SUITMA 11
11 th Conference on Soils of Urban, Industrial, Traffic and Mining Areas
Soils and the food, water, energy nexus
05.09.– 09.09 2022 Berlin, Germany

Soil ecosystems of the Arctic under anthropogenic loads (Taimyr Peninsula)

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The development of the Arctic is a crucial strategy for the coming years for a number of countries in the Northern Hemisphere. Recently the soils have been often subjected to several threats from direct or indirect anthropogenic sources, including heavy metals, oil and diesel fuel emergency spills. Therefore, the interest to Arctic zone is also increasing, in the aspects of soil contamination. Soil properties, characteristics and functions determine ecosystem functioning as a whole. Measuring microbiological parameters, such as soil respiration, microbial biomass carbon (Cmic) or enzyme activities, might serve as an efficient indicator of the contamination load on soil health. The objectives of the study were to: (i) evaluate the quality of total hydrocarbons (TPH) contaminated soils (South Tundra, Taimyr Peninsula), using chemical parameters, (ii) examine the change of enzyme activity, and soil respiration to contamination; and (iii) assess approaches to mitigate the toxicity of TPH in soils triggering mechanisms of self-cleaning, allowing the soil system to perform its ecological functions.

The studied area is located at the junction of the East Siberian permafrost-taiga and the Eurasian polar soil-bioclimatic region. The climate is severe, with long cold winters and short summers; the average annual air temperature is -8.8...-10.1°C. Average annual precipitation is 450-613 mm. We studied typical soils of South Tundra: Fluvisols, Histic Cryosols Reductaquic, Haplic Cryosols Reductaquic and their backgrounds analogues in field and lab experiments. The main features of the tundra soil formation are the severity of the climate and the presence of permafrost close to the surface, as well as the enrichment of rocks with heavy metal.

The amount of TPH was analyzed by a gas chromatograph, GC 6890N Agilent Technologies (USA) with flame ionization detector. The total metals' contents in the soil were determined using the inductively coupled plasma mass-spectrometer (ICP-MS) at Agilent 7500a (USA). The soil pH was determined using the portable ion meter HI 8314 (Hanna Instruments, USA). The density and moisture capacity of soils were determined by Kachinskii method.

Main uncontaminated soils' characteristics were: pH around 4.5 – 6.0, high moistening and content of soil organic matter (SOM) (7-70%). TPH presence in soils shifted the biota structure and increased oil – oxidizing microorganisms' share in soils. Metalls in soils were in unsoluble forms. We applied some sorbents and meliorants to improve the soil characteristic and assessed the changes in soil functioning. Our findings are crucial in making clarifications and working out the the bioremediation strategies for the Arctic.