years
Associated health effects	✓ Increased thyroid volume ✓ Hearing problems ✓ Dental problems ✓ Cancer

2.2 *Methods and protocols needs*

This chapter described how we actually perform the exposure calculations for both PAHs and PCBs. The more detail description of methods and modeling tools can be found in D1.1.

Before we actually perform the exposure calculations by using exposure models, first consideration is the source categories of a hazard agent; another consideration is the medium complexity of the exposure. A general exposure assessment protocol is described in Figure 2.

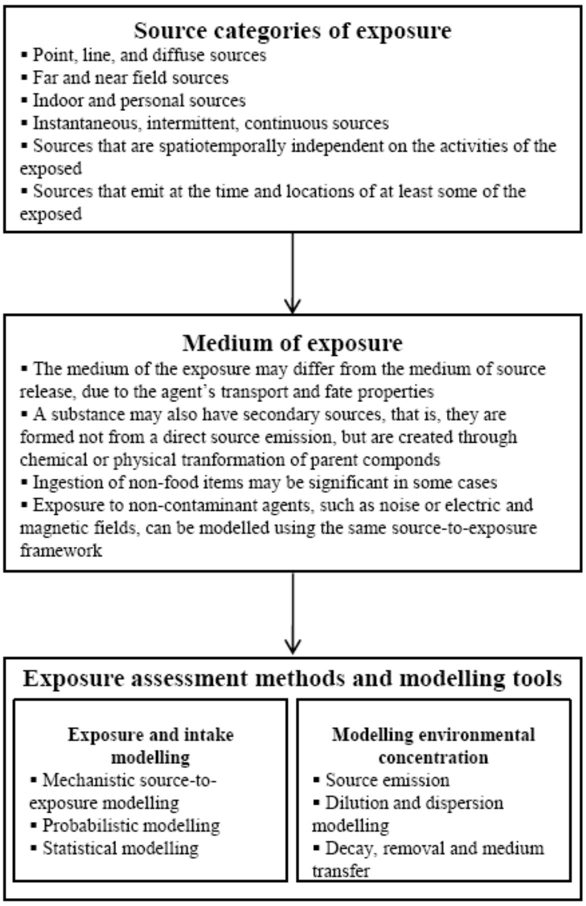

Figure 2 A **g**eneral exposure assessment protocols

The type of models are divided into five categories (Table 3): dispersion models, time-microenvironment activity models for inhalation exposures, probabilistic intake models (generally for multi-route exposures), multi-pathway and food chain models (for modelling source-to-intake transfers), and regression models. Probabilistic intake models tend to model individual-level exposures with greater detail, while multi-pathway and food chain models tend to be on a larger scale (e.g. regional), and often are based on a compartment modelling approach.

Table 3 Model description by category

Type	Name	Source	Description
Dispersion models	CALPUFF	http://www.src.com	CALPUFF is a multi-layer, multi-species, non-steady state puff dispersion model which can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF consists of three main components: CALMET, which is a diagnostic 3-dimensional meteorological model, CALPUFF, an air quality dispersion model and CALPOST, a post processing package. CALPUFF can handle point sources (constant or variable emissions), line sources (constant emissions), volume sources (constant or variable emissions with 1-hour time constant) and area sources.
	AERMOD	http://www.epa.gov	AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. There are two input data processors that are regulatory components of the AERMOD modelling system: AERMET, a meteorological data pre-processor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP, a terrain data pre-processor that incorporates complex terrain using USGS Digital Elevation Data.
	AURORA	http://www.vito.be	The AURORA model consists of several modules. The emission generator of AURORA calculates hourly pollutant emissions at the desired resolution, based on available emission data, and proxy data to allow for proper downscaling of coarse data. Vehicle emissions can be generated by coupling the MIMOSA road traffic emission model to the emission generator. The actual Chemistry Transport Model then uses the hourly meteorological input data and emission data to predict the dynamic behaviour of air pollutants (both gaseous and particulate) in the model region. This results in hourly three-dimensional concentration and two-dimensional deposition fields for all species of interest. Available on request for research purposes.
	CAMx	http://www.camx.com	CAMx is an Eulerian photochemical dispersion model that allows for integrated "one-atmosphere" assessments of gaseous and particulate air pollution (ozone, PM2.5, PM10, air toxics) over many scales ranging from sub-urban to continental. It is designed to unify all of the technical features required of "state-of-the-science" air quality models into a single system that is computationally efficient, easy to use, and publicly available. CAMx can be provided environmental input fields from any meteorological model (e.g., MM5, RAMS, and WRF) and emission inputs from any emissions processor (SMOKE, CONCEPT, EPS, EMS).

Type	Name	Source	Description
	UDM-FMI, CAR-FMI and EXPAND	http://pandora.meng.auth.gr	For the assessments of air pollutant (NO_2, NO, O_3, $PM_{2.5}$, CO, and SO_2) concentrations in urban areas, a more extensive modelling system has been developed for evaluating traffic flows, emissions from stationary and vehicular sources, and atmospheric dispersion of pollution in an urban area. The dispersion modelling is based on combined application of the Urban Dispersion Modelling system (UDM-FMI) and the road network dispersion model (CAR-FMI), developed at FMI. The modelling system has been extended to contain a mathematical model for determination of human exposure to ambient air pollution in an urban area (EXPAND). These models are available within research co-operation
Time-microenvironment activity models	MENTOR/SHEDS	Georgopoulos PG et al. Journal of Exposure Analysis and Environmental Epidemiology, (2005) 15, 439-457	These models estimate population exposure and dose by calculating ambient outdoor concentrations and subsequent in-microenvironment concentrations, characterizing populations by demographics and their associated time-activity patterns and inhalation rates, and in some cases using biologically-based modelling to estimate target tissue dose. The model is essentially a joint application of concentration, exposure and dosimetry models and databases. Mass balance and indoor source emission factors are used to estimate indoor concentrations from both indoor and outdoor sources. Outdoor concentrations may be derived from measurement or dispersion modelling. Time-activity is based on diary days (not distributional). Model is stochastic.
	STEMS	Gulliver J and DJ Briggs. Environmental Research (2005) 97(1), 10-25.	STEMS models a time series of exposure from a specific source (or sources) to a specific individual across his/her movement paths and locations over a specific time span. For input data STEMS requires air pollution source and/or concentration data of high space and time resolution (See Dispersion Models fact sheet), and respective path and location data (e.g. from GPS) of the individual(s) whose exposure is/are being modelled. It is possible to model also indoor exposures to air pollutants of outdoor origin (See Ventilation/dilution Modelling fact sheet). It is also possible to run STEMS in a probabilistic modelling mode using the activities, paths and locations of simulated individuals. A disadvantage, however, is that running STEMS for an extended time and large number of individuals – representing a population – is a quite data intensive process.
	EXPOLIS	Kruize H, et al. Journal of Exposure Analysis and Environmental Epidemiology (2003) 13 (2): 87-99.	Probabilistic application using Latin hypercube sampling of a simple microenvironment model was used to estimate population exposures to PM10 in the Dutch population and PM2.5 exposure distributions in four European cities. Model was developed using Microsoft Excel with the @Risk add-on. The model is best for 24-hour or more averaging times. Input data were measured indoors and outdoors at home and indoors at work with participant time activity data to model personal exposure from the EXPOLIS study. Both time activity and concentration distributions were developed.
Probabilistic intake models	SHEDS models	Zartarian, V. G., H. Ozkaynak, et al. Environ Health Perspect (2000), 108(6): 505-14	Available for various applications in different media, such as particulate matter and pesticides; also part of MENTOR/SHEDS toolbox for source-to-dose modelling; dermal and non-dietary exposure models developed for home pesticide use and arsenic in playground equipment for children.

Type	Name	Source	Description
	CONSEXPO	http://www.rivm.nl	Developed by RIVM, the Dutch National Institute for Public Health and the Environment, CONSEXPO is a model that allows for estimation of exposure or intake for several classes of consumer products and various use scenarios. The model is available in both deterministic and stochastic versions.
Multimedia and Food Chain Models	WATSON	Bachmann, 2006	WATSON facilitates the coverage of exposures towards hazardous substances, i.e. heavy metals, through ingestion of various food items in a spatially-resolved pan-European setting by following the Impact Pathway Approach (IPA). The overall method relies on a coupled set of environmental fate models for air on the one hand and for soil and (fresh) water on the other, the latter described with the help of a spatially-resolved climatological box model similar to Mackay level III/IV models (Mackay, 1991). The estimation of ingestion-related exposures builds on the site-specific risk assessment approach recommended by the US-EPA for hazardous waste combustion facilities (United States - Environmental Protection Agency, 1998), thereby striving for representative rather than for protective estimates. The exposure assessment follows administrative units taking the availability of food and population data into account. Trade is considered as an extension of the (natural) environmental fate.
	IMPACT 2002	Pennington et al., 2005; Jolliet et al., 2003; Pelichet, 2003 http://www.sph.umich.edu	A delineation of the atmosphere according to a grid is suggested which is in line with many existing air quality models for larger scales (Pekar et al., 1999; Green et al., 2000; Bey et al., 2001; Ilyin et al., 2001) and with global water balance models (e.g. Vörösmarty et al., 1998). While the sea environment also follows the grid delineation for air, the terrestrial environment is spatially differentiated in IMPACT 2002 according to watersheds. For human health, different exposure pathways are aggregated into the so-called Intake Fraction (Bennett et al., 2002) which assesses the portion of an emission that a population will be finally exposed to. The effects on human health due to the estimated exposure are assessed following the Disability Adjusted Life Years (DALY) concept (Murray and Lopez, 1996a, 1996b).
	TRIM	United States - Environmental Protection Agency, 1999a, 1999b, 2002a, 2002b http://www.epa.gov	The TRIM design offers a rather flexible framework for the assessment of so-called hazardous and criteria air pollutants, examples for the latter are particulate matter (PM), ozone, carbon monoxide, nitrogen oxides, sulphur dioxide, and lead. The flexibility is realized, for instance, by the capability of using different environmental fate models that may be based on first-order or higher order algorithms. While aiming at multimedia capabilities, the modular design may even allow the use of single medium models, i.e. Gaussian plume models for air. In addition to providing exposure estimates relevant to ecological risk assessment, TRIM generates media concentrations relevant to human ingestion exposures that can be used as input to the ingestion component of the Exposure-Event module. Human exposures are evaluated by tracking either randomly selected individuals that represent an area\'s population or population groups referred to as "cohorts" and their inhalation and ingestion through time

Type	Name	Source	Description
			and space.
	CalTOX	http://eetd.lbl.gov	CalTOX has been developed as a set of spreadsheet models and spreadsheet data sets to assist in assessing human exposures from continuous releases to multiple environmental media, i.e. air, soil, and water. It has also been used for waste classification and for setting soil clean-up levels at uncontrolled hazardous wastes sites. The modelling components of CalTOX include a multimedia transport and transformation model, multi-pathway exposure scenario models, and add-ins to quantify and evaluate uncertainty and variability.
	EUSES2	http://ecb.jrc.it	EUSES is a risk assessment model, which includes module for exposure assessment. Other modules included are input, emission, distribution, effect, risk characterization and output module. Calculations can be made in personal, local, regional and continental levels. Inhalation, dermal and ingestion routes are considered and also consumer and occupational exposures can be calculated. Requires free registration.
	Dynabox	Heijungs, 2000 http://www.leidenuniv.nl	
Regression models	MLR	Espigares et al. 2003	Levels of THMs in water seem to correlate directly with levels of combined residual chlorine and nitrates, and inversely with the level of free residual chlorine. Statistical analysis with multiple linear regression was conducted to determine the best-fitting models. The models chosen incorporate between two and four independent variables and include chemical oxygen demand, nitrites, and Ammonia. These indicators, which are commonly determined during the water treatment process, demonstrate the strongest correlation with the levels of trihalomethanes in water and offer great utility as an accessible method for THM detection and control.
	Linear regression	Harris et al. 2002	Purpose of the study was to define what factors affect to the level of exposure for pesticides among professional turf applicators. Level of three pesticides in urine was collected from the test persons. The group also filled out questionnaires to acquire information on all known variables that could potentially increase or decrease pesticide exposure relative to the amount handled. Linear regression was used to assess the relationship between the concentrations of the substances in urine and the questionnaire data.

3 Data needs and description of available data

This chapter contained a summary of the data needs and description of available databases (Table 4). The more detail information can be found in D1.1.

Table 4 Data for general exposure assessment.

Data needs		**Available databases name and source**
Data for general exposure factors	Time activity data	✓ ExpoFacts, http://cem.jrc.it ✓ HETUS, https://www.testh2.scb.se ✓ Exposure Factors Handbook, http://www.epa.gov ✓ CHAD, http://www.epa.gov ✓ MTUS, http://www.timeuse.org ✓ AHTUS, http://www.timeuse.org ✓ Time use studies, http://www.timeuse.org ✓ UK time use survey 2000 and 2005, http://www.statistics.gov.uk ✓ Dutch Time Use Survey (TBO), http://www.scp.nl ✓ Finnish time use survey, http://www.stat.fi
	Ingestion data	✓ ExpoFacts, http://cem.jrc.it ✓ Eurostat, http://epp.eurostat.ec.europa.eu FAOSTAT, http://faostat.fao.org ✓ Food Consumption and Other Exposure Data, http://www.foodrisk.org
	Physiological data	✓ ExpoFacts, http://cem.jrc.it
	Housing data	✓ ExpoFacts, http://cem.jrc.it
	Land use data	✓ CORINE Land Cover (CLC2000)-Version 8/2005, http://dataservice.eea.europa.eu ✓ CORINE Land Cover (CLC90)-Version 12/2000, http://www.eea.europa.eu ✓ Global Land Cover 2000 (GLC2000), http://dataservice.eea.europa.eu ✓ PELCOM grid, http://www.geo-informatie.nl ✓ FAOSTAT, http://faostat.fao.org ✓ EUROSTAT, http://epp.eurostat.ec.europa.eu
	Population data	✓ Eurostat, http://epp.eurostat.ec.europa.eu

		✓ xpoFacts, http://cem.jrc.it ✓ Gridded Population of the World (GPV), http://sedac.ciesin.columbia.edu
Emission data	Air	✓ WebDab, http://webdab.emep.int ✓ EPER, http://www.eper.cec.eu.int ✓ RAINS emissions, http://www.iiasa.ac.at ✓ CEPMEIP Database – Emissions, http://www.air.sk ✓ EDGAR, http://www.mnp.nl ✓ Greenhouse Gas Inventory Data, http://ghg.unfccc.int ✓ National emission statistics, http://www.naei.org.uk ✓ REZZO, http://www.chmi.cz
	Water	✓ EPER, http://www.eper.cec.eu.int
	Soil and sediment	✓ EMEP-MSCE, http://www.msceast.org
	Emission factors	✓ RAINS emissions, http://www.iiasa.ac.at ✓ CEPMEIP Database – Emissions, http://www.air.sk ✓ WebFIRE, http://cfpub.epa.gov ✓ Emission Factors Database, http://www.naei.org.uk ✓ Material Emission Database for 90 Target VOCS, http://irc.nrc-cnrc.gc.ca ✓ AP42, http://www.epa.gov
	Emission profiles	✓ SPECIATE, http://www.epa.gov
Data for media concentrations	Outdoor air	✓ AirBase, http://air-climate.eionet.europa.eu ✓ EMEP measurement data, http://www.nilu.no
	Indoor air	✓ EXPOLIS measurement data, http://www.ktl.fi
	Water	✓ GEMStat database, http://www.gemstat.org ✓ Waterbase, http://dataservice.eea.europa.eu
	Soil and sediment	✓ EMEP-MSCE, http://www.msceast.org
	Food	✓ GEMSfood, http://sight.who.int ✓ National Food Residue Database (NFRD), http://nfrd.teagasc.ie ✓ Annual EU-wide Pesticide Residues Monitoring Report, http://ec.europa.eu

4 Costs for the relevant data and information gathering

4.1 Cost on relevant data gathering for general PAHs exposure assessment

4.1.1 Cost for the PAHs measurement

There is no searchable information for the price for the PAHs measurement and its relevant data gathering. The cost of sampling and analysis is a function of the number of monitoring stations, the sampling method used, the frequency and analytical methodology adopted.

Opportunities exist to optimize measurement cost effectiveness for predominantly particulate bound PAH by using sites or equipment measuring other particulate pollutants such as metals.

Table 5 Price for the PAHs measurement in Norway (Source: http://husavisen.nilu.no, contact person: Stein Manø, sm@nilu.no)

Code	Text	Unit	Price (€)
2201	Extraction and preparation	Piece	260
2202	Analysis GC/MS EPA 16	Piece	200
2203	Analysis GC/MS	Piece	260
2205	Weighted filter, PUR- samples	Piece	51
2206	EPA 16 in oil	Piece	460
2207	EPA 16 in air	Piece	460
2008	Full program PAH in air	Piece	520
2018	Fine grinding plant material	Piece	10
2019	Filtering	Piece	10
2252	Preparation of extract	Piece	125
2256	Cleaning/burning of sampler and cassett	Piece	17
2257	Cleaning/burning of sampler, simplified	Piece	33
2258	Cleaning/burning of sampler, dioxin sampler	Piece	125

Table 6 Cost information for characterization of PAHs in marine sediment by using near-real UV fluorescence Technique (Source: http://costperformance.org, contact information: Dr. Jim Leather, leather@spawar.navy.mil; Nick Ta, tant@nfesc.navy.mil).

No.	Text	Unit	Price (€)
1	Screening	Sample	Approx 77 (20-30 samples per day)
2	Laboratory GCMS (PAHs)	Piece	310-387 (30-90 days turnaround time)

4.1.2 Cost on data gathering for general PAHs exposure assessment in Czech Republic

Here we present some cost for analysis of PAHs exposure assessment in Czech Republic (Table 7).

Table 7 Cost for analysis of PAHs exposure assessment in Czech Republic

Type	Type of data	Unit	Cost (€)	Description
Data for general exposure factors	Time activity data		Free	Not available, only from different research projects
	Ingestion data			National Public Health Institute, not available
	Physiological data		Free	Data from extbooks
	Population data		Free	Data from web pages
Emission data	Air		Free	-Information from the DB of the Czech Hydrometeorology; -Institute or Report on the environment of the CR, issued by the Ministry of Environment; -Data from web page of CHMI.
	Water		Free	CENIA
	Sediment	Year	About 35,700	Ministry of Agriculture and CHMI
Data for media concentrations	Outdoor air	Year	About 35,700	DB of the Czech Hydrometeorology
	Indoor air		Free	Indoor air from specific studies (available on web NIPH)
	Food			Monitoring by the National Institute of Public Health in Prague
	Soil		Maybe free	CENIA = “old ecological owerload”, global information available, results from campaign investigation in projects in MOE

	Land for agriculture	Year	About 35,700	Central Control and Experimental Agriculture Institute
	Water	Year	About 35,700	Surface water, CHMI; Underground water, CHMI; Drinking water, Ministry of agriculture from database of producers.
Data on health effects	Increased thyroid volume, Hearing problems, Dental problems			Increased thyroid volume, Hearing problems, Dental problems and exposure to c-PAHs were not studied. Data has not been gathered
	Cancer		Free	Cancer is usually evaluated according to the dose-response related to occupational history. Cancer data (incidence, mortality) on regions and district aggregated (available on www.uzis.cz)
Data analysis and result interpretation: using biomarkers to analyze the impact of c-PAHs	PM2.5: stationary monitoring	1 day sampling	20	
	c-PAHs: personal monitoring, stationary monitoring	1 sample chemical analysis	100	
	VOC: personal monitoring, stationary monitoring	1 sample chemical analysis	100	
	Cotinine	1 sample	30	
	Triglycerids, Total, HDL and LDL cholesterol	1 sample	40	
	Vitamins: A, C, E	1 sample	40	
	DNA adducts: by 32P-postlabeling	1 sample	400	
	PIG-A mutations	1 sample	100 – 200	
	Chromosomal aberrations: Conventional	1 sample	150	Now substituted by MN

	Chromosomal aberrations: FISH	1 sample	350	
	Chromosomal aberrations: Micronuclei	1 sample	100	
	Oxidative damage: 8-oxodG, 15-F2T-isoP, proteins	1 sample	150	
	Genetic polymorphisms	1 sample	350	
	Gene expression	1 sample	400	It means at least 2 groups, 60 subjects each, 3 times (usually winter, summer, next winter)
	Gene expression	1sampling/subject	2,000	
	Gene expression		10,000	Statistical analysis
	Gene expression		100,000	Personal cost
Data analysis and result interpretation: using health data from pediatricians to analyze the impact of c-PAHs	Data from stationary monitoring			Free available on web page CHMI, only time spent by computer
	Questionnaire from mothers and pediatricians	1 subject	60-70	
	Data on GIS	1 subject	5-10	
	Statistical analysis		5-10,000	
	Personal cost		50,000	
Total			145140-155240	

4.2 Cost on relevant data gathering for general PCBs exposure assessment

The costs of PCB analytics and sampling can vary a lot depending on what you are doing and where. For example you can measure only one congener PCB 153 and doing that you can use GC-ECD technique, GC-low resolution MS, or GC-high resolution MS technique, and of course depending on the technique the cost vary. The most challenging task is to measure dioxin-like PCB congeners and this requires high resolution MS technique and of course the costs will go up.

Sampling costs is the most difficult part to estimate since it depends on what is the study aim. For example with only PCB 153 and indicator PCBs the analytics will need 1-5 ml of serum which means collecting 5-10 ml of blood and doing that and separating serum out of it is possible with quite common clinical lab equipment and the main cost in this scheme is probably the personnel cost of the nurse. But when it comes to dioxin-like PCBs it needs to be taken at least 50 ml of serum or even more. This normally requires qualified nurses, since the blood sampling is done with open tubing's, and not with vacuum tubes, and also the equipment required for extracting the serum from blood is not available in routine labs.

4.2.1 Cost for PCBs measurement in Norway

Table 8 Price for the PCBs measurement (Source: http://husavisen.nilu.no, contact person: Ellen Katrin Enge, eke@nilu.no; Anders Røsrud Borgen, arb@nilu.no; Martin Schlabach, msc@nilu.no)

Code	Text	Unit	Price (€)
2103	Dioxin & koplanare PCB	Piece	850
2104	Dioxin & full PCB-program	Piece	1094
2157	7 PCB + HCB (low solution)	Piece	130
2161	DDT + (HCH + PeCB)	Piece	425
2162	33 PCB + HCB	Piece	487
2164	Pesticide + PCB AMAP (included working hours)	Piece	1167

4.2.2 Cost for PCBs measurement in Finland

Table 9 Price for the PCBs measurement (Source: National Institute for Health and Welfare, Finland (http://www.thl.fi)), and contact person: Hannu Kiviranta, hannu.kiviranta@thl.fi)

Code	Text	Unit	Price (€)
1	PCB 153 (including equipment, lab, and personnel costs)	Piece	70
2	7 indicator PCBs	Piece	250
3	Dioxin-like PCB congeners	Piece	560

4.2.3 Cost on data gathering for general PCBs exposure assessment in Slovakia

Table 10 Cost for analysis of PCB exposure assessment in Slovakia Republic (Source: Research Base of the Slovak Medical University, http://ww.szu.sk, and contact person: Lubica Palkovicova, lubica.palkovicova@szu.sk)

Type	Type of data	Unit	Cost (€)	Description
Data for general exposure factors	Time activity data			Not available
	Ingestion data			Not available
	Physiological data		Free	Data from textbooks
	Population data		Free	Data from web pages and Slovak Statistical Institute
Emission data	Air	Yearly	Possibly free	Estimation done by Slovak Hydrometeorological Institute based on industrial data and emission factors
	Water	Yearly	Possibly free	The same as above
	Sediment	Yearly	Possibly free	The same as above
Data for media concentrations	Outdoor air	Year 1997	15,000	Data from scientific projects
	Food	Year 1997-8	15,000	Data from scientific projects
	Soil	Years 1997-8	15,000	Data from scientific projects
	Water sediment	Years 1997-8, 2002	15,000	Data from scientific projects
Data on health effects	Increased thyroid volume, impairment of Glucose metabolism	Years 2001-2003	15,0000	Data from scientific projects
	Hearing problems, dental problems, immune and nervous systems alterations in children	Years 2003-current	15,0000	Data from scientific projects
	Cancer		Free	Cancer data (incidence, mortality) on regions and district aggregated

Type	Type of data	Unit	Cost (€)	Description
Data analysis and result interpretation: using biomarkers to analyze the impact of PCBs	PCB analyses in biological samples (blood, breast milk)	1 sample	100	
	Lipid analyses	1 sample	10	
	Thyroid hormones	1 sample	70	
	OAE examinations	1 subject	25	
	Glucose levels	1 sample	5	
	Immune analyses – Ig	1 sample	30	
	Immune analyses – CD markers	1 sample	70	
	Dental examinations	1 subject	30	
	Neurobehavioral testing	1 subject	35	
	Thymus USG	1 subject	40	
	Birth weight	1 subject	Free	
	Tympanometry	1 subject	10	
	Pure tone audiometry	1 subject	10	
	Sex hormones	1 subject	40	
Data analysis and result interpretation: using health data from pediatricians to analyze the impact of PCBs				
	Questionnaires from mothers and pediatricians	1 subject	70	
	Data on GIS	1 subject	10	
	Statistical analyses		16,000	
	Personal costs		70,000	
Total			446,555	

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ABSTRACT
The aim of this report is to provide the relevant information for assessing the available options for exposure protocols in the view of providing a cost-benefit recommendation for exposure and health impact assessment. It includes: (i) define the exposure scenarios, methods and protocols for both PAHs and PCBs; (ii) summarize the data needs and describe the available data; (iii) analyze the cost for data and information gathering relevant for methods and protocols in several countries.

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