Mixed forest model parameterization and integration into simulation platforms as a tool for decision-making processes

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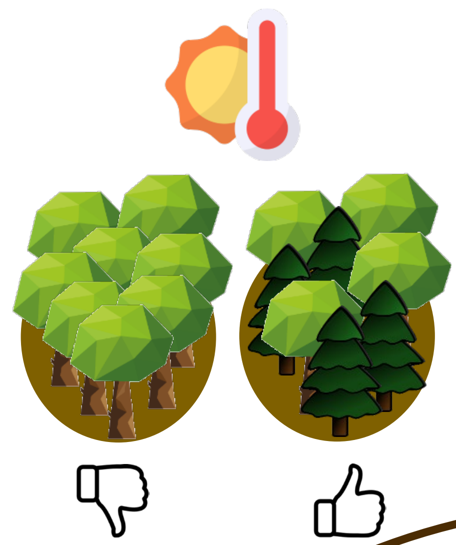
1 Introduction



Global warming challenges ecosystems, causing shifts in forest productivity and species distribution. Understanding abiotic factors affecting growth and quantifying local-scale productivity variations are crucial for effective management. Researchers have explored mixed forests' potential to mitigate climate change impacts, attributing complementary effects and efficient resource utilization. Yet, experimental and observational studies alone cannot cover all scenarios, thus simulation emerges as a valuable tool for understanding management effects on forest adaptation. This study integrates mixed-forest growth models in a simulation platform and shows a practical case study to demonstrate its potential when ranking silviculture paths.

2 Mixed forest models

Mixed-forest models implemented on SIMANFOR are described in Rodríguez de Prado (2022), made of three core modules (Figure 1): basal area increment (BAI), height-diameter ratio (h/d) and Stand Density Index (SDI) and Maximum Stand Density Index(SDImax). A total of 29 parametrizations within the same model structure are available for the most common forest species mixtures in Spain. Additionally, allometric equations complete the model content with canopy, biomass and volume estimations among others.

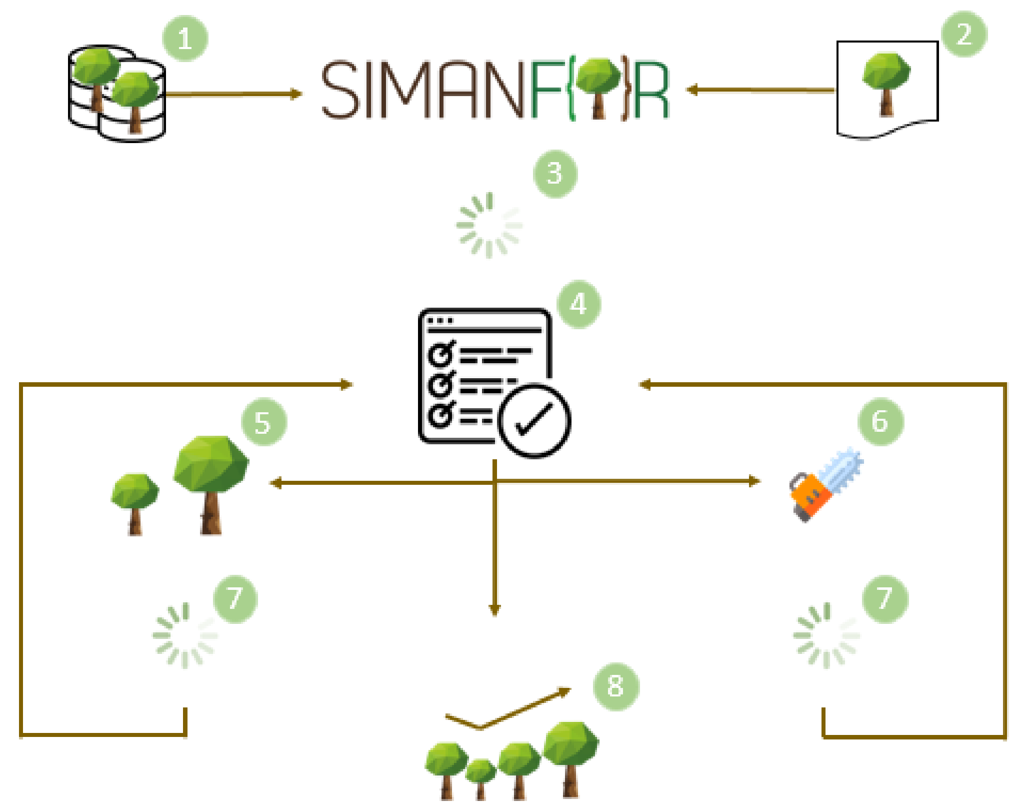


Figure 1. SIMANFOR main structure and workflow: (1) data and (2) model/parametrization selection; (3) initialization: tree and plot data is imputed (*h/d, SDI, SDImax*); (4) scenario configuration by the user; (5) when a *projection* is selected, the survival/mortality, growth (*BAI*) and ingrowth ingrowth modules are activated; (6) when a *thinning* is selected, trees are harvested according to the thinning criteria and intensity selected by the user; (7) after *projection* or *thinning*, tree and plot information is updated (*h/d, SDI, SDImax*); (8) when the scenario is finished, results for each scenario step and plot are generated.

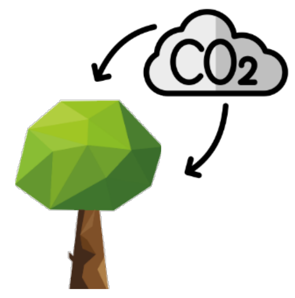
3 SIMANFOR

The SIMANFOR forest management simulator (Bravo et al. 2024) has been used for different purposes: educational, both in academia and outside, from students to forest managers; forest management, thus ranking different silvicultural approaches to select the most adequate; and research, to better understand forest dynamics at both tree and stand level.

website

documentation

4 Practical case study



Different silviculture itineraries were applied to 4 different species mixtures for ranking them in terms of carbon storage at stand level. Simulations were conducted using data from the Spanish Fourth National Forest Inventory and the climate-sensitive models developed by Rodríguez de Prado (2022) through the SIMANFOR platform (Bravo et al. 2024). The study area was restricted to Castilla and León region (Spain), where representative *Pinus sylvestris* mixed stands (with *Pinus nigra*, *Pinus pinaster*, *Fagus sylvatica*, and *Quercus pyrenaica*) were the selected ones to develop the simulations. Silvicultural itineraries were obtained from Del Río et al. (2006), where alternatives for *Pinus sylvestris* pure stands in Castilla and León are detailed based on the Site Index (SI).

5 Results and Discussion

Differences in growth and yield were clear among the studied management scenarios. Biomass and carbon content evolved very similarly in different scenarios, as seen in the yields for both standing and harvested trees (Figure 2). Scenarios for SI 12 and 15 were the most productive in terms of total biomass and carbon content, while differences among scenarios were reduced. Greater tree dimensions were reached with lower-intensity silviculture, consistently among mixtures. Results should be taken with caution as they are the combination of several plots with different initial conditions. Nonetheless, through that work, the potential of SIMANFOR and the mixed-forest models implemented are shown for comparing and ranking silviculture guidelines under different purposes.

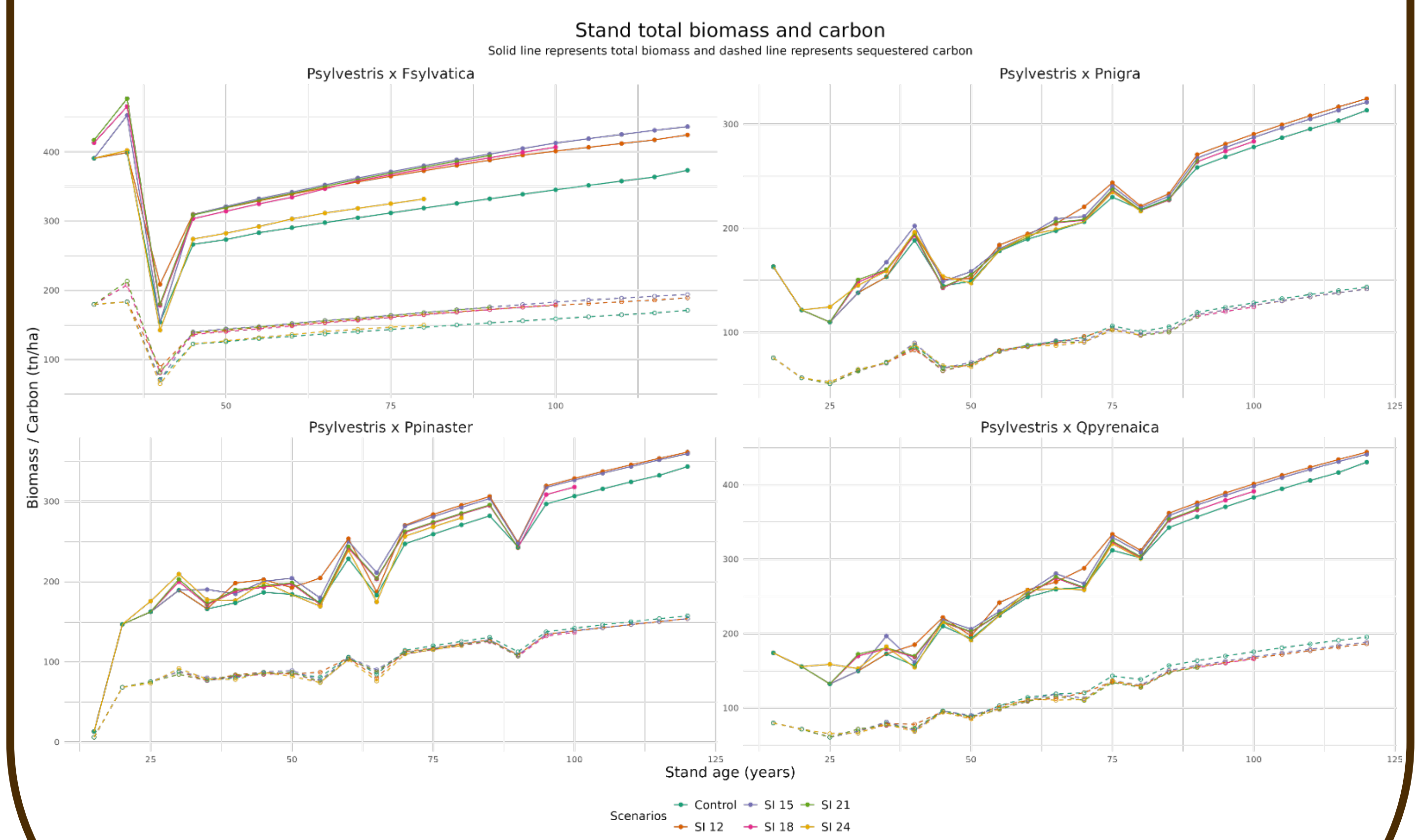


Figure 2. Stand total biomass (solid lines) and carbon (dashed lines) production for the four mixtures and six scenarios studied (one colour per scenario according to the legend). Data refers to both standing and harvested trees. Peaks in the evolution trends are caused by the different initial age of each plot included in the study, also with different initial stand conditions.

References

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Code and data

Scientific symposium

Promoting diversity in plant-based ecosystems

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