

## C.A.F.E.

### A software to support pyro-eco-hydrological-oriented forest management for goods and services.

#### Description

C.A.F.E. (Carbon, Aqua, Fire & Eco-resilience) is a Decision Support System for a multiple-criteria forest management. This tool determines the optimum silvicultural activities to manage multiple products, goods and services such as biomass production, CO<sub>2</sub> sequestration, fire risk, water provisioning, climatic resilience or biodiversity, which are simultaneously quantified in time and space for a selected solution. To that end, C.A.F.E. combines eco-hydrological simulation with multiple-criteria optimization with generic evolutionary algorithms.

This tool enables the decision-making process of forest managers when dealing with multiple-criteria forest planning. It allows selecting the most optimum solution while answers the four main questions of forest management: How much? Where? When? And How? In other words, the management intensity, forest working units selection, frequency and type of management (thinning/plantation).

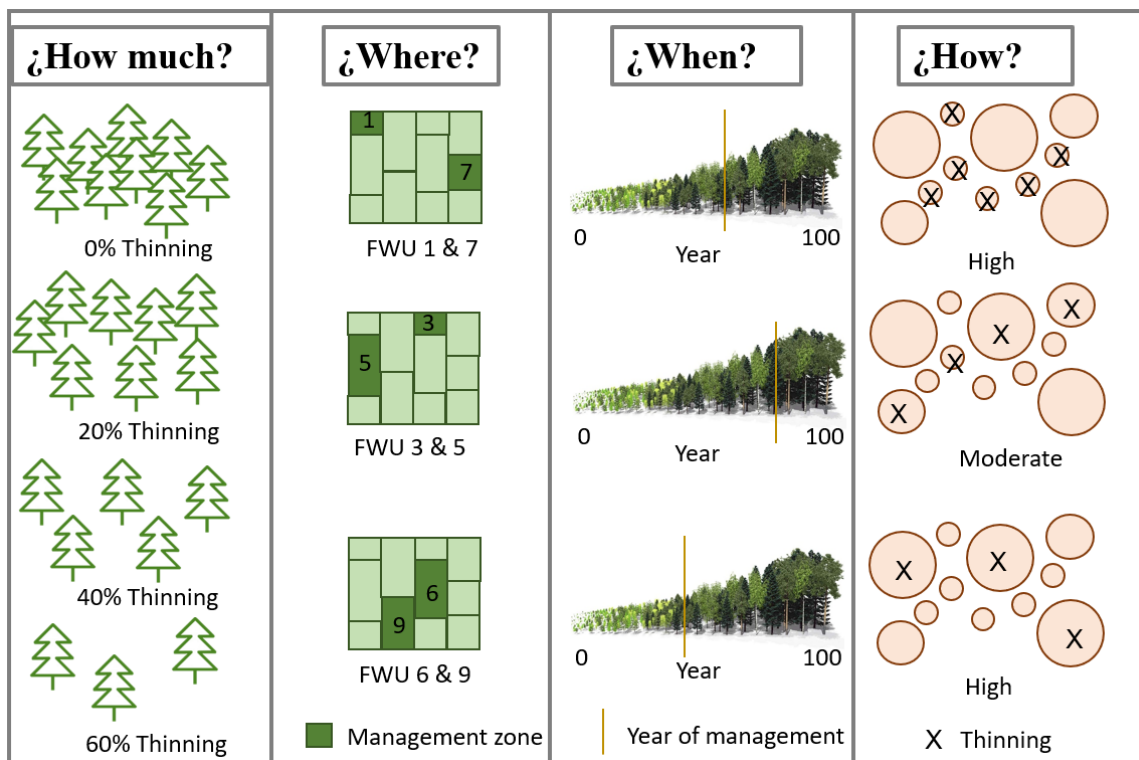


Figure 1: Representation of the 4 main questions of forest management that C.A.F.E. can answer

Hence, this tools helps to understand the more complex ecosystem processes and its interactions (growth dynamics, hydrology, fire risk, ecosystem resilience, etc.), as well as the modulating factors (climate, physiography, management, etc.), with the aim of maximizing the optimum goods and services provisioning. In this way, the decision-making process will be stronger and aligned with the planning goals and the potential of the study site.

Providing the high operational costs and the wide temporal scale of forest management, a decision support system could, on the one hand, optimize costs, and on the other hand, deliver results consistent with the spatial-temporal scale. This fact is even more important within the current situation, where there is a high social demand of forest goods and services that should be quantified and optimized as forest management products such as water provisioning or fire risk decreasing. It could stimulate (as coffee does) and increase the forest management opportunities of areas where forest activity has significantly decreased for many reasons. Therefore, C.A.F.E. enables a sustainable and productive forest management, from a multifunctional and many-criteria point of view.

### Main characteristics

C.A.F.E. is a tool that combines eco-hydrologic dynamic simulation with many-criteria optimization, where the user can carry out forest management according to more than one product at the same time and choose the relevance of each objective/product.

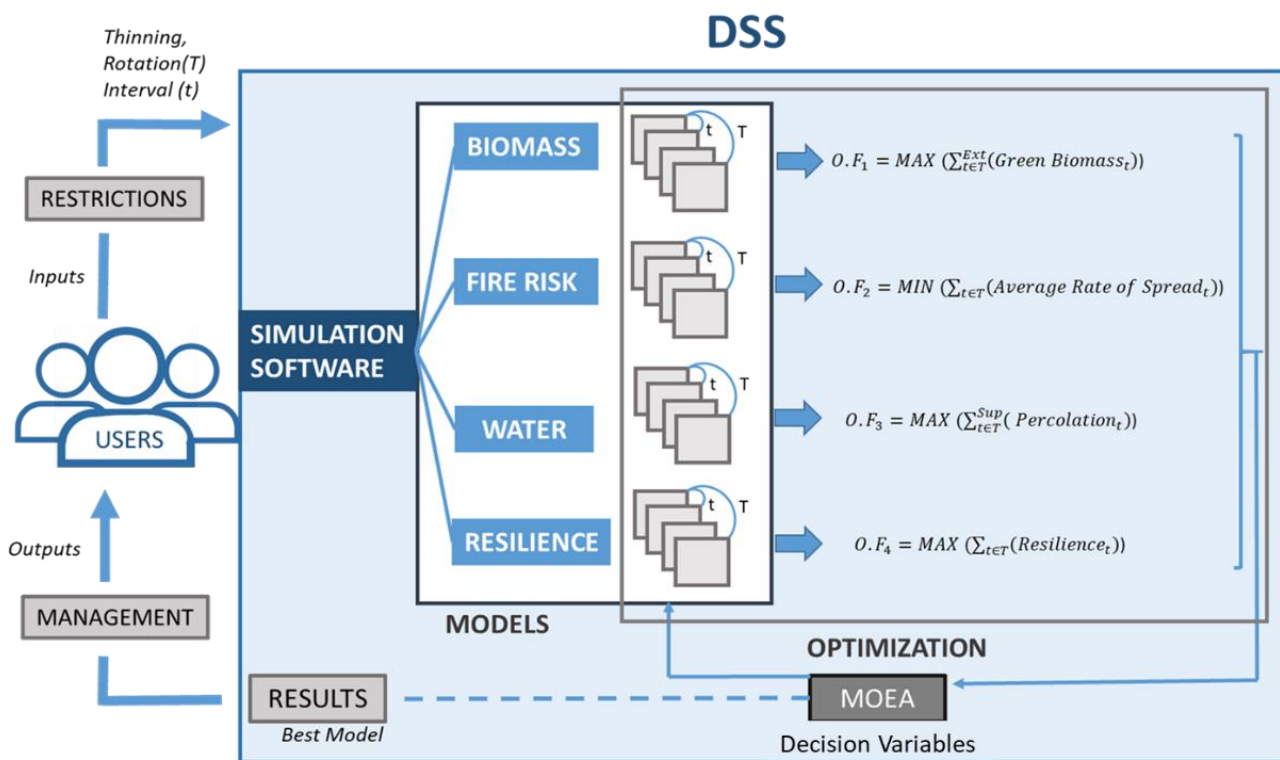


Figure 2: Scheme of the Decision Support System (DSS), C.A.F.E.

This software can work under different climatic regions thanks to the previous calibration of the eco-hydrological simulation. Furthermore, it is possible to modify the spatial scale moving from plot to catchment, integrating a strong biophysical unit. In the same way, simulating different climatic scenarios is also possible.

The result is a group of possible solutions among which forest manager can decide and apply. These solutions are shown in a dynamic and interactive way (Figures 3 and 4), where the user chooses according to desired objectives.

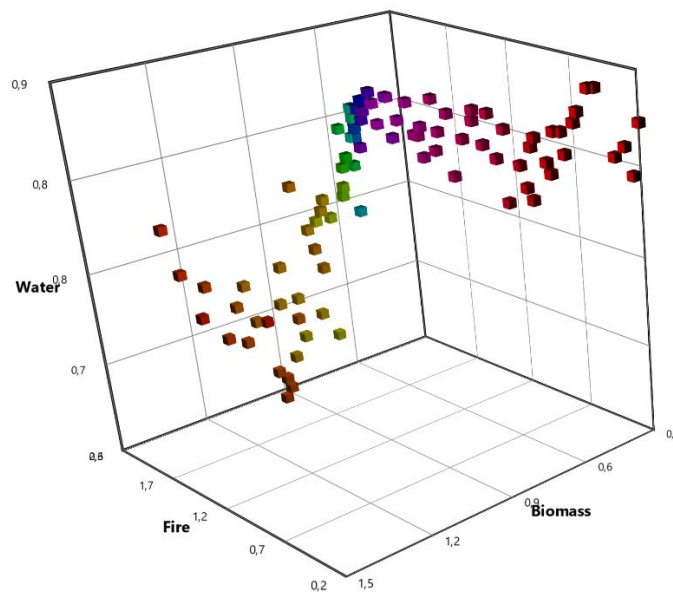


Figure 3: Example of 3D representation of the obtained results in terms of water, fire and biomass of a group of possible solutions (cubes) calculated using C.A.F.E.

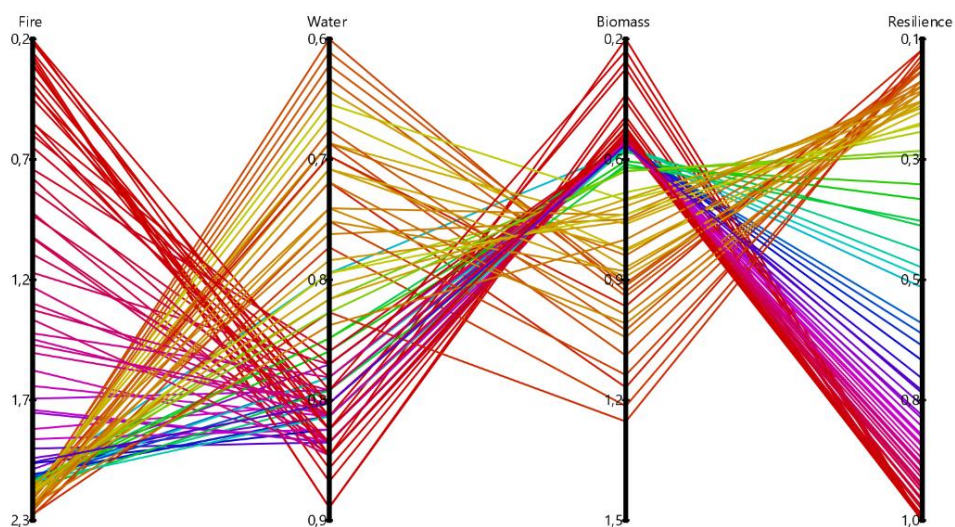


Figure 4: Example of linear representation of the obtained results in terms of water, fire and biomass of a group of possible solutions (lines) calculated using C.A.F.E.

### **Main advantages:**

- Changing the mono-objective approach in order to include a group of ecosystem goods and services.
- Improving the economic performance of low productive areas by quantifying and valorising other resources that could be remunerated attending to the environmental value.
- Holistic optimization of multiple goods and services out of forest management.
- Adequacy to the specific characteristics of each site.
- Multi-scalar results (plot, forest working unit, catchment, etc.).