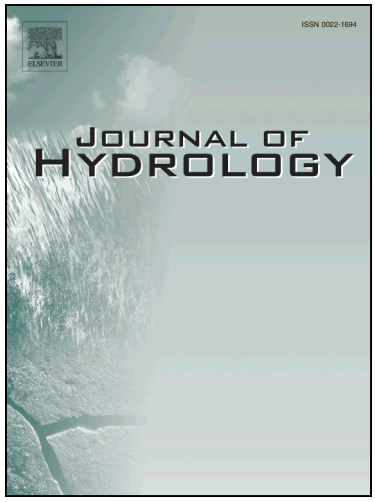

Research papers

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The water balance components of Mediterranean pine trees on a steep mountain slope during two hydrologically contrasting years

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Abstract

Pines in semi-arid mountain environments manage to survive and thrive despite the limited soil water, due to shallow soil depths, and overall water scarcity. This study aims to develop a method for computing soil evaporation, bedrock water uptake and transpiration from a natural, open forest, based on sap flow (Heat Ratio Method), soil moisture and meteorological observations. The water balance of individual trees was conceptualized with a geometric approach, using canopy projected areas and Voronoi (Thiesen) polygons. The canopy approach assumes that the tree's root area extent is equal to its canopy projected area, while the Voronoi approach assumes that the tree roots exploit the open area that is closer to the tree than to any other tree. The methodology was applied in an open *Pinus Brutia* forest (68% canopy cover) in Cyprus, characterized by steep slopes and fractured bedrock, during two hydrologically contrasting years (2015 wet, 2016 dry). Sap flow sensors, soil moisture sensors, throughfall and stemflow gauges were installed on and around eight trees. Rainfall was 507 mm in 2015 and 359 mm in 2016. According to the canopy approach, the sum of tree transpiration and soil evaporation exceeded the throughfall in both years, which implies that the trees' bedrock water uptake exceeds the surface runoff and drainage losses. This indicated that trees extend their roots beyond the canopy-projected areas and the use of the Voronoi polygons captures this effect. According to the stand scale water balance, average throughfall during the two years was 81% of the rainfall. Transpiration was 61% of the rainfall in 2015, but only 32% in 2016. On the contrary, the soil evaporation fraction