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Compensating effect of sap velocity for stand density leads to uniform hillslope-scale forest transpiration across a steep valley cross-section

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Roberts (1983) found that forest transpiration is relatively uniform across different climatic conditions and suggested that forest transpiration is a conservative process compensating for environmental heterogeneity.
Here we test this hypothesis at a steep valley cross-section composed of European Beech in the Attert basin in Luxemburg. We use sapflow, soil moisture, biometric and meteorological data from 6 sites along a transect to estimate site scale transpiration rates.
Despite opposing hillslope orientation, different slope angles and forest stand structures, we estimated relatively similar transpiration responses to atmospheric demand and seasonal transpiration totals. This similarity is related to a negative correlation between sap velocity and site-average sapwood area. At the south facing sites with an old, even-aged stand structure and closed canopy layer, we observe significantly lower sap velocities but similar stand-average transpiration rates compared to the north-facing sites with open canopy structure, tall dominant trees and dense understorey.
This suggests that plant hydraulic co-ordination allows for flexible responses to environmental conditions leading to similar transpiration rates close to the water and energy limits despite the apparent heterogeneity in exposition, stand density and soil moisture.

References

Roberts, J. (1983). Forest transpiration: A conservative hydrological process? Journal of Hydrology 66, 133–141.