# FIRE RECURRENCE IN E SPAIN FORESTS

## Natural dynamics and restoration approach

**A CASCADE Project case study in Ayora, Spain**
**by**
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*The Ayora field site area, where land degradation is associated with recurrent wildfires (photo by V.R. Vallejo)*

The Ayora site is located within the province of Valencia, on the eastern side of Spain. The climate is dry Mediterranean with mean temperatures between 13°C and 17°C, and an annual mean rainfall around 500 mm. Vegetation consists of mature Aleppo pine (*Pinus halepensis* Mill.) forests in lower-level south-facing areas, and maritime pine (*P. pinaster* Ait.) in higher, more shady, north-facing areas. The exploitation of these forests (for timber and livestock) has provided one of the most important traditional economic resources at the Ayora site.

In the wetter areas, natural oak forests were used mainly for wood gathering and charcoal production, involving, in many cases, root removal and disturbance that led to severe land degradation. A secondary use of the land was agriculture, but many cultivated areas were abandoned and recolonized by early secondary successional shrubby species or, frequently, planted with pines.
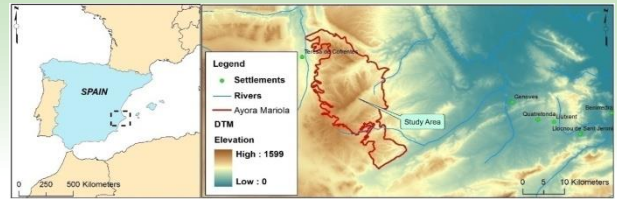


*A map of Spain showing the location of the Ayora field site (Technical University of Crete)*

As a consequence, pine forests with well-developed understory dominated the landscape at the mid and long term in these former agricultural lands. These plant formations are characterized by a large accumulation and density of standing biomass, conferring a very high fire hazard to the system.
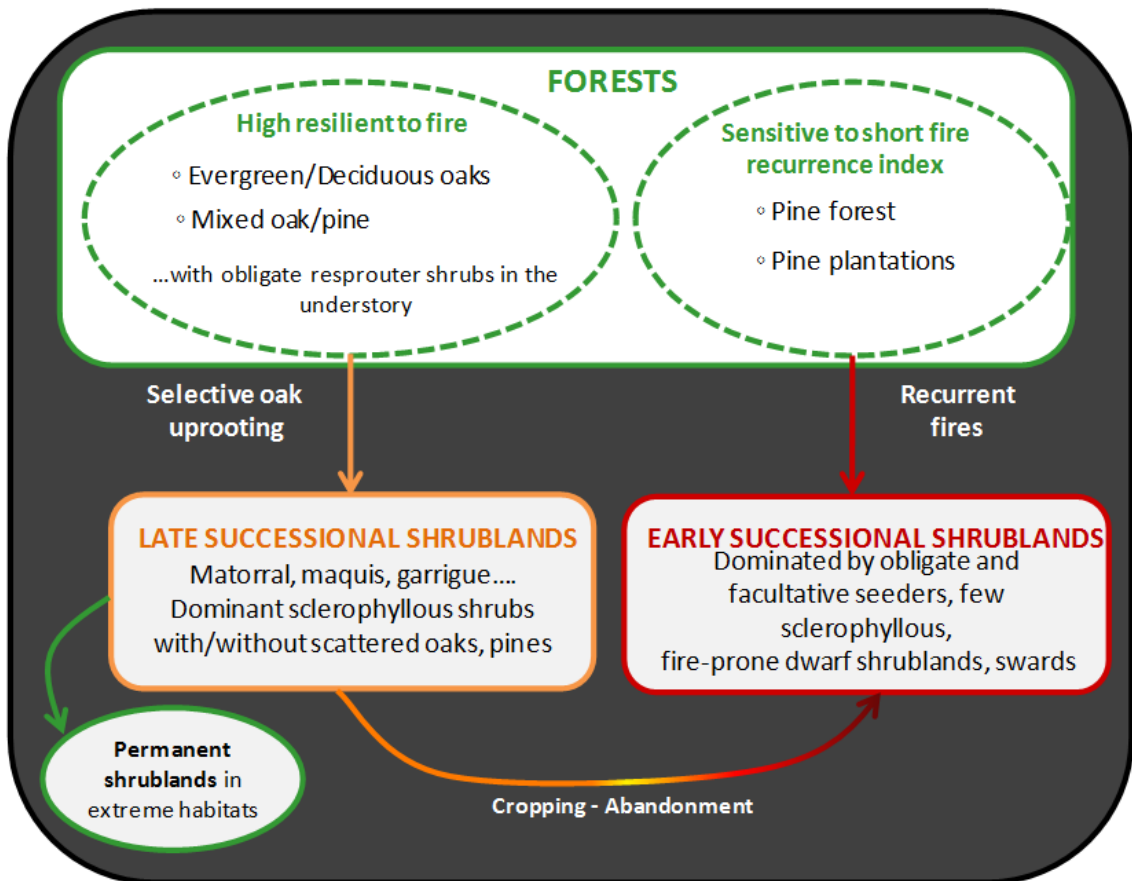
The extensive fire in the summer of 1979 (31.700 ha) burned mixed pine forests strongly, altering the local economy based on timber production. This triggered the abandonment of forestry, marginal agriculture and grazing activities by the local population and migration to larger urban areas, in accordance with the dominant socio-economic trends in Spain and, in general, in other European Mediterranean countries. Slowly, local people moved their economic activities towards the tertiary sector, including rural tourism, which was quite sensitive to landscape aesthetic values (and to fire impacts on the landscape). Currently, the most prevalent productive land uses are honey production in shrublands, and hunting.



| | Date |
|---|---|
| 1 | 1979 |
| 2 | 1989 |
| 3 | 1991 |
| 4 | 1992 |
| 5 | 1993 |
| 6 | 1996 |
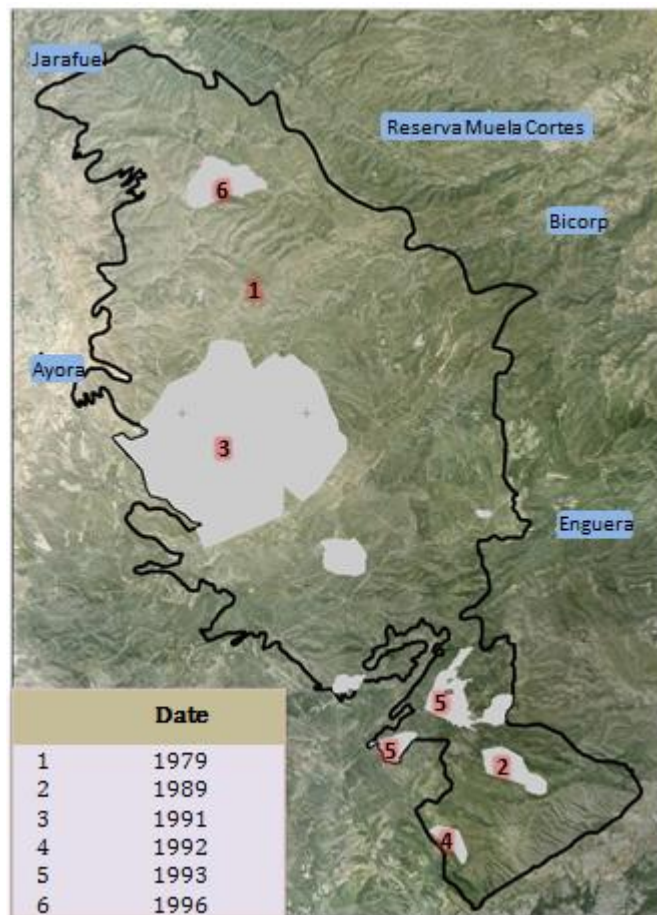
*Map of fires in the Ayora field site*

After the widespread 1979 fire, several smaller fires took place between 1984 and 1996. The most important of these occurred in 1991, burning 5,000 ha in the higher elevations of the Ayora site.

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Currently, dominant vegetation on the Ayora site corresponds to a shrubland matrix with different degrees of development and species composition, in a range that runs from sparse shrubland with a high presence of grasses to very young regenerating forest and scattered mature pine forests that escaped fires. Within these extremes we found several transitional vegetation types.



*Map of plant communities found in the Ayora field site 23 years after the 1979 fire*

Gorseland
Kermes oak
Mixed shrubland
Open shrubland
Rosemary
Rosemary mixed
Shrubland + pine
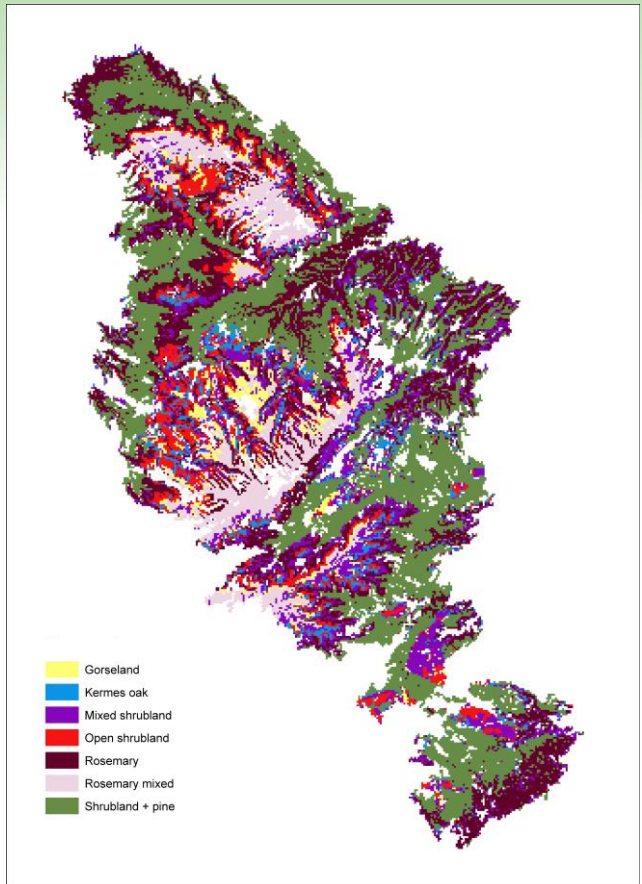
After fire, plants can re-establish at the site by two main mechanisms: by germinating from seeds (seeder species), or by resprouting from protected organs above or below ground (resprouter species).



*Palm trees (Chamaerops humilis) resprouting two weeks after a wildfire (photo by A.Valdecantos)*



*Germination of Aleppo pine (Pinus halepensis) 1.5 years after fire (photo by A.Valdecantos)*

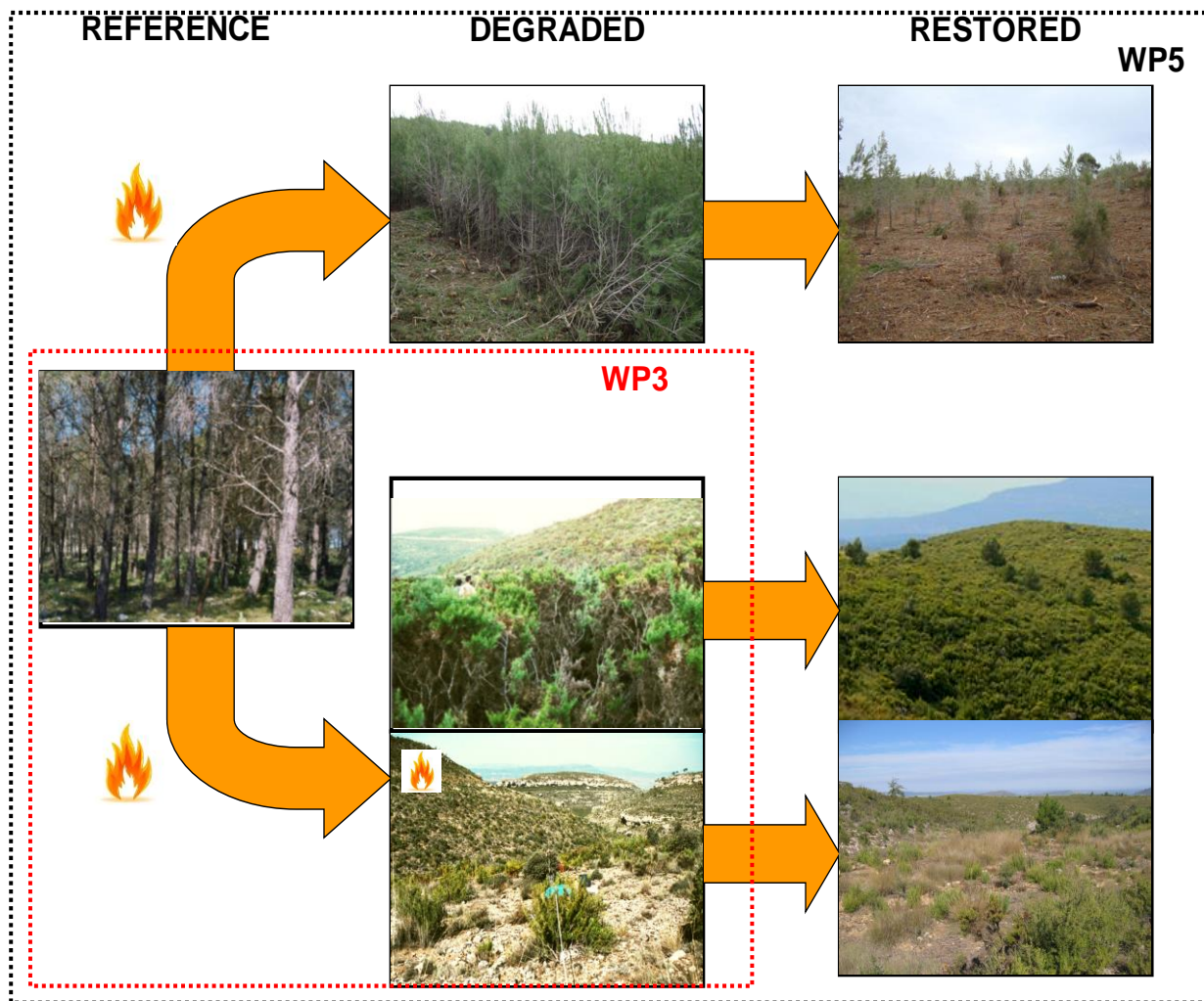CASCADE
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As described above, the land use history resulted in the elimination of tree and shrub resprouting species, reducing the response capacity of the ecosystem (resilience). Therefore, after disturbances such as fire, *Ulex parviflorus*, *Rosmarinus officinalis,* and several species of *Cistus* are among the shrub seeder-species most frequently found. These new/regenerated communities show homogeneous vertical and horizontal structure with much standing dead material, resulting in high flammability and fire risk. Intense and severe fires are more likely to occur in the mature and senescent phases of these communities than in the youngest states. This fact establishes a positive feedback between fire risk and landscape degradation.
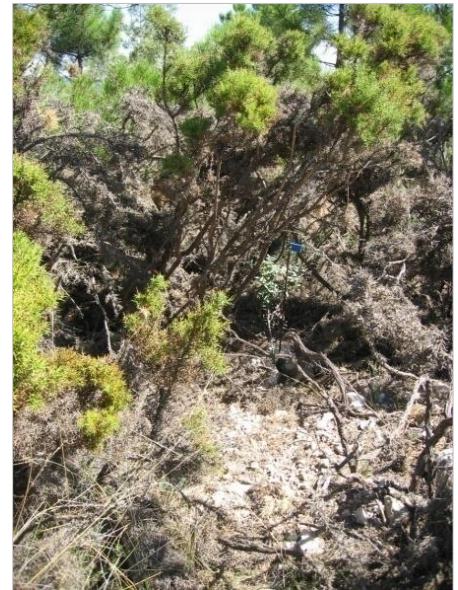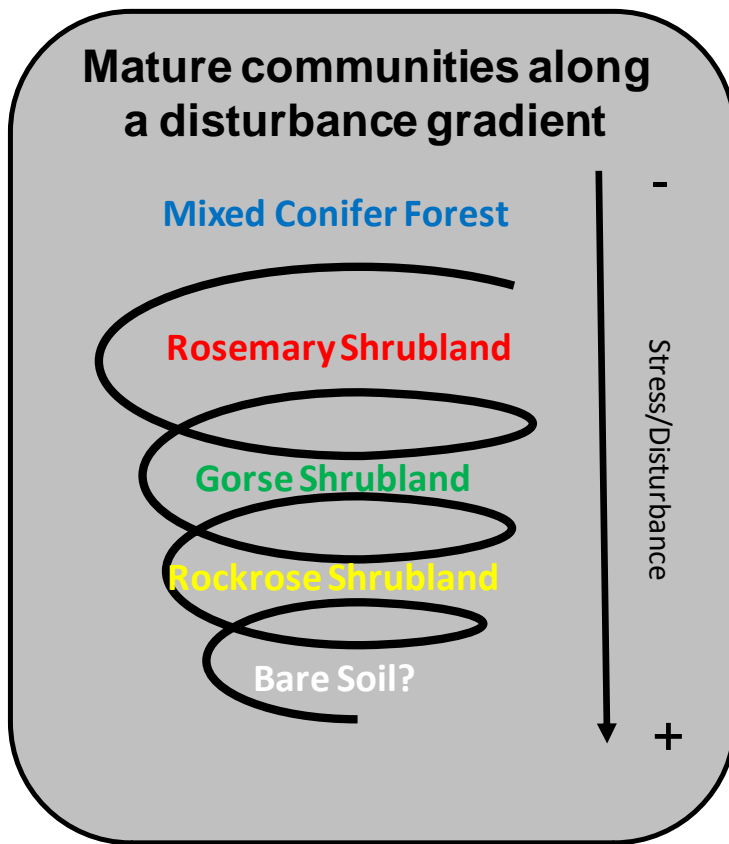




*Accumulation of dead material in gorse shrublands (photo by V.R.Vallejo)*

The traditional strategy since the nineteenth century for the management of burned areas in the Mediterranean region was based on afforestation with pines. The lack of further management and maintenance of these pine plantations resulted in the accumulation of large amounts and continuity of fuel in the forest.

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The aim of fire-prevention silviculture is to reduce fire hazards and facilitate fire-control efforts in the forest by breaking the horizontal and vertical continuity of fuels. Under these conditions, the use of prevention techniques to reduce fire hazard produces the fragmentation, reduction and/or modification of the fuel load towards less flammable structures.



*Different scenarios (Degraded) and the corresponding management alternatives (Restored) from a former common mature pine forest community (Reference). The red dotted line selects scenarios for CASCADE Work Package 3 while the black dotted line includes the focus for Work Package 5*

The combination of selective clearing and planting seedlings of resprouting species represents a management alternative aimed to reduce the fire hazard and to increase ecosystem resilience and biodiversity at the same time. Selected clearing permits the selection of resprouting species, which are generally very scarce in these communities, and thus increases the capacity of the vegetation to respond to different kinds of disturbance. Brush chips generate a layer of slash on the ground surface which protects the soil from the new environmental conditions created by the elimination of the vegetation. In addition, mulching reduces obligate seeder germination through buffering soil surface temperatures and reducing light intensity.
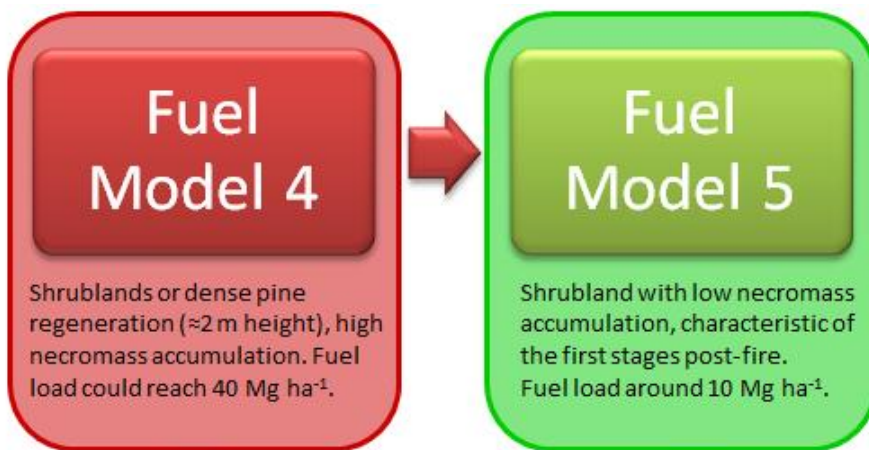


*Clearing machine*
*(photo by A.Valdecantos)*



*Incorporation of the slash, and root development (right) in the surface soil 13 years after the application of management treatments (photos by V.R.Vallejo)*

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*Restored plot by clearing fire-prone individuals and planting resprouting seedlings (photo by A.Valdecantos)*



**Fuel Model 4**

Shrublands or dense pine regeneration (≈2 m height), high necromass accumulation. Fuel load could reach 40 Mg ha$^{-1}$.

**Fuel Model 5**

Shrubland with low necromass accumulation, characteristic of the first stages post-fire. Fuel load around 10 Mg ha$^{-1}$.

*Changes in the Fuel Model in the medium term through restoration (photos by V.R. Vallejo)*

Pines are key species in these Mediterranean forests. The traditional restoration approach considered monospecific pine plantations. Current afforestation trends promote multiple species with a range of life-forms to reduce the propagation of fires and pests, and to increase forest resilience in case of fire. For instance, the combination of pines and oaks in afforestation will optimize the complementary features of both types of tree: rapid growth and, hence, microclimate improvement where there are pines, and greater fire resilience from oaks.



*Selective clearing may indirectly foster the establishment of pine individuals from isolated mother trees by creating gaps in the continuous packed shrubland (photos by V.R.Vallejo)*

# Conclusions

- The Ayora mountain range offers a case study that represents typical landscapes of inland areas in E Spain, with a long land use history and multiple management changes and wildfires during the last 50 years

- The reference ecosystem is a pine forest that could be considered as resilient to single fire events but extremely sensitive to short fire recurrence intervals

- Restoration approaches of areas with low natural recovery of pines should include both the reduction of fire hazard and the increase of ecosystem resilience to further disturbances

- Selective clearing of fire-prone shrublands combined with the plantation of seedlings of resprouter species may achieve these objectives

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