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Soil water availability as controlling factor for actual evapotranspiration in urban soil-vegetation-systems

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The City of Hamburg is characterized by a large number of greens, parks and roadside trees: 600.000 trees cover about 14% of the city area, and moreover, 245.000 roadside trees can be found here. Urban vegetation is generally known to positively contribute to the urban micro-climate via cooling by evapotranspiration (ET). The water for ET is predominantly stored in the urban soils. Hence, the actual evapotranspiration (ETa) is - beside atmospheric drivers - determined by soil water availability at the soil surface and in the rooting zones of the respective vegetation.
The overall aim of this study is to characterize soil water availability as a regulative factor for ETa in urban soil-vegetation systems. The specific questions addressed are: i) What is the spatio-temporal variation in soil water availability at the study sites? ii) Which soil depths are predominantly used for water uptake by the vegetation forms investigated? and iii) Which are the threshold values of soil water tension and soil water content (Θ), respectively, that limit ETa under dry conditions on both grass-dominated and tree-dominated sites?
Three study areas were established in the urban region of Hamburg, Germany. We selected areas featuring both single tree stands and grass-dominated sites, both representing typical vegetation forms in Hamburg. The areas are characterized by relatively dry soil conditions. However, they differ in regard to soil water availability. At each area we selected one site dominated by Common Oak (Quercus ruber L.) with ages from 40 to 120 years, and paired each oak tree site with a neighboring grass-dominated site.
All field measurements were performed during the years 2013 and 2014. At each site, we continuously measured soil water tension and Θ up to 160 cm depth, and xylem sap flux of each of three oak trees per site in a 15 min-resolution. Furthermore, we measured soil hydraulic properties as pF-curve, saturated and unsaturated conductivity at all sites. Automated weather stations for the continuous measurement of all relevant climatic factors were established at all grass-dominated sites. Based on the field data, soil water balances were simulated for all sites with the HYDRUS model. Potential ET for the grass-dominated sites was calculated using the Penman-Monteith equation.
Results regarding the spatio-temporal variability of available soil water of the study sites will be shown and discussed in this contribution. Moreover, correlations between soil water availability and ETa will be presented.