International POPs Elimination Project

Fostering Active and Efficient Civil Society Participation in Preparation for Implementation of the Stockholm Convention

---

Lindane in the Czech Republic

Miroslav Beránek (Czech Ecological Society)
Ing. Milan Havel (Arnika)
Czech Ecological Society

Czech Republic
April 2006

About the International POPs Elimination Project

On May 1, 2004, the International POPs Elimination Network (IPEN http://www.ipen.org) began a global NGO project called the International POPs Elimination Project (IPEP) in partnership with the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Program (UNEP). The Global Environment Facility (GEF) provided core funding for the project.

IPEP has three principal objectives:

- Encourage and enable NGOs in 40 developing and transitional countries to engage in activities that provide concrete and immediate contributions to country efforts in preparing for the implementation of the Stockholm Convention;
- Enhance the skills and knowledge of NGOs to help build their capacity as effective stakeholders in the Convention implementation process;
- Help establish regional and national NGO coordination and capacity in all regions of the world in support of longer term efforts to achieve chemical safety.

IPEP will support preparation of reports on country situation, hotspots, policy briefs, and regional activities. Three principal types of activities will be supported by IPEP: participation in the National Implementation Plan, training and awareness workshops, and public information and awareness campaigns.

For more information, please see http://www.ipen.org

IPEN gratefully acknowledges the financial support of the Global Environment Facility, Swiss Agency for Development and Cooperation, Swiss Agency for the Environment Forests and Landscape, the Canada POPs Fund, the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM), Mitchell Kapor Foundation, Sigrid Rausing Trust, New York Community Trust and others.

This report is available in the following languages: English

Lindane in the Czech Republic

Miroslav Beránek (Czech Ecological Society), Milan Havel (Arnika Association)

Foreword

When reading the two words „dangerous pesticides“, it surely reminds you of DDT and you can just think that it is over and that now much safer chemicals are used. Unfortunately, it is far from true. There are a lot of chemicals with proven or suspected similar pernicious effects not only to insects, but also to humans. Nevertheless, they are still used, including in the Czech Republic.

Among the most dangerous chemicals are those, which are decomposed very slow in nature, and are accumulated in food chains; so called persistent organic pollutants (POPs). This class includes the pesticide Lindane. The substance is included in the international Protocol on Persistent Organic Pollutants in the Convention on Long-range Transboundary Air Pollution. It is also one of the "hot" candidates for addition to the list of substances forbidden by Stockholm Convention on Persistent Organic Pollutants. Even so, we still can come across use of Lindane up to this day. But far more serious problems in the Czech Republic are caused by its production and use in the past. This did not happen long ago - the last commercial substance containing Lindane was approved in our country in 1995.

We tried to briefly summarize problems connected with Lindane in Czech Republic. It can be instructive also for a number of other pesticides used on a much larger scale and sprayed or stored in many places, apart from their obvious harmfulness for humans and animals (not only so called pests). We tried also to include suggestions for safe destruction of Lindane and other chlorinated pesticides. The existence of this way forward gives us hope for a potential solution to many contaminated sites. On the other hand this does not give us an excuse to produce and use such substances further.

In Prague, April 9, 2006

Jindřich Petrlík

Content

1. Introduction: Lindane (γ-HCH)

CAS: 58-89-9

1.1 Basic characteristics, occurrence and use in the Czech Republic

Lindane is an organochlorine pesticide (OCPs). It is a persistent, bioaccumulative substance and an endocrine disruptor. Chemically it is the gamma-isomer of hexachlorocyclohexane. It was used for protection of roots, leaves and seeds of all usual cultivated crops. It was also used for treatment of wood, wool, cotton and sheds against parasites. Today its use is limited. However, it is also used in preparations for control of lice. During assessment of its presence in the environment, it is more objective to assess both the presence of γ-HCH, and its metabolite β-HCH which persists in the environment for a much longer time. Because of that, we include measurements of all HCH metabolites in the results of measurements.

1.2 Impact on human health

According to IARC, Lindane is included in group 2B; possible human carcinogen. This category indicates sufficient evidence of carcinogenicity in animals. Technical HCH (see below for definition) and alpha HCH (a Lindane isomer) are classified as possible human carcinogens. Like other isomers of hexachlorocyclohexane, it is ranked among persistent organic pollutants and can therefore accumulate in human fat tissues and subsequently cause damage to both the immune and endocrine systems of people.

2. Lindane in Czech Republic

2.1 Production

In the past, a lot of chlorinated pesticides were used extensively in crop production. From 1953 - 1966 most of the consumption of chlorinated pesticides was covered by the factory CHJZD (Chemické závody Juraja Dimitrova - Chemical Plants of Juraj Dimitrov) in Bratislava, Slovakia. The whole production of this factory was 13 000 tons of γ-HCH (Lindane). It is estimated, that total consumption of Lindane in Slovakia was 1 t per year. Most of production was exported. The toxic impact of this production still can be noticed, for example by the pollution of the Danube River below the factory (see Table 1).

.

Table 1: Data about pollutants in waste water discharged into Danube below Istrochem Bratislava (former CHZJD).

PCB	Hexachlorobenzene	γ – HCH	Heptachlor	p.p. DDT	Methoxychlor
µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
0.005	0,027	0,7465	0.01	0,2825	0,0965

For comparison: values of γ – HCH (Lindane) measured in rivers Ondava near Nižný Hrušov: 0,0395 µg/l in 1998, and Nitra near Chalmová: 0,0678 µg/l in 1998 and 0,0495 µg/l in 1999.[1]

In the Czech Republic, γ-hexachlorocyclohexane started to be produced in Spolana

Neratovice factory in 1961. The technical mixture of γ-hexachlorocyclohexane was prepared by methanol extraction and re-crystalisation.

Technical HCH is mixture of isomers - alpha (65-70%), beta (6-8%), gamma (12-15%), delta (2-5%) and others (5-10%). The disturbing smell of technical HCH, which also caused a burning taste in potatoes and vegetables, was one of the reasons, why HCH stopped being used on large scale. However, Lindane was different.

From 1963 - 1996, 61,680 tons of Lindane pesticides were used in the territory of the former Czechoslovakia. It was used especially in the 1960s when annual production varied from 4 to 9,5 thousands tons annually.

2.2 Today's use of Lindane in CR

The technical mixture of HCH isomers is now used in the Czech Republic on a small scale as an intermediate product of chemical production.

In the Czech Republic, the use of products containing at least 99% of gamma isomer of HCH (Lindane) is restricted for:

a) treatment of seeds;
b) application to surface levels of soil
c) professional recovering and industrial treatment of wood
d) local insecticides for protection of human and animal health
e) point application for treatment of tree planting, grasslands, seed-plots and amenity trees;
f) indoor industrial or residential applications.

The last approved substance containing Lindane intended for treatment of forest stands on a large scale was Endelit, authorized in 1995.

Nevertheless, appendix 8 of Decree No. 84/1997 Sb on plant treatment alleged the list of active ingredients, which cannot be principally contained in imported substances. On the list, there is HCH with content less than 99% of gamma isomer. Because the minimal purity of Lindane is 99%, it means paradoxically, that substances based on Lindane are allowed to be imported, and therefore also can be used in Czech Republic.

Use of Lindane in both health care and veterinary practice is allowed in our country. In lower concentration, it is recommended for treatment of scabies. Imported substances for this purpose include Jacutin and Skabicid. Jacutin is recommended also against lice. References about the use of Jacutin and Skabicid can be found in manuals for dog care and other treatments (e.g. among substances for aquariums).

2.3 Presence of Lindane in environment

2.3.1 Air

The gamma isomer of HCH has, in comparison to DDT, a higher ability to evaporate. This feature is also useful for pesticides. Therefore, Lindane is however able to get from the soil to

the air better, and that is why its concentration in the air is high. Within the SYMOS project, the concentration of Lindane was measured in the meteorological station in Košetice (outdoor locality, 633 m. above sea level) in 1994-1995. Measurements went on also in 1996-1999 within the TOCOEN project. [2]

Table 2: Concentration of Lindane in the air in pg/m^3 in Košetice – SYMOS.project

Year	Average	SD	Minimum	Maximum	Median
1994-95	416.2	190.2	100	720	400

SD – standard deviation

Table 3: Concentration of Lindane in gaseous phase and aerosol in pg/m^3 in Košetice in 1996-99 – TOCOEN project.

Medium	Average	SD	Minimum	Maximum	Median
gas phase	50,3	-	0,4	641	12
aerosol	5,8	-	0,4	89	2

SD – standard deviation

In 1998, the concentration of Lindane was approximately 3.7 times higher than in 1997. In these years, the concentration peaked, but decreased the next year. The reason for the increase was the large flood, which rinsed out old sediments containing organochlorine pesticides (OCPs).

This thesis is supported also by results of measurement on the Morava River near Otrokovice, which were done after the flood in 1997 and published by J. Hajšlová et al. [3] (in Table 6 in Chapter 2.3.3 called „inundated area“).

2.3.2 Soil

The TOCOEN project monitored concentrations of hexachlorocyclohexane in soil in different places in [7]. Results are summarized in Table 4.

Table 4: Summary of data about contamination of selected areas of CR by hexachlorocyclohexane in ng/g in 1993 - 2001.

Locality	Number of places	Number of samples	Median	Minimum	Maximum
Košetice	9	82	0,59	0,02	182
Zlín	51	63	0,89	0,22	8,51
Beroun	25	25	1,03	0,34	1,62
Mokrá	12	120	0,74	0,11	64,7
border mountains	14	15	1,34	0,22	5,78
surroundings of highways	112	45	1,18	0,17	356

2.3.3 Water and sediments

A number of the projects monitoring the state of surface water were run in Czech Republic, with different names. Holoubek et al.[3] summarized projects measuring various pollutants in Morava, Odra, Labe and BMPF (on Czech tributaries of Elbe). In Table 5, we put at least some of the published results from the Morava project, for years 1996–99.

Table 5: Concentration of Lindane in ng/l in sediments below selected industrial sources of pollution.

River	Profile	Average concentration of sum of HCH	Concentration of Lindane (max)	Concentration of Lindane C_{90}
Morava	Šumperk	37,0	8,4	8,1
Morava	Olomouc	19,1	9,9	8,8
Bečva	Val. Meziříčí	16,7	9,5	9,5
Bečva	Přerov	18,3	11,9	9,6
Morava	Otrokovice	34,3	9,8	8,7
Morava	Uh. Hradiště	22,4	771,1	359,1
Morava	Hodonín	33,0	97,1	49,3
Svratka	Brno	29,0	8,4	8,1
Svitava	Svitavy	32,6	9,6	9,0
Jihlava	Jihlava	20,3	15,0	10,7
Jihlava	Třebíč		23,0	17,2
Morava	Poštorná	20,7	9,0	8,1
Dyje	Znojmo	14,8	7,3	7,1
Dyje		22,7	8,5	8,0

Higher concentrations of Lindane were reported from central and southern Moravia, but also in the Bílina River below the Spolchemie plant in Ústí nad Labem. For sediments, the higher concentrations were observed in Moravia. The preliminary national inventory of POPs also gave an overall review of results of measurements of Lindane in groundwater. According to authors of the report, monitoring did not find specifiable values, e.g. above 2 ng/l. [4]

Table 6: Concentration of organochlorine pesticides in rivers after the flood in 1997. Inundated area = Morava river near Otrokovice. Source: Hajšlová, J. et al. (1999). [5]

Sample	Analyzable share	Sum of chlorinated pesticides (ng/l)
Check area	filtrate	12,9
Check area	filtrate including sediment	19,4
Inundated area	Filtrate	20,4
Inundated area	filtrate including sediment	33,1

2.4 Impact of Lindane on health

Lindane in CR has the potential to contribute to the theoretical increase of cancer growth risk (TICGR). In the half of the 1990s each person in CR could get a cancer caused by this pesticide with probability of $10^{-5} – 10^{-6}$. The theoretical risk of cancer from Lindane

exposure is almost two orders of magnitude higher than for DDT or DDD. Other chlorinated pesticides like aldrin, dieldrin or the alpha isomer of HCH, have a similar value for TICGR as Lindane. In the late 1990s, the TICGR for Lindane decreased (SZÚ Prague, 1994-1997).

The draft risk profile for Lindane written by Mexico as part of the Stockholm Convention POPs Review Committee also mentions several toxic effects.[6] These include toxic effects on the liver, immune system, reproductive system, and developmental damage. Acute exposures in humans can induce dizziness, headaches, diarrhea, nausea, vomiting, and even convulsions and death. Alterations in blood cells occur in workers after chronic exposure in production facilities. Lindane has been found in the serum, fat, and semen of people exposed environmentally or occupationally. The report notes that Lindane is also very toxic to aquatic organisms and moderately toxic to birds and mammals after acute exposure. Reproductive impacts in animals include reduced egg production in birds; altered sex ratios in frogs; testicular atrophy and disrupted sperm formation in male rats; and reduced ovulation in female rats.

The high danger of chlorinated pesticides for human health is affirmed also by statistical estimation of international Pesticide Action Network (http://www.pan-uk.org), stating, that pesticides are the worldwide cause of death of 547 people daily. We know cases from abroad, in which pesticides directly poisoned several people during their use against human parasites like lice or fleas (for example in USA).[7]

An overview of the Lindane burden on Czech inhabitants is revealed by data about its presence in food chains and breast milk in following chapter.

2.5 Lindane in food chains in CR

Exposure of the population to the gamma isomer of HCH has been monitored in CR since 1994. Detailed information is in monitoring reports of State Health Institute in Prague, describing dietary human exposure. Table 7 shows overall data from this monitoring.

Concentrations of Lindane in breast milk are known abroad from many countries. In Delhi, India, concentrations of 2130 ng/g fat were measured. Levels found in Europe are roughly similar as values in CR. Higher concentrations of Lindane in breast milk were found in 1988 in Turkey.

Table 7: Levels of Lindane found in samples of breast milk in 1994-2001 within Monitoring of State of Health of Inhabitants (ng/g of lipids). Source: SZU 1996 - 2002.[8]

		γ - HCH
1994	median	7,0
	Kv0,1 - Kv 0,9	3,0 - 16,0
1995	median	6,0
	Kv0,1 - Kv 0,9	2,0 - 13,6
1996	median	6,4
	Kv0,1 - Kv 0,9	0,5 - 17,2
1997	median	7,4
	Kv0,1 - Kv 0,9	2,5 - 14,0
1998	median	12,8
	Kv0,1 - Kv 0,9	6,34 - 28,8
1999	median	8,2
	Kv0,1 - Kv 0,9	2,5 - 20,3
2000	median	*
	Kv0,1 - Kv 0,9	
2001	median	*
	Kv0,1 - Kv 0,9	
* values more than 50% under limit of specifiability		

Burden of inhabitants of the Czech Republic

The burden of inhabitants has been monitored since 1994. Exposure of inhabitants generally appears to be very low at the level of 0.1 % of the acceptable dose (ADI), set at the level of 0.008 mg/kg of body weight/day (1989).

The highest level of γ-HCH in breast milk of 28.8 ng/g of fat was observed in 1998 (C90, MZSO - Monitoring of State of Health of Inhabitants, 1998). The β-HCH level in breast milk was at most 428 ng/g of fat in Ústí nad Labem in 2000 and the observed median for this group of measurements was 173 ng/g of fat (VaV 520/6/99). [9] In 2003 β-HCH level in breast milk was at most 371.9 ng/g of fat in Plzeň observed, median for this group of measurements was 22.2 ng/g of fat, a higher median level of β-HCH in breast milk (36 ng/g of fat) samples was observed in 2003 in Ústí nad Labem again (Černá, M. et al. 2005). [10]

Table 8: Overview of monitoring of Lindane in the food chain in CR, in 2002 and 2004. Source: SVS ČR. [11, 12]

Sample	Median	Maximum 2002	Maximum 2004
Cow milk, fresh	n.d.	0.010	0.015
Sheep milk, fresh	n.d.	n.d.	-
Goat milk, fresh	n.d.	0.005	0.012
Fresh butter	n.d.	0.007	n.d.
Curd cheese, over 4% of fat	n.d.	0.004	0.008
Curd cheese, less than 4% of fat	n.d.	n.d.	0.000
Yellow cheese	n.d.	0.007	0.010
Processed cheese	n.d.	0.010	0.003
Other kinds of cheese	n.d.	0.013	0.019
Hen eggs	n.d.	0.001	0.020
Egg products	n.d.	n.d.	0.013
Quail eggs	n.d.	0.000	0.004
Meat products	n.d.	0.028	0.014
Poultry meal products	n.d.	0.015	0.004
Meat cans	n.d.	0.005	0.009
Honey	n.d.	n.d.	n.d.
Sea fish	n.d.	n.d.	0.001
Sea fish products	n.d.	0.001	0.106
Freshwater fish	n.d.	n.d.	0.001
Calves	n.d.	0.005	0.000
Young stock, under 2 years	n.d.	0.060	0.001
Cows	n.d.	0.019	0.000
Sheep	n.d.	0.013	0.012
Pigs	n.d.	0.040	0.017
Chicken	n.d.	0.030	0.020
Hens	n.d.	0.014	n.d.
Turkey-hens	n.d.	0.014	0.001
Water poultry	n.d.	0.005	0.012
Ostrich	n.d.	0.007	n.d.
Quails	n.d.	0.012	n.d.
Rabbits	n.d.	n.d.	0.000
Horses	0,005	0.005	0.001
Hoofed game (from farms)	n.d.	0.007	0.000
Snails	n.d.	0.004	0.000
Carps (breeding)	0,000	0.005	0.003
Trout (breeding)	n.d.	0.002	0.000
Other freshwater fish	0,000	0.000	0.001
Freshwater fish - flood	0,000	0.011	-
Pheasants	n.d.	0.015	0.000
Wild duck	n.d.	0.011	0.000
Hares	n.d.	0.015	n.d.
Wild boar	n.d.	0.066	0.000
Other hoofed game	n.d.	0.028	0.001

Explanatory notes:
median is a mean value of a set of results (if less than half of results are positive, is this value expressed by abbreviation n.d. - not detected)
maximum is the highest value in the set of results
monitored values for Lindane are in mg/kg of fat - in case of eggs and fish in mg/kg of product

The State Veterinary Administration of CR (SVS ČR) monitors the presence of Lindane in different animal products, providing so called food chain monitoring. Its results are summarized in Table 8. According to Information Bulletins SVS ČR No. 1/2003 and 1/2005, the exposure of the Czech population to Lindane in 2002 and 2004 did not represent serious danger. As the report noted, higher concentrations were found only locally, but these concentrations did not exceed valid hygienic standards. It is, however, in contradiction with findings of Codex Alimentarius from 1997 for European region.[13] In addition, the bioaccumulative nature of Lindane means that low levels in food can result in much higher levels in humans as time passes.

On the top of the list of products containing Lindane are chocolate and non-chocolate sweets, but also wine and nuts. From other food products, mostly animal, the following ones are typical for presence of Lindane in Czech Republic: haslets, fish and sea fruits, cheese and dairy products. Residues of Lindane were found during monitoring of fish in Czech rivers, as one of the main organochlorine pesticide pollutants. This monitoring was done by VŠCHT Praha (Chemichal Technology Institute Prague) for the Ministry of Environment. [14]

Lindane was found also in mushrooms, in different localities in Czech Republic. It was one of conclusions of research, made by Research Institute of Forestry and Hunting in the whole territory of CR in 1997. The highest concentrations of Lindane were measured in mushrooms from area of Hrubý Jeseník and Moravskoslezské Beskydy (see Table 9). [15]

Table 9: Results of measurement of concentrations of Lindane in mushrooms in different forest areas in CR in 1997 (descriptions of areas was not explained in report available on the Internet). Data are in μg/kg of dry mushrooms.

Forest area	LO 1	LO 6	LO 7	LO 9	LO 10	LO 13	LO 15	LO 16	LO 21	LO 27	LO 30	LO 36	LO 39	LO 40
Lindane	<0.1	0,2	<0.1	0,7	0,4	1,0	0,7	0,9	<0.1	2,0	0,4	0,3	0,9	2,0

2.6 Legislation

2.6.1 Legislation controlling use of chemicals

According to an Appendix No. 2 to Decree of MoE No. 302/1998 Sb., Lindane is on the list of substances, which can be imported only with the agreement of the Ministry. The last substances containing Lindane, designed for the treatment of forest stands, were registered in the List of Approved Mixtures for Plant Protection in 1995, under the name Endelit. Currently, no mixture is approved for this purpose, not even for exceptional use. Since 23rd October 2003, the Protocol on POPs within Treaty on Distant Air Transboundary Pollution has been binding for the Czech Republic, including the assignment concerning Lindane.

According to the Government Order No.258/2001 Coll., Lindane is classified as a toxic substance (T), hazardous for the environment (N). R-phrases R 23/24/25, R 36/38, R 50/53. S-phrases S(1/2-)13-45-60-61.

Lindane appeared also in Integrated Pollutant Register, approved by the Government. If a plant or farm releases more than 1 kg of Lindane annually to the air, water or soil, the total sum released from the facility has to be reported and published in a publicly available register. According to the Decree of Government on Integrated Pollutant Register (IPR), the same rule holds for an amount of Lindane greater than 1 kg in waste or wastewater. The Decree has been enforced since 1st of January 2004, and the public got the access to this data, published on Internet, in October 2005. The Czech register does not monitor inputs to the processes of production. No single value was reported in the first release of data of IPR. We think this is due to very high threshold levels set up for Lindane.

2.6.2 Food

A decree of the Ministry of Agriculture No. 68/2005 Coll. lays down the maximum level of residue (MLR) of Lindane in tea and hop at 0.05 mg/kg, and in other foodstuffs of plant origin at 0.01 mg/kg. It also lays down the MLRs for sum of α-HCH and β-HCH in tea, hop and oil seeds at 0.02 mg/kg, and in other foodstuffs of plant origin at 0.01 mg/kg. Levels set up for foodstuffs of animal origin are specified in Table 10.

Table 10: MLRs for Lindane and other HCH isomers in milk, meat and eggs (according to Appendix 4 to Decree of the Ministry of Agriculture No. 68/2005 Coll.). All values are in mg/kg.

Sort	Lindane (γ-HCH)	α-HCH	β-HCH	Notes
poultry meat	0.7	-	-	1)
meat - slaughter	0.02	-	-	1)
all meat	-	0.2	0.1	1)
milk	0.001	0.004	0.003	2)
eggs	0.1	0.02	0.01	3)
fish	0.05	0.02*		4)

Notes:

1) Values are in mg/kg of fat. *In case of food with 10% of fat or less (percentage by weight), residues are related to the total weight of boneless food. In these cases, maximal value is one tenth of value related to the content of fat, but not less than 0.01 mg/kg.*
2) *For assessment of the content of residues in raw cow milk and whole milk, the ground for calculation should be content of fat 4% (percentage by weight). For raw and whole milk from other animals, residues are calculated to the content of fat. For other diary product, listed in Appendix 1, with content of fatless than 2% (percentage by weight), maximal values is defined as half of value of raw milk and whole milk. If content of fat is 2% or higher (percentage by weight), maximal value is expressed in mg/kg of fat. In these cases, maximal value is 2.5 times value for raw milk and whole milk.*
3) *For eggs and egg product with lipid content exceeding 10% maximal value is expressed in mg/kg fat. In these cases, maximal value is 10 times value for fresh eggs.*
4) *For fish and fish products with lipid content exceeding 10% maximal value is expressed in mg/kg fat. In these cases, maximal value is 10 times value for fresh eggs.*

- *If it is not stated otherwise, meat means also poultry including fat, giblets and meat products.*
- *If it is not stated otherwise, milk means also milk products.*
- *If it is not stated otherwise, eggs mean also egg products.*
- *If it is not stated otherwise, fish means fish including sea fish and fish products*

** limit is set for sum of α-HCH and β-HCH*

2.6.3 Contamination assessment - soil and sediments

Czech legislation defined a lot of standards for concentration of Lindane in soils. In this chapter, we try to summarize them. Maximal values for concentrations of toxics for agricultural land resources (ZPF) are defined by Decree No. 13/1994 Sb. Values valid for Lindane are put in Table 11.

In terms of precautionary values (high limit of natural concentrations and anthropogenic diffuse inputs), the amendment of Decree No. 13/1994 Sb. is prepared. Proposed changes are shown in Table 12.

Ministry of Environment Czech Republic released methodical instruction, published in Bulletin of MoE (Věstník MŽP) 3/1996. This instruction is used for assessment of contamination of soils. In the Appendix, there are criteria for soils, which can be used also for soils categorized according to land use. You can find these criteria in Table 14.

Maximal values for concentration of Lindane in sediments do not exist yet in Czech legislation. For this purpose, the criteria of MoE CR for assessment of level of contamination of soil can be used. These criteria are also shown in Table 13.[16]

Table 11: Maximal allowed values (MPH) of concentration of Lindane in soil according to Decree No. 13/94 Coll. in mg/kg.

Substances	MPH
Organochlorine pesticides (individual)	0.01
Organochlorine pesticides (total)	0.1

Table 12: Proposed precautionary values of content of Lindane in agricultural land.

Substance	precautionary values ($mg.kg^{-1}$ in DM)
HCH (Σ α+β+γ)	0,01

Table 13: Criteria for assessment of contamination of soils, according to methodic instruction of MoE CR, standards are in mg/kg in DM.

Substance	Category of area					
	A	B	Cinhab.	Crekr.	Cindust.	Cgen.
hexachlorocyclohexane	0.05	2	2.5	5	10	2,5

Explanation of standards A - C of methodic instruction of MoE CR [16]: Exceeding of standards in category A in soils (and groundwater) is considered as pollution of corresponding environmental factor, excluding areas with naturally higher concentration of monitored substances. Exceeding of standards B is considered as contamination, which can have a negative impact on human health and individual environmental factors, and which requires further measures. Exceeding of limit value C is a pollution, which can mean important risk of danger for human health and state of environmental factors.

All cited norms (valid decree, proposal of amendment and methodic instruction) for assessment of limit values were based foremost on statistical processing of available results. Therefore, they can be seen as reference values, not values based on subsequent impact on living organisms, or elaborated from eco-toxicological studies (so called "effect-based levels").

2.6.4 Contamination assessment - water

Control of concentration of Lindane in water bodies in Czech Republic is more comprehensive than in the case of soil. Limit values of pollutants in surface water are approved by Government of CR. Government Order No. 61/2003 Coll. lays down emission standards: indicators and values of acceptable pollution of surface waters 0.01 µg/l. The emission standards express the acceptable pollution of surface waters at flow Q355, or, optionally, at the minimum guaranteed flow of water in the watercourse, or value, which will be met, if the annual number of samples not-complying with this standard is not higher than 5 %.

For groundwater, limit values for concentration of pesticides are assigned according to the same criteria as for soil (see chapter 2.6.3). Table 14 put their overview for individual groups of pesticides (compared to data in Klatovy - Luby, chapter 3.3). Lindane is considered to be organochlorine pesticide (OCPs).

Table 14: Limit values for criteria A - C (content of pesticides in ground waters in µg/l).

Pesticides	A	B	C
OCPs individually	0.01	0.1	0.2
Methoxychlor	0.01	25	50
Other pesticides - individually	0.01	0.2	0.5
Triazine herbicides	0.1	25	50

A decree of the Ministry of Health of the Czech Republic No. 376/2000 Coll. lays down the highest limit value for pesticide substances in drinking water at 0.1 µg/l.

3. Lindane - source of environmental burdens in Czech Republic

3.1 Spolana Neratovice - former producer of Lindane

Lindane was produced in Czech Republic together with other organochlorine pesticides in the Spolana Neratovice factory. Their production has been stopped, but the impacts showed inside the plant and in its surroundings as unwanted by-products and increased concentration of residues. One of three contaminated buildings ended up in a concrete sarcophagus, and the other two will be de-contaminated by chemical decomposition of complicated organochlorine compounds using the BCD method (see appendix in the end of the study).

History of production in the Spolana Neratovice plant:

1961 - beginning of production of technical hexachlorocyclohexane (HCH)
1965 - beginning of production of ballast isomers
27. 1. 1967 - first fire in HCH section
5. 8. 1968 - fire in the Lindane section, after that, Lindane was treated in Bratislava
1968 - stop of production of ballast isomers
28. 10. 1972 - second fire in HCH section, after that, production was not renewed.

According to Holoubek et al. (2003/2005), about 3,300 tons of Lindane was produced in Spolana, which means about 5% of production of technical HCH. [17]

Within monitoring done by the State Veterinary Administration after the flood in 2002, the concentrations of DDT above limit values were found in eggs in the area of Spolana (the mixtures of DDT were also produced in Spolana from 50s to 70s). Lindane was not monitored in samples of eggs. However, it was measured, together with other isomers of HCH, in samples of soil, sediments and water around Spolana after the flood. As reported by Ocelka, T., Grabic, R. et al. (2003), high concentrations of organochlorine pesticides were found in samples of air, water and soil in Spolana Neratovice and in outflow water courses.[18]

3.2 Dump of mine "Hájek"

One of the serious environmental burdens in Czech Republic, but less known than Spolana Neratovice, is connected with former production of Lindane and technical HCH in the body of the dump of mine "Hájek" near the village with the same name (south-eastward from Ostrov in region of Karlovy Vary). The only detailed piece of information we have found, is the report by L. Hešnaur and J.Jech (2001) from DIAMO company published on the Internet. From this report we derived all data for following brief overview.

In the 1960s, governmental authorities (in accord with the Ministry of Health Care) decided, that ballast isomers from production of Lindane and chlorinated benzenes in Spolana Neratovice to deposit at the dump of mine "Hájek". These substances were released in wastes from 1966 to 1968 and carried to different places of the dump, in metal barrels, paper packages or freely embedded. The estimated amount of chemicals, placed in a dump like this, is about 3,000 to 5,000 tonnes.

Later on, it was discovered, that the dump was created improperly on a water-bearing drain of groundwater, which is supplied mostly from groundwater from the slope of Krušné Hory. Water logging of the foot of the dump eventually caused a slide of soil in 1977. Chlorinated organic substances embedded in the body of dump were uncovered.

Recovery of slide was done in the end of the 1970s by covering it with a heavy basalt mound completed by a drainage system. According to Hešnar's and Jech's report, "Currently, the outflow from the drainage system vents into a former fish pond, which was there before recovery. Mine water flows eastward to Ostrovský creek, which supplies a system of fish ponds 1.5 kms away from the dump. Due to the high level of groundwater below the dump, solid particles, as well as dissolved chlorinated organic substances are washed out to surface waters, with the possibility of transfer of these substances to food chains (game preserve and fish ponds on Ostrovský Creek).

The problem is that the precise location of embedded chlorinated organic substances in the body of dump with a volume of approximately 7 million cubic metres is unknown. Due to wash-out of solid particles of chlorinated organic substances, contamination of surrounding materials in the dump can be expected."[19]

To illustrate this, the article on the Internet provided tables with values of total estimated amounts of released hexachlorocyclohexane and chlorobenzene (see Tables 15 and 16).

Table 15: Total amounts of hexachlorocyclohexane (HCH) and chlorobenzenes (CB) released to the channel of Ostrovský stream (kgs per year).

Year	HCH	CB
1993	10.71	3.98
1994	14.52	7.84
1995	40.83	18.21
1996	28.39	18.19
1997	22.50	12.30
1998	9.07	12.43
1999	14.68	7.96
2000	19.47	11.65
Period before recovery (1993-1998)	21.0	12.16

Note of the authors of report [5]: based on balanced values, it seems that total transfer depends on annual precipitation. The biggest outflow was observed in 1995-1996 period, when total sum of precipitation in the area reached 1 000 mm. It is apparent, that real impact of recovery to annual transfer can be assessed in next years.

In 1999, the recovery works started to prevent the release of precipitation into the body of dump and outflow of contaminated water from the area of the slide. Recovery was completed in an area of 12.1 hectares.

With detailed research, the DIAMO company discovered a dependency of concentration of chlorinated organic substances on seasons. There is a decrease in winter and maximal ingress in summer. One of possible explanation is the solubility-temperature characteristics of crystalloid substances in out flowing drainage water.

District Sanitary Station Karlovy Vary conducted analyses of surface water in surrounding fish ponds. It was discovered, that HCH concentration did not exceed allowed limit values in any case. It has to be proved by following measurements, whether it is a stable occurrence.

In the fish pond Horní Štít, approx. 1.5 km from Ostrav, higher concentrations of HCH were found in fish in comparison to fish ponds Konopka and Ottův (between Ostrov and village Hájek). Values of concentrations of HCH in the edible share of fish exceeded the limit of total content of HCH according to Decree No. 298/1997 Sb. Hešnar, L. and Jech, J. (2001) ascribed this accumulation to pollution existing before recovery works. [20]

Table 16: Total amounts of hexachlorocyclohexane (HCH) and chlorobenzenes (CB) transported outside the dump by groundwater (kg per year).

Year	HCH	CB
1994	1.96	0.82
1995	1.78	0.62
1996	0.98	0.60
1997	1.41	0.78
1998	1.40	0.91
1999	0.77	0.14
2000	0.49	0.10
Period before recovery (199-1998)	1,51	0.75

In 2000, a decreased concentration of pollutants HCH and CB were found in water of Ostrovský creek, measured in the vent to the public watercourse. However, these

concentrations still exceeded allowed concentrations by several fold according to Decree of Government No. 82/1999 Sb.

Recovery with costs of approximately 63 million of CZK (it was supposed to be completed by 2002) can soften the pollutant load of the surroundings, but it cannot solve the problem of contamination of the dump, which is still an environmental time bomb. The only long lasting solution would be the extraction of the contaminated part of the dump and its de-contamination via chemical processes. However, the question is, whether it is possible to make this operation safe enough not to cause even bigger environmental harm. It would be certainly a very costly solution. Anyway, the case of this dump is a warning about storage of dangerous chemicals in landfills, even those, that currently seem to be safe.

3.3 Klatovy-Luby - former store of pesticides

Not only *production* of Lindane and other chlorinated organic pesticides caused serious contamination of some localities in Czech Republic for many years. Similar impact was caused to places, where pesticides were *stored* and prepared for use. Among them we can find a commercial complex of buildings in Klatovy - Luby, identification number 167, located in the center of an inhabited area of the community. The nearest residential house is several meters from the backyard of these buildings.

Commercial buildings in Klatovy - Luby were used for storage and preparation of pesticides from the 1960s to the beginning of the 1990s of the 20th century (firstly as STS - technical-machinery center, later as Agrochemický podnik - Agro-chemical company). The analyses of plasters of the building, soil and groundwater proved that this activity had a disastrous impact. Buildings and their surrounding are strongly contaminated by toxics - pesticides like DDT, Lindane, fenson or atrazine, and by oil products. Not only is the soil polluted, but also water in wells. Eggs of hens grown in the backyard are contaminated by pesticides.

Table 17: Concentrations of chemicals (pesticides) measured in April of 1995 in samples of plasters from commercial buildings in Klatovy-Luby.[21] Values for limit C are taken from Methodological Instructions of MoE CR - see chapter 2.6.3.[22]

Pesticides	**Values in mg/kg (April 1995)**					**Limit C**
	P	**S**	**G**	**H**	**M**	
α HCH	<10	<10	<10	141	<10	
γ HCH (Lindane)	773	780	< 10	4390	548	**2.5**
o,p – DDE	<10	69	<10	147	65	
p,p – DDE	1080	334	<10	953	339	
o,p – DDT	1 590	540	<10	6060	925	
p,p – DDT	4570	242	<10	1680	822	
o,p – DDD	235	103	<10	<10	175	
p,p – DDD	2090	291	<10	1 880	386	
atrazine	4790	<10	9620	<10	199525	**6**
OCPs - individually	max. 4570	max. 780	<10	max.6060	max. 925	**2,5**

Explanatory notes: P - preparation hall, S - store of rodenticides, G - garage, H - main store of pesticides M - room next to store of rodenticides, OCPs - organic chlorinated pesticides

Owners, who received the buildings in restitution, tried everything: they demanded cleaning of buildings and surrounding by Agropodnik Klatovy area in court. They did not succeed. They sued for the right from Mr. President, Ministry of Environment, and the ombudsman. Everybody had an understanding and a good piece of advice. Contaminated buildings and the surrounding area however still stay near the house, they live in.

Pollution of groundwater was monitored in 2000 in Luby by the District Sanitary Station Klatovy, which had concentrations of DDT and its metabolites measured too. District Sanitary Officer stated, that pollution of waters by pesticides decreased, but as for DDT, it still exceeds limit B of Methodological Instructions of MoE. In his report wrote, among others: "Comparison to existing standard for drinking water is not completely appropriate, because it does not include a wider spectrum of pesticide-like substances. The new proposal assumes maximal concentration of 1 μg/l for each individual pesticide. Thus, only sample No. 1 371 (well 2) could fulfill this criteria, other samples of water would not comply with new decree for drinking water."[23] The water from the contaminated well next to entrance was used as drinking water till the beginning of the 1990s.

According to calculations of experts from 1997, decontamination would cost over 3.5 million CZK. But in this calculation, "only" embedding of contaminated plaster to landfill was assumed, not its real cleaning from toxics using chemical decontamination. It could be expected, that really safe decontamination of buildings will be even more expensive. The last estimation of experts from MoE CR already talked about 30 million CZK.

Contamination of the whole complex by pesticides and other toxics was discovered by the new owners, when they tried to rent it to some company for commercial use, and it firstly had chemical analyses of plasters made. Since that time, a lot of chemical analyses have been made. You can find some summarized results in Tables 17 to 20.

Hrabal, J. et al. stated, based on measurements from 1995, that: "The highest level of pollution was found in sample of groundwater labeled as "Basement", taken from the interior of the part of flooded basement of commercial building. Concentrations of pesticides found in that sample exceeds limit C according to Methodological Instructions of MoE CR in categories individual organochlorine pesticides and individual other pesticides without triazines. In well "S1 - entrance" values were indicated exceeding limit C for individual organochlorine pesticides. "It would mean practically the need to clean part of groundwater under the building of former store and preparation room for pesticides."[24]

Samples swept from the floor of pesticide preparation room, taken in June 2003, exceeded limit C for individual organochlorine pesticides (in case of Lindane) and total sum of DDT. It means that it is still necessary to decontaminate the whole commercial entity.

Table 18: Results of analyses of razed and swept samples from the floor, ordered in June 2003 by Arnika

Compound	Main store + preparation room of pesticides (µg/kg)	Oil store (µg/kg)	limit C inhabit.	limit B	limit A
Alfa - BHC	344	NA	2500	2000	50
Beta - BHC	10	NA	2500	2000	50
Lindane	***3904***	NA	2500	2000	50
Hexachlorobenzene	16,0	NA	není	2000	50
Octachlorostyrene	3,1	NA	2500	2000	50
Oxychlordane	ND	NA	2500	2000	50
trans-Nonachlor	0,3	NA	2500	2000	50
o,p'-DDD	NA	NA	není	2000	50
p,p'-DDD	4431	NA	není	2000	50
o,p'-DDE	669	NA	není	2000	50
p,p'-DDE	950	NA	není	2000	50
o,p'-DDT	11298	NA	není	2000	50
p,p'-DDT	18265	NA	není	2000	50
DDT total	***35612***	NA	2500*	not analyzed	not analyzed
OCPs - total	39890	NA	not analyzed	not analyzed	not analyzed
simazine	<200	1800	4000	3000	50
atrazine	870	9700	6000*	3000	50
MCPA	1500	***1300000***	4000	3000	50
As	6500	45000	70000	65000	30000
Cd	2400	3900	20000	10000	500
Hg	70	400	10000	2500	400
sum of 7 congeners of PCB	NA	<250	5000 (1000*)	2500	20

Explanatory notes:

* limit C is determined for multi-purpose use of the area.
- values in bold a italics indicated exceeding of limit C

Analyses were made by Axys Varilab (OCPs) and Ecochem (other monitored substances). For comparison, limits laid down by Methodological Instructions of MoE CR [16] for soils. Analyses includes also content of heavy metals, because pesticides containing them (rodenticides) were also stored there.

Table 19: Concentrations found in groundwater under former store of pesticides in Klatovy-Luby and its neighborhood in April of 1995. Source: Hrabal, J. et al. [25]

Chemical name	Common name	Concentration (µg/l)			
		Well 1 entrance	Basement	Well 2 (Ší.)	Well 3 (Šil.)
2-sek-butyl-4,6-dinitrofenylacetát	Dinoseb	<0,01	155	<0,01	<0,01
2-chlor-4-ethylamino-6-terc-butylamino-1,3,5-triazine	Terbutylazin	<0,01	2,46	<0,01	<0,01
2-methylthio-4-ethylammo-6-terc-butylamino-1,3,5-triazine	Terbutrin	1,46	31,9	<0.01	<0.01
2-chlor-4-ethylamino-6-izo-propylamino-1,3,5-triazine	Atrazine	4,67	42	1,4	0,42
2-etylamino-4-sek-butyl-6-metoxi-1,3,5-triazine	Secbumeton	1,09	<0.01	<0.01	<0.01
4-amino-3-methylthio-6-terc-butyl-1,3,4-triazine	Metribuzin	1,51	<0.01	<0.01	<0.01
2-izopropylamino-4-methylamino-5-on-6-metylthio-1,3,5-triazine	Desmetryn	1,13	<0.01	<0.01	<0.01
2-methylthio-4,6-bis-izopropylamino-1,3,5-triazine	Prometryn	5,49	15,4	<0.01	<0.01
2-methylo-6-methylthio-1-methoxy-2-propyl-chloracetanilide	Metolachlorine	0,9	5,82	<0.01	<0.01
2-methylthio-4,3-methoxipropylamino-6-izopropylamino-1,3,5-triazine	Methoprotryn	1,54	<0.01	<0.01	<0.01
a-chlor-2,6-diethyl-N-methoxymethyl-acetanilide	Alachlorine	<0.01	2,47	<0.01	<0.01

Table 20: Comparison of maximal values found in Klatovy-Luby in April of 1995 to limits for groundwater designated by Methodological Instructions of MoE CR - in µg/l.

Groups of pesticides	Well 1 entrance	Basement	Well 2 (Ší.)	Well 3 (Šil.)	Limit exceeded
other pesticides - individual (without triazines)	max. <0.01	max. 155	<0.01	<0.01	C (0.2)
other pesticides - herbicides (triazines)	5.49	42	1.4	0.42	B (25)
organochlorine pesticides	0.9	5.82	<0.01	<0.01	C (0.2)

Explanation of limits A to C of Methodological Instructions of MoE CR: Exceeding of limits of category A in soils (and ground waters) acc. to Methodological Instructions of MoE from 3rd July is considered as pollution of appropriate component of environment, with exception of areas with naturally higher content of monitored substances. Exceeding of limits B is considered as pollution, which can adversely impact human health and individual components of environment, and which needs further measures. Exceeding of limits C is considered as pollution, which can represent significant risk for human health and components of environments, and requires preventive action.

An even worse finding is that eggs of hens grown in nearby areas contain high concentrations of residues of pesticides. This was the result of analyses, ordered by Arnika in June (1 egg) and August (mixed sample of 12 eggs taken in July) 2003. Measured values exceeded limits

for DDT in eggs designated by Czech laws (Decree No. 68/2005 Sb., which defines maximal allowed content of residues of different kinds of pesticides in food and food raw materials) and limit for dioxin designated by EU Regulation. The eggs contained 34-60 times the amount DDT permitted by regulatory limits.

Table 21: Results of analysis of eggs taken in June - July 2003 in the neighborhood of the former pesticide storehouse in Klatovy-Luby, with regards to content of residues of pesticides, polychlorinated biphenyls (PCBs) and polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs).

Compound	**Sample 1 egg (sampling on 7th June 2003) ng/g**	**Mixed sample of 12 eggs (sampling July 2003) ng/g**	**limit acc. to Decree No. 465/2002**
Alfa - BHC	0.097	not detected	
Beta - BHC	0.102	0.984	
total of HCH	0.199	0.984	30
Lindane	0.46	1.09	100
Hexachlorobenzene	1.0	2.4	20
Octachlorostyrene	0.007	not detected	not available
Oxychlordane	0.010	not detected	not available
trans-Nonachlor	0.010	not detected	not available
o,p'-DDD	not analysed	not available	
p,p'-DDD	91.3	137.7	
o,p'-DDE	0.09	0.28	
p,p'-DDE	1.6	4.7	
o,p'-DDT	2.00	4.24	
p,p'-DDT	74.3	108.4	
total of DDT	**169**	**255.32**	5
OCPs - totally	171.211	259.79	
sum of di- to octa-chlorobiphenyls (PCB)	11	NA	
sum of 7 congeners of PCB	4.777	NA	
sum of PCDD/F (in pg/g of fat I-TEQ)	not available	**3,2 - 3,4** pg per g of fat	3*

Explanatory notes:
- if it is not stated otherwise, data are calculated to the weight of fresh eggs
* limit for content of dioxins acc. to EU Regulation

The case of the pesticide store in Klatovy-Luby is certainly not the only one in the Czech Republic. In the former Czechoslovakia, similar stores and preparation halls for pesticides may have been more/or less in each district. It would mean that there are tens of such places in the Czech Republic. In addition, the second version of the National POPs Inventory mentions Václavice (no. 9) in Benešov region, where contamination of HCH, DDT and HCB was detected and where now the demolition and removal of soil is taking place. In another chapter of the Inventory is information about the storage of 5000 kg of pesticides based on Lindane in Agroslužby Čáslav (Agro-services Čáslav). [26]

3.4 Trial Decontamination of contaminated plaster from Klatovy - Luby

Contaminated plaster and part of the inside walls was used for demonstration decontamination using a non-combustion technology called CMD (copper mediated destruction). This method was developed by the Czech scientist Vladimír Pekárek (Institute of Chemical Process Fundamentals, Czech Academy of Sciences). Its results were presented at the 8th HCH and Pesticide Forum in Sofia, May 2005.[27] Destruction efficiency of this method for Lindane was 99.2%. Its results for this matrix are shown in Table 22.

Table 22: Results of trial detoxification process for contaminated material from Klatovy - Luby. Source: Pekárek, V. et al. (2005).

	Before detoxification	After reaction
	ng/g	
HCB	43	<0.6
Σ HCH	5514	4.5
HCB	43	below LOD
DDT	10173	below LOD
Total OCPs	15730	4.5

The same method was used also for contaminated material from Spolana Neratovice. The results are in the power point presentation from 8th HCH and Pesticide Forum in Annex 1.

4. Conclusions

Even though Lindane has not been used for tens of years, it still appears in food chains and contaminates even commonly consumed food. Therefore, limits of its content in food are important- In 50 grams of eggs from Klatovy-Luby we consume 0.4 - 0.9 ngs of Lindane per kg of bodyweight. This appears low compared to the recommended limit of the Codex Alimentarius. However, as a bioaccumulative substance, Lindane will keep increasing in humans from all food sources. In addition, the same eggs also contain DDT, whose concentration in eggs from Klatovy-Luby exceeds the limit designated for Czech Republic by 34-60-fold.

Limits may attempt to address the consequences of environmental load by pesticides such as Lindane, but they do not affect the sources of the problem. The Czech Republic still has hidden sources of contamination by these substances. This was proved by increased concentrations of γ-HCH in air after the floods in 1997, as well as its higher concentrations in rivers. Some sources of contamination by Lindane are known, others are hidden in the old river sediments.

Identified sources of pollution by Lindane and other persistent organic pollutants (POPs) should be cleaned up to prevent their further release to the environment and to decrease risks of higher contamination of food chains by these substances. Among places contaminated by Lindane and other POPs are the Spolana Neratovice plant and its neighborhood, the dump of mine Hájek, the former store of pesticides in Klatovy-Luby and other former stores of pesticides in Czech Republic.

Ways of disposal of the old environmental load connected with the production of Lindane in the Czech Republic did not lead to clean up of polluted areas. This applies generally to solving of the old environmental load connected with persistent organic pollutants (POPs), including e.g. DDT, dioxins and others.

From the point of view of organizations associated in the international network IPEN, the most appropriate methods are those leading to complete disposal and destruction of persistent organic pollutants, not only their transformation or transfer to other media. For these reasons, landfilling, as well as incineration of waste containing POPs or the potential to form them are inappropriate. During incineration of POPs, ash and fly ash are formed which contain persistent organic pollutants. More appropriate methods use mostly different kinds of chemical decomposition of complex organic compounds such as used for trial decontamination of the contaminated material from Klatovy - Luby. Its disadvantage at this stage is a lower destruction efficiency rate for Lindane compared to other methods and the fact that it is not commercially available. We suggest supporting further development of this and other methods that truly destroy POPs.

Two pilot projects will be important for disposal of old environmental loads in the Czech Republic: disposal of dioxins in the Spolana Neratovice factory and cleaning of the former PCB production facility, Chemko Strážské, in Slovakia. For disposal of dioxins, the State Estate Fund chose the BCD technology. The Chemko Strážské site is the subject of a Slovakian government project being carried out in collaboration with the United Nations Industrial Development Organization (UNIDO) and funded by the Global Environment Facility (GEF). The project is currently examining appropriate technologies for the clean up.

The prevention of the risks connected to Lindane would be significantly strengthened, if it was completely forbidden in Czech legislation, as well as on the European or global level by Protocol on POPs to the Convention on Long Range Transboundary Air Pollution 'LRTAP' and by the Stockholm Convention.

The whole story of the pesticide with the inveterate name "Lindane" is probably coming to an end in our country. However, it has been replaced by a range of pesticides, which are still used on a large scale, and which were at the same time proven to have comparable risks to Lindane. Instead of repeating old mistakes, we should avoid or at least limit their use, as has already been done in many European countries.[28] They are for example 2,4-D, acetochlorine, alachlorine, atrazine, dicofol, endosulfan, chlorpyrifos, linuron, simazin, thiram, trifluralin, vinclozolin, zineb and others.

The public should have the right to know more information about these substances including their annual consumption in individual agricultural plants etc through an Integrated Pollution Register. The Ministry of Agriculture together with the Ministry of Industry and Trade together pushed through a restriction of number of substances, which were supposed to be reported within the Integrated Pollution Register beginning in 2005. The Register will contain information about total emissions and transfer of selected chemicals from individual plants (the first data will be collected for 2004). Representatives of both ministries deleted the following dangerous substances from the list used as pesticides: atrazine, diuron, fenylhydrazine, chlorfenviphos, chlorpyrifos, chlordane, chlordecone, isoproturon, methylbromide, para-dichlorobenzene, simazine, tetrachlorophenol, toxaphene, trifluralin, and others. Note that chlordane is on the Stockholm Convention list and that chlordecone is a

candidate for the list after being nominated in 2005 by the European Union. The POPs Review Committee of the Convention recently declared chlordecone to be a POP.

5. Lindane (γ-HCH) in the Czech Republic - Summarized Information

CAS: 58-89-9

Basic characteristics, occurrence and use in the Czech Republic:

Lindane is an organochlorine pesticide (OCPs). It is a persistent, bioaccumulative substance and an endocrine disruptor. Chemically it is the gamma-isomer of hexachlorocyclohexane. It was used for protection of roots, leaves and seeds of all usual cultural crops. It was also used for treatment of wood, wool, cotton and sheds against parasites. Today its use is limited. However, it is used for example, in preparations for control of lice. It was produced in Chemické závody Jurije Dimitrova in Bratislava, and in the Spolana Neratovice factory in the Czech Republic. Approximately 61 680 tons of pesticides based on Lindane have been used in the Czech Republic since 1996. During assessment of its presence in the environment, it is more objective to assess both the presence of γ-HCH, and its metabolite β-HCH which persists in the environment for a much longer period of time. Because of that, we include measurements of all HCH metabolites in the results of measurements.

Impact on human health:
According to IARC, Lindane is included in group 2B; possible human carcinogen. This category indicates sufficient evidence of carcinogenicity in animals. Technical HCH (a mix of isomers) and alpha HCH (a Lindane isomer) are also classified as possible human carcinogens. The Stockholm Convention POPs Review Committee named Lindane a POP, confirming its known ability to bioaccumulate in human fat tissues and subsequently threaten public health.

Burden of inhabitants of the Czech Republic:
The burden of inhabitants has been monitored since 1994. The available data appears to indicate that exposure of inhabitants is low at 0.1 % of the "acceptable" dose (ADI), set at the level of 0.008 mg/kg of body weight/day (1989). However, the bioaccumulative nature of Lindane and other POPs calls into question regulatory limits based on "acceptable" doses.

Monitoring:
Higher Lindane concentrations in Czech rivers were found in central and south Moravia, but also in the river Bílina downstream of the Spolchemie Company in Ústí nad Labem. In the case of river sediments, higher values were also found in Moravia. The Initial National POPs Inventory also provided a summary of results of measurements of Lindane in subsurface waters. According to the authors of the report, monitoring did not find values above the detection limit, i.e., 2 ng/l. J. Hajšlová et al. (1999) found higher values of the total sum of organochlorine pesticides in water of Moravian rivers after the floods in 1997. Concentrations were in the range from 12.9 to 33.1 ng/l.[29]

Results of measurements:

Soil: The highest HCH sum was 115.5 ng/g (Libiš, Mělnická 114, August 30, 2002) [30], the amount of γ-HCH in this sample was 12.0 ng/g, the amount of β-HCH 68.0 ng/g;
0.0002 – 0.356 pg/g of dry weight (data from the years 1993 – 2001, measurements in the vicinity of motorways)[31]

Water (surface): The highest C90 value (value which will not be exceeded with the probability of 90 %) 137.1 ng/l (analyses 1995 - 2002, Czech Hydro-meteorological Institute)[32]
Spolana - HCH sum 9,083.0 ng/l (Spolana Neratovice, building A1420, water after floods, inside the industrial premises, August 30, 2002) [33]
Spolana - HCH sum 681.8 ng/l (Spolana Neratovice, amelioration drain, gatehouse, at discharge from the industrial premises, September 2002) [34]

Breast milk: γ-HCH - at most 28.8 ng/g of fat (C90, MZSO - Monitoring of State of Health of Inhabitants, 1998)
β-HCH - at most 428 ng/g of fat (VaV 520/6/99, Ústí nad Labem, 2000), median for this group of measurements is 173 ng/g of fat (VaV 520/6/99, Ústí nad Labem, 2000)

Fish: HCH sum 101.5 ng/g of muscle (carp, Libiš, pool in floodplain forest, in the vicinity of Spolana Neratovice, October 2002) [35]

Eggs: HCH sum 2.074 ng/g of whole eggs (household farm, composite sample of 12 eggs, Klatovy - Luby, 2003)[36], 20 ng/g of fat (year 2004, place was not stated).[37]

Further results of measurements:
Sediments: the highest annual arithmetic mean 161.25 ng/g (year 1999, Czech Hydro-meteorological Institute) [38]
Spolana and its vicinity - HCH sum 28,400.0 ng/g (Spolana Neratovice, building A1420, sediment after floods, inside the industrial premises, August 30, 2002) [39]

Underground water: the highest annual arithmetic mean 0.15 μg/l (analyses 1995 – 2002, Czech Hydro-meteorological Institute)

Suspended sediments: the highest annual arithmetic mean 19.5 ng/g (year 2001, Czech Hydro-meteorological Institute) [40]

Mushrooms: 0.1 – 2.0 ng/g of mushroom dry weight[41]

Butter: at most 7 ng/g fat[42]

Cow milk: at most 15 ng/g fat in 2004. [43]

Limits:
Decree of the Ministry of Agriculture No. 68/2005 Coll. lays down the maximum residual amount of Lindane in tea and hop 0.05 mg/kg, and in other foodstuffs of plant origin 0.01 mg/kg.

Government Order No. 61/2003 Coll. lays down emission standards: indicators and values of acceptable pollution of surface waters 0.01 μg/l. The emission standards express the acceptable pollution of surface waters at flow Q355, or, optionally, at the minimum

guaranteed flow of water in the watercourse, or value, which will be met, if the annual number of samples not-complying with this standard is not higher than 5 %.

Decree of the Ministry of Health of the Czech Republic No. 376/2000 Coll. lays down the highest limit value for pesticide substances in drinking water 0.1 μg/l.

In the case of pesticide substances, also limits for soil are laid down by the Decree No. 13/1994 Coll. The limit is laid down for the individual substances at the level of 0.01 mg/kg of dry weight, and for the sum of pesticides at the level of 0.1 mg/kg of dry weight.

Government Order No. 368/2003 Coll. on integrated pollution register lays down limits for reporting in kg/year: 1 kg/year for emission into water, 1 kg/year for emission into soil, and 1 kg/year for transfers out of the plant. In the case of emission into air, limit for reporting was not set.

According to the Government Order No.258/2001 Coll., Lindane is classified as a toxic substance (T), hazardous for the environment (N). R-phrases R 23/24/25, R 36/38, R 50/53. S-phrases S(1/2-)13-45-60-61.

Not binding (orientation) limits are laid down for:
Methodical Instruction of the Environmental Damage Department of the Ministry of the Environment of the Czech Republic published in 1996, lays down criterions for pollution of soils and underground water.

The substance is: banned for use in agriculture. The last permitted preparation containing Lindane, intended for treatment of forest stands on a large scale, was Endelit, permitted in 1995. It can be used in health care. In lower concentrations, it is recommended as an active substance for treatment of scabies as used with imported preparations Jacutin and Skabicid. Jakutin is recommended also against lice. References to use of Jacutin and Skabicid can be found in descriptions of treatment of dogs and other applications (for example, among preparations for use in aquariums).

Importance of the substance for implementation of the Stockholm Convention: The substance is one of the candidates for the Stockholm Convention list of substances and has been declared a persistent organic pollutant by the POPs Review Committee.

Main sources of releases: The substance is neither produced nor used in the Czech Republic on a larger scale. However, it can be released from contaminated places or old stocks of this pesticide.

State of inventory of sources: The inventory is not complete. There exists a basic list in the National POPs Inventory.

Main measures proposed by NGOs: Mapping of places where pesticides were stored and prepared in the past; Decontamination of the affected localities; Monitoring of levels of Lindane and its metabolites during decontamination of old burdens in Spolana Neratovice; and consistent measures for prevention of further releases of this and other substances from contaminated sites. Arnika has also tried to push through decontamination of the former pesticide storage site in Klatovy-Luby. The storage was returned in restitution back to the original owner. It is necessary to clean similar localities in the Czech Republic.

Main hot spots in connection with this substance:
High Lindane concentrations were found for example, in the former pesticide storage in Klatovy-Luby, and in the Spolana Neratovice factory and its vicinity. Further places highly contaminated by Lindane are tied to former pesticide storehouses and preparation rooms (see table in Chapter 5).

References

[1] Mistrík, M., Hegyi, L. (2001): Perzistentné organické polutanty a Slovensko. Spoločnosť priatelov Zeme, Košice 2001.

[2] Holoubek, I. et al. (2001): Persistent, Bioaccumulative and Toxic Chemicals in Central and Eastern Europen Countries –Stete-of-the-Art Report, TOCOEN Rep. No.150a, May 01, 2001.

[3] Holoubek, I. et al. 2003/2005: Úvodní národní inventura persistentních organických polutantů v České republice. Projekt GF/CEH/01/003: ENABLING ACTIVITIES TO FACILITATE EARLY ACTION ON THE IMPLEMENTATION OF THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POPs) IN THE CZECH REPUBLIC. TOCOEN, s.r.o., Brno v zastoupení Konsorcia RECETOX - TOCOEN & Associates, TOCOEN REPORT No. 249, Brno, srpen 2003. Verze 2003.

[4] Holoubek, I. et al. 2003/2005: Úvodní národní inventura persistentních organických polutantů v České republice. Projekt GF/CEH/01/003: ENABLING ACTIVITIES TO FACILITATE EARLY ACTION ON THE IMPLEMENTATION OF THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POPs) IN THE CZECH REPUBLIC. TOCOEN, s.r.o., Brno v zastoupení Konsorcia RECETOX - TOCOEN & Associates, TOCOEN REPORT No. 249, Brno, srpen 2003. Verze 2003.

[5] Hajšlová, J. et al. (1999): Hodnocení stavu životního prostředí - Monitoring cizorodých látek v potravních řetězcích v roce 1997. Vydavatelství VŠCHT, Prague 1999.

[6] Stockholm Convention POPs Review Committe – Mexico, Draft risk profile for Lindane, April 2006 available here: http://www.pops.int/documents/meetings/poprc/tech_comments/default.htm

[7] Dutta, M., Schafer, K. S. (2003): Lindane - Answers to common questions. IPEN Pesticide Working Group. Dakar 2003.

[8] SZÚ 1996 - 2002: Database of biological monitoring SZÚ (Sate Health Institute),subsystem of Bilogical monitoring 1995 - 2001, SZÚ Praha, 1996 - 2002 (http://www.szu.cz/chzp/monitor.htm).

[9] Bencko, V., Černá, M. 2001: Studie výskytu persistentních organických látek v ovzduší a jejich depozice na území České republiky. Part II.: Biologický monitoring expozice populace ČR polyhalogenovaným uhlovodíkům ve vybranýc oblastech. Final report on the process of carrying out a project of the programme VaV 520/6/99.

[10] Černá, M. et al. 2005: Expozice české populace persistentním organickým látkám - přehled dostupných dat o zátěži české populace (biologický monitoring). In: Holoubek, I. et al. 2003/2005: Úvodní národní inventura persistentních organických polutantů v České republice. Project GF/CEH/01/003: ENABLING ACTIVITIES TO FACILITATE EARLY ACTION ON THE IMPLEMENTATION OF THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POPs) IN THE CZECH REPUBLIC. TOCOEN, s.r.o., Brno representing Consortium RECETOX - TOCOEN & Associates, TOCOEN REPORT No. 249, Brno, August 2003. Version 2003.

[11] SVS ČR 2003: Kontaminace potravních řetězců cizorodými látkami - situace v roce 2002. Informační bulletin No. 1/2003. State Veterinary Administration.

[12] SVS ČR 2005: Kontaminace potravních řetězců cizorodými látkami - situace v roce 2004. Informační bulletin No. 1/2005. State Veterinary Administration.

[13] Codex Alimentarius Commission (1998): Consideration of intake of pesticide residues: Reports on pesticide residue intake studies at international and national level based on revised guidelines for predicting dietary intake of pesticide residues. Reports of 13th session of the Codex committee on pesticide residues. FAO/WHO, April 1998. (http://www.codexalimentarius.net)

[14] Hajšlová, J. et al. (1999): Hodnocení stavu životního prostředí - Monitoring cizorodých látek v potravních řetězcích v roce 1997. Vydavatelství VŠCHT, Prague 1999.

[15] VÚLHM 1997: Recent results of the contaminates monitoring of forest ecosystems indicated high concentrations of cadmium in mushrooms (Annual Report from 1997). VÚLHM Prague - Zbraslav.

[16] MOE 1996: Metodický pokyn MŽP. Věstník MŽP 3/1996. Praha. Ministry of Environment of the Czech Republic.

[17] Holoubek, I. et al. 2003/2005: Úvodní národní inventura persistentních organických polutantů v České republice. Projekt GF/CEH/01/003: ENABLING ACTIVITIES TO FACILITATE EARLY ACTION ON THE IMPLEMENTATION OF THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POPs) IN THE CZECH REPUBLIC. TOCOEN, s.r.o., Brno v zastoupení Konsorcia RECETOX - TOCOEN & Associates, TOCOEN REPORT No. 249, Brno, srpen 2003. Verze 2003.

[18] Ocelka, T., Grabic, R. et al. 2003: The monitoring of POPs surrounding of Spolana Neratovice after summer flood episode. In: International Workshop on Non-Combustion Technologies for Destruction of POPs, Prague, January 15 - 19, 2003. Arnika, Praha 2003.

[19] Hešnaur, L., Jech, J. (2001): Řešení problematiky důlních vod z výsypky lomu Hájek, kontaminovaných uloženými odpady z výroby organochlorových insekticidů. http://www.diamo.cz/hpvt/hp2002/historie/2001/sekce/sanace/18/S18.htm (DIAMO, s. p., o. z. SUL Příbram 2001).

[20] Hešnaur, L., Jech, J. (2001): Řešení problematiky důlních vod z výsypky lomu Hájek, kontaminovaných uloženými odpady z výroby organochlorových insekticidů. http://www.diamo.cz/hpvt/hp2002/historie/2001/sekce/sanace/18/S18.htm (DIAMO, s. p., o. z. SUL Příbram 2001).

[21] Hrabal, J. et al. (1997): Znalecký posudek evid. č. 620/6037/97 finanční posouzení starých ekologických zátěží v areálu bývalého skladu pesticidů (hospodářský objekt č.p. 167) bývalého Agrochemického podniku Klatovy v části Luby č.p. 56. Mega, Stráž pod Ralskem, prosinec 1997.

[22] MOE 1996: Metodický pokyn MŽP. Věstník MŽP 3/1996. Praha. Ministry of Environment of the Czech Republic.

[23] Krýsl, S. (2000): Komentář k výsledkům kontaminace hospodářského objektu manželů Rychtaříkových (Klatovy - Luby). OHS Klatovy, 17. 5. 2000.

[24] Hrabal, J. et al. (1997): Znalecký posudek evid. č. 620/6037/97 finanční posouzení starých ekologických zátěží v areálu bývalého skladu pesticidů (hospodářský objekt č.p. 167) bývalého Agrochemického podniku Klatovy v části Luby č.p. 56. Mega, Stráž pod Ralskem, prosinec 1997.

[25] Hrabal, J. et al. (1997): Znalecký posudek evid. č. 620/6037/97 finanční posouzení starých ekologických zátěží v areálu bývalého skladu pesticidů (hospodářský objekt č.p. 167) bývalého Agrochemického podniku Klatovy v části Luby č.p. 56. Mega, Stráž pod Ralskem, prosinec 1997.

[26] Holoubek, I. et al. 2003/2005: Úvodní národní inventura persistentních organických polutantů v České republice. Projekt GF/CEH/01/003: ENABLING ACTIVITIES TO FACILITATE EARLY ACTION ON THE IMPLEMENTATION OF THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS

(POPs) IN THE CZECH REPUBLIC. TOCOEN, s.r.o., Brno v zastoupení Konsorcia RECETOX - TOCOEN & Associates, TOCOEN REPORT No. 249, Brno, srpen 2003. Verze 2003.

[27] Pekárek, V., Ocelka, T., Grabic, R. 2005: The application of CMD method for destruction of chlorinated pesticides and some pre-dioxin and POP compounds. 8th International HCH and Pesticide Forum, 26-28 May 2005, Sofia.

[28] Kotecký, V. (2003): Rizika pesticidů s endokrinními účinky: srovnání přístupů a řešení v České republice a v Německu, Hnutí Duha, leden 2003.

[29] Hajšlová, J. et al. (1999): Hodnocení stavu životního prostředí - Monitoring cizorodých látek v potravních řetězcích v roce 1997. Vydavatelství VŠCHT, Prague 1999.

[30] Holoubek, I. et al. 2003: Shrnutí měření kontaminace okolí Spolany Neratovice polychlorovanými dibenzo-p-dioxiny, dibenzofurany a bifenyly po povodních 2002. TOCOEN, s.r.o. Brno. TOCOEN Report No. 236, February 2003.

[31] Holoubek, I. et al. 2003/2005: Úvodní národní inventura persistentních organických polutantů v České republice. Projekt GF/CEH/01/003: ENABLING ACTIVITIES TO FACILITATE EARLY ACTION ON THE IMPLEMENTATION OF THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POPs) IN THE CZECH REPUBLIC. TOCOEN, s.r.o., Brno v zastoupení Konsorcia RECETOX - TOCOEN & Associates, TOCOEN REPORT No. 249, Brno, srpen 2003. Verze 2003.

[32] CHMI 2003: Hexachlorocyclohexane profile in internet database at: http://hydro.chmi.cz/ojv2/htm/pasporty/clpesticidy/gamaHCH.htm

[33] Holoubek, I. et al. 2003: Shrnutí měření kontaminace okolí Spolany Neratovice polychlorovanými dibenzo-p-dioxiny, dibenzofurany a bifenyly po povodních 2002. TOCOEN, s.r.o. Brno. TOCOEN Report No. 236, February 2003.

[34] Holoubek, I. et al. 2003: Shrnutí měření kontaminace okolí Spolany Neratovice polychlorovanými dibenzo-p-dioxiny, dibenzofurany a bifenyly po povodních 2002. TOCOEN, s.r.o. Brno. TOCOEN Report No. 236, February 2003.

[35] Holoubek, I. et al. 2003: Shrnutí měření kontaminace okolí Spolany Neratovice polychlorovanými dibenzo-p-dioxiny, dibenzofurany a bifenyly po povodních 2002. TOCOEN, s.r.o. Brno. TOCOEN Report No. 236, February 2003.

[36] Beranek, M., Havel, M., Petrlik, J. 2003: Lindane - pesticide for the black list. Czech Ecological Society Report, Prague, Nov 2003.

[37] SVS ČR 2005: Kontaminace potravních řetězců cizorodými látkami - situace v roce 2004. Informační bulletin No. 1/2005. State Veterinary Administration.

[38] CHMI 2003: Hexachlorocyclohexane profile in internet database at: http://hydro.chmi.cz/ojv2/htm/pasporty/clpesticidy/gamaHCH.htm

[39] Holoubek, I. et al. 2003: Shrnutí měření kontaminace okolí Spolany Neratovice polychlorovanými dibenzo-p-dioxiny, dibenzofurany a bifenyly po povodních 2002. TOCOEN, s.r.o. Brno. TOCOEN Report No. 236, February 2003.

[40] CHMI 2003: Hexachlorocyclohexane profile in internet database at: http://hydro.chmi.cz/ojv2/htm/pasporty/clpesticidy/gamaHCH.htm

[41] VÚLHM 1997: Recent results of the contaminates monitoring of forest ecosystems indicated high concentrations of cadmium in mushrooms (Annual Report from 1997). VÚLHM Prague - Zbraslav.

[42] SVS ČR 2003: Kontaminace potravních řetězců cizorodými látkami - situace v roce 2002. Informační bulletin No. 1/2003. State Veterinary Administration.

[43] SVS ČR 2005: Kontaminace potravních řetězců cizorodými látkami - situace v roce 2004. Informační bulletin No. 1/2005. State Veterinary Administration.