Environmental monitoring in Belarus

Final report – part two

Organochlorine pesticides, heavy metals
and petroleum products

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ARNIKA

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Sampling 16.8. – 22.8. 2012 and 26.12. – 29.12. 2011

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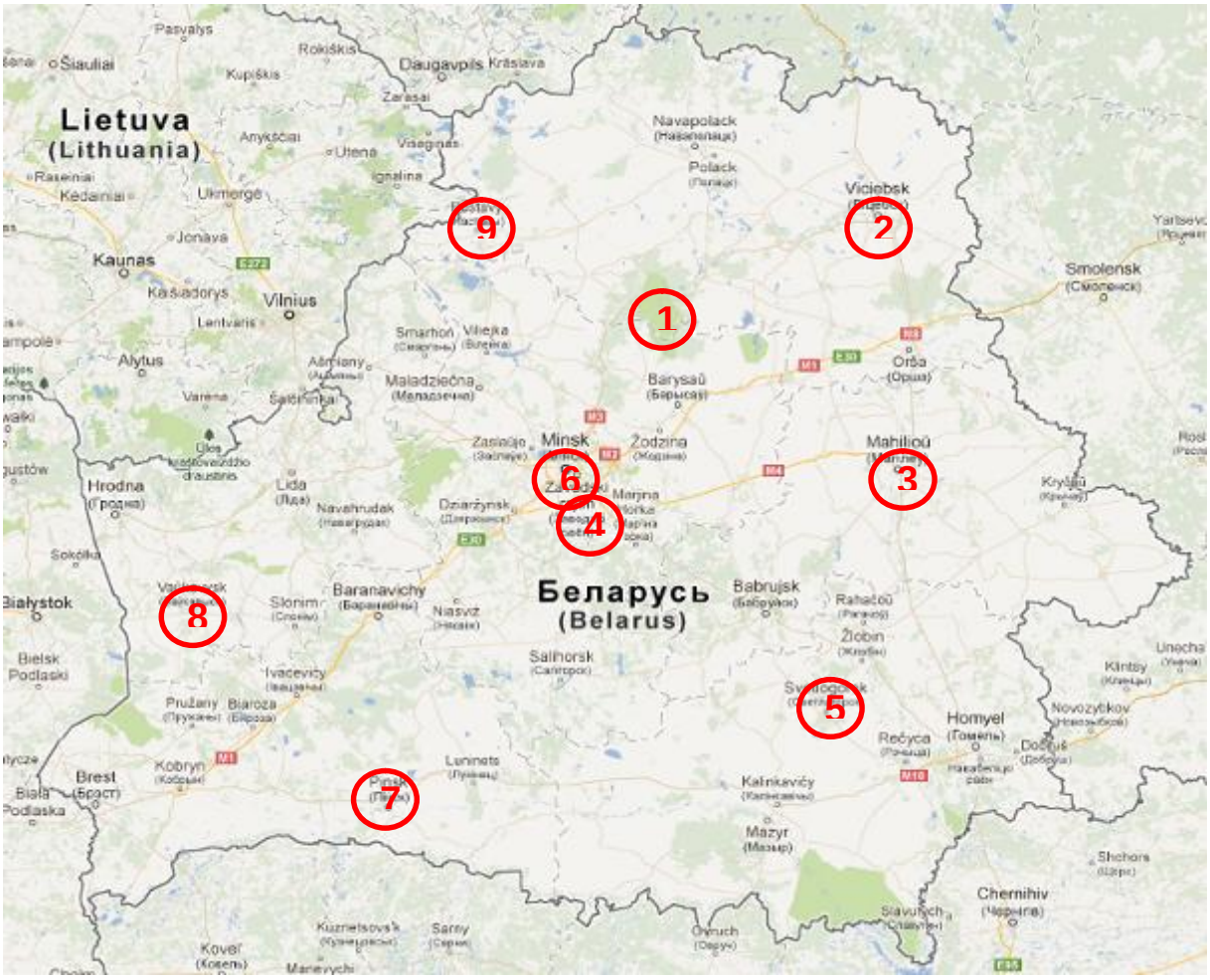
Introduction

In cooperation with the Czech non-profit organisation Arnika, we visited Belarus in August 2012. In Belarus, the mission was prepared and organised by a local non-governmental organisation CES (Centre for Environmental Solutions).
The purpose of our visit was monitoring of contamination in selected localities. The present report comprises description of the visited localities and taken samples. Results presented in this study concern with pesticide, heavy metals, arsenic and petroleum product pollution in river sediments and soils. Comparison of detected pollution with levels of pollution limits and criteria of pollution was made. Results of sampling in 2011 conducted by CES is also part of this study.

Localities



We visited 9 localities in 2012. Total of 61 samples were collected. The localities included surrounding of industrial areas: Svetlogorsk (8 samples), Mogilev (12 samples), Vitebsk (4 samples), Krasnosyelski (8 samples) a Gatovo (5 samples), surrounding of wastewater treatment plant: Pinsk (3 samples), Minsk (4 samples), one locality with an old ecological burden Pastavy (14 samples) and one biosphere reserve Berezinsky (3 samples).
In 2011 10 samples was taken for analysis: Krasnosyelski (2 samples), Minsk (3 samples), Druzhnyi (1 sample), Zhlobin (2 samples), Gatovo (2 samples)

Dates of sampling

18.8.2012	Svetlogorsk, Krasnosyelski, Pinsk
19.8.2012	Mogilev, Gatovo, Minsk
20.8.2012	Vitebsk, Berezinsky, Pastavy

26.12.2011	Minsk
27.12.2011	Druzhnyi, Zhlobin
28.12.2011	Gatovo
29.12.2011	Krasnosyelski

Obr. 1: Locality Krasnosyelski.

Obr. 2: Locality Minsk.

Obr. 3. Locality Berezinski.

Obr.4: Locality Krasnosyelski.


Obr. 5: Locality Pastavy.

Methodology of sampling and sample analysis

Sampling

Several samples were taken in each of the localities. Mostly, mixed samples were taken, formed by several partial samples taken in various places of the given locality. The samples were taken by means of a shovel into plastic sample containers (V = 500 ml) with screw lids. Samples were stored in a cold and dark before analysis.

Sample preparation

Samples were homogenised and a representative part (10 g) was used for the determination of dry matter by a gravimetric method. Another representative part was taken for analysis.

Determination of pesticides

A representative part of the sample was taken for analysis, specifically, 2.5 g of the sample. The sample was placed, together with 10 ml of hexane, into an extraction bottle, and extracted in ultrasound water bath for the period of 20 minutes. Subsequently, the extract was analysed by means of a gas chromatograph GC HP 5890 with ECD detector and capillary column HP – 5MS (lenght: 60 m, stationary phase: 5% diphenyl a 95% dimethylsiloxan).

Determination of heavy metals

Samples were mineralized by nitric acid. 5 g of sample was placed into a beaker together with 30 ml of destiled water and 10 ml of concentrated nitric acid. Sample was boiled for the period of 2 hours. Then it was filtered and metals were determined by atomic absorption and emission spectrometre SensAA. Lead, cadmium, copper, zinc and arsenic were determined by this procedure. Mercury was measured directly in solid samples by AMA analysator (AMA254, Altec).

Determination of petroleum products

Petroleum products were were determined like non-polar extractected componds by IR specrometry. 5 g of sample was placed together with 25 ml of tetrachloromethane into the flask and in ultrasound water bath for the period of 15 minutes. Petroleum products were determined in extract in 1 cm cuvette by FTIR spectrometre.

Results

Tab. 1: Concentration of pesticides.

	Name	Locality	Matrix	Oxychlordan	beta-HCH	4,4-DDE	2,4-DDT	4,4-DDT
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	SVE01	Svetlogorsk	mollusc					
2	SVE02	Svetlogorsk	sediment	0,17				
3	SVE03	Svetlogorsk	sediment	0,03				
4	SVE04	Svetlogorsk	sediment	0,33	0,04			
5	SVE05	Svetlogorsk	mollusc					
6	SVE06	Svetlogorsk	mollusc					
7	SVE07	Svetlogorsk	sediment	0,20				
8	SVE08	Svetlogorsk	mollusc					
9	MOG01	Mogilev	sediment					
10	MOG02	Mogilev	sediment					
11	MOG03	Mogilev	mollusc					
12	MOG04	Mogilev	sediment	1,40				
13	MOG05	Mogilev	water					
14	MOG06	Mogilev	sediment	0,10				
15	MOG07	Mogilev	water					
16	MOG08	Mogilev	sediment	0,11				
17	MOG09	Mogilev	sediment	0,10				
18	MOG10	Mogilev	mollusc					
19	MOG11	Mogilev	water					
20	MOG12	Mogilev	water					
21	VIT01	Vitebsk	sediment	0,04				
22	VIT02	Vitebsk	sediment	0,06				
23	VIT03	Vitebsk	sediment					

	Name	Locality	Matrix	Oxychlordan	beta-HCH	4,4-DDE	2,4-DDT	4,4-DDT
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
24	VIT04	Vitebsk	mollusc					
25	BER-BAR	Berezinsky	sediment					
26	PAST 1	Pastavy	soil			0,02	0,03	0,16
27	PAST 2	Pastavy	soil				0,02	0,06
28	PAST 3	Pastavy	soil			0,01	0,01	0,17
29	PAST 4	Pastavy	soil				0,03	0,05
30	PAST I	Pastavy	soil			0,01	0,02	0,06
31	PAST II	Pastavy	soil				0,02	0,12
32	PAST III	Pastavy	soil					0,01
33	PAST IV	Pastavy	soil					
34	PAST - S	Pastavy	soil				0,01	
35	PAST – M	Pastavy	soil					
36	PAST – M	Pastavy	soil					
37	PAST – H	Pastavy	mushrooms					
38	PAST–H2	Pastavy	mushrooms					
39	PAST-R	Pastavy	soil					
40	KR 1	Krasnosyelski	sediment					
41	KR 2	Krasnosyelski	sediment	0,02				
42	KR 3	Krasnosyelski	sediment					
43	KR 5	Krasnosyelski	soil					
44	KR 6	Krasnosyelski	soil					
45	KR 7	Krasnosyelski	sediment	0,19				
46	KR 1 ryby	Krasnosyelski	fish					
47	PI 1	Pinsk	sediment	0,41	0,05			
48	PI 2	Pinsk	sediment	0,91	0,06			
49	PI 1 ryby	Pinsk	fish					
50	GA 1	Gatovo	sediment	0,30				
51	GA 2	Gatovo	sediment	0,20				

	Name	Locality	Matrix	Oxychlordan	beta-HCH	4,4-DDE	2,4-DDT	4,4-DDT
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
52	GA 3	Gatovo	sediment	0,37				
53	GA 4	Gatovo	sediment	0,67				
54	GA 4 ryby	Gatovo	fish					
55	MI 1	Minsk	sediment					
56	MI 2	Minsk	sediment	0,05				
57	MI 3	Minsk	sediment	2,90	0,14			
58	MI 1 ryby	Minsk	fish					
59	BE 1	Berezinsky	peat					
60	BE 2	Berezinsky	soil					
61	BE 3	Berezinsky	sediment					

Tab. 2: Concentration of heavy metals

	Name	Locality	Matrix	Pb	Cd	Cu	Cr – celk.	Zn	As	Hg
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	SVE01	Svetlogorsk	mollusc							
2	SVE02	Svetlogorsk	sediment	50	0,7	3,1	24,8	14		0,007
3	SVE03	Svetlogorsk	sediment	1,7			20,7	7		0,004
4	SVE04	Svetlogorsk	sediment	2,2		3,3	16,8	37		0,013
5	SVE05	Svetlogorsk	mollusc							
6	SVE06	Svetlogorsk	mollusc							
7	SVE07	Svetlogorsk	sediment	3,6		5,1	44,1	39		0,012
8	SVE08	Svetlogorsk	mollusc							
9	MOG01	Mogilev	sediment							
10	MOG02	Mogilev	sediment							
11	MOG03	Mogilev	mollusc							
12	MOG04	Mogilev	sediment	70	1,8	29,8	119	1030	25,8	0,41
13	MOG05	Mogilev	water							
14	MOG06	Mogilev	sediment	3,8		5,9	17,5	29		0,022
15	MOG07	Mogilev	water							
16	MOG08	Mogilev	sediment	6,6		27,2	87,9	127		0,030
17	MOG09	Mogilev	sediment	2,5		6,8		45		0,013
18	MOG10	Mogilev	mollusc							
19	MOG11	Mogilev	water							
20	MOG12	Mogilev	water							
21	VIT01	Vitebsk	sediment	6,9		7,6		41		0,009
22	VIT02	Vitebsk	sediment	13,4		12,5	11,8	60		0,026
23	VIT03	Vitebsk	sediment							
24	VIT04	Vitebsk	mollusc							
25	BER-BAR	Berezinsky	sediment	5,1		3,3		28		0,011

26	PAST 1	Pastavy	soil							
	Name	Locality	Matrix	Pb	Cd	Cu	Cr – celk.	Zn	As	Hg
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
27	PAST 2	Pastavy	soil							
28	PAST 3	Pastavy	soil							
29	PAST 4	Pastavy	soil							
30	PAST I	Pastavy	soil							
31	PAST II	Pastavy	soil							
32	PAST III	Pastavy	soil							
33	PAST IV	Pastavy	soil							
34	PAST - S	Pastavy	soil							
35	PAST – M	Pastavy	soil							
36	PAST – M	Pastavy	soil							
37	PAST – H	Pastavy	mushrooms							
38	PAST–H2	Pastavy	mushrooms							
39	PAST-R	Pastavy	soil							
40	KR 1	Krasnosyelski	sediment	4,6		1,7		9		0,006
41	KR 2	Krasnosyelski	sediment	17,7		15,1	7,7	75		0,013
42	KR 3	Krasnosyelski	sediment	58	3,6	35,7		257		0,015
43	KR 5	Krasnosyelski	soil	9,7	0,6	7,8	8,2	29		0,021
44	KR 6	Krasnosyelski	soil	7,3		3,9	10,5	21		0,016
45	KR 7	Krasnosyelski	sediment	22,6		32,7	14,2	97	14,1	0,013
46	KR 1 ryby	Krasnosyelski	fish							
47	PI 1	Pinsk	sediment	4,0		31,1		45		0,094
48	PI 2	Pinsk	sediment	3,3		6,4	7,2	19		0,009
49	PI 1 ryby	Pinsk	fish							
50	GA 1	Gatovo	sediment	11,8		20,4	69,5	81		0,031
51	GA 2	Gatovo	sediment	4,6		8,8	14,7	65		0,012
52	GA 3	Gatovo	sediment	81	8,6	398	1120	680	21,9	0,17

53	GA 4	Gatovo	sediment	8,9		19,8		108	31,7	0,035
54	GA 4 ryby	Gatovo	fish							
	Name	Locality	Matrix	Pb	Cd	Cu	Cr – celk.	Zn	As	Hg
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
55	MI 1	Minsk	sediment	5,5		8,2	12,1	32		0,023
56	MI 2	Minsk	sediment	3,9		4,6	6,4	26		0,013
57	MI 3	Minsk	sediment	36,9	1,3	74,4	87,5	830		0,026
58	MI 1 ryby	Minsk	fish							
59	BE 1	Berezinsky	peat							
60	BE 2	Berezinsky	soil	8,7		2,1		16		
61	BE 3	Berezinsky	sediment	5,5		2,7		20		

Tab. 3: Concentration of petroleum products.

	Name	Locality	Matrix	Nepolární extrahovatelné látky
				mg/kg
12	MOG04	Mogilev	sediment	211
14	MOG06	Mogilev	sediment	32
16	MOG08	Mogilev	sediment	77
17	MOG09	Mogilev	sediment	38
51	GA 2	Gatovo	sediment	33
52	GA 3	Gatovo	sediment	636
53	GA 4	Gatovo	sediment	408

Tab. 4: Concentration of pesticides in 2011.

	Name	Locality	Matrix	HCB	alfha-HCH	gama-HCH	p,p - DDE	o,p - DDT	p,p - DDT	o,p - DDD	trans-heptachlorepoxid	gama-HBCD
				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
1/2011	KR1/2011	Krasnosyelski	sediment	0,34			3,37	6,62		0,66		
2/2011	KR2/2011	Krasnosyelski	sediment				2,64	4,66		0,36	0,72	0,38
3/2011	GA1/2011	Gatovo	sediment	0,31			2,91	2,31		0,33		
4/2011	GA2/2011	Gatovo	sediment / soil	0,35			1,55	5,06	0,66	0,46		
5/2011	MI1/2011	Minsk	sediment	1,59	1,15	0,62						
6/2011	MI2/2011	Minsk	sediment	1,29			0,51					
7/2011	MI3/2011	Minsk	sediment					1,53				
8/2011	ZH1/2011	Zhlobin	sediment	0,56			0,91	1,35				
9/2011	ZH2/2011	Zhlobin	sediment				0,52					
10/2011	DRU1/2011	Druzhnyi	sediment	0,59				1,68			1,47	

Tab. 5: Concentration of heavy metals in 2011.

	Name	Locality	Matrix	Pb	Cd	Cu	Cr – celk.	Zn	As	Hg
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	KR1/2011	Krasnosyelski		20	0,25			214	0,36	0,061
2	KR2/2011	Krasnosyelski		19,9	0,3			171	0,48	0,057
3	GA1/2011	Gatovo		24,1	1,845			304	0,23	0,177
4	GA2/2011	Gatovo		17,8	0,19			140	0,28	0,113
5	MI1/2011	Minsk		5,87	0,045			25,1	0,31	0,018
6	MI2/2011	Minsk		7,82	0,14			39,2	0,36	0,032
7	MI3/2011	Minsk		12,2	0,135			67,9	0,28	0,03
8	ZH1/2011	Zhlobin		15,5	0,39			124	0,69	0,047
9	ZH2/2011	Zhlobin		7,78	0,36			75	0,36	0,053
10	DRU1/2011	Druzhnyi		6,04	0,18			17	0,23	0,023

Pollution limits

Concentration of pollutants in samples were compared with RSL (Regional Screening Levels). These levels were derived using exposure parameters and factors representing the maximum justifiable chronical exposure. This expusure is based on the direct contact with target compounds. Regional screening levels were derived by USEPA (United States Environmental Protection Agency) for some compounds, that have CAS registration number. They are not defined for mixtures. RSL are concentration of chemical compounds in the environment (soils, sediments, water ar air). If RSL are exceeded, further exploration or removal of contamination shoul be carried out. But some specifics should be taken into account, when RSl are used - such as content of some substances as a result of geological conditions. (Eg. Natural content of arsenic in rocks and soils in the Czech Republic is higher than indicator of pollution.

If there are not exposition limit for substance – criteria of pollution can used for comparation. These criteria were valid in the Czech Republic before RSL were applied.

Tab. 4: Levels of pollution limits (RSL/SSL).

Compound	Registration CAS number	Sediment, soil		
		Industrial areas	Other areas	Threats to the water quality by leaching from soil
		mg/kg dry matter		
beta HCH	319-85-7	0,96	0,27	0,0017
DDE	72-55-9	5,1	1,4	0,047
DDT	50-29-3	7	1,7	0,067
Arsenic	7440-38-2	1,6	0,39	0,0013
Cadmium	7440-43-9	800	70	1,4
Copper	7440-50-8	41000	3100	51
Mercury	7439-97-6	43	10	0,033
Lead	7439-92-1	800	400	9,3
Zinc	7440-66-6	310000	23000	680

Tab. 5: Criteria of pollution.

Compound	A	B	C – .
	mg/kg dry matter		
Chlorinated pesticides	0,05	2	2,5
Chromium	130	450	500
Non-polar extracted compounds	100	400	500

Criterion A – exceeding the criteria A is considered as an environmental pollution excluding areas with naturally higher levels of target substances.

Criterion B – exceeding the criteria B is considered as an environmental pollution, which may have a negative impact on human health and environment. It is necessary to collect additional data.

Criterion C - exceeding the criteria C is considered as an environmental pollution, which may represent a significant risk for human health and environment. Risk analysis is required to assess the severity of pollution

Conclusions

Contamination of pesticides, heavy metals and petroleum product was determined in river sediments and soils at selected locations. Content of contaminats were compared with Levels of pollution limits (RSL/SSL) or Criteria of pollution.

Contamination of oxy-chlordane was found in studied samples. Oxy-chlordane is a degradation product of chlordane, which was used as an insecticide. Increased oxy-chlordane concentration was found in the most of the studied sediments. Relatively highest concentration were found in sediments under wastewater treatment plant in Minsk and Pinsk and below Mogilev. Increased concentration of beta-HCH was also found in sediments below Minsk and Pinsk, increased concentration of DDT was found below Minsk and Krasnosyelski.
In the vicinity of the pesticide site (Pastavy), increased levels of DDE and DDT were found, although only surface samples were taken. Groundwater and deeper layers of the geological environment can be also contaminated, initial survey revealed, that the geological vicinity is compoused mainly by sandy soil with high permeability.
Increased concentration of heavy metals were found in river sediments below Mogilev (especially cadmium, mercury and arsenic), in sediments near cement works in Krasnosyelski (especially cadmium and arsenic), in sediments below Pinsk (especially mercury), in sediments near car scrapyard Gatovo (espcally cadmium, copper, chromium, arsenic and mercury) and in sediments below Minsk (especially cadmium)
High concentration of petroleum products were found in river sediments near car scrapyard Gatovo and in sediments below Mogilev.

In general, most of the contaminants were below pollution limits. These concentrations reach values, which are found in areas where pesticides have been used in the past or in industrial areas. (such as Czech republic).
But pollution can be considered as significant at some spots. The surroundings of these locations is widely used for fishing, which represents a risk for human health. There is the possibility of cumulative effects of hazardous substances in fish – and trasfer into the food chain. Contaminants in sediments represent also a risk to surface water and ground water.

In conclusion, following measures can be recommended:

- Further monitoring of contamination and searching for other ,,hot spot“ should continue. Concentration of contaminants can be collected in the database.

- Local pollution limits are needed – especially related to the local geological conditions.

- Risk analysis should be carried out at the target locations.

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