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Carbon sink activity is stronger under grazing than under mowing: results from a paired eddy flux towers experiment

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Effect of grazing vs. mowing on carbon balance of a grassland was investigated by a paired eddy towers (one of them measuring the grazed, the another the mowed treatment) experiment at the Bugacpuszta sandy grassland site (HU-Bug, 46.69˚ N, 19.6˚ E, 114m asl, 10.4 ˚C annual mean temperature, 562 mm annual precipitation sum) located in the Hungarian Plain. Eddy covariance measurements started in July, 2002. The area of the mowed treatment is 1 ha, it is located within the grazed treatment (500 ha). Electric fence was set up around the selected area in spring of 2011. Study years include 2011, 2012 and 2013. The pasture is managed extensively (average grazing pressure of 0.5 cattle per hectare), the cattle herd regularly took several kilometres during a grazing day.

Annual net ecosystem exchange (NEE) of the grassland is strongly limited by precipitation, there were 2 source years within the 11 years (2003-2013) of measurements, during which the average annual balance was –109 $gCm^{-2}year^{-1}$ with standard deviation of 106 $gCm^{-2}year^{-1}$.

Carbon sink activity of the grassland was stronger in the grazed treatment than in the mowed treatment during the three year study period (paired t-test, P=0.058). In the grazed treatment the average sink strength was –142.8 $\pm$40 $gCm^{-2}year^{-1}$, while in the mowed treatment the average sink strength was –61.5 $\pm$46.5 $gCm^{-2}year^{-1}$.

Differences of carbon balances between the treatments were positively correlated to the annual sum of evapotranspiration (ET), while ETs of the treatments were almost identical (differences within a 10mm $year^{-1}$ range) in each study year. Water use efficiency in the mowed treatment was 44% of that in the grazed treatment (P=0.045) as a result of the differences in sink capacity. The higher sensitivity to drought by the mowed treatment manifested in decreased sink capacity during summer and in decreased regeneration capacity during autumn rains as shown by the cumulative NEE in the different years.

Minor but consistent differences in total ecosystem respiration (R_{eco}) (higher in the mowed treatment by 5-13%) and gross primary production (GPP) (lower in the mowed treatment by only up to 3%) resulted in significantly weaker sink activity with NEE_{mowed} to NEE_{grazed} ratios of 56%, 60% and 10% in 2011, 2012 and 2013, respectively.