PCB LEVELS IN SOIL INSIDE ELECTROTRANSFORMER STATION 110/35 KV IN ZADAR

Mladen Picer, Nena Picer and Vedranka Hodak Kobasić

Institute " Ruđer Bošković", Bijenička cesta 54, 10000 Zagreb, Croatia

Introduction

During the recent war in Croatia, the karstic area of this country has been endangered by hazardous waste. It deserves particular attention because of its exceptional ecological sensitivity and the unfortunate unscrupulous destruction of its natural resources, infrastructure, homes and enterprises. There are great fears and concrete evidence that significant quantities of polychlorinated biphenyls (PCBs); various flame-retardants, explosives and the by-products thereof were released into the environment by warfare.[1] During 1996, waste oil and soil samples near damaged transformer stations were collected in the Delnice, Zadar, Šibenik, Split and Dubrovnik areas and analyzed for polychlorinated biphenyls. The results shown do not indicate significant soil contamination with polychlorinated biphenyls at the transformer station or in the oil samples taken from the oil trenches of TS Delnice and TS Split. Concerning the distance from the capacitor battery hit by a rocket fired at the transformer installation in Komolac near Dubrovnik, the soil showed significant levels of polychlorinated biphenyls. PCB levels indicate significant soil contamination below the capacitor battery hit by a rocket fired in the area of the 220/110/30 kV transformer station TS Bilice in Šibenik. Results of the analysis of the polychlorinated biphenyls in the soil from the four locations (in some locations, at two depths) indicate significant contamination of the area of the 110/35 kV TS Zadar. This was the reason for a thorough investigation of this site for PCB levels in the soil samples around the damaged capacitor.

Area of investigation

The soil sample points at the Zadar transformer station are present in Figure 1. One square = 1 m^2: 0 is the zero point for the presentation in Figure 2; K1, K2 and K3 are capacitors; black square = samples sampled in August and October 1996; grey square = soil samples sampled in July 2001; only numbers = soil samples sampled in May 2002. The K1 capacitor was damaged during the war from an air attack in 1991. A soil sample from the hole under the K1 capacitor was collected in November 2002.

Methodology of Analysis

Air-dried soil samples were extracted at 24 hours with n-hexane by Soxhlet extraction. The analytical method used for the analysis of the samples included filtration through a column of Na_2SO_4 anh., cleaning on an alumina column and the separation of the PCBs from the organochlorine insecticides on a miniature silica gel column. After concentration from 0.3 to 1 cc, elutes were analyzed by EC gas chromatography. During all the analytical procedures, the Mirex standard was used as the internal standard. More details of the methods have been described in numerous published papers.[2, 3, 4]

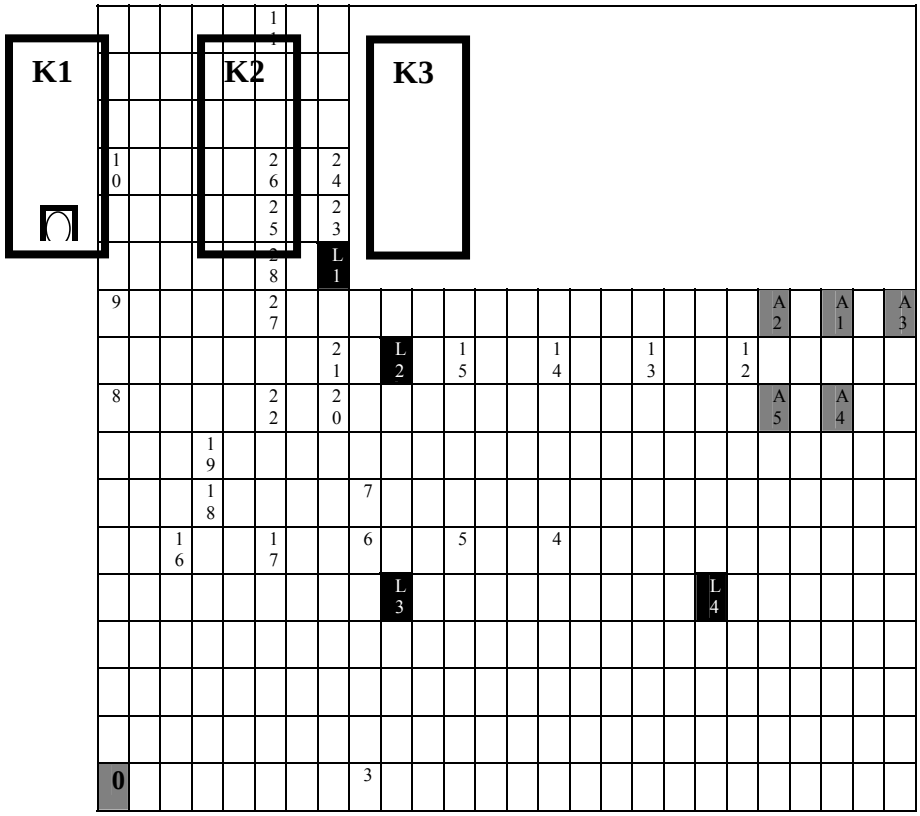


Figure 1. Soil sample points at Zadar electro trafostation (1 square = 1 m^2:0 Zero point; K1, K2 and K3 capacitors; Black square = sampled 08 and 10 1996; Grey square =sampled 07-2001; numbers = sampled 05-2002. K1 capacitor was damaged◯ sample from the hole under K1 capacitor

Results and discussion

Statistical investigation of the chlorinated hydrocarbon levels in many biotic and abiotic samples from the Adriatic Sea and other environments shows that the standardized coefficients of the kurtosis and the skewness are much higher than 2, which means that these data may depart significantly from a normal distribution.[2] Consequently, medians and geometric means ought to be more appropriate measures of the central tendency of the investigated pollutant data than arithmetic means (averages). For that reason, besides providing the year and level of collecting samples, Table 1 also presents the minimum, maximum and geometric mean of the levels. Due to the extremely high range of PCB levels found in the investigated soil samples, an arithmetic mean would not represent the central tendency of the PCB levels in the investigated samples.

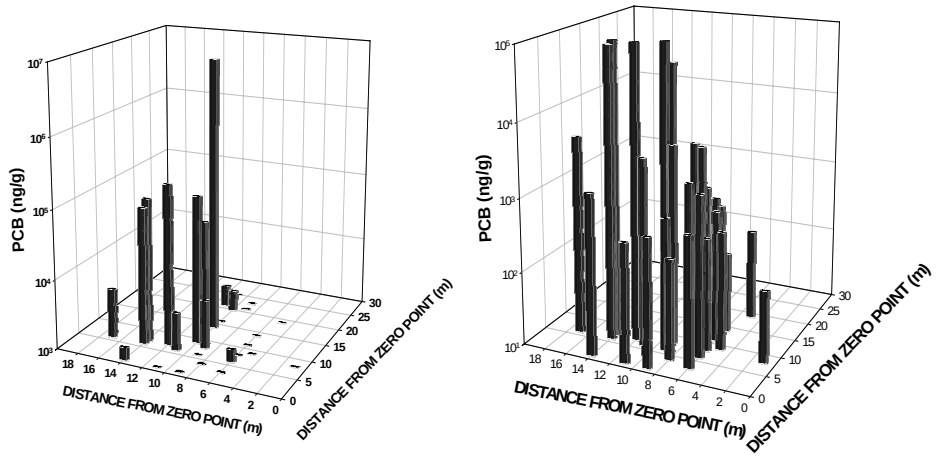
The dispersion of the PCB levels in the soil samples around the damaged capacitor is presented in Figure 2. In Figure 2a, all the data are presented and we can see the very high PCB level in the sample collected from the hole situated just under the damaged capacitor. For a better presentation

of the dispersion levels of the other soil samples, the PCB levels of the soil samples without the sample from the previously mentioned hole are presented in Figure 2b.

Table 1

POLYCHLORINATED BIPHENYL CONTENT IN SOIL SAMPLES FROM TRANSFORMER STATION IN ZADAR AREA (mg kg $^{-1}$ d.w.)

Sampling year	Depth (cm)	Number of samples	PCB – total minimum	PCB – total maximum	PCB - total (Geometh. mean)
1996	0 -10	6	0.2	214.4	19.2
1996	20 -30	4	1.3	124.5	4.3
2001	0 -10	5	0.2	1.2	0.5
2002	0 -10	23	0.1	7922.2	3.6
2002	20 -30	6	0.1	104.6	1.1



2a) **2b)**

Figure 2. Levels of PCB as Arochlor 1254 in soil samples collected from 1996 to 2002 depended about distance from zero point present in Figure 1. Figure 2a) PCB data of samples with the sample from the hole under the capacitor K1; Figure 2b) PCB data of samples without sample from the hole

The distribution of some of the 8 congeners (IUPAC No. 28, 44, 52, 66, 101, 138, 153 and 180) in the soil samples collected during 2002 at the Zadar site is presented in Figure 3. ZD 25 and ZD 23 samples were collected from a 15–20 cm soil layer. Other samples were collected from 0–5 cm soil layers.

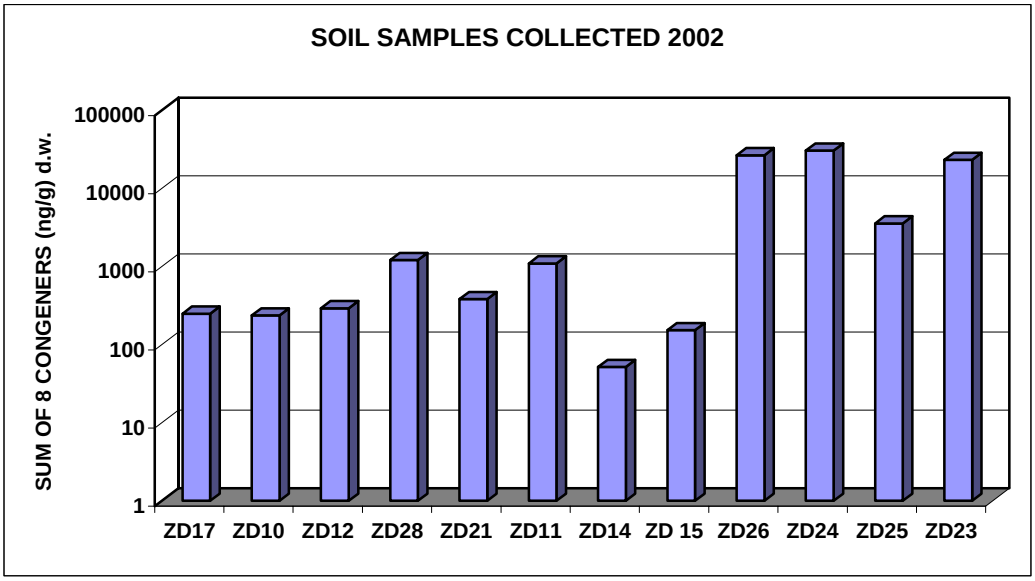


Figure 3 Distribution of sum of 8 congeners (IUPAC No. 28,44,52,66,101,138,153,180) in soil samples collected during 2002 at Zadar site. ZD 25 AND ZD 23 samples from 15-20 cm soil layer, other samples from 0-5 cm soil layer

Conclusion and future research

Results of PCB analysis of the soil from TS Zadar indicate significant contamination of the area with polychlorinated biphenyls. Comparing the given PCB levels in the soil from TS Zadar with the tolerance criteria accepted in the Netherlands, the levels of contamination in some locations far exceed the tolerated levels that do not require remediation (by more than two hundred times). For that reason, the overall objective of the "remedial research group" within the APOPSBAL Project[5] is to propose a method for the restoration of the soils contaminated by PCBs in the vicinity of the 110/35 kV Transformer Station TS Zadar.

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 Community and Rudjer Boskovic Institute, Zagreb, Croatia.

References

1.Picer, M., Picer, N., (1998) Croatian Water Management 7, No. 73,10. (in Croatian).
2.Picer M. (2000). Croatica Chemica Acta 73, 123.
3.Picer, M. and M. Ahel (1978), J. Chromatogr. 150, 119.
4.Picer, M., Picer, N.(1993):Water, Air and Soil Pollut. 68, 435.
5.Picer, M (2003) APOPSBAL PROJECT – THIS CONFERENCE