Abstract of the doctoral dissertation

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EFFECTIVENESS OF SOIL-PLANT SYSTEMS IN WASTEWATER TREATMENT PLANTS

The main objective of the doctoral thesis was to determine the effectiveness of soil-plant bed systems. The specific objective was to identify, characterize, and analyze additional technical, physicochemical, and biological parameters that allowed for a comprehensive assessment of the effectiveness of soil-plant systems.

As a result of the literature review, a research problem was formulated in the form of questions.

The research covered seven soil-plant systems that had been functioning for over fifteen years as the third stage of plant-based wastewater treatment plants. These treatment plants were located in private households in the Sokoły municipality in the Podlaskie Voivodeship, and they received only domestic sewage.

The effectiveness of the soil-plant systems was determined using basic parameters, which included changes in biochemical oxygen demand (BOD_5), total suspended solids, as well as additional parameters.

The additional parameters were determined based on a literature review, applicable legislation, and preliminary own research. They were divided into three groups: technical, physicochemical, and microbiological.

Under the technical parameter, an assessment of the technical condition of the plant-based wastewater treatment systems was conducted, and comprehensive characteristic cards were prepared for each research facility.

The physicochemical parameter analysis captured variations in the concentrations of oxygen (O_2), chemical oxygen demand (COD), total nitrogen (TN), ammonium nitrogen (NH_4-N), nitrate nitrogen (NO_3-N), nitrite nitrogen (NO_2-N), total phosphorus (TP), phosphate phosphorus (P-PO_4), pentoxide phosphorus (P_2O_5) in the wastewater flowing through the soil-plant systems.

Furthermore, statistically significant differences were demonstrated in the wastewaters' physicochemical characteristics of the inflow to soil-plant systems. In addition, the chemical status of groundwater around the sewage treatment plants was determined and assessed by examining the concentration of nitrates (NO_3^-), nitrites (NO_2^-), ammonium ions (NH_4^+), phosphates (PO_4^{3-}) and chlorides (Cl^-).

The microbiological parameter encompassed two aspects. As part of the first one, the abundance and trophic groups of nematodes (Nematoda) inhabiting the soil-plant systems and the soil surrounding the systems were investigated. Additionally, the canonical correspondence analysis (CCA) method was used to determine the impact of physicochemical parameters in the wastewater on the abundance and trophic groups of nematodes in the soil.

The second aspect focused on the analysis of the abundance of pathogenic bacteria, including Enterococcus faecallis (fecal streptococcus), coliform bacteria (coliform group), and Escherichia coli (fecal coliform), in the sewage sludge from the anaerobic tank, wastewater from the denitrification pond, and groundwater from the piezometer.

The doctoral dissertation was concluded with a summary and final conclusions drawn from the conducted analyses.

Keywords: soil-plant systems, soil-plant beds, constructed wetlands, effectiveness, efficiency, basic parameters, additional parameters.