Emission of heavy metals, resulting from civilization development, has a negative impact on soil environment, causing its pollution. In Poland, the problem of the largest soil contamination with heavy metals occurs in the areas of mining and metal ores processing, and mostly involves Cu, Pb and Zn. According to the ATSDR, among 275 hazardous substances, Pb, Cu and Zn are at the 2nd, 75th and 118th positions, respectively (Agency for Toxic Substances and Disease Registry 2017). According to Polish law, contaminated soils should be subjected to remediation, i.e. to take actions aimed at removal or decreasing pollutant content, controlling and limiting their migration in soil in order to the contaminated area no longer pose a threat to human health or the environment. Among many remediation activities, only a method of soil washing/soil flushing provides permanent metal removal from soil, and enables achieve soil quality standards. The effectiveness of the soil washing/soil flushing is influenced by many factors, including soil type, soil properties and type of washing agent.

To remove metals from soil, different washing agents can be used, i.e. washing agents which are able to reduce the pH (solutions of acids), redox potential (reducing agents) or exhibit high metal complexing ability (chelating agents), including frequently used EDTA (ethylenediaminetetraacetic acid). A high potential in remediation of soils contaminated with heavy metals also show natural agents (e.g. saponin, a commercial plant biosurfactant). However, the high cost and low availability of saponin limit the use of plant biosurfactants on a wide scale.

The latest research trends are therefore focused on searching for both effective, cheap and readily available washing agents. A promising source of alternative washing agents are waste materials, therein sewage sludge, which amounts are growing year by year. Sewage sludge is a rich source of dissolved organic matter (including humic substances), able to complex heavy metals. Sludge are also source of macronutrients. Thus, application of washing agents from sewage sludge can simultaneously remove heavy metals and enhance soil fertility. It should be emphasized that washing agents can be extracted from sewage sludges, in which heavy metals exceed the limits, i.e. sludges that are unsuitable for agricultural use or composting. Moreover, heavy metals present in sewage sludges are not extracted to washing agent solutions, thus they do not pose secondary pollution of soil.

The aim of this project is to determine the efficiency of remediation of soil contaminated with Cu, Pb and Zn using, as washing agents, humic substances (HS) and dissolved organic matter (DOM) recovered from municipal sewage sludge. The process efficiency will be compared with commercially available EDTA. The physico-chemical properties of the soil after remediation will also be determined. The investigations will be conducted in three stages: physico-chemical characteristics of soil, sewage sludge and washing agents (stage I); soil remediation in simulated ex-situ conditions (batch scale) depending on type of washing agent (HS, DOM, EDTA), pH of washing agent, washing time and washing number (stage II); soil remediation in simulated in-situ conditions (column reactor) depending on type of washing agent (HS, DOM, EDTA) and rate flow of washing agent (stage III). In soil after remediation, in order to soil valorization, physico-chemical analysis will be performed, including balance of organic matter and macronutrients.

The results of this project will affect the development of remediation systems based on strategy of permanent metal removal from soils, and the use of washing agents derived from municipal sewage sludge is a part of circular strategy in which waste is a resource.