# Scaling up tree growth with an analytical size-structured model to assess forest resilience under increasing aridity.

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## 1 Introduction

Mediterranean managed dry-edge pine forests maintain biodiversity and supply key ecosystem services but are threatened by climate change and are highly vulnerable to desertification. Analytical tractable models of forest dynamics can help to identify key mechanisms underlying drought resilience and to design management options to prevent these ecosystems from crossing a tipping point over a degraded alternate state. In this study we investigate the role of tree growth and forest structure on forest resilience under increasing aridity and different policy-management regimes ranging from strict mitigation to high biomass yield.

## 2 Methods

The study site is part of a pine-covered landscape ecosystem covering sandy flatlands in Central Spain. We parameterized and tested an analytical size-structured forest dynamics model with last century tree growth and forest structure historical management records from a dry-edge P. pinaster forests. We explore resilience boundaries for the different scenarios and suggest optimal management from an adaptation viewpoint. We discuss possible modelling avenues by combining analytical and simulation models to find a reasonable balance between model realism and mathematical intelligibility.

## 3 Results

Management exerts a strong control on drought resilience through changes in forest structure. Current management and increasing aridity results in a reduction of stock, productivity, and maximum mean tree size. Resilience boundaries differed among conservation and high yield scenarios and there were several resilient forest management regimes. Yet, manifold of resilient

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possible management regimes was significantly smaller for high yield scenarios and it resulted in smaller tree sized forest structure. Moderate thinning rates and a moderate reduction in tree harvest size allowed for stock preservation and maintenance of landscape heterogeneous structure.

## 4 Conclusions

Forest management through its control on forest structure can play a key role on forest drought resilience. Analytical tractable models of forest dynamics can help to identify adaptation options that decrease the risk of forests undergoing desertification processes under increasing aridity.

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## References

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