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Effects of climate and policy changes on growth, carbon sequestration and mortality risk for 9 species within a regional natural park

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Forests will be highly impacted by global change. But its effects will differ according to the species and will differentially impact the different processes: growth, carbon sequestration or drought-induced mortality. Current researches simulate the effect of global changes either at the plot scale on a small number of species, or at the global scale by simplifying the representation of vegetation through the use of Plant Functional Types. On another side, few studies focus on carbon sequestration, growth and mortality risk together. In this study, we have parameterized a process-based model (CASTANEA) for 9 representative species of a regional natural park, using a literature review, remote sensing and forest inventory data. The simulations were first evaluated at three FLUXNET sites where some of the studied species are present and using growth data on all the studied species. Then we simulated the water and carbon fluxes across an elevational gradient for different types of stands (open .vs. closed and three types of soil) under past and future climate (two contrasted climate models and two RCP) under different policies scenario of forestry management. The risk of drought-related mortality by carbon starvation was assessed by CASTANEA (Davi and Cailleret, 2017) and the risk of hydraulic failure was estimated using another model SurEau (Martin-StPaul et al., 2017). In all scenarios, climate change induces an overall decrease in carbon sequestration and Non Structural Carbon content. A decrease in growth and a higher risk of mortality was only observed in one climate model. Over the whole stand revolution, silviculture increases sequestration, limits the effect of climate change, but decreases standing volume. The responses to climate change are very different depending on the species and the overall species effect on carbon sequestration is much stronger than climate, silviculture or soil effects. In conclusion, our results demonstrate the value of coupling carbon balance approaches and more recently developed hydraulic approaches to assess forest ecosystem services.