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Climate Extremes and Land-Use Change: Effects on Ecosystem Processes and Services

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Extreme climatic events, in particular droughts and heatwaves, have significant impacts on ecosystem carbon and water cycles and a range of related ecosystem services. It is expected that in the coming decades the return intervals and severities of extreme droughts will increase substantially and may result in the passing of thresholds of ecosystem functioning, potentially causing legacy effects, which are so far poorly understood. Observational evidence suggests that different land cover types (forest, grassland) are differently influenced by extreme drought, but there is a lack of knowledge whether and how future, increasingly severe climate extremes will affect their concurrent and lagged responses, as well as land-use decisions determining future shifts in land cover.

The ClimLUC project aims to understand how extreme summer drought affects carbon and water dynamics of mountain ecosystems under different land uses, and to analyse implications for ecosystem service provisioning. Overall, we hypothesize that land-use change alters the effects of extreme summer drought on ecosystem processes and the related services, grassland responding more rapidly and strongly but being more resilient to extreme drought than forest. To address the aims and hypotheses, we will 1) test experimentally how (a) a managed, (b) an abandoned mountain grassland and (c) an adjacent subalpine forest respond to a progressive extreme drought and will analyse threshold responses of carbon and water dynamics and their implications for ecosystem services (timber and fodder production, carbon sequestration, water provisioning); 2) quantify carry-over effects of the extreme event on ecosystem processes and services; 3) project and attribute future carbon and water cycle responses to extreme drought and related socio-economic changes, based on a process-based dynamic general vegetation model; 4) analyse the interrelation between land-use changes and the occurrence and severity of past and future extreme events and to identify their individual and combined effects on the provisioning of ecosystem services; and 5) identify management options that allow increasing the resilience of the socio-ecological system to climate extremes.