The abstract in english of doctoral dissertation **„The influence of the biochar on sorption, mobility and bioavailability of selected heavy metals in the soil amended by the sewage sludge/ Wpływ biowęgla na sorpcję, mobilność i biodostępność wybranych metali ciężkich w glebie użyźnionej osadem ściekowym".**

While the industry is still developing, toxic substances are introduced into the environment. This may be a reason of surface and groundwater deterioration as well as soils quality decrease. Heavy metals are a particularly dangerous group of inorganic contaminants.

The studies were focused on the usage of adsorption properties of thermally modified materials (biochars) for the immobilization of heavy metals in contaminated soils and sewage sludges. Due to immobilization, the mobility of metals in the environment is reduced, and indirectly also their toxicity and bioaccumulation in living organisms.

The studies were carried out in two main stages. The purpose of the first stage (Publications [1], [2], [3]) was to determine the adsorptive capacity of biochars, obtained from various feedstocks (including waste), in relation to selected heavy metals. Biochars obtained from plant biomass (wheat straw, wicker, *Sida hermaphrodita*) and organic waste after biogas production (RBP) were tested. The first stage of research aimed to optimize the adsorption conditions of heavy metal ions on different types of biochars from aqueous solutions. Model tests were based on determination of the effect of solution pH on adsorption of selected heavy metals, determination of kinetics and adsorption isotherms, as well as on the determination of the effect of interfering substances, which may reduce the adsorption efficiency (ie nitrate(V) and chloride ions). In addition, the desorption studies to determine the binding force of metal ions by biochars and the degree of reversibility of the adsorption process were also carried out.

The second stage of the research was carried out as part of a field experiment. The experiment was based on the use of the demonstrated sorption potential of biochar for the immobilization of heavy metals in sewage sludge (Publication [4]). In Poland, the prohibition of landfilling of municipal waste and sewage sludge started on 1 January 2016. Hence, solutions related to the safer utilization of this type of waste raw materials are urgently needed. Application of sewage sludge to the soil is one of the desirable directions of its development. Because of the presence of valuable ingredients, it is possible to increase the fertilizing properties of soils, especially those deficient in nutrients and carbon. For the above-mentioned reasons, sewage sludge can also be used for the reclamation of degraded soils. Unfortunately, alongside valuable nutrients, sewage sludge may also contain potentially hazardous and toxic substances, such as heavy metals. One solution to this problem may be the addition to sludge an adsorbents that have strong affinity for metals (before application to the soil). As proved in the first stage of research (Publication [1], [2], [3]), biochars have a great potential in this aspect. At this stage of the research, studies were focused on determining the mechanisms responsible for the adsorption of

ions (Cd(II), Cu(II), Ni(II), Zn(II)) through the soil, sewage sludge, biochar and a mixture of these materials (various additions of biochar in sewage sludge), which is the basis for the estimation of factors affecting the bioavailability of metals in soil fertilized with sewage sludge and biochar (Publication [4]). In this work, it was showed that biochar introduced with sewage sludge not only increases the adsorption capacity of the sewage sludge itself, but also reduces the potential desorption (through stronger bonding) of the investigated metals, which significantly reduces the environmental risk associated with their presence in the environment.

As part of this stage (Publication [5]) it was also determined the effect of adding biochar to sewage sludge, and then to the soil for the speciation of Ni(II), Zn(II) ions (Publication [5]), compared to soil fertilized only with sewage sludge. It was reported that the introduction of sewage sludge itself into the soil caused an undesirable increase in the content of mobile forms and bioavailable metals in the soil. Supplementing sewage sludge in biochar before its application to the soil not only significantly reduced the content of metals in the mobile fraction and bioavailable, but also influenced the transfer of PTEs over time from potentially available fractions to inaccessible fractions. The reduction of PTEs content in the mobile fraction and the collection of their main load in the inaccessible fraction indicates that the proposed method can be an interesting, easily accessible and effective solution for the future reducing the environmental risk associated with using sewage sludge.