More than 120 years ago, James Alfred Ewing discovered the phenomenon in which the system's current state depends on the states in the preceding moments, which he eventually named hysteresis. A classic example of the hysteresis is the process of magnetization of magnetic materials (particularly ferromagnetics), which, on a graph in the magnetization (I) - magnetic field (H) coordinates, is described as a closed-loop composed of two symmetrical curves. Hysteresis can also be found in mechanical systems, such as elastic materials and adsorption. Hysteresis phenomenon can also be observed by examining soil's two essential hydrophysical characteristics: soil water content-soil water pressure head (retention curve) and soil hydraulic conductivity coefficient in the unsaturated zone-soil water pressure head dependency (Kutilek and Nielsen 1994, Iwata et al. 1988). These characteristics significantly impact the whole processes in the soil, especially the wetting and drying processes, thus determining the conditions for plant growth.

Unfortunately, the hydraulic conductivity coefficient in the unsaturated zone is a challenging soil characteristic to measure. The measurement of this coefficient is highly time-consuming and limited by the measuring range of used methods. Because of those difficulties, laboratory measurements of unsaturated soil hydraulic conductivity coefficient-soil water pressure head dependency are usually limited to the main drying branch. Thus, hysteresis phenomena of this coefficient are poorly investigated and ignored in the models. This is an essential gap in the actual state of knowledge. Elaboration of a physical-empirical model that takes into account the hysteresis effect of hydraulic conductivity coefficient in the unsaturated zone would make up this gap, affecting at the same time a better understanding of the topic of the macroscopic description of mass transport in the unsaturated zone of the soil. It would also allow taking into account the hysteresis effect of hydraulic conductivity coefficient in the simulation-forecasting models currently used, making them more accurate.

Therefore, this project aims to develop a physical-empirical model of the soil hydraulic conductivity coefficient in the unsaturated zone taking into account the hysteresis effect of selected soil types. The aim will be realized based on the soil hydraulic conductivity coefficient measurements in the saturated and unsaturated zone and measurements of the chosen soil physical properties. At the same time, unique in the world scale, measurements of the hysteresis of hydraulic conductivity coefficient, performed for an extensive range of soil types and collected in the form of a database, will also be highly beneficial results of the proposed project.

1. Kutilek M., Nielsen D.R., 1994. Soil Hydrology, Catena Verlag, 93.
2. Iwata S, Tabuchi T., Warkentin B.P., 1988. Soil-Water Interactions. Mechanisms and Applications. New York, M. Dekker.