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# Soil moisture dynamics in the montane beech-fir-spruce forest belt within karstic headwaters

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The drinking water supply of the City of Vienna is provided by karstic springs of a water protection zone (WPZ) within the North-Eastern Limestone Alps of Austria. For water protection purposes, the protection of the karstic soil layers by an adequate vegetation cover is one of the most important features. The montane beech-fir-spruce forests can be described as the most important forest type within the WPZ, covering between 40 % and 50 % of the forested area. In order to improve the understanding of the characteristics of this forest type, three hydro-meteorological long-term monitoring plots were installed at the elevation of
1040 m asl, comparing a mixed old growth stand (OGS), a young stand (YS) and a homogeneous spruce pole stand (PS). The data acquisition has been in operation since June 1999.
The soil type at all three plots is Rendzic Leptosol with loam content in the upper soil horizons. The moder humus layers within the undisturbed mixed OGS plot are ranging between 5 cm and 60 cm depth, hence forming a significant water and nutrient storage zone of the karstic soil formations. At YS, only shallow humus layers remained due to mineralization processes after a wind-throw event, and also the humus layers at PS stand show minor depths in comparison with OGS.
For the delineation of the soil moisture dynamics within the karstic soil formations, especially the data sets of volumetric soil moisture, soil temperature, air temperature, and precipitation measurements were of interest. The data loggers at the monitoring stations recorded the values of the specific variables in a 10 minutes interval during the whole year, also including the winter season. Volumetric soil moisture was measured in 20 cm and 50 cm depth with 5 repetitions at OGS and with 3 repetitions at the other two plots. For data analysis, the comparison of the time series between the three monitoring stations but also between the particular measurement sites at each plot were of specific interest.
During summer season, soil moisture dynamics were governed by precipitation events and intermittent dry spells. The course of soil moisture showed a typical karstic behaviour, with a fast increase during precipitation events, a subsequent fast decrease caused by percolation of soil water into the aquifer and after about two days a slow decrease, obviously caused by evapotranspiration. It became evident that the differences between the measurement sites within e.g. the OGS plot were rather high hence it was possible to differentiate between measurement sites, where soil moisture content reacted fast on precipitation events, and others, where it reacted slowly on them. All of the slow reacting measurement sites were characterised by moder humus layers with more than 25 cm depth, whereas the fast reacting sites exhibited either huge humus layers or were characterised by mineral soil conditions. OGS showed during all measured periods the highest average values of soil moisture in comparison with YS and PS. During winter season, the soil moisture dynamics were governed by snow ablation periods.
For water protection purposes especially the stability of the humus layers is of importance in order to avoid the intrusion of soil nutrients and humus substances into the karstic aquifer, where those would be converted into contaminants of the drinking water source. The gathered data supported the elaboration of forest management concepts with the aim of source water protection, where the clear cut technique is replaced by more adapted continuous cover forest systems, which facilitate the sustained stability of the huge moder humus layers within the WPZ.