

Description for the general public

The main objective of this project will be recognition of environmental risk, in terms of the risk to human health and to ecosystems, caused by the presence of extremely high concentrations of arsenic in soils in the areas of former arsenic ore mining and processing, in the Sudetes and Sudeten Foreland.

Arsenic belongs to the elements highly toxic to biota, included in the WHO list of ten substances and groups of substances that are most hazardous for humans. Previous studies confirmed considerable, or locally extreme, enrichment of the environment in arsenic in the sites of historical mining and industrial processing of arsenic ores, among which the one of particular importance and large scale of pollution is Złoty Stok. Arsenic concentrations in soils in that area, and in the waste material disposed on the dumps are locally as high as several thousand mg/kg, and in some localities over 1%, which means that they exceed by manifold Polish soil quality standards, set at the levels of 20 and 60 mg/kg. Very high concentrations of arsenic in soils occur both in forested ecosystems, wastelands and in some farmlands.

No comprehensive studies have been done until now to recognize a real effects of arsenic accumulated in those soils posed to living organisms and the whole ecosystems. There are some fragmentary data that indicate enhanced risk to biota, including several mutagenic and teratogenic effects that affected plants, the failures in land afforestation and recurrent dieback of tree seedlings, as well as severe effects of phytotoxicity to grass observed in pot experiments. Considerably enhanced concentrations of arsenic in the surface water and in underground water were reported as well. All these fragmentary reports should be considered as premises that justify the need to thoroughly and comprehensively examine the environment in the problematic sites, focusing on the risk to humans and to potentially endangered ecosystems. Moreover, it should be stressed that Polish environmental law, related to remediation of contaminated lands, requires that such assessment of environmental risk should be performed, and related procedure cannot rely exclusively on total concentrations of hazardous substance in soil, but it should consider potential adverse effects to humans and ecosystems.

Despite relatively poor solubility of arsenic in soils, its poor bioavailability and usually negligible plant uptake, in certain conditions it may get mobilized from soil solid phase to the pore water and further may be leached to the groundwater or taken up by biota, i.e. incorporated into the food chain, therefore posing the hazard to humans, in particular to local residents, as well to several functions of ecosystems. Arsenic solubility may be considerably modified in changing conditions, such as long-lasting flooding, or input of phosphates or soluble organic matter that may cause desorption of arsenic originally bound to iron oxides.

The study planned in this project is going to examine arsenic ecotoxicity, phytotoxicity, and bioavailability, in soils of three areas: Złoty Stok, Czarnów and Radzimowice, as related to various soil properties and various environmental conditions (various soil moisture, input of organic matter from natural sources – decomposition and transformation of forest litter) and from human activity (fertilization with phosphates or with manure). The project involves field studies and the series of laboratory and pot experiments. carried out with soil material representative of various localities and various ranges of arsenic. In the incubation tests, the samples of pore water will be collected, and analyzed on chemical composition, with special focus on arsenic concentrations and species. A crucial part of the project will be that based on ecotoxicological tests carried out with pore water and soil solid phase obtained during incubation. The test will be performed to examine acute and chronic toxicity to the organisms that represent various trophic levels in ecosystems, including polybacterial tests. Pot experiments will involve the assessment of arsenic phytotoxicity and phytoavailability to herbaceous plants and to tree seedling, and bioavailability to soil mezofauna. The analysis of experimental results will provide identification of the factors crucial for possible effects of toxicity. Based on these results, a proposal of a simplified method for environmental risk assessment will be worked out, that will be applicable for similar sites, with considering the risk to human health and ecological risk.

The results of this study will provide valuable knowledge concerning biological effects of soil enrichment with arsenic, as dependent on environmental conditions and some human activities. This knowledge will be of high importance for local communities, as it will contain reliable information on the real environmental hazard, that will be useful for land management and decisions on remediation measures. Furthermore, the results will be used for working out or verifying the methods of environmental risk assessment to be applied in Poland to all the cases of historical contamination, as required by Polish law.