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Assessing the effects of management on forest growth across France: insights from a new functional-structural model.

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The structure of a forest stand, i.e. the distribution of the tree size features, has strong effects on its functioning. Management is thus considered as an important tool in mitigating the impact of climate changes on forest, especially with respect to drought. We present here a new functional-structural model and we use it to assess the influence of management on forest functioning over France.

The stand process-based model (PBM) CASTANEA was coupled to a stand structure module (SSM) based on empirical tree-to-tree competition rules. The SSM calibration relied on a thorough analysis of the inter-site and inter-annual variability of competition asymmetry. The coupled CASTANEA-SSM model was evaluated over France using forest inventory data and used to compare the effect of contrasted silvicultural guidelines on simulated stand carbon (C) fluxes and growth. This study was conducted in two important European deciduous species, European beech and sessile oak.

The asymmetry of competition varied consistently with stand productivity at both spatial and temporal scale. Our modelling of the competition rules allowed to efficiently simulate the changes in stand structure observed in 30 permanent plots. The coupled model predicted an increase in net primary productivity (NPP) along with management intensity, resulting in higher growth. This positive effect of management was contrasted over France: the highest increase in NPP was reached in forests facing moderate to high water stress. However, the absolute effect of management on simulated stand growth remained moderate to low because thinning had involved changes in C allocation at the tree scale.

Our modelling approach helps identifying the proportion of the territory where management efforts should be concentrated to mitigate near-future drought impact on national forest productivity. Around one-fourth of the French temperate oak and beech forest are currently in zones of high vulnerability where management could mitigate the influence of climate changes on forest yield.