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Modelling the functionally diverse Caatinga: insights into a unique tropical forest

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From heightened canopy dieback to tree die-off, many forest ecosystems are showing signs of poorly coping with more severe, more frequent, or hotter droughts. Understanding forest resilience to drought has become paramount, and eco‐physiological optimisation approaches that test behavioural hypotheses have been proposed as a means to build this understanding in global terrestrial models. Here, we used a land-surface model that considers competing optimality principles to simulate canopy gas exchange and leaf nitrogen investments into the photosynthetic apparatus, whilst also accounting for sustained hydraulic impairment (Sabot et al., 2022). We applied this model to a pristine observational site of the Caatinga, Brazil's drought-hardy, seasonally deciduous, and exceptionally diverse dry tropical forest. Six woody species dominate 80% of the study area whilst displaying contrasting functional strategies – for example, their respective P50s (the water potential at which 50% of a plant's hydraulic conductivity is lost) range between -1 MPa and -5 MPa. Model predictions were assessed against species-specific leaf-level observations of stomatal conductance and photosynthetic uptake, as well as eddy covariance measurements of ecosystem carbon and water fluxes spanning a period with high interannual rainfall variability (and including a severe multi-year regional drought). We found that none of the six species could, in isolation, explain the magnitude and dynamics of the observed surface fluxes. However, taken together and accounting for their relative contribution to total ecosystem fluxes, they did. Further, our analysis emphasises the vital role of phenology in mitigating seasonal and

inter-annual hydraulic risks, with foliage reductions triggered by a 10 to 20% loss of hydraulic conductivity in the canopy. On the whole, accounting for diverging species-level responses and their relative influence at the ecosystem-scale appears key to improving model predictions in functional diverse forests.

Reference: Sabot, M.E.B., De Kauwe, M.G., Pitman, A.J., Ellsworth, D.S., Medlyn, B.E., Caldararu, S. et al. (2022) Predicting resilience through the lens of competing adjustments to vegetation function. *Plant, Cell & Environment*, 45, 2744–2761.