

War in Croatia, Bosnia and Herzegovina and Kosovo, and PCBs hazards

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Introduction

During the recent warfare, the karstic area of Croatia, Bosnia and Herzegovina and Kosovo was jeopardized by hazardous waste and merits special attention because of its exceptional ecological vulnerability and the unfortunate unscrupulous destruction of its natural resources, infrastructure, homes and enterprises. Data on contaminant levels from water and soil samples collected before 1995 didn't show significant contamination of the investigated locations in Croatia (Oštarije, Ogulin, Transformer Station (TS) "Konjsko", Cetina River and Jadro River) by organochlorinated pesticides and PCBs¹. Also there was no ecologically significant contamination with PCBs of soil near Transformer Stations in Delnice and Kaštela, while in the area of Electrical Transformer Station (ETS) "Komolac", TS "Zadar" and TS "Bilice" significant levels of PCBs were observed^{2,3}. European Commission experts of the fifth framework Programme (Call Identifier ICFP501A2PR02) recognized these problems and approved the proposed investigations under Contract APOPSBAL ICA2- CT2002-10007. Nowadays the Project has been carry out in 12 institutions from Croatia (3 institutions), Slovenia, Bosnia and Herzegovina, Kosovo, Serbia and Montenegro (2 institutions), Austria, Czech Republic and Greece. Scientists will do execution of the Project through 6 work packages coordinated from the involved institutions and principal investigators⁴. Work package 2, entitled: "The level and hydrogeological fate of some POPs in several Croatian, Bosnian and Herzegovina and Kosovo areas as a consequence of war damages" has been coordinated by Rudjer Boskovic Institute (dr.sc. M. Picer is coordinator of the Work package 2 and scientific coordinator of the whole APOPSBAL Project). The aim of this paper is to preview some of the results obtained during 2 years of the Project inside work package 2.

Area of investigation and methodology

Area of investigation covered nowadays two independent countries from former Yugoslavia and Kosovo district under protection of UN, from Serbia and Montenegro.

Short description of PCBs analysis: Soil and sediment samples were extracted by using ASE – 200 extractor with n-hexane: acetone (1:1 volume). Non polar fraction has been reextracted with n-hexane. Edible part of fish samples were extracted by using high revolution blender with n-hexane. The analytical method used for the analysis of the extracts included filtration through a column of Na₂SO₄ anh., cleaning on an alumina column and the separation of the PCBs from organochlorine insecticides on a miniature silica gel column. For quantification PCBs was used ECD gas chromatography. Analytical methods were intercalibrated in numerous international exercises and published in numerous papers⁵.

Results and discussion

Basic statistical data about the levels of PCBs in soil, sea and river sediments, marine and fresh water fish from Croatia, Bosnia and Herzegovina and Kosovo obtained in samples collected from 1996 to 2004 (Croatia); from 2003 to 2004 (Bosnia and Herzegovina); 2003 (Kosovo) are presented on the Table 1.

EMV - General – Environmental Levels

Table 1. Basic statistical data about the levels of PCBs (as Aroclor 1254 equivalents) in soil, sea and river sediments, marine and fresh water fish from Croatia, Bosnia and Herzegovina and Kosovo obtained in the samples collected from 1996 to 2004 (Croatia); from 2003 to 2004 (Bosnia and Herzegovina); 2003 (Kosovo).

	Croatia				Bosnia and Herzegovina			Kosovo	
	West Slavonia	Dalmatia			Soil	Sed	Fish	Soil	Sed
Matrix	Soil (mg/kg) d.w.	Soil (mg/kg) d.w.	Sed (µg/kg) d.w.	Fish (µg/kg) w.w.	Soil (mg/kg) d.w.	Sed (µg/kg) d.w.	Fish (µg/kg) w.w.	Soil (mg/kg) d.w.	Sed (µg/kg) d.w.
Sampling period	2002-2004	1996-2004	1997-2004	1997-2004	2003-2004	2003-2004	2003-2004	2003	2003
No. of sampling stations	11	83	88	46	33	45	1	4	5
No. of samples	11	104	117	120	47	60	6	4	14
Min.	0,02	0,007	1,22	6	0,01	2	2	0,01	19
Max.	1784	10455	8814	4004	178954	8073	73	0,8	208
Arith. mean	390,7	196,6	585,4	303,0	5861,9	406,4	27	0,4	71,8
Geom. mean	16,59	0,88	114,73	100,6	0,79	66,29	17,09	0,14	55,55

The comparison of the PCBs level as arithmetic means of all soil, sediment and fish samples collected from Croatia (Dalmatia and Western Slavonia), Bosnia and Herzegovina and Kosovo are present in Figures 1 to 3. The levels of the total of PCBs as Aroclor 1254 equivalents are presented as dark columns, and levels of the sum of the 7 key PCBs (IUPAC No. PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) are presented as light columns. The positions of the investigation areas in Dalmatia are marked at figures as: Zadar area - Z; Šibenik area - Š; Rijeka Dubrovačka - D. Positions of investigation areas in Bosnia and Herzegovina are marked at figures as: Bihać - B, Tuzla - T, Sarajevo - S. Due to large range of concentrations, levels for soil samples are present in logarithmic scale.

Levels of PCBs in soil samples from Bosnia and Herzegovina sampled during autumn 2003 and during June and July 2004 (altogether 47 samples) show significant levels (more than 10 ppm) of total PCBs in the Bihać, Tuzla and Tešanj areas. If we compare the levels of the PCBs in the soil near TS "Zadar" and TS "Bilice" in Croatia and three locations in Bosnia and Herzegovina (Bihać, Tuzla and Tešanj) by the criteria of tolerance accepted in the Netherlands, the levels of contamination at all these locations far exceed tolerable levels that do not require remediation. During June 2004, 4 soil samples were collected from 4 sites in Kosovo, but levels of PCBs were relatively low (under 1 ppm). Taking into account location of destroyed Zadar, Bilice and Dubrovnik Electrical Transformer Stations, there was some speculation regarding the potential hazard from organo halogenated toxicants to the Lake Vransko and the coastal sea around the Zadar, Šibenik and Dubrovnik areas. Sediment and some aquatic organism samples were collected and analyzed from the mentioned areas. The results indicate there were no significant or high levels of contaminants in the areas of Lake Vransko, Šibenik, Dubrovnik (Petke location), while in these areas: Mikulandra bay near Šibenik; Rijeka Dubrovačka near Dubrovnik; Brodanovo location and Marina near Vruljica Creek in Zadar, significantly higher level of PCBs were observed.

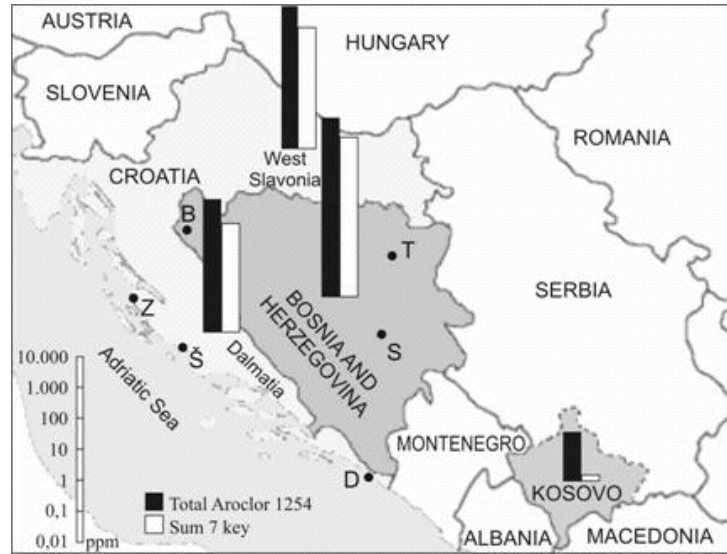


Figure 1. The comparison of the PCB levels as arithmetic means of all soil samples collected from Croatia (Dalmatia and Western Slavonia), Bosnia and Herzegovina and Kosovo. Levels are presented in the logarithmic scale.

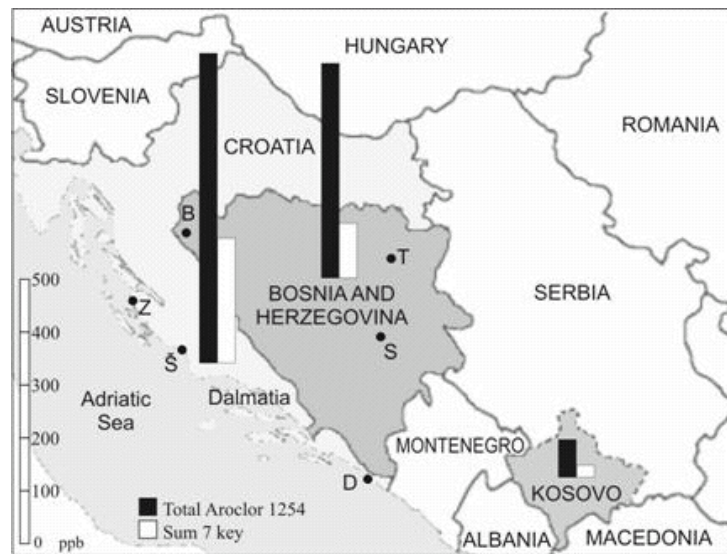


Figure 2. The comparison of the PCB levels as arithmetic means of all sediment samples collected from Croatia (Dalmatia), Bosnia and Herzegovina and Kosovo. Ranges of levels are presented in the linear scale.

During autumn of 2003 and June 2004 (altogether 60 samples) in Bosnia and Herzegovina sediment samples were collected for the PCB analysis from 9 rivers (Bosna, Una, Miljacka, Spreča, Buna, Bijela, Gostilja, Jala and Tešanjka), and from seven water springs and creeks. In some sediment samples from Bosnian rivers significant levels of PCB were observed, even more than 1000 ppb. In Kosovo 14 sediment samples were collected during June 2003, from rivers Ibar, and Sitnica, but only in some samples significant levels of PCBs were observed.



Figure 3. The comparison of the PCB levels as arithmetic means of all fish samples collected from Croatia (Dalmatia) and Bosnia and Herzegovina. Ranges of levels are presented in the linear scale.

The results indicate that the levels of PCBs in fish sampled in Bosnia and Herzegovina in December 2003 and July 2004 were significantly lower in comparison with the levels of PCBs in fish sampled in Dalmatia, Croatia in the period from May 1997 to May 2004. Maximum values for PCBs were observed in the fish edible tissue (Golden grey mullet) collected in Vruljica Creek in Zadar area (4004 $\mu\text{g}/\text{kg}$ wet weight of PCBs as equivalent of Aroclor 1254).

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