

WAR WASTE AND POLLUTION OF KARSTIC AREA OF BOSNIA AND HERZEGOVINA WITH PCBs

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Introduction

During the recent war, the karst area of Bosnia & Herzegovina has been jeopardized by hazardous waste and deserves particular attention because of its exceptional ecological sensitivity and unfortunately unscrupulous destruction of natural resources, infrastructure, homes and enterprises. This was the reason for creation and planning of a joint three year Project – APOPSBAL, within which scientists from the jeopardized countries (Croatia, Bosnia & Herzegovina, and Serbia and Montenegro) with the help of scientists from other friendly countries (Czech Republic, Austria, Slovenia and Greece) would identify the real problems concerning the PCB and other POPs contamination of the environment¹.

Objectives of this Project in Bosnia and Herzegovina are:

- 1) To collect data about damaged facilities with oil with PCBs and also other even more dangerous POPs in Bosnia and Herzegovina.
- 2) Much better determining the hydrogeological fate of PCBs and other POPs compounds in the most threatened areas of Bosnia and Herzegovina polluted with the POPs. Special emphasis will be paid for the sensitive karstic media of these areas.
- 3) To recognize in the field directly the technical state of electrotransformers and capacitors with pyralene with special attention to spilling of this oil into the environment.
- 4) To sample soil and sediments from the sites thought polluted with PCBs and to analyse themselves on its content.
- 5) To choose several sites for atmospheric monitoring samples with POPs, which are in surroundings to the ground argumentative contaminated with POPs in Bosnia and Herzegovina to establish real data about level of contamination of this very important part of human ecosphere. In this paper it will be reported the results of investigation from the first to the fourth objectives.

Methodology

Collection of field data about sources of pollution

Requests for data on oil with PCBs spills in the environment in Bosnia and Herzegovina were performed from various State, Entities and Cantonal institutions as they are Ministries, Directions, Inspectorates, Health institutes, Institutes, Faculties, Chambers, Offices and especially from Public Enterprises «Elektroprivreda BiH» - Sarajevo (EP BiH), «Elektroprivreda HZHB» - Mostar (EP HZHB) and «Elektroprivreda RS» - Trebinje (EP RS) as the most competent enterprises for this problem, and a series of other industrial, public companies, factories, mines etc. Obtained data were focused on data with oil leakage with PCBs into the environment. For further investigations have been concentrated on next positions: 1) ETS with capacitors in EP B&H and 2) ETS in other industrial enterprises, 3) Capacitors in coal mines and 4) Ex military industrial facilities with electro transformers and capacitors, 5) Ex military relays locations on peaks of Bosnian high mountains.

Choosing of locations for soil and sediments sampling

Soil and sediments sampling was performed on soil and aquatic sediments (58 samples) round Bihać, Sarajevo, Mostar, Tuzla and Tešanj. The samples of sediments from some rivers are taken to see are there pyralene spillings from military relays in high mountains, which communicate toward significant karstic springs and particularly from factories and towns upstream and downstream of rivers. The soil samples were taken in the sites of leaking of oil from transformers and capacitors to determine was it the pyralene or other oil with PCBs.

Analysis of PCBs in soil samples

An air dried soil samples after sieving on 2 mm were extracted by using ASE extractor with mixture acetone and n-hexane (1:1 volume). The analytical method used for the analysis of extracts included filtration through a column of Na_2SO_4 anhydrous, cleaning on an alumina column and the separation of the PCB's from organochlorine insecticides on a miniature silica gel column. After concentration down to 1 μL , elutes were analyzed by EC gas chromatography. During all the analytical procedures, the Mirex standard was used as the internal standard. More circumstantially details of used methods were described in numerous published papers^{2,3,4}.

Results and discussion

Levels of total PCBs as Aroclor 1254 equivalents and sum of 7 key PCBs (PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) in soil samples collected in autumn 2003 from Bosnia & Herzegovina are present on Figure 1. Due to very large differences in observed levels (from 0.002 to over 100 000 ppm), levels have to be present on decade logarithmic scale. As consequence of that it is not possible on the first glance to see so large differences of levels of PCBs in soil samples collected around Bosnia & Herzegovina.

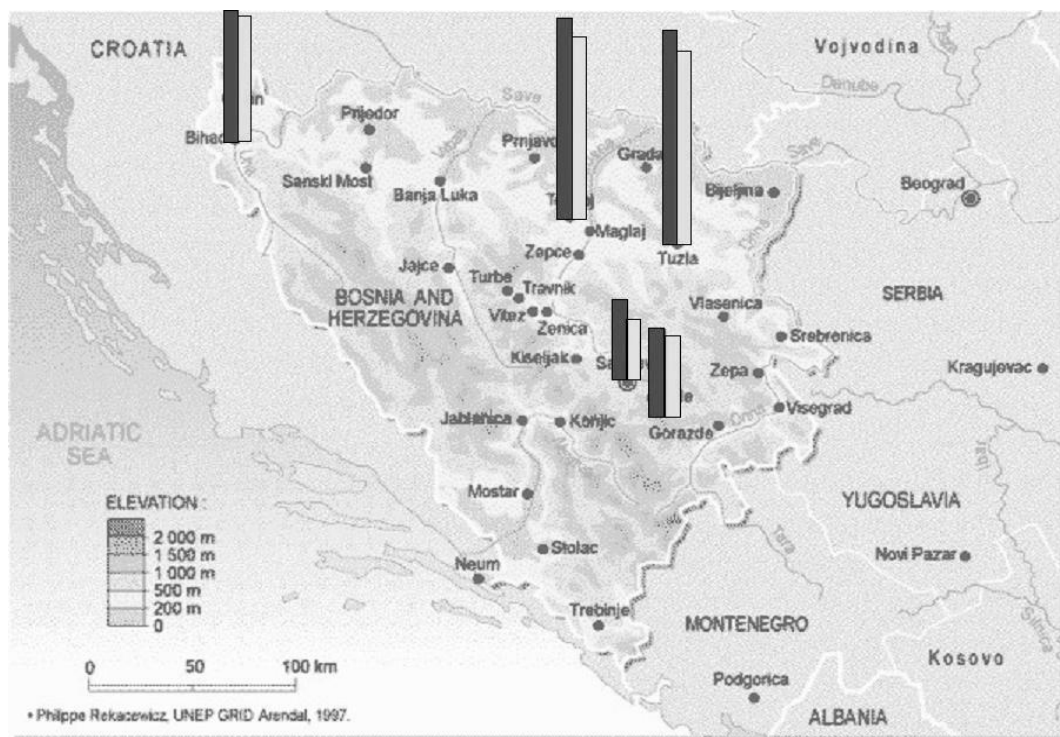


Figure 1 Level of total of PCBs as Aroclor 1254 equivalents (dark column) 7 key PCBs (PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) (light column) in soil samples from Bosnia & Herzegovina. Columns are present at logarithmic values.

For better recognition the real situation, on the next figures are present levels of PCBs separately from the three different areas. On the Figure 2 level of total of PCBs as Aroclor 1254 equivalents and sum of 7 key PCBs (IUPAC No. PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) in soil samples from Bihać and mountains around Sarajevo are present. Level of total PCBs are present as dark columns and 7 key PCBs congener as light columns. On the right ordinate are present percentage of 7 key PCBs of total PCBs. As is seen the percentage of 7 key PCBs is variable from nearly 100% in soil sample collected from Bihać –station Klokot 3 where is

observed the lowest value of PCBs. 7 key PCBs are only 27% of total PCBs in soil sample collected from mountain Trebević near Sarajevo (station - Debelo brdo 2). In this area the highest level of PCBs (over 100 ppm) were found in soil sample collected from military airport installation near Bihać - Željava tunel 1.

The other soil samples do not show significantly level of PCBs although some of them have level higher than 1 ppm (Jahorina mountain, military installation –5.5 ppm; Trebević mountain, military installation – 2.4 ppm).

On Figure 3 levels of total of PCBs as Aroclor 1254 equivalents and sum of 7 key PCBs (IUPAC No. PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) in soil samples from town Sarajevo and close surroundings are present. Levels are present on linear scale because in this area were not observed so large difference in levels as in Bihać and mountains area previously presented. The highest level of PCBs were found in sample of soil collected near electro transformer station in wire factory in Sarajevo- 1.1 ppm. All other soil samples had not significant level of PCBs.

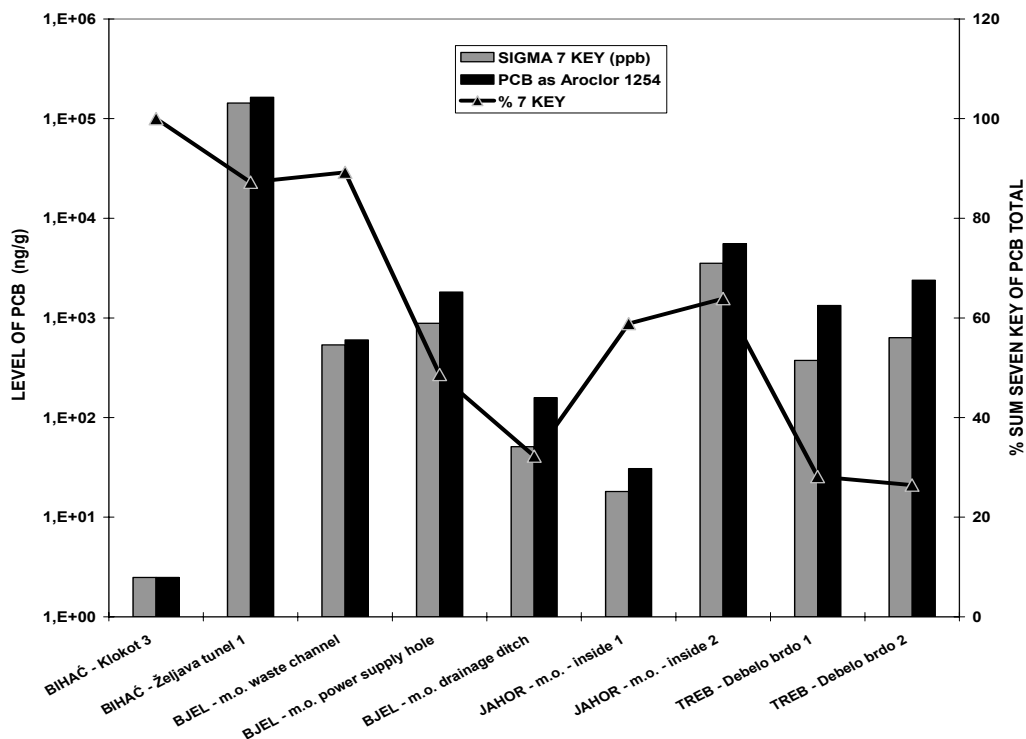


Figure 2 Level of total of PCBs as Aroclor 1254 equivalents and sum of 7 key PCBs (IUPAC No. PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) in soil samples from Bihać and mountains around Sarajevo.

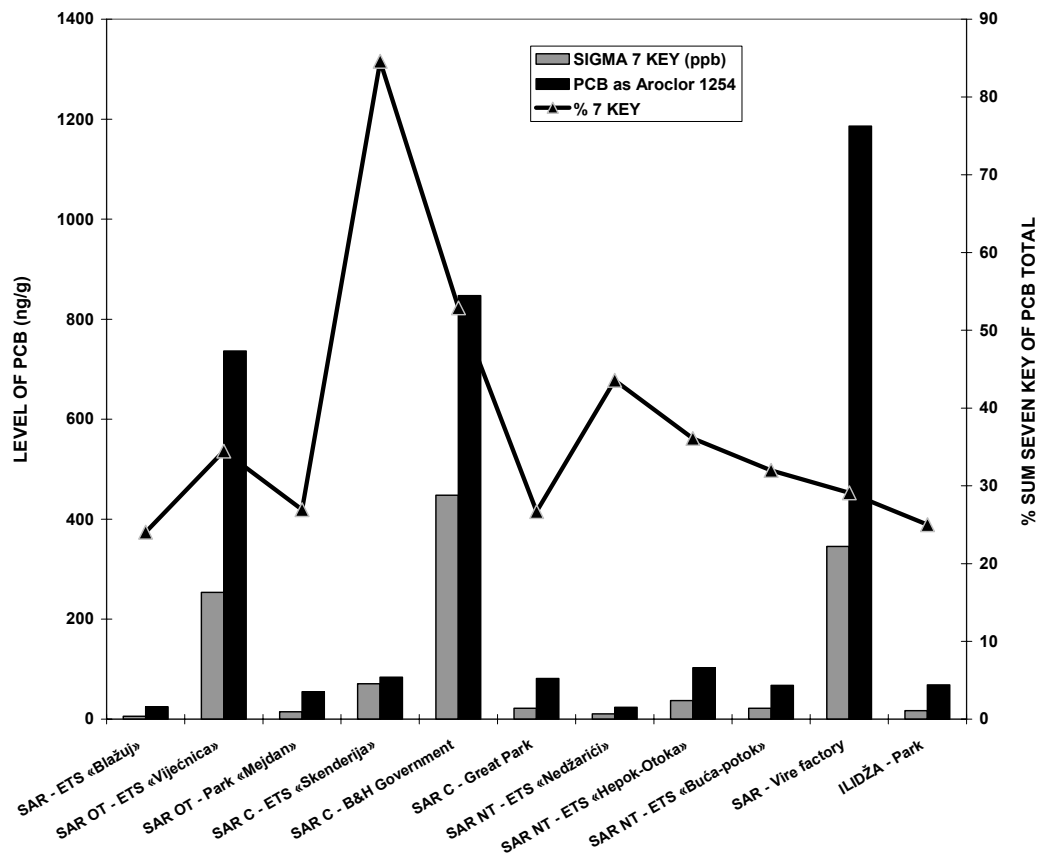


Figure 3 Level of total of PCBs as Aroclor 1254 equivalents and sum of 7 key PCBs (IUPAC No. PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) in soil samples from town Sarajevo and close surroundings.

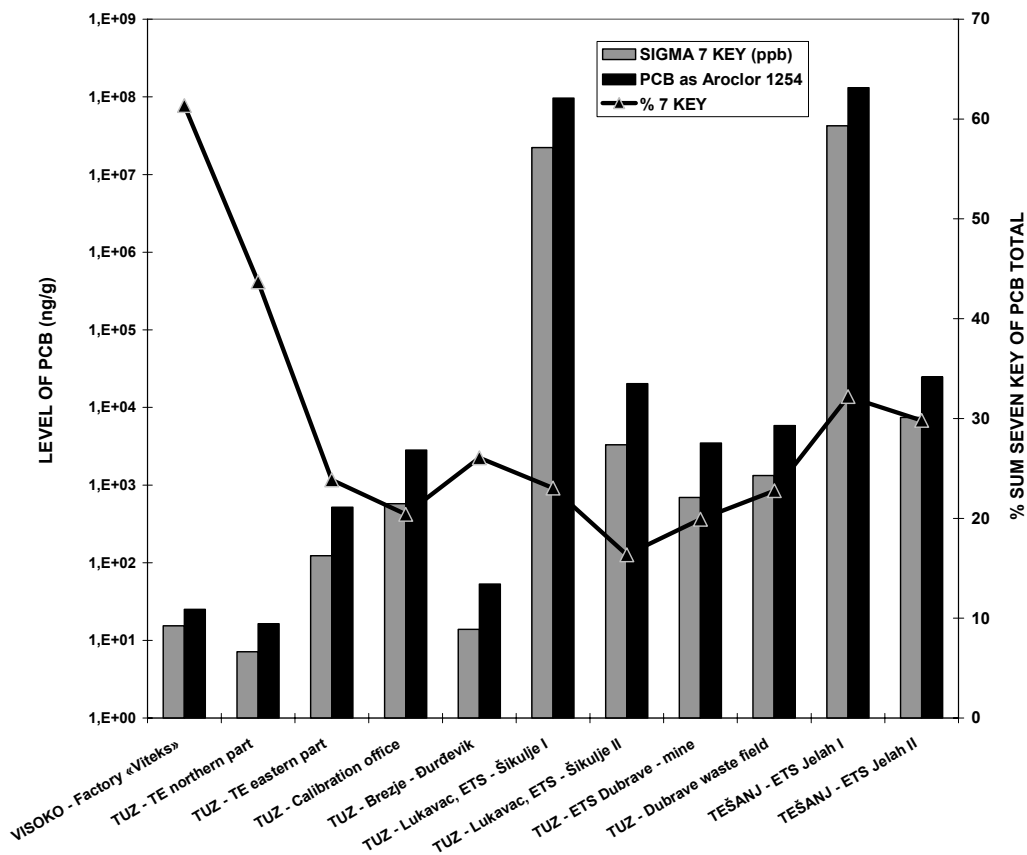


Figure 4 Level of total of PCBs as Aroclor 1254 equivalents and sum of 7 key PCBs (IUPAC No. PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) in soil samples from Tuzla, Visoko and Tešanj

On Figure 4 Level of total of PCBs as Aroclor 1254 equivalents and sum of 7 key PCBs (IUPAC No. PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) in soil samples from Tuzla, Visoko and Tešanj have to be again present at decade logarithmic basis because of large difference of levels of PCBs between collected soil samples. Obviously levels of PCBs in soil sample collected from Factory «Viteks» in Visoko is not significant as some other soil samples from Tuzla area. Two samples from Tuzla, ETS Lukavac- Šikulje II and from Tešanj ETS Jelah II show significant levels of PCBs (over 20 ppm). But two soil samples show extremely high level of PCBs – nearly or even more than 100 000 ppm (Tuzla, ETS Lukavac- Šikulje I and Tešanj ETS Jelah I).

For comparison these data on Table 1 and Figure 5 are present data about levels of some POPs in soil of Bosnia & Herzegovina obtained on the basis of calculations of Meteorological Synthesizing Centre - East Moscow, Russia ⁵ (means over the country, minimum and maximum values in the

country for year 1998). In Figure 5 for comparison are present columns of maximal values of level of total PCBs and 7 key PCBs obtained during our investigation.

Table 1

Mean, minimum and maximum annual concentrations in soil compartment of Bosnia & Herzegovina for 1998

(http://www.msceast.org/countries/Bosnia_Herzegovina/index.html#popaver)

POPs	Mean	Min	Max
HCB	0.21	$6.34 \cdot 10^{-2}$	0.37
PCBs	8.89	3.73	13.84
B[b]F	5.17	3.96	6.26

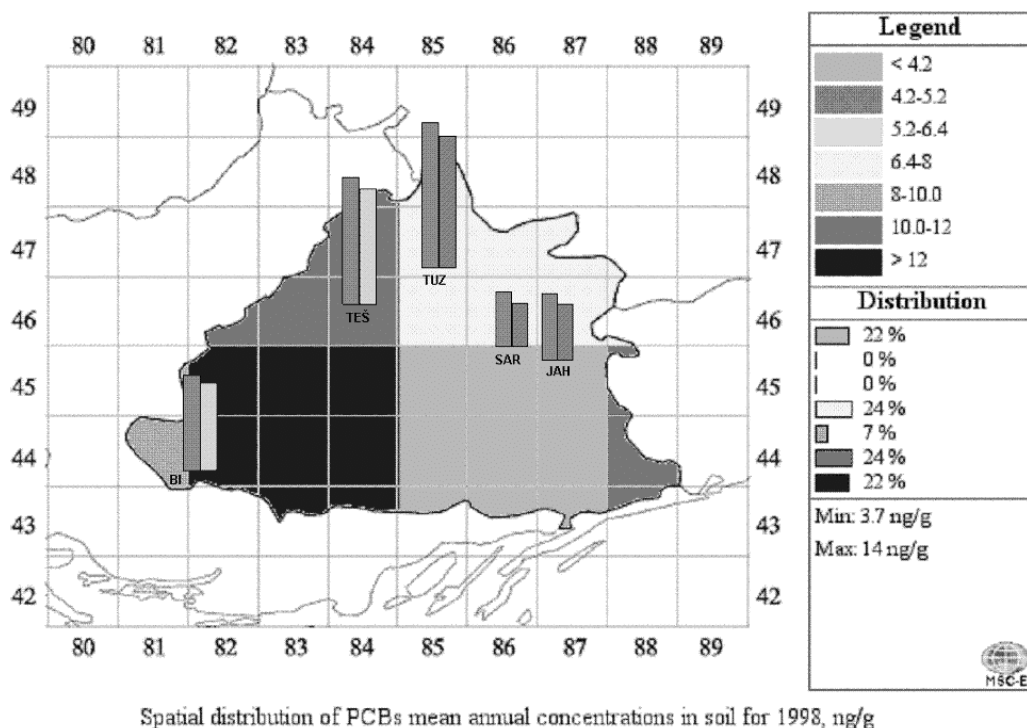


Figure 5 Comparison of calculated mean values of PCBs level in soil of Bosnia & Herzegovina for year 1998 and the maximum levels of PCBs obtained during our investigation of samples collected in autumn 2003. Mark on Map: BI- Bihać area; SAR – Sarajevo; TES- Tešanj; TUZ- Tuzla; JAH- mountain Jahorina.

Conclusion

On the basis of the first systematic research of contamination soil in Bosnia & Herzegovina with PCBs it could be made next conclusions:

- 1) In the area of Bihać and military instalations on mountains around Sarajevo the highest level of PCBs (over 100 ppm) were found in soil sample collected from military airport installation near Bihać – Željave tunel I. Other collections point in this area did not show significantly level of PCBs.
- 2) The highest level of PCBs were found in sample of soil collected near electro transformer station in wire factory in Sarajevo- 1.1 ppm. All other soil samples had not significant level of PCBs in town Sarajevo and it neiberhood.
- 3) Two samples from Tuzla, ETS Lukavac- Šikulje II and from Tešanj ETS Jelah II show significant levels of PCBs (over 20 ppm). But two soil samples show extremely high level of PCBs – nearly or even more than 100 000 ppm (Tuzla, ETS Lukavac- Šikulje I and Tešanj ETS Jelah I).
- 4) The percentage of 7 key PCBs is variable from nearly 100 % in soil sample collected from Bihać –station Klokot 3 where is observed the lowest value of PCBs. 7 key PCBs are only 16 % of total PCBs in soil sample collected from Tuzla, ETS Lukavac- Šikulje II.

Acknowledgements

The authors express their gratitude to the Ministry for Science and technology of Republic Croatia for financial support. This work has been carried out as part of the Contract ICA2- CT-2002-10007 (APOPSBAL) between the European Commission and Rudjer Boskovic Institute, Zagreb, Croatia and Geological survey – Sarajevo, Bosnia and Herzegovina.

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