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Assessing drought-induced mortality on beech and pine

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As climate models predict increasing temperatures in Central Europe by 2.7–4°C, a decrease in summer precipitation by 21–28% toward the end of the 21st century and increased frequency and duration of extreme weather events like severe droughts, the question of how plants cope with imminent drought conditions is highly important. There have been numerous studies on tree mortality, but the underlying physiological mechanisms are still not fully understood. In this study we apply a conceptual model (Gessler et al. 2018) combining tree-ring width, and tree-ring carbon and oxygen isotopes. On the basis of the growth history and the stable isotope derived intrinsic water-use efficiency of trees the model implies the occurrence of four types of dying trees. These four combinations might be an indication of a tree's predisposition towards hydraulic failure or carbon starvation. Here we compare dead and surviving trees from a given species and location, investigating their annual radial growth and tree-ring isotopic signatures. We selected three species and sites for our study. Two species, Pinus sylvestris and Fagus sylvatica, were sampled in an inner-alpine dry valley, the Valais in Switzerland. Pine decline is a long-lasting issue there, and beech decline occurs more frequently since a couple of years with particularly dry growing seasons. The third site is located in the Thimphu Valley in the central mountainous region of Bhutan. Here our Bhutanese colleagues observe increasing decline of Pinus wallichiana. Using three different species growing in two different climatic zones under different ecological conditions (coniferous, broad-leafed, European and Himalayan), we hope to find not only intraspecific trait variability, but also interspecific differences in the respective mortality processes. Overall, this approach will provide us with a deepened understanding of the predisposing factors as well as the general physiological mechanisms of drought-induced mortality.

Gessler A, Cailleret M, Joseph J, Schönbeck L, Schaub M, Lehmann M, Treydte K, Rigling A, Timofeeva G, Saurer M (2018) Drought induced tree mortality – a tree-ring isotope based conceptual model to assess mechanisms and predispositions. New Phytologist 219, 485-490.