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Using plant traits to evaluate the resistance and resilience of ecosystem service provision

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Mountain grassland ecosystems are a hotspot of biodiversity and deliver a multiplicity of ecosystem services. Due to a long history of well adapted agricultural use and specific environmental conditions (e.g. slope, altitude, or climate), various types of grassland ecosystems have developed. Each of them shows specific attributes in forms of plant communities and abiotic characteristics, which lead to particular ranges of ecosystem service provision. However, ongoing climate and societal changes thread plant community composition and may lead to changes in plant traits, and therefore, the provision of ecosystem services. Currently it is not clear how vulnerable these ecosystems are to disturbances, or whether they have developed a high resilience over time. Thus, it is essential to know the ranges of resistance and resilience of an ecosystem service. We, therefore, developed a static approach based on community weighted mean plant traits and abiotic parameters to measure the boundaries of resistance and resilience of each ecosystem service separately. By calculating actual minimum and maximum amounts of ecosystem services, we define the range of resistance of an ecosystem service. We then calculate the potential amount of an ecosystem services (via simulated plant communities) by assuming that no species is lost or added to the system. By comparing actual and potential values, we can estimate whether an ecosystem service is in danger to lose its resilience.

We selected different ecosystem services related to mountain grassland ecosystems, e.g. carbon storage, forage quality, forage quantity, and soil fertility. We analysed each ecosystem service for different grassland management types, covering meadows and pastures of very low land-use intensity through to grasslands of high land-use intensity. Results indicate that certain ecosystem services have a higher resilience than others (e.g. carbon storage) for all management types. The ecosystem may provide steady amounts of ecosystem services also in future when facing environmental or societal disturbances. In contrary, other services are very depending on actual conditions and are, therefore, less stable (e.g. forage quantity). When comparing ranges of resistance and resilience, the actual amount lies very close to the boundaries of the potential provision. This gives us a hint that the ecosystem service is in danger to lose its resilience and amount of ecosystem service provision when facing disturbances in future.