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# Saving forests from climate change – can livestock grazing reduce the vulnerability of trees to drought?

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Tree mortality in dryland forests is pronounced following extreme drought events. Moreover, long-term monitoring showed that the die-off rate of oaks in a Mediterranean woodland increased exponentially with decreasing annual rain amounts. In forests and woodlands of low water availability, trees are subjected to competition for water, and likely also for nutrients, by neighboring woody and herbaceous vegetation. Increasingly arid conditions induced by a hotter and drier climate intensify the “battle” for resources among plants. Trees might be partly released from competition by nearby vegetation when subjected to livestock grazing, a common forestry practice in many regions worldwide. Grazing not only reduces competing vegetation, but also modifies the chemical and physical soil environment. While the impact of grazing on herbaceous biomass, species composition and diversity has been extensively studied over the past decades, its influence on trees remains largely uncertain. We investigated tree growth, water relations and nutrient status as affected by livestock grazing in semiarid forests and woodlands subjected to extreme seasonal drought conditions. Livestock grazing alleviated drought stress of evergreen oaks (*Quercus calliprinos*) at the dry edge of their distribution and enhanced their growth 2-3 fold. Oaks in grazed plots showed higher leaf gas exchange and a lower drop in leaf water potential under very dry conditions than oaks in plots from which grazing was prevented. Grazing exclusion also shifted the trees’ water use strategy to be more isohydric. In addition, the size of oaks increased along a gradient of increasing grazing intensity, a gradient which did not include extreme overgrazing intensities. Grazing did not affect tree water relations and even tended to increase drought stress of *Pinus halepensis* trees in a very dry semiarid forest. Yet, the environmental growing conditions appeared to be improved for pines in grazed compared to pines in non-grazed plots, according to longer needles of trees in grazed plots. Needle length has previously been proven to act as a reliable index of tree health in this species. In a more moist *Pinus pinea* forest, grazing influenced soil moisture and leaf water potential negatively. However, tree-ring analyses showed a higher growth rate of *P. pinea* trees in grazed compared to trees in non-grazed plots, which may be related to higher nutrient availability (nitrogen, phosphorus) in soils under grazing. Livestock grazing intends to generate economic revenue and to reduce fire risks in forests. Here we showed that this type of forest management may decrease the

vulnerability and potentially increase the resistance and resilience of trees to drought in forests and woodlands subjected to sparse water supply. Consequently, grazing may benefit trees in mesic forests experiencing increasing frequency and severity of extreme droughts and heatwaves.