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# Are diversification a good option to reduce drought-induced risk of forest decline? Carbon accounting and economic approach

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## Résumé

Extreme or recurrent drought event is the principal source of stress impairing forest health and it causes financial losses for forest owners and amenity losses for society. The major part of the forested area in the Grand-Est region (France) is dominated by beech, which is predicted to decline in the future due to repeated drought events driven by climate change. Beech forests need to adapt and diversification is a management option to reduce drought-induced risk of dieback. For this purpose, we studied two types of diversification that we analysed separately and jointly: mixture of beech species with oak species and mixture of different tree diameter classes (*i.e.* uneven-aged forest), which is rarely considered as an adaptation strategy. We also considered two types of loss (financial, and in terms of carbon sequestration) under different frequencies of drought events, that are a consequence of climate change. We combined a forest growth simulator (MATHILDE) with a traditional forest economic approach (Fautsmann's LEV and Hartman's LEV). The maximisation of the two LEV criteria made it possible to identify the best adaptation strategies in economic terms. We also developed the carbon approach considering three accounting methods (*i.e.* market value, shadow price and social cost of carbon). The results shows that diversification reduces the loss of total volume of wood due to drought-induced risk and increases LEV, but reduces carbon storage. The trade-offs between the financial balance and the carbon balance, and the underlying question of the additivity (or not) of the two adaptation strategies are discussed.

**Mots-Clés:** Drought, Adaptation, Climate change, Mixed forest, Economics, Carbon, Risk.

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