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Trace Metals in Soil Samples from War-impacted Areas in the Republic of Croatia

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Our research consisted of the determination of the trace metals in the soil samples originating from the regions of the Republic of Croatia where military activities were taking place during the 1991-1995 war. Samples have been taken from following areas: Banovina, Kordun with river Kupa region (Pokuplje), Eastern Lika, river Sava region (Posavina), Western Slavonia and the regions of the towns of Osijek, Vukovar and Šibenik. The content of about 20 metals has been analyzed. In this communication the focus will be given to the metals which are usually considered as originating from the ammunition [1,2].

Air drying of the samples under laminar flow with subsequent separation of the $<$ 2 mm fraction has been performed. This fraction of the samples was milled in order to obtain fine homogenous material for analysis. Samples were mineralized by a MW-assisted wet digestion procedure, using concentrated nitric acid in the closed microwave digestion system Anton Paar 3000. Analyses were performed by high-resolution ICP-MS (Element-2, Thermo, Bremen, Germany).

The obtained results indicate that in about half of the analyzed samples, the concentrations of two or more toxic metals were higher than the MPC (Maximal Permissible Concentration) for agricultural soils in Croatia [3]. In the majority of these samples the concentrations were up to twice higher than the MPC, but at several sampling locations highly contaminated soil samples (with the range of concentrations from 5 to 100 times higher than MPC for some metals) were found. For some of above mentioned regions the impact of the industrial origin of some metals cannot be excluded, but in other ones (especially Western Slavonia) the most probable origin cause of the very high concentration of Zn, Pb, Cu and Sb was the ammunition deployed in the

shelling of these areas.

It can be concluded that by analysis of the trace metal contents in the soils, the war impact on the environment, although limited in some areas, can be identified even after more than 10 years after the end of the war activities.

[1] M. Migliorini, G. Pigino, T. Caruso, P.P. Fanciulli, C. Leonzio, F. Bernini, *Pedobiologia* **49** (2005) 1-13.

[2] C.T.R. Darling, V.G. Thomas, *Sci. Total Environ.* **346** (2005) 70-80.

[3] *Narodne novine, Legal Bulletin* 15/1992 (in Croatian)