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Estimation of soil subsurface hydraulic conductivity based on inverse modelling and soil morphology

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Soil hydraulic properties play a primary role in water infiltration and movement, and transport of nutrients and contaminants through the soil profile. However, the determination of soil hydraulic properties, especially the hydraulic conductivity at lower depths within the soil profile is very challenging. We investigated the use of inverse modelling based on APSIM (Agricultural Production Simulation Model) to determine likely ranges of the hydraulic conductivity at saturation (Ksat) and field capacity (KDUL) for a slowly permeable subsurface soil. Simulations were run for the poorly drained Otokia silt loam, in the Otago region of New Zealand. APSIM simulations were set up either according to the site specific soil profile description or based on the national soils database (S-map) description. Simulated temporal soil moisture data were compared to measurements from a field experiment. Within a sensitivity analysis Ksat values of the subsurface soil were varied from 2.4 to 192 mm/d, and values for KDUL from 0.05 to 1 mm/d. Finally simulations were run over 45 years using two climatic conditions, with annual rainfall amounts of 730 and 628 mm. The effect of varying the hydraulic conductivity of the subsurface soil (Cg) on the wetness status of the overlying B2g horizon was determined by calculating the average duration of soil moisture above field capacity. These were then used to estimate ranges of the hydraulic conductivity that contributes to a soil being imperfectly, poorly or very poorly drained.