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Predicting drought-induced forest mortality at tree to lanscape scales

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Drought-induced forest mortality has major impacts on ecosystem carbon and water cycles and is expected to increase in many regions of the globe with ongoing climate change. Despite intense research and important advances in our understanding of plant water and carbon relations under extreme drought, we still lack generalizable, cross-scale indicators of mortality risk. Here, I review some of the limitations of current indicators and present recent developments in two approaches that hold promise in upscaling mortality risk assessments to the landscape and regional scales. The first one focuses on radial growth as an indicator of tree vigor and health status. Using a unique global ring-width database including data from ~200 sites where dead and living trees were sampled at the same time (paired experimental design) I show that dead trees present consistently lower growth before mortality and that their growth time series shows specific statistical signatures that can be used as early warning signals of impending mortality. The nature and robustness of these signals, however, differ markedly between angiosperm and gymnosperm trees. The second approach advocates for a more explicit consideration of tree water pools to improve our ability to monitor and anticipate mortality risk. It focuses on measures of tissue water content (e.g., the relative water content, RWC, a classic metric in plant water relations), as potential indicators of mortality risk that are physiologically relevant and integrate different aspects related to hydraulics, stomatal responses and carbon economy under drought. Measures of plant water content are likely to have a strong mechanistic link with mortality and to be integrative, threshold-prone and relatively easy to measure and monitor at large spatial scales with remote sensing, and may complement current mortality metrics based on water potential, loss of hydraulic conductivity, and non-structural carbohydrates. I will discuss some of the potential advantages and limitations of these metrics to improve our capacity to monitor and predict drought-induced tree mortality.