C.A.F.E.: SOTFWARE to stimulate piro-eco-hydrological forest management oriented to provisioning goods and services

carbono, agua, fuego y eco-resiliencia
c.a.f.e.

Description

C.A.F.E. (Carbon, Aqua, Fire & Eco-resilience) is a Decision Support System for a many-criteria forest management. This tool determines the optimum silvicultural activities to optimize the simultaneous provisioning of multiple goods and services such as biomass production, CO2 sequestration, fire risk, water provisioning, climatic resilience and/or biodiversity, which are quantified and optimized in time and space, providing a list of possible optimum solutions. To that end, C.A.F.E. combines eco-hydrological simulation with many-criteria optimization based on generic evolutionary algorithms.

This tool enables the decision making process when dealing with forest planning, as on the one hand, it accurately quantifies the goods and services provisioning, and on the other hand, optimizes it following the user priorities. In this sense, C.A.F.E. provides the answer to 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) that better matches the user preferences.

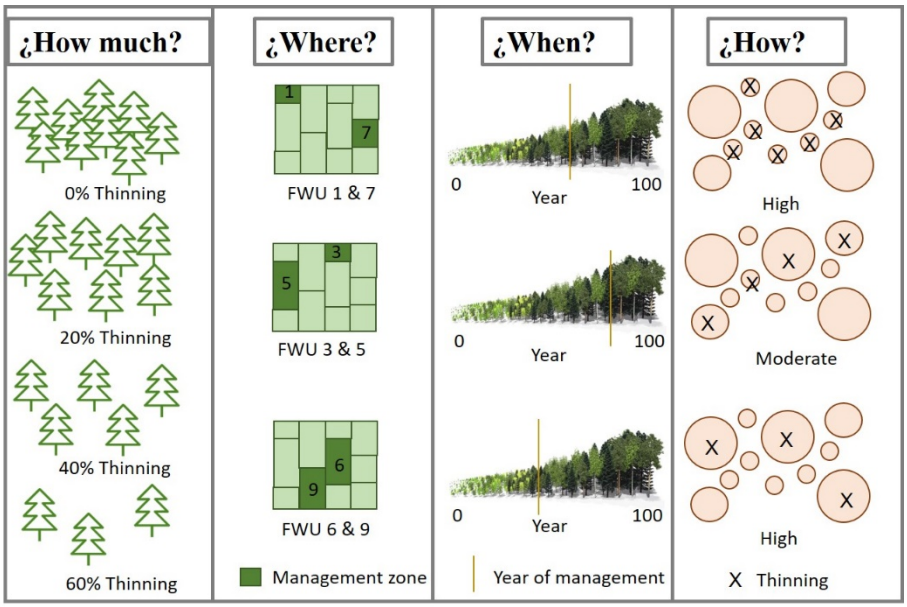

Figure 1: Representation of the 4 main questions of forest management that C.A.F.E. is capable of answering.

Hence, this tools helps to understand the more complex ecosistemic 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, an expected results provision 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 and if there is one that predominates over the rest. In addition to optimising up to 5 metrics, it also allows quantifying the rest of them to assess how management affects these goods and services, even if they are not optimised.

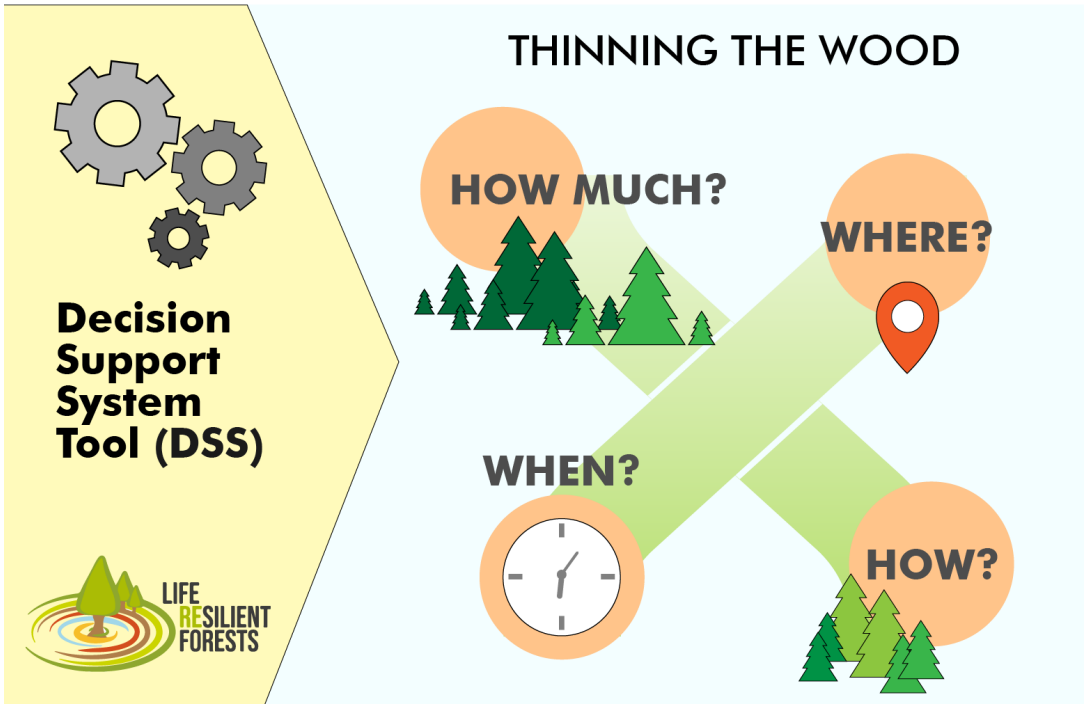

Figure 2: Scheme of the Decision Support System (DSS), C.A.F.E.

This software is capable of working 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, by having different simulation models based on processes (Distributed: Rhessys or Tetis; Non-distributed: BIOME or CLM), which make them integrate as a robust biophysical unit. Simulations can also be made with current climate data or with climate change scenarios, to see how the quantification and optimisation of the metrics of interest vary under different climatic conditions.

The result provided to the planner or manager is a set of possible solutions where all are equally valid and allow to see how the relationship between the metrics is. In addition, for each solution, the type of action (intensity of thinning per stand, date

of new action or on which stands to act, etc...) that must be carried out to obtain these results is also known. These solutions are shown in a dynamic and interactive visualiser, which the user manages according to the weight or relevance given to each of the objectives, in order to filter and discard solutions that are not of his choice.

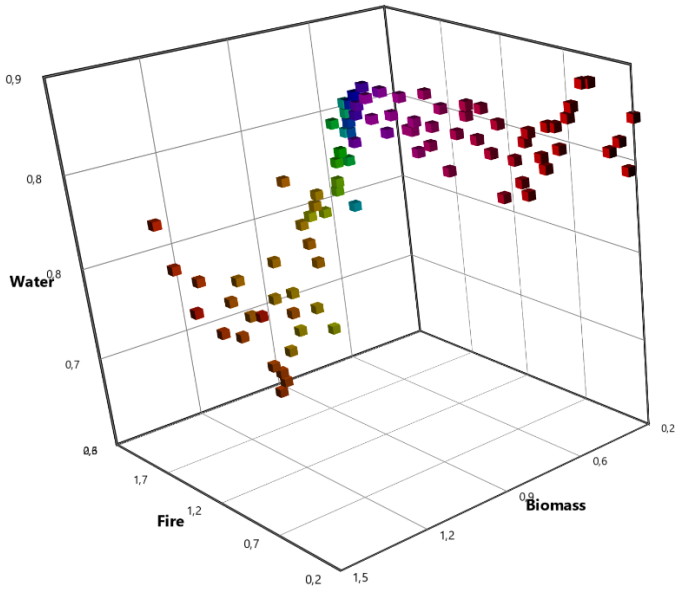

Figure 3: Example of 3D representation of the obtained results in terms of water, fire and biomass of a group of possible solutions (cubes) calculated using C.A.F.E.

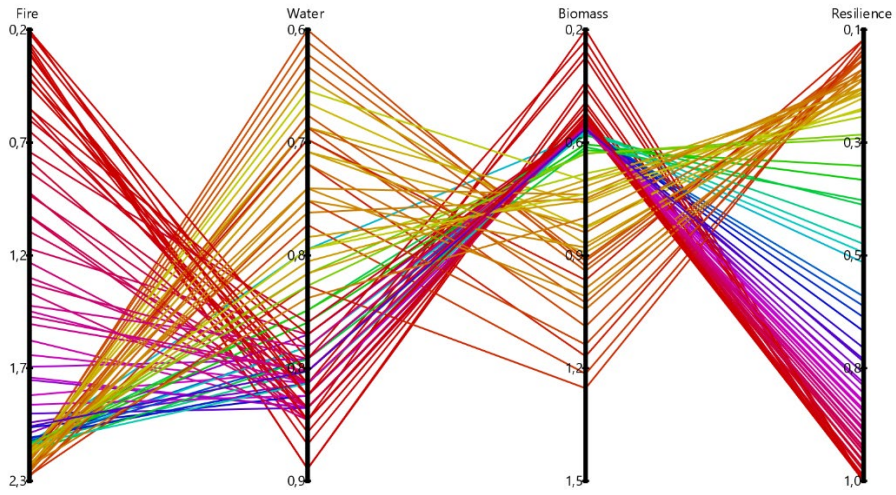

Figure 4: Example of linear representation of the obtained results in terms of water, fire and biomass of a group of possible solutions (lines) calculated using C.A.F.E.

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.).

El proyecto "LIFE RESILIENT FORESTS – Coupling water, fire and climate resilience with biomass production from forestry to adapt watersheds to climate change" está cofinanciado por el Programa LIFE de la Unión Europea de referencia LIFE 17 CCA/ ES/000063.