INTARESE

Integrated Monitoring: Review of case study on PCBs in Slovak Republic

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Introduction: PCBs were widely used in industrial and consumer products. Because these compounds are stable and highly lipophilic, their residues are ubiquitous and occur in increasing concentrations moving up through the food chain. In Slovak Republic (SR), the Chemko-Strazske Chemical Company located in the Michalovce district, produced PCBs between 1959 and 1985. Considerable amounts of PCBs released into the environment due to poor technological measures which resulted in long-term contamination of air, soil, sediment, and water. Many studies performed by the team led by Slovak Medical University in the last 20 years showed that high levels of PCBs in food and persons who eat locally raised food in this district have higher serum concentrations of PCBs.

Previous research results show that 1) main driving forces are emissions from previous Chemko Inc. Plant; 2) higher levels of PCBs in homemade eggs and butter was found from district of Michalovce; mothers residing in eastern Slovakia are highly exposed to PCBs, and have high body burdens of PCB metabolites; population living in the watershed of the river Laborec, PCB exposure has continued and occasionally increased; PCB levels in blood are the highest of the levels published in the world scientific literature in Michalovce; exposure to PCB does not always decrease over time; 3) relationships between the contamination of the residential areas by PCBs and health consequences including hearing impairment, neurobehavioral changes, diseases of the thyroid, and diabetes have been demonstrated; 4) prolonging study periods, extending study areas, strengthening political protection are strongly suggested. In addition, an integrated monitoring of PCBs at national level is needed.

Objectives: In the EU INTARESE project, we have proposed two frameworks (IEHM and IEHD) for integrated environment and health impact assessment. To illustrate two frameworks further, this paper reviews 35 articles on PCBs studies in SR. It includes: 1) to describe PCBs and its relevant monitoring data and data sources from environmental monitoring, ecosurveillance, biomonitoring and human health surveillance; 2) to analyze the existing individual data; 3) to illustrate the way to integrate individual data; 4) to summarize the existing research results; and 5) to recommend the new action.

Results and conclusion: The complex research system that was designed and performed over the years in Slovakia is a basis to design environmental and health monitoring program that would allow the appropriate authorities to carry out risk assessment in the area and to control effectiveness of measures and developments over time. The necessary elements of the integrated monitoring should be based in knowledge presented in the summaries below.

Study Area of PCBs in SR

Scope and Variety of Data in SR

General type of data	Detail type of data	Example of source of data and URL	Comments
Data for general exposure factors	Time activity	----	*Not available*
	Ingestion	----	*Not available*
	Physiological	• http://www.privireal.org/content/dp/slovakia.php	*Data from textbooks*
	Population	• http://data.worldbank.org • http://www.statistics.sk	Data from web pages and Statistical Office of the Slovak Republic
Emission data	Air	• http://www.shmu.sk/sk	Estimation done by Slovak Hydrometeorological Institute (SHMU) based on industrial data and emission factors
	Water	• http://www.shmu.sk/sk	Estimation done by SHMU based on industrial data and emission factors
	Sediment	• http://www.shmu.sk/sk	Estimation done by SHMU based on industrial data and emission factors
Data for media concent-rations	Ambient air	• TOCOEN project (Toxic Organic COmpounds in the ENvironment) (Holoubek et al., 1994) • Project Tocoen-The fate of selected organic pollutants in the environment. XXIII. Sampling and analysis of PCBs, PCDDs and PCDFs in ambient air in Bratislava (Chovancov á et al., 1994) • Environmental contamination with polychlorinated biphenyls in the area of their former manufacture in Slovakia (Kocan et al., 2001)	*Data from scientific projects*
	Food products	• PCB Exposure and early Childhood Development in Slovakia (http://slovakchildren.ucdavis.edu) • PCDDs, PCDFs and dioxin-like PCBs in food of animal origin (Slovakia) (Chovancová et al., 2005). • The Burden of the Environment and Human Population in an Area Contaminated with Polychlorinated Biphenyls (Kocan et al., 1999)	*Data from scientific projects*
	Soil	• PCB Exposure and early Childhood Development in Slovakia (http://slovakchildren.ucdavis.edu) • Environmental contamination with polychlorinated biphenyls in the area of their former manufacture in Slovakia (Kocan et al., 2001) • Environmental contamination with polychlorinated biphenyls in the area of their former manufacture in Slovakia (Kocan et al., 2001)	*Data from scientific projects*
	Surface water	• Environmental contamination with polychlorinated biphenyls in the area of their former manufacture in Slovakia (Kocan et al., 2001)	*Data from scientific projects*

Available Data Overview

Monitoring	Items	Study area	Study period	Conclusions/Comments/Recommendations
Environmental monitoring	Ambient air	Michalovce and Stropkov	1997-1998	Levels of PCBs from Michalovce in ambient air, soil, surface water and bottom sediment contained much higher PCBs levels than those from the Stropkov ones.
	Soil	Michalovce and Stropkov	1997-1998	
	Surface water	Michalovce and Stropkov	1997-1998	
	Bottom sediment	Michalovce and Stropkov	1997-1998	The highest levels of PCBs in ambient air, soil, surface water and bottom sediment were found around the effluent canal flowing from the Chemoko factory. Data on levels of PCBs in indoor air need to be investigated. Data on environmental monitoring of PCBs in Michalovce and Stropkov, and other regions of Slovak Republic in recent years from other sources need to be investigated. Environmental monitoring of PCBs need to be extended to other regions of eastern Slovakia and monitoring period must be extended as well.
Ecosurveillance	Food Wildlife (fish and game)	Michalovce Michalovce and Stropkov	2001 1997-1998	Wildlife shot in forest and fields and food products from locally raised animals or locally caught fish from the Michalovce contained much higher PCB levels than those from the Stropkov ones. Ecosurveillance of PCBs in plants (both water and terrestrial) from the Michalovce is suggested to be monitored. Ecosurveillance of PCBs need to be extended to other regions of eastern Slovakia and monitoring period must be extended as well.
Human biomonitoring	Breast milk Human adipose tissues	Slovak Republic Bratislava, Trenčín and Martin	2001 1991	The highest concentrations of PCBs in maternal serum samples/serum samples from adults, and human adipose tissues were found from Michalovce.
	Serum samples of adults	Michalovce and Stropkov/Svidnik districts	2001	Data on other biomarkers (e.g. urine, hair) on PCBs biomonitoring in Michalovce, Stropkov, and other regions of Slovak Republic in recent years from other sources need to be investigated.
	Maternal serum samples	Michalovce and Stropkov/Svidnik districts	2002-2004	Biomonitoring of PCBs need to be extended to other regions of eastern Slovakia and monitoring period must be extended as well.
Human health surveillance	Impaired immunologic developments	Michalovce and Svidnik	2002-2004	The relationships between the contamination of the residential areas (Michalovce) by PCBs and health consequences including hearing impairment, neurobehavioral changes, impaired immunologic development, and breast cancer have been demonstrated.
	Breast cancer	Michalovce	1998-1999	
	Hearing impairment	Michalovce, Svidnik and Bratislava	2006-2008	Data on human health surveillance of PCBs in Michalovce, Svidnik and Bratislava, and other regions of Slovak Republic in recent years from other sources need to be investigated. Human health surveillance of PCBs need to be extended to other regions of eastern Slovakia and monitoring period must be extended as well.
	Neurobehavioral changes	Michalovce and Svidnik	2002-2004	
Integrated monitoring		Michalovce, Stropkov/Svidnik, Bratislava	1997-2008	More monitoring and measuring on specific items between 1997 and 2008 is suggested. An integrated monitoring program of PCBs (large area and long term) in Slovak Republic is suggested.

Elements of Future Integrated Monitoring and Intervention Options

Environmental monitoring	Ecosurveillance	Human biomonitoring	Human health surveillance	Intervention options
Emission of PCBs • Air • Sediment • Water Concentration of PCBs • Ambient air • Soil • Surface water • Bottom sediment	• Plants • Benthic invertebrates • Fish and water column invertebrates • Wildlife (game) • Food products (egg, cow milk, pork, beef, chicken, infant milk formula, cod liver, butter, fish)	2047 adults and 431 8-9 years old children • Blood sample for PCBs and organochlorine pesticide, hormones, antibodies, biomarkers • Questionnaires on biomedical data 2047 adults • 1200 adults with no contraindication for the oral glucose tolerance test • 300 adults for additional estimatations of OH-PCBs, MeSO2-PCBs, PCDDs, PCDFs, coplanar PCBs, metals (Cd, Hg, Pb, Mn, Zn, Se), bioassays of dioxin-like activity and xenoestrogenic activity 431 children • 431 children for cognitive and hearing functions, dental status and organochlorine and toxic metal levels in serum and thyroid morphology and function	• Increased thyroid volume • Impairment of Glucose metabolism • Diabetes • Hearing impairment • Dental problem • Immune and nervous systems alterations • Cancer	Prolonging study periods • Final remediation • Monitoring of body burden of the population • Monitoring of local food quality and environmental contamination. Extending study areas to other regions of eastern Slovakia Strengthening political protection • Immediate implementation of measures for population protection • Exact determination of the environmental contamination and the cause of the increasing exposures to PCBs in children • Prevention of further exposure of the population as a whole • Ensuring appropriate health care for the exposed population with active search for and follow up of exposed individuals. • Establish an independent body including international experts, to guide and to oversee that resources are used efficiently and in agreement with current scientific knowledge.