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Beech vs. Pine – how different tree species manage their water demands

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In north-eastern Germany large parts of the landscape are covered by pine trees. Although beech used to be one of the typical species for the region, today it makes up only a small fraction of the forested area. In order to reinstate a more natural forest composition an effort is made to decrease the coniferous forest in the next 30 years from 70% to 40% while increasing the deciduous forest from 20% to 40%. This will have consequences for the forest water balance that we would like to understand better. In an attempt to capture the complete tree water balance for both species we monitored all relevant hydrologic fluxes in four stands of pure beech and pine (both young and old stands) as well as in eight mixed stands (as part of the TERENO observatory). Extensive measurements of throughfall and stemflow were conducted with 35 rain trough systems, 50 stemflow collectors and tipping buckets. Soil moisture was monitored in 70 depth profiles with a total of 450 sensors ranging from 10 cm down to 200 cm. In combination with soil water potential measurements at 5 depths root water uptake from different depths and hydraulic redistribution between depths could be determined. Sapflux sensors recorded tree water use for 16 trees and groundwater level was monitored at 16 locations. We found that soil moisture conditions under beech were more variable than under pine, especially in the upper 100 cm. This was due to the higher influx of water from stemflow on the one hand and to the more intensive/effective use of soil water by the beech on the other hand. Our sap flux measurements show that beech was able to sustain steady rates of sapflux even under extremely dry soil conditions. While annual average sapflow was twice as high for pines compared to beeches, pine trees were less effective in taking up water from the soil and reduced sap flow considerably during dry phases. We still found the upper 100 cm of soil under pine to be generally wetter than under beech and considered this as an indication that pine had access to a second water source – possibly the groundwater reached by its deep tap roots. These differences in how tree species organize and optimize their water use and adapt to potential changes in trends in precipitation patterns and amounts have important ramifications for groundwater recharge and we should continue considering them when making decisions on future forest management.