Incorporating hydraulic traits within the functional strategy spectrum of woody plants globally

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Global-change-type droughts, resulting from climate warming and changes in precipitation patterns are believed to be accelerating the rates of tree mortality globally. Simulation of these changes, for instance in global vegetation models, requires parameterisation of plant strategies with respect to drought. However, our understanding of realised combinations of drought-relevant physiological and morphological traits across the range of global forest types is still limited.

We constructed a dataset consisting of 12 functional traits related to resource acquisition, growth rate, plant defence, water conductivity and hydraulic vulnerability for 11,000 woody species globally. We used a novel envelope-based analysis to assess the functional space occupied by these species whilst circumventing the problem of sparse sampling for many traits. We then subdivided the space into a continuum of strategic “clusters”. These clusters only map partially onto groupings of traditional plant functional types based on leaf type and phenology.

We found that the functional spaces for the plant strategies are highly interrelated globally, showing that the traits related to resource acquisition are positively associated with growth rates and leaf water conductivity, which together are negatively associated with conservative traits of plant defence, although these associations differ greatly between needleleaf and broadleaf species. However, the trait related to hydraulic failure demonstrated positive associations with resource acquisition, but no relationship with woody defence. Furthermore, there are clear linkages between water flow and hydraulic vulnerability traits, and climatic drivers relating to aridity and plant distribution.

The clusters identified in this systemic work can form a basis for new plant functional type definitions, facilitating including plant hydraulics in global vegetation models and, taking a step towards making reliable large-scale simulations of drought-driven tree mortality.