PUBLISHABLE SUMMARY of the project research work –
1st Year (period SEP.2019 – AUG.2020)

The main activities within the **WP1** work package were mainly in the direction of optimizing the preparation of functionalized nanomaterials for efficient removal of heavy metal ions from model solutions, with emphasis on Pb^{2+} and Cr_{total} ions. At the beginning of the WP1 work program, based on our own knowledge and experience in the preparation of different types of nanomaterials and surface treatment of nanoparticles, we focused on the preparation of SiO_2 nanoparticles and superparamagnetic spinel iron oxide nanoparticles - maghemite (γ-Fe_2O_3) - and their surface functionalization with different aminos by sol-gel method. We investigated the influence of various parameters that have a key influence on the size and morphological properties of nanoparticles and their surface interactions, which proved to be extremely important for providing a homogeneous surface coating with a sufficient number of functional groups for binding heavy metal ions from aqueous solutions. Prepared nanomaterials with functional coatings were characterized to obtain information on morphology, composition and surface characteristics using modern characterization techniques, such as analysis of specific surface area and porosity by BET method, measurement of electrokinetic potential (ξ), infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), magnetometry (VSM), transmission electron microscopy (TEM / EDXS), X-ray powder diffractometry (XRD), atomic absorption spectroscopy (AAS). With the prepared nanomaterials, we performed adsorption and desorption testing and attempts to reuse regenerated functionalized nanomaterials in new adsorption cycles, and determined the adsorption characteristics of the adsorption nanomaterials used **(WP3).**

Throughout the entire period of research work on the preparation of functionalized nanomaterials, we have been, based on the many ongoing challenges that have arisen through laboratory frameworks, the question of how to transfer the synthesis of nanomaterials from the laboratory to the pilot-scale level, constantly confronted in order to maintain their key adsorption characteristics. Although some of the initial scale-up experiments have already been carried out due to the need to develop, design and test the cartridge system as part of the WP2 work package, certain issues remain to be explored in **WP4** in the next project flight. All this serves as a guide in providing guidelines for establishing the mode of transfer and conditions for the synthesis of adsorption nanomaterials on a pilot-scale scale, which begins in the WP4 work package.

In the continuation of our project work, we are part of the **WP3** work package for prepared and functionalized nanomaterials performed toxicological tests on human skeletal muscle cell lines (SKMDC), fibroblast cells, macrophage cells (RAW264.7) and umbilical vein endothelial cells (HUVEC). This was followed by toxicity tests of lead and chromium on biomass and regeneration, and the establishment of regeneration methods of nanomaterials.

As part of the **WP7** work package, which includes project management, a number of presentations of the project's purpose and project results took place. All these activities have not yet started or have started on a small scale. Research The development results of these activities will be presented in working reports, in accordance with the objectives set out in the project timeline.

In the continuation of the project, more intensive activities related to **WP4** will start “Scale-up” preparation and optimization of nanomaterials, which will prove to be the most suitable in the laboratory in achieving maximum efficiency of adsorption of heavy metal ions from water.

Later, as part of the **WP5** work program, we expect the development of a prototype MBR system with an integrated cartridge (adsorption column), where selected nanomaterials pre-prepared by the scale-up process will be used as adsorbents in the prototype system for adsorption of heavy metals from model and real wastewater. The operating conditions of the prototype system operation process itself will be tested and the adsorption efficiency on heavy metal ions through the cartridge system will be optimized. At the same time, an LCA / LCCA process analysis will be performed in parallel.

Under **WP6,** field testing and validation of the system will be carried out. We do not expect any problems with the **WP7** project management and dissemination activities. So far, these activities have been ongoing, with numerous promotions of project work at various scientific and professional events.