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Biodiversity and plant water-use strategies control productivity and water use efficiency in periods of drought

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Changing precipitation patterns and temperature increase affect valuable ecosystem services of grassland ecosystems (i.e. water provisioning and grassland productivity / forage production). It remains questionable to which extent gradients of biodiversity and plant water-use strategies can buffer negative consequences of drought periods for these ecosystem services. To address gradients of agricultural intensity and environmental characteristics different types of grassland ecosystems were investigated in a common garden experiment at the long term socio-ecological research (LTSER) site 'Stubai Valley', Tyrol, Austria. In addition to local grassland types from the Stubai Valley characterized by the Northern Central-European climate, soil-vegetation monoliths from an inner-alpine dry valley, the Matsch Valley in South Tyrol, Italy, belonging to the LTSER platform 'Val Mazia/Matschertal' were moved to the Stubai Valley. Analyses were performed using high precision lysimeters (Smart Field lysimeters®, SFL, METER Group) with 0.3m in diameter and depth, containing respective soil-vegetation monoliths from both sites. Additionally, seed mixtures commonly used when recultivating grassland at both sites have been selected and grown directly in the lysimeters on standardized soils. Different treatments with three replicates of each grassland type were applied: control (long-term precipitation amount and frequency), drought (no precipitation), drought and heat (no precipitation, increase of surface temperatures by +2K). Besides water balance, both water use efficiency (WUE) of productivity (also called integrated water-use efficiency) by harvesting and photosynthetic WUE (also referred to as intrinsic or instantaneous WUE) using ecosystem chambers on the lysimeters were assessed. Measurements of stomatal conductance for species abundant in all grassland types complemented the dataset. Results showed that impacts of drought on water related ecosystem services could only be evaluated by considering water-use strategies of the dominant plant species. It became also evident, that commonly used seed mixtures for reseeding or recultivation lack specific adaptations which make mature grassland ecosystems more resilient to drought. However, responses to drought revealed marked differences between site-specific grassland types, functional groups and even within species adapted to different environmental conditions. To a certain degree it remains debatable whether more frequent droughts will lead to a shift to better adapted plant communities or plants can initially adapt to drought physiologically / morphologically (i.e. as ecotypes).