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Chemical and ecotoxicological analyses of soils historically contaminated with PAHs

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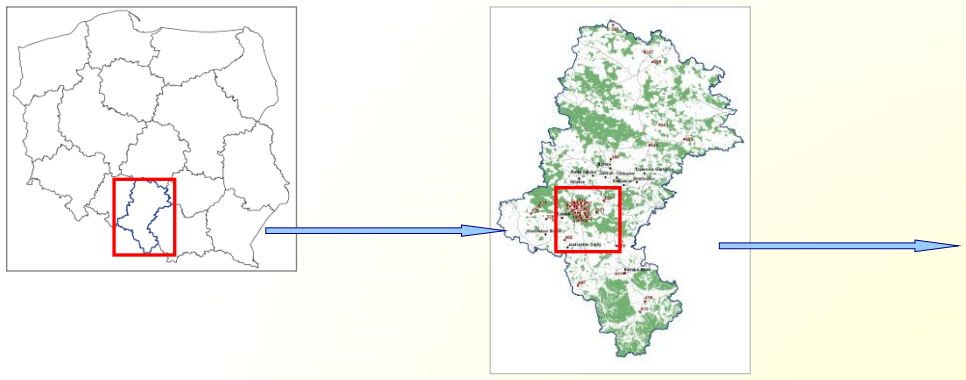
Introduction & objectives

Soil is a sink for a wide range of anthropogenic hazardous contaminants such as polycyclic aromatic hydrocarbons (PAHs) formed in the most of the combustion processes, coke production, petroleum refining, etc. High level of soil contamination with PAHs creates a risk not only for humans, but also for biotic elements of soil ecosystems and may endanger soil habitat function. Chemical determinations, widely applied for evaluation of PAHs content in soils, are not sufficient for comprehensive assessment of ecological risk and have to be complemented with ecotoxicological tests, which reflect reaction of soil organism to biologically available fraction of contaminants.

The aim of the study was to compare two methods - chemical and ecotoxicological - applied for evaluation of the concentrations and effects of PAHs in historically contaminated soils.

Materials & methods

STUDY AREA



The study area covered the territory of about 100 km² in the Upper Silesia region in Poland. Samples were collected from the surface layer of agricultural land surrounding coking plant of over 100 years production history.

SOILs CHARACTERISTIC (n=19)

	range	median	SD	CoV (%)
physicochemical properties				
clay (%)	0.85-10.0	2.06	1.91	73
silt (%)	15.8-38.3	26.89	6.17	23
sand (%)	54.0-82.3	70.65	7.50	11
Corg (%)	0.62-10.69	1.32	2.42	107
pH_{KCl}	3.9-6.8	5.3	0.9	16
chemical contamination				
Σ 16 PAH[a]	0.422-316.1	1.434	71.927	364
Σ 9 PAH[a]	0.302-224.7	1.014	51.146	364
BaP[d]	0.023-40.7	0.133	9.289	381

CHEMICAL METHOD

Chemical analyses (GC/MS method) comprised determinations of the total content (CH_2Cl_2 extraction) of 16 PAHs from US EPA List.

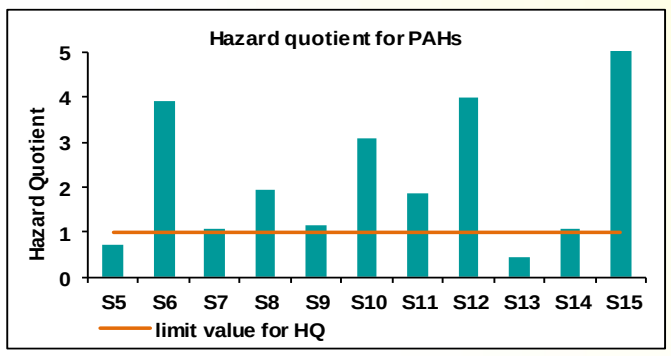
ECOTOXICOLOGICAL METHODS

The ecotoxicological evaluations covered soils and soil water phase. Soil ecotoxicity tests embraced determinations of the effects on plants (phytotoxicity tests with mustard *Sinapis alba*) and soil microorganisms (nitrification potential measurement).

The acute toxicity of water-extractable pollutants was determined by measuring luminescence inhibition of the bacterium *V. fischeri* with application of Toxi-Screening kit microbiotest.

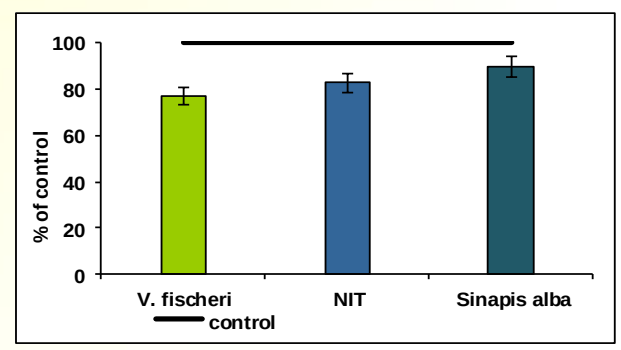
Results

CHEMICAL EVALUATION – selected soils



Hazard quotient values above 1 (limit value) were found in 75% of soils indicating the potential negative effects towards the ecological receptors

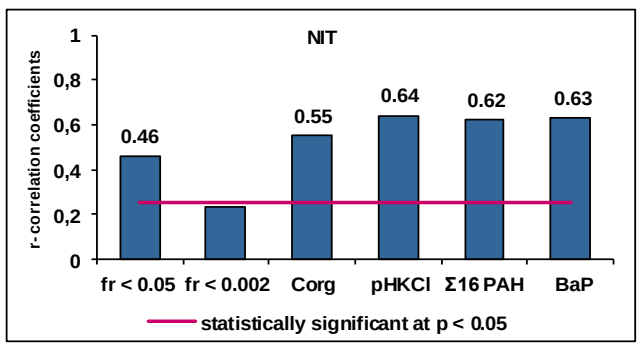
COMPARISON OF ECOTOXICOLOGICAL TESTS



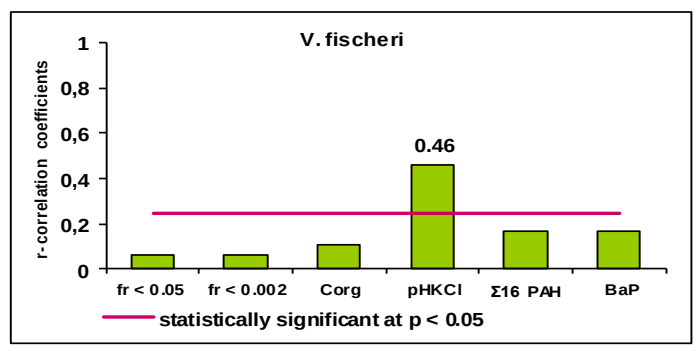
Sensitivity of tests:
V. fischeri* > nitrification > *Sinapis alba
water phase > soil (microorganisms) > soil (plants)

RELATIONSHIP BETWEEN CHEMICAL AND SENSITIVE BIOLOGICAL SOIL DESCRIPTORS

soil – nitrification activity



soil water phase – *Vibrio fischeri*



Stronger relationships with soil properties (pH, Corg) were observed for solid tests

Main parameter determining the toxicity (solid and liquid-phase tests) was soil acidity (r = 0.64)

Relationship between liquid-phase test (*V. fischeri*) and PAHs content was rather weak.

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