Alnus shrub expansion increases evapotranspiration in the Swiss Alps

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Author(s) van den Bergh, Thijs; Körner, Christian; Hiltbrunner, Erika
Author(s) at UniBasel Hiltbrunner, Erika ; Körner, Christian ; Van den Bergh, Thijs ;
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Shrub encroachment is one of the main consequences of abandonment of montane grassland. Higher surface roughness of shrubs leads to stronger aerodynamic coupling. This should increase evapotranspiration (ET), but lower surface temperatures (due to higher ET and reduced aerodynamic resistance) could counter this effect. We explored this question by employing weighable lysimeters in adjacent grass- and shrubland understorey, and by measuring canopy transpiration in Alnus with sap flow sensors at 1675 m a.s.l. in the Swiss central Alps. For 11 bright days, ET rates of Alnus clearly exceeded those from grassland by on average 31 ś 14% or 1.2 ś 0.6 mm d−1 (mean ś sd). During days with a high vapour pressure deficit (VPD), differences in ET were largest, indicating that enhanced aerodynamic coupling had a greater influence than evaporative cooling. Cooler Alnus than grassland canopies were confirmed by infrared thermography. For the growing season (mid May to end of September), we estimate that this increase in ET results in a reduction in runoff by 78 to 81 mm (2010, 2011). Accounting for the falling height of water, this lower runoff reduces the hydro-electric potential of the upper Reuss catchment (227 km2) by 0.47Mio Swiss Franc (CHF) per growing season (same amount in US Dollar (USD); Alnus cover analysed for the year 2004/05) and by 1.8 Mio CHF for a scenario where all grasslands below the natural treeline would be converted into shrubland. So, shrub encroachment clearly exerts hydrological drawbacks.
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