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Vegetation structure and productivity of three temperate upland grasslands

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An improved regional assessment of the productivity of grasslands depends on detailed knowledge of the interactions between climatic drivers, nutrient cycles, vegetation properties and human activity. Managed grasslands in central Europe display considerable potential for dynamic growth and phenological change, which contributes to the challenges in making representative observations in the field, as well as by remote sensing and model applications.

We have investigated the relationships between vegetation state changes and productivity of meadow grasslands by comparing three sites in Southern Germany (DE-Fen, DE-RbW, DE-Gwg) that are characterized by different management intensities and elevations. Weekly observations of vegetation height, leaf area, above-ground biomass and plant species composition were compared to estimates of the surface exchange of carbon dioxide. This revealed that the productivity of these grasslands correlated positively with management intensity (negatively with elevation) at the seasonal scale. However, at the scale of harvest periods the relationship between (gross) productivity and vegetation dynamics appeared to follow unified patterns for all sites. The variability in above-ground vegetation properties was most pronounced during the spring period and contributed to significant differences in carbon and nitrogen biomass yield between the sites. Furthermore, the study highlighted a substantial potential for bias based on the techniques used to quantify vegetation properties and we discuss a mitigating approach. Continuous observations of vegetation height showed only limited potential for prediction of carbon uptake by these grasslands, but highlighted the timing of phenological transitions between sites and years.

These outcomes may serve as a reference for model studies on the seasonal allocation of carbon (and nitrogen) in relation to phenology in managed grassland systems. The study built on multi-disciplinary TERENO/ScaleX cooperation.