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Soil Hydraulic Properties and Water Flow Estimation Using Uni- and Bimodal Porosity Models in Erosion-Affected Hillslope

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Soil degradation processes, such as erosion, has been reported as one of the main concerns in agricultural areas. The resulting erosion-affected soils are characterized by modified soil hydraulic and other properties, strongly affecting the agricultural productivity. The study objective was to identify hydropedological factors controlling soil water dynamics in erosion-affected hillslope vineyard soils and to test uni- and bimodal porosity models. The hydropedological study was conducted at three locations: Jastrebarsko (location I), and Jazbina (II) and (III). The selected sites had same agricultural management practices and similar slope with identified Stagnosol soil type. Soil Hydraulic Properties (SHP) were estimated using Evaporation and WP4C methods on intact soil cores while the soil hydraulic functions were fitted using uni- and bimodal porosity models in HYPROP-FIT software. The study illustrated that erosion-affected soil structural properties governing hillslope hydrology in the arable landscape, in this case, vineyards, were evident and had a significant impact on SHP and, consequently, soil water dynamics. Both unimodal and bimodal soil hydraulic models fitted the data agreeably; although, it can be clearly noticed that the bimodal model performed better in particular cases where data showed non-uniform pore size distributions. HYDRUS-1D simulations showed, in general, that both models provided a similar distribution of flux components between infiltration, surface runoff, and drainage (bottom flux) in most cases. Overall, the differences generated when using the bimodal hydraulic functions can lead to a large discrepancy in water flow quantification. It is evident that the SHP and water dynamics in highly erosion-affected heterogeneous soils with developed structure and pore space (e.g., compacted soil with cracks and biopores) cannot be adequately explained using the unimodal porosity functions or by applying single porosity models. However, the validity of more complex approaches should be further tested, and parametrization should be performed with extra care, as using the non-appropriate model can lead to errors in the water balance.