FORTY YEARS OF USING THE VAN GENUCHTEN EMPIRICAL FUNCTIONS AND A PROPOSAL TO REPLACE THEM WITH PHYSICALLY ADEQUATE ANALOGUES

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The relevance of the study is determined by the demand for mathematical models of soil hydrophysical properties. The research problem lies in the presence of gaps in substantiating the water-retention capacity and hydraulic conductivity of soil within the framework of fundamental physical concepts. The purpose of the study is to identify and substantiate the patterns of interfacial abiotic interactions in soil with the participation of water in a liquid state of aggregation. A physical substantiation of these interactions is proposed. It is based on the concept of space structure of a capillary-porous medium, as well as on the forces of water surface tension and the sorption interaction of moisture with the solid phase. On this basis, pairs of hydraulic functions with common parameters were formulated. These functions were grouped into three systems. The first system is formed by functions that are used within the framework of the Mualem-Van Genuchten method. The second system is represented by functions that are an improved analogue of the models used within the framework of the Mualem-Kosugi method. The third system is formed by an improved analogue of the Haverkamp et al. model and the original hydraulic conductivity function. The improvements of the Kosugi model, as well as the model of Haverkamp et al., were achieved by including an additional additive parameter that takes into account the "bubbling pressure". As part of a computational experiment, a comparative analysis of the three systems of hydraulic functions was performed using data on 22 objects from the Mualem catalog. The reliability of the differences between the three systems in terms of modeling errors was assessed using the Williams-Kluth criterion. The advantages of the second and third systems of functions were revealed. The shortcomings of Van Genuchten functions were characterized.

Key words: soil, water-retention capacity, relative hydraulic conductivity, mathematical model, point approximation of experimental data, predictive estimation, Williams-Kloot criterion.