CTFC

Net Forest

Network of knowledge for efficient private forests

IO5 – Forest Management in the Catalan territory.

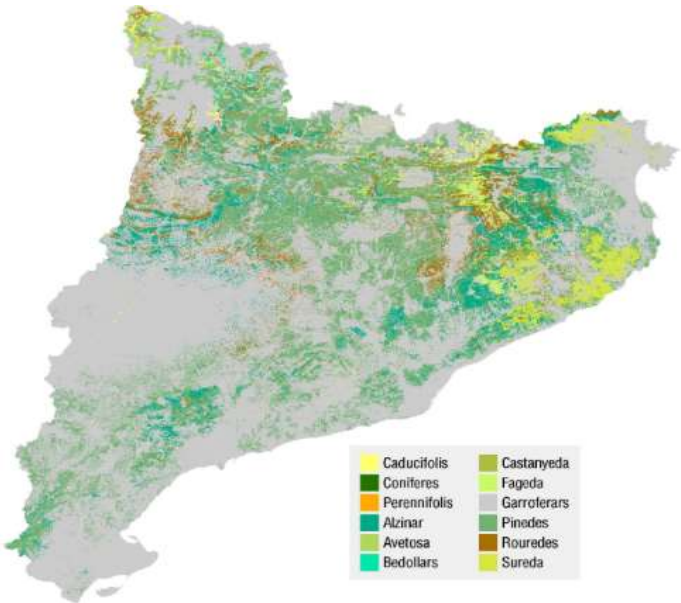
08/10/2021

Content

1. THE CATALAN TERRITORY.

1.1. Brief introduction.

Catalonia is an extended region in the north-east of Spain. 3 M Ha on a total surface. 64% of this surface is forest land and a 42% of forest surface with trees. Most of ¾ of forest is private ownership, a ¼ part of this forest is certified. Public forest is most located in the north, in the Pyrenees. Catalonia surface has many differences of landscapes and usages due to the variability of the territory. In the north-east forest, you can find a great biodiversity of plants and species. A common product is *Pinus sylvestris* wood for pallets, *Quercus sp*. for firewood and furniture sometimes, also *Populus sp*. and few Platanus sp. plantations. The most popular forest works enterprises are 2-3 self-employed people, working together. Silviculture forest management is the most activity, but nowadays government allows clear cuts to stop wildfires and support mosaic landscapes. Normally machinery is adapted from agriculture to forest. Forest products depend on the type of forest, we have a great diversity from pallets, firewood, cork, medical plants, and mushrooms passing through honey and pine seeds to truffles. Due to globalisation and climate change the Catalan forest has many pests who affect the economy, some examples of insects or pests are coming from commerce others from climate stresses. The Catalan forestry sector has most enterprises of forests' works followed by environmental consultancies, after biomass and firewood suppliers and Forestry and agriculture machinery other types of forestry nurseries, recycling forest wood and paper industry or fisheries.



If we look at Catalonia's map, we will see that more than 64% of the territory is forest. Over 2.036.574 Ha are forest area. 73% of the property of the forest is forest is private, counting more than 220.000 forest owners.

Picture 1. Map of Catalonia's Forest area. (Source OFC, 2021)

Catalonia is a small country but with a great diversity of landscape and forests. As follows you can see an example of this through different pictures.

Picture 2. Catalan different landscapes.

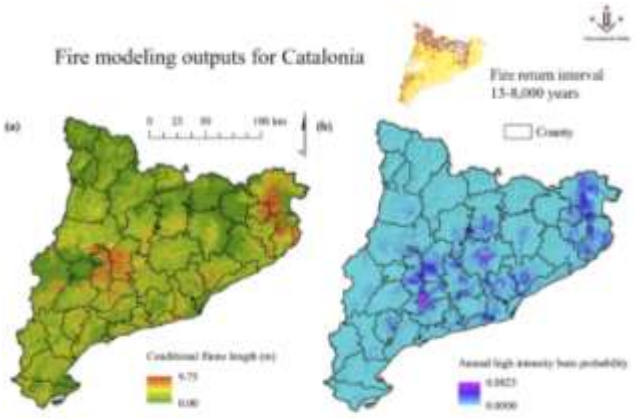
1.2. Wildfire situation in Catalonia.

The last wildfires in the Catalan territory have turned to be wilder and more extreme during the last 25 years thanks to the new climate conditions. We've also seen examples of extreme wildfire events in Chile, Portugal, and Australia recently. These types of wildfires are impossible to be controlled through the means of extinction once are active, so the only way to fight against these events is to promote the culture of prevention and resilience. That implies forestry management focused on the upcoming climate conditions to avoid allowing fire to have the environment to burn uncontrollably. Lots of efforts have been set to determine the conditions and occurrence probabilities but this is a science which is still under investigation.

Catalonia presents forest structures that were originated during reforestations in the 1930s or because of the land abandonment after the 1950s. These structures are not favourable to silviculture. Cultural landscapes have high complexity (hard to mechanise), seminatural flammable vegetation (adapted to draughts), abandonment (continuous extensions of fuel), largely non-commercial biomass and low prices, but valuable forest in ecosystems services and biodiversity (more than 100 species, high rate of epidemics). The social perception of the forest is often seen as a recreative scenario rather than a productive one. Catalonia has more than 30% protected area forest and all kind of social problems inside forest areas. Catalonia

has also the highest wildland-urban interface (WUI) and an extreme behaviour resistant to suppression efforts. Problems with invasive species, fires, wind-blows, and climate uncertainly linked to dry spells, heat waves and synoptic situations: i.e. northern advection: very hot and dry wind. *Catalonia has a high wildfire problem but also a forest management problem.* Some of these problems can be addressed by preventive silviculture.

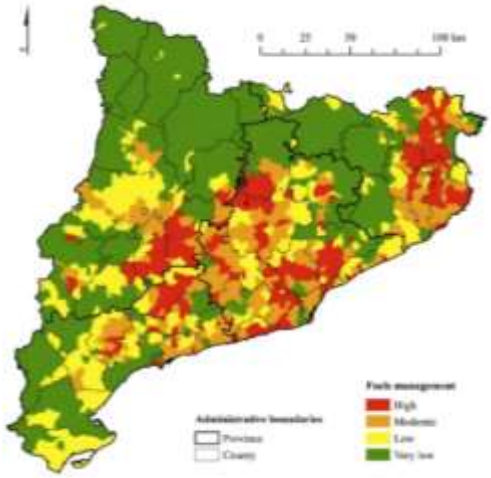
A long-term wildfire risk management needs beyond suppression and ignition prevention. Fuel's strategies are imperative to avoid high risks.



Mosaic landscapes helped fire prevention in the past. Fire simulators are very helpful. Fire historical ignitions maps and models were built regarding when the fire occurred. Many models with many parameters contrasted information. The final modelling output to assess hazard, exposure, and transmission.

Picture 3. Fire modelling outputs

1.2.1. Wildfire Management Priority Maps.



Spatial prioritization for fuel reduction programs in Catalonia from cross-tabulated wildfire hazard on forest fuels (CFL levels) and burned area transmission (outgoing). The highest priorities are in the central and north-eastern portions of Catalonia.

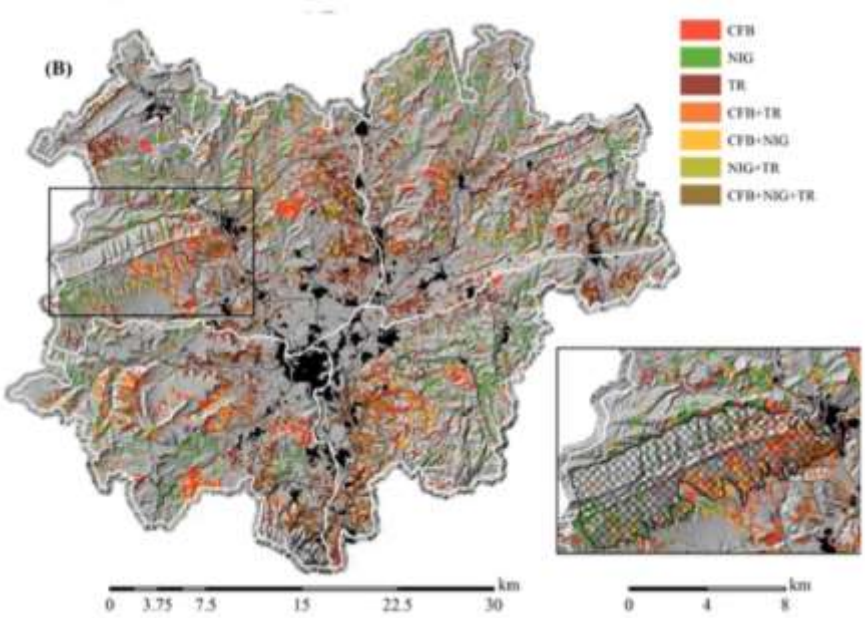
Different recommendations strategies were given by maps. Although, for forest management, a higher resolution was needed.

Picture 4. Wildfire Priority Map of Catalonia

1.2.2. Strategic management points.

Fire fighter's services have marked some "Controlled points" that need to treat to prevent wildfire. Some preventive treatment needs in these topographic areas like mechanical treatment prescribed burning, thinning, clearing. Many objectives can influence detecting these points. Many goals can differ in these points.

Emission fire maps for fuel maps probability, maximizing carbon stocks by protecting them from fire. If the focus is on resilient landscapes and fuel treatment, must consider multiple objectives. Because resources are scarce. Few optimal models of strategic points exist and are suitable depending on the goal.



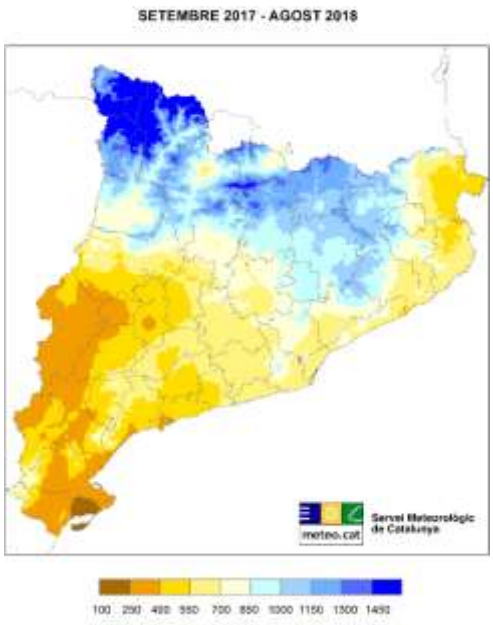
Picture 5. Spatial analysis of treatments depending on different goals.

Through this document, different associations, and the administration responsible for the forestry subsidies are presented along with their management techniques to be used as an example of forestry management in the Catalan territory. The actions are mainly focused on wildfire risk reduction for low profitability forest stands, but including timber and cork production in those few cases where it's possible to get revenues, but requires a strategic management to be sustainable and profitable.

2. HUMID FORESTS: Example for Guilleries and Garrotxa region.

Catalonia has several climates that make a great diversity in forests. One of these examples is the humid forests situated in the Pyrenees, traverse mountains and Montseny. Over these areas, the annual precipitation is higher than 800l/m2.

Accumulated precipitation (mm)
Sep 17 – Aug 18



This map shows the accumulated precipitation in Catalonia. The blue areas that have a higher amount of precipitation are "humid forests". Life and biodiversity inside these ecosystems have an important role. Forestry is and has been for many centuries ago, one of the most important economic activities.

Protection in forest areas from the headwater rivers was established more than a century ago to protect forests and rivers and to ensure a water supply to industrial and urban activities.

Picture 6. Map of Catalonia showing accumulated precipitation in one year period.

Let's take as an example a couple of forest areas located in the Guilleries (blue) and in the Garrotxa (orange).

Picture 7. Map of Guilleries- Montseny.

Picture 8. Map of La Garrotxa region.

The two areas are between one and one hour and a half drive from Barcelona city. Many differences between both estates can be found although good climate and forest stations join them. The average of Ha par owner in Montseny is higher than in Garrotxa.

2.1. The Guilleries.

The relevant facts of Guilleries are the continental climate, with more than 1000 l/m^2 per year, the hottest month average temperature is 30ºC and the coldest 1,4ºC. The maximum altitude of 1.204 m and the main town is called Sant Hilari Sacalm. Little production and structure wood sawmills can be found in the area and many little enterprises of forestry exploitation are still present nowadays.

Picture 9. View of the Montseny-Guilleries forest

The main natural tree species in Mediterranean forests are evergreen oak (*Quercus ilex*) and cork oak (*Quercus suber*) in south faces or lower forest, oaks (*Quercus pubescens*) and natural hybrids in higher levels mixed with beech (*Fagus sylvatica*) in north faces. Alder (Alnus *glutinosa*) is found in river flows or humid areas together nuts (*Coryllus avellana*). These species coexist with introduced species in exploitation and forest plantations. Chestnut tree (*Castanea sativa*) for fruit and wood, Douglas fir (*Pseudotsuga menziesii*) is common and naturalized is most of the Guilleries. Cedar (*Cedrus atlantica* and *Cedrus deodara*) is another adapted species used for wood exploitation. Radiata pine (*Pinus radiata*) plantations have a good growing result due to their high adaptability at the Guilleries sites.

Picture 10. Track of a Douglas fir forest, showing granitic soil

The soil that we find are acidic soil with a loam-gravel texture, 30-50 cm depth and the mother rock is granite. Without superficial rock on the surface. The average slope is 25-30% sometimes slope rises to 60%. All these conditions influence a good growing of forest and tree plantations and make worth for forestry enterprises exploitation economy.

Forest management is between wood exploitation in plantations and multipurpose forest objectives. These forests have many other secondary uses, as mushroom collection, medical plants, forest's fruits or touristic use like treetop cabins.

One forest estate of Guilleries is called Mas Carbó, located in Sant Hilari Sacalm (Girona).

Picture 10. View of Mas Carbó landscape and estate.

The land's surface is 270 Ha, and the altitude goes from 750 m to 1.115 m. The average slope of the station is 35 %, but the maximum is 60% in some places. Pluviometry is around 800 l/m2 but in some rainy years can reach 1.500 l/m2. Temperature moves from 30ºC to 1,4ºC from the hottest to the coldest month. Continental fresh climate makes especially conifers and lush species plantations perfect for forestry plantations. Granitic rock and depth of 30-50 cm with an acid pH make the soft soil of this estate a good station for growing for forest stands.

2.1.1. Forest typology in Guilleries.

Picture 11. View of a Douglas fir plantation with beech forest

In Mas Carbó, we can find high biodiversity of natural and introduced tree species. The main tree species that we find are Douglas fir (*Pseudotsuga menziesii*), Cedars (Cedrus atlantica and *Cedrus deodara*), chestnut (*Castanea sativa*), beech (*Fagus sylvatica*), oaks (*Quercus petraea*), Scot's pine (*Pinus sylvestris*) and evergreen oak (*Quercus ilex*).

As secondary species, we can find Austrian pine (*Pinus nigra*), Monterrey pine (*Pinus radiata*), maritime pine (*Pinus pinaster*), oak (*Quercus humilis*), cherry tree (*Prunus avium*), lime (*Tilia platyphillos*), mediterranean maple (*Acer opalus*).

In this estate, a particular planting plan for conifers is established depending on altitude and quality of stations:

- For altitudes higher than 700 m, the best stations, Douglas fir is planted and, the rest with Monterrey pine.
- For altitudes lower than 700 m high, the best stations are for Monterrey pine and cork oak.

Picture 12. View of a young Monterrey pine plantation.

We can compare 3 parcels of Douglas fir plantations.

STAND	*SURFACE (Ha)*	*ALTITUDE (m)*	*SLOPE (%)*	*ORIENTATION*
59	3.6	970	20	S-W
65	1.91	970	15	W
118	4.2	1030	25	E

The planting system varies according to the slope. A few years ago, consisted of planting manually for those places with high slope and mechanically on flat areas. Since 2014, mechanical excavators have worked for high slope works. Better results of established living plants are significant for mechanical planting.

Picture 13. Mechanical excavator adapted for slope works in plantations.

The origin of clones from two different varieties adapted to Mas Carbó station. These varieties are:

- Washington 412-422
- La Luzette PME-UG-002

Plants have more than 2-3 years and the roots have a cutting when the plant is 2 years.

Picture 13. Young plant of Douglas fir.

The thinning and final cutting plan is:

Unit	initial	1st 25 years	2nd 35 years	3rd 45 years	final 65 years
59	1.000	700	400	275	200
65	1.000	700	400	275	200
118	1.000	700	400	275	200

In 2007, the stand was measured, and the numbers were:

unit	age years	mean diam cm	mean height m	units/Ha	basal A m3/Ha
59	42	39	20	350	42,2
65	45	35	22	319	31,3
118	44	43	26	415	63

Pruning is one of the first works at plantations. The plan for this action is in function of heigh of plants. For the type of Douglas' station, we have the following plan.

Year	height (m)	units
10	2	all
15	4	best 400
20	6	best 200

Picture 14. Douglas fir plantation after pruning works.

Pruning is often a "cost-operation" for forest owners. Sometimes if they do not come from forest tradition, the pruning would not be done; consequences in low selling prices are significant. In this area, large properties and forest tradition, pruning is not a problem but, it is often a problem in management because of the cost in other places of Catalonia with less forest tradition of forest knowledge by owners.

The expected production for this kind of stands is:

operation	**biomass,** Tn/Ha	**packing,** Tn/Ha	**wood 20cm** Tn/Ha	**wood** Tn/Ha	**>30,**	**total,** Tn/Ha
1st thinning	25	25	-	-		*50*
2nd thinning	40	24	16	-		*80*
3rd thinning	18	40	26	26		*110*
final cutting	80	110	135	225		*550*

Pictures 15 and 16. Thinning works in Douglas fir estate.

Forestry works Costs in Douglas estates plantations are:

Operation	units	€/unit
Plantation	Ha	2.500
Cutting and extraction 1st thinning	Tn	21
Cutting and extraction 2nd thinning	Tn	19
Cutting and extraction 3rd thinning	Tn	16
Cutting and extraction final cutting	Tn	11
Direct transport to mill (up to 120 km)	Tn	12
extraction + transport (long distance)	Tn	22

If we look at the table above, the first and second cutting is combined with other third or final cuts to balance cost. Sometimes the owners delay first cuts or prunings to compensate costs. The price of wood is low and, most of the times, the incomes in first cuttings are higher than selling products obtained.

Actual selling prices, at destination:

product	unit Price €/Tn
Biomass	30
Pallets, packing	60
Wood for plank milling, d 20 mm	76
Wood for plank milling, d> 30 mm	95

Pictures 17. Douglas stands near final cut.

2.2. Santa Pau.

Picture 18. Map of Garrotxa region.

La Garrotxa is a region located in the northeast of Catalonia. The whole surface is 29 km2 and, the population concentrates in 20 towns. Olot is the capital city. The region has good communication between Girona at 30 minutes drive and 1h 30 to Barcelona. Also is well communicated to France.
The economy is related to agriculture, forestry, and industry. Tourism in nature and historic towns is a strong point for the economy in a few towns, grace to their network of hotels, rural houses, and campsites close to nature.

The main Natural Parc of the region is The Volcanic zone Parc. This is the best example of volcanic terrain on the Iberian Peninsula. It has 40 volcanic cones and more than 20 lava flows. Ninety-eight per cent of the Natural Park territory is private property.

Picture 19. Natural parc of Volcanic zone of Garrotxa.


Picture 20. Garrotxa landscape.

2.2.1. Example of forestry in Santa Pau.

Oak and holm oak mixed forest (picture 3) is the most common forest in this region.
A smooth climate with high rain and volcanic soil makes a good combination for agriculture and forestry. The average temperature of the year is 13,5ºC and, the accumulated precipitation in 2020 was 1254,6 mm. Calcific rock in the mountains and deep and rich organic material in the valleys is a perfect combination for agriculture and forestry management engine economy. Most of the forests are private and, the average surface is less than 30 Ha.

The historical use of the forest of this area has been charcoal, firewood, structural wood, floor, and roof wood for forest products and pastures fields in agriculture. To let the grass grow trees were kept spaced.

Picture 21. View of Santa Pau landscape.

Charcoal and firewood production of evergreen oak (*Quercus ilex*) maintained and managed in the hills and mountains of Garrotxa with a low density of trees before the decade of 1960s. After this date, when gas for cooking and heating came to cities, the forest is abandoned. We can still find charcoal production rests in the site (Picture 22).

Picture 22. Charcoal rests on the ground.

Picture 23. Firewood in evergreen oak forest

Nowadays, firewood is a forest product with high demand, especially holm oak. Firewood can defray production costs and forest management in the local economy. The majority of forestry works enterprises produce firewood in rainy months and can balance their economic business. In the last five years, the demand for firewood has increased because of the price of energy. Also, another reason depending on the area, is that secondary houses for weekends and holidays demand firewood for heating and pleasure like barbecues.

Structural wood of oak for traditional houses built more than 200 years ago are still in good conditions. Also, furniture and other complements built-in oak and evergreen oak because of their resistance to termites.

Picture 24. Structural wood of oak in traditional houses.

2.2.2. Multipurpose Management in Santa Pau.

In this type of estates, Multipurpose management has been during the last centuries the best solution for forest and agricultural ecosystems.
The aim is to organize the whole ecosystem, obtaining: wood production, environmental services, biodiversity and landscape.

The goal of Santa Pau multipurpose management is to establish and consolidate mixed oak and evergreen oak. For keeping biodiversity is imperative to keep other species like cherry trees (*Prunus avium*), Mediterranean maple (*Acer campestre*) or ashes (*Fraxinus excelsior*). One uneven-aged stand with trees coming from seeds, not coppice. Diameters of 50 cm trunks and over with a structural wood or planks production use.

Picture 25. Multipurpose forest management.

Picture 26. Evergreen oak of optimal diameter.

Two kinds of dynamics are in this estate. One part of the forest pastured till 1960 with open structure, so oaks grew with many extended arms. After the pasture, this mixed mass established their seedlings under the protection of old oaks. We can find young, thin and dense trees that reach the canopy under the protection of large, debilitated, aged trees. In the case of no management, big trees would fall and, they create a cleared area ready for regeneration. Large and old trees contribute to biodiversity: as arboreal support, microhabitats, epiphytes, and such as a source of deadwood, also, for structural resistance to the winds of the stand and a landscape functionality.

Picture 27. Big oak tree in the mixed stand.

The other forest dynamic found in Santa Pau comes from a regular estate, from trees propagated vegetatively and a few from seeds. This area is quite common in oak destined for firewood. Most of the times, the cover is complete, the soil has superficial mother rock. This forest cannot be pasture in some livestock explorations could be used as a refuge for hot weather. Thinning operation is planned every eight years for this forest.

Picture 28. Regular oak stand for firewood.

2.2.3. Biodiversity.

In this multipurpose management, many species of flora and fauna coexist. Fauna has a big importance in the composition of the forest's species and dynamics. Wild boar and roe deer have a high-level population. Their presence damages crops but, on the other hand, helps sometimes keeping the paths of the forest transitable. Birds, especially Jay regarding oak seeds dispersion is important.

For keeping and maintaining biodiversity in Santa Pau estate is important to keep species that produce food for fauna, such as nuts, chestnuts, or oaks. Animals are propagators of fruit trees as wild plums, apples, and shrubs (not objective trees). In young plantations trees, it is recommended to use individual tree protection.

3. THE FOREST OF THE CENTRAL PART OF CATALONIA AND BOSCAT ASSOCIATION.

BOSCAT is the Association of forest owners of the middle part of Catalonia. Non-profit Entity supported by the administration who helps the forest's owners financing management.
This federation was created in 2011 and is a group of forest owners associations. It has grown from 8 till 25 associations.

Picture 29. Map of BOSCAT federated forest owners' associations in Catalonia.

The total forest area is around 200.000 Ha, 10% of the surface of Catalonia with more than 2.000 individual owners, private and public and, the managed surface is 3.000 Ha per year. The annual volume of wood mobilised is 40.000 tons.
BOSCAT associations are non-profit organisation. Each association has a specific territory and specific own management.
BOSCAT is in the majority of the forest's areas of Catalonia. Biodiversity and different forests are present. Continuity of the mass is a critical point for fire prevention.

3.1. BOSCAT Functions.

- *Encourage the establishment* of forest owners' associations, strengthen ties between the federated associations and establish exchanges between them of information.
- Develop the *valorisation of new forest product services Concentrate the supply of forest products (biomass) and market through the Association of forest Producers Boscat Fusta.* Assures and manages wood or biomass regular supply.

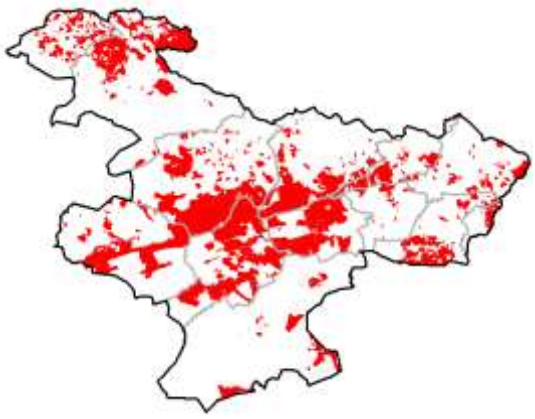
Also, manage and maintain the forest after the clearing with livestock. An example with donkeys in a project of 60 Ha Forest.

Picture 30. Miralles-Orpinell location.

There's a little association in the middle of Catalonia which is called *Serres Miralles-Orpinell Association.*
Members must be owners of more than 1 Ha. This non-profit organisation takes care of the management of 13 municipalities. The whole area has 30.972 Ha. The forested area is 62%, around 19.297 Ha. This association runs its own and specific management team.

There are 180 members who have 5.094 Ha with the 26 % of the forest area.
The average area per owner is 28,3 Ha.

The natural species of the Mediterranean dry are forest 2/3 of conifers: half of it composed by *Pinus halepensis* and *Pinus pinea*. Deciduous species are oaks and evergreen oaks in fresh estates. 15 % of the area is composed of bushes.
Soil characteristics are alkaline pH, sedimentary soil, and marginal rocky soil.



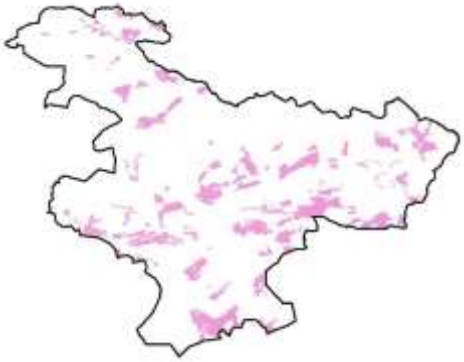
Picture 31. Map of vegetation in red areas.

Picture 32 and 33. Landscape of Miralles-Orpinell and vineyards with Montserrat mountain in the background.

The strategies of work have many constraints. It is an important industrial area near Barcelona. In rural areas, people moved to the industrial areas and the forest was abandoned after the 1960s. The "forest does not pay what the industry does" because of the poor soil, hilly mountains, and dry weather. Also, the poor quality of wood aggravates the situation. Owners get the 75% of biomass because of the quality of trees.

Picture 34. Situation of the abandoned forest.

The defensive approach of a private forests owner's association focuses on brush fires risks areas. They draw a map of the present forest and forecast situation. Expert engineers, fire-fighters, private entities with knowledge of the territory, municipality, and forest association coordinated this action. The map emphasizes brush fire risk areas and approved by the administration. After, is a joint forest planning instrument.



3.593 Ha, 18% of the area has a high fire risk. These areas in pink are suitable to work and reduce fires risk. Forest's work raised the value of the forest in the future.

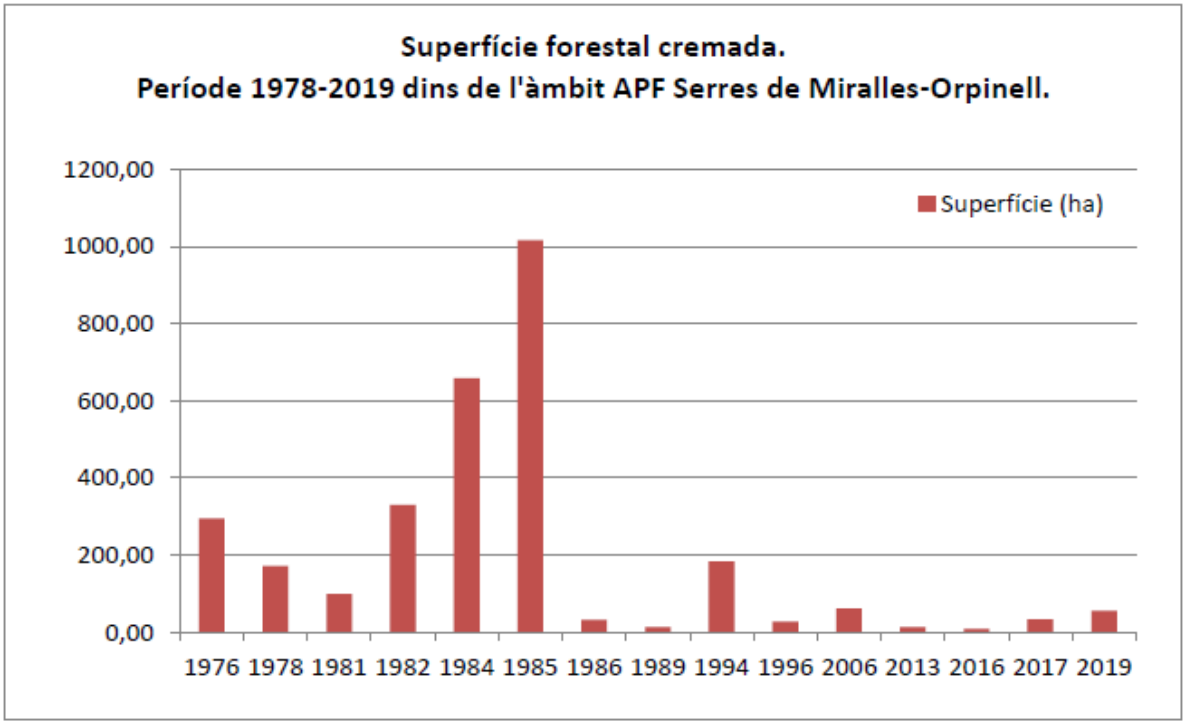
Picture 35. Map of brush fire risk areas.

The association ask owners from the risky spots and ask them to clear the forest. Owners do not receive any money but do not have to spend money on clearing the forest. The association get subsidies in exchange for forest works. Sometimes neighbours ask them to do the same and improve the Forest. They can start with 5 Ha and finish with more than 30 Ha cleared if the area is near the spot areas. It is fire prevention work.

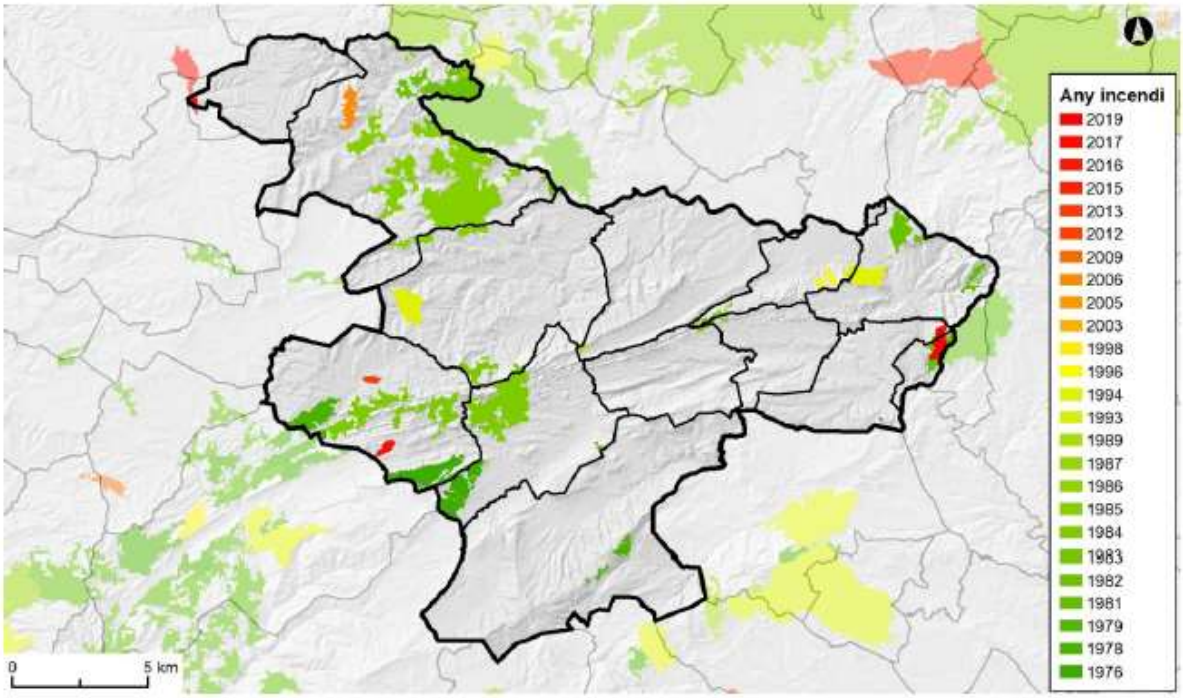
Pictures 36 and 37. Before and after intervention of the forest.

This kind of forest reaches 1.300 €/Ha and the wood production is around 25 Tones/Ha.

Picture 38. Aspect of the forest after intervention.



Picture 39. Graph of Burned surface from 1976 to 2019 in Serres de Miralles-Orpinell.



Picture 40. Map of burned areas in Serres Miralles-Orpinell forest association.

The success of the low fires surfaces in the land is probably because all fire prevention organisation is better connection and fast and effective reaction.

3.2. Example of Capellades fire.

In 2019, a car caught fire on the road. The flames spread in the forest. This forest has a slope higher than 65%, on rocky soil and without any path or roads inside. The burned surface was 56 Ha, and 45 owners were affected. Many actors were affected by this fire: train tracks, river, motorway, and many forest owners. The cost of the damage was 147.811€. The train rails had been repaired against erosion.

Picture 41. Fire of Capellades.

Picture 42. Capellades fire after some time, showing kindling's for avoiding erosion.

4. THE FOREST OWNERSHIP CENTRE.

Catalonia is a forested country over 2 million Hectares are forest, but the Catalan people perception is opposite.
The Catalan's Forest biodiversity has a high level of species. More than the 50% are mixed forests, containing continental and Mediterranean species.
Most of the forests are considered young forest with less than 100 years. The 40 % of them in the last 50 years.

Picture 43. Comparison of the Catalonian landscape.

Multifunctional Catalan's Forests give a great diversity of products. Sawed wood, pallets, firewood, woodchips and pellets for woody products and cork, mushrooms, honey, medical plants, and truffles.
The 78% ownership of Catalonia's Forest is almost private and 22% public. Family small-scale forestry is the most common way of the 264.747 forests owners. 95 % of forest owners have less than 25 Ha states and only the 5 % more than 25 Ha.
In the 80s, due to the fragmentation of forest's ownership, the low economic profitability of most Forests and the will to protect nature, the government was interested in promoting (sustainable) forest management. Thanks to the Catalan Forest law of 1988, the Forest Ownership Centre (CPF) was created. CPF mission is promoting sustainable forest management in the Catalan private forest.

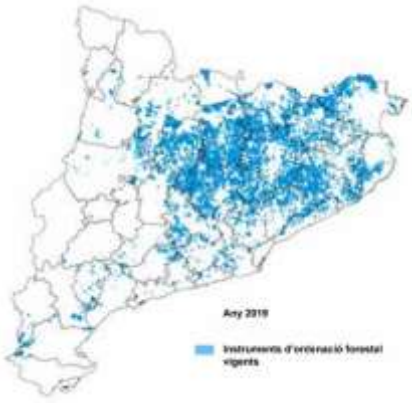
4.1. Functions.

The main aim of the CPF is the approval of Forest Management Plans. There are two types of management in the function of the size of the property: Simple Forest Management Plan (PSGF) for less than 25 Ha and Technical Forest Management and Improvement Plan (PTGMF) for more than 25 Ha. These plans are voluntary but provide some advantages like tax reduction, insurance, the priority of grants, etc. For promoting forest management sustainability.

CPF has published different orientations of forest management and many models of suggested management for different forest typologies, these publications are called the ORGEST (Sustainable Forestry Management Guidelines).

Picture 44. Publications of the CPF.

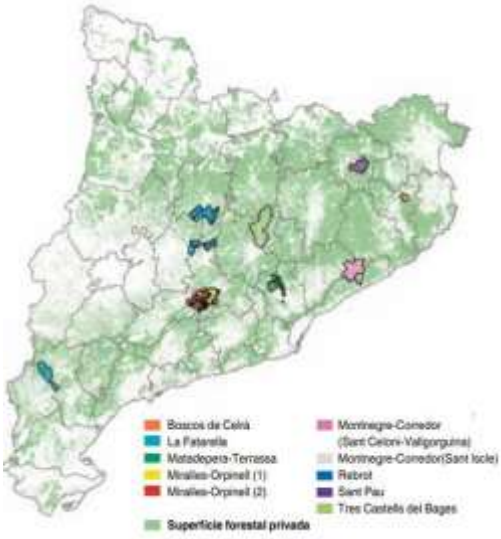
In 2019 a third of the surface (450.000 Ha) of forest in Catalonia had a current forest management plan. 3.700 Forest managing plans counting simple plans and technical plans.



Picture 45. Map of current forest managed plans areas.

The Joint Forest Planning Instrument (PTGMFc) is a tool for forest management on a large scale, around 5.000 and 10.000 Ha have a Joint this type of management. We have 16 estates of PTGMFc with more than 60.000 Ha and more than 50 new forest owners who decided to join this management, especially for Fire Prevention Joint Forest Management.

Picture 31. Map of the Joint Forest Planning zones



The monitoring and consultancy services on the implementation of the forest management plans are other main tasks of the CPF. They have several technical consultant foresters linked to the territory. Helping forest owners to obtain grants for sustainable forest management is another role of CPF. Knowledge transfer and innovation take an important purpose. CPF is part of some EU-funded projects like Biorgest or MIXforchange or Climark. Dissemination activities and documents are one task complemented by the network of demonstrative plots with more than 100 in private forests. G.I.S. statistics and databases on forestry are available for CPF and certification of sustainable forest management.

5. MONTNEGRE-CORREDOR FOREST OWNERS ASSOCIATION.

Another Forest Owner Association is *Montnegre-Corredor Forest owners association.* It is a non-profit private association founded in 1992. The association is composed of one manager, one forest engineer and one accountant. The creation of the corporation is in 2017. The corporation has one manager, two forest engineers and one field technician.

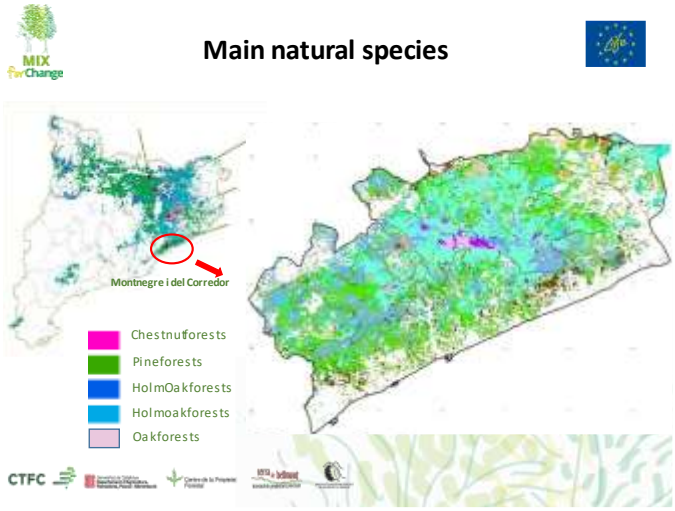
The typology of ownership is practically private, having 95% private and 5% public. The number of associates is 190 forest owners and 8.000 Ha forested. The action area covers the Montnegre-Corredor mountain: 20 municipalities with more than 44.000 Ha.

The main objectives of this association are a representation of the members, promotion of forest planning and more efficient management techniques, integration of multifunctional management and conservation of the environment guidelines, development of a mechanism for members co-operation and, work towards a better understanding of the region.

The actions of this association are the representation and defence of the forest owners' interests when dealing with administration also, Forest planning and execution of forest works and commercialisation of products. Transfer of forest knowledge is present in developing innovation projects, meetings and conferences, publications, etc.

The faced challenges by the association are the improvement of silvicultural efficiency diversifying products in quality and quantity, Challenges like the adaptation of disturbances like plagues, diseases and climate change, the diversification of commercialisation, new markets, and the generation of knowledge with the increase of innovation projects and transfer of knowledge.

Last year, the association plus the corporation invested near 1M € with public investment and others. 8.600 Tons of wood, firewood and pallets produced and, the surface of silvicultural treatments reached 400 Ha.



Picture 32. Presentation of Montnegre-Corredor.

The location of Montnegre-Corredor starts on the coast and goes inland north. In between of industrial cities, only a 30min drive to Barcelona capital city. The principal forest species found in Montnegre-Corredor are pines forest followed by holm oak forests and few chestnut forests in the humid areas.

In many towns or cities of the association, the forest reaches WUI (Wildland Urban Interface) and, many houses and the little town with big cities coexist with a high risk of wildfire in hot periods

Humit Oak (Quercus canariensis and Q robur) Forest

Pinus pinea forest in a WUI (Wildland Urban Interfase) ubication

Picture 33. Pictures of vegetation and WUI in Montnegre-Corredor.

The association implements solutions in forest work like thinning's, changing the combustible structure, promoting the mixed forest, or acting directly in landscape (opening spaces and maintaining them with livestock). For this reason, they implement planning in demonstrative parcels. These challenges for implementation need to be estimated and need for grants and public investments.

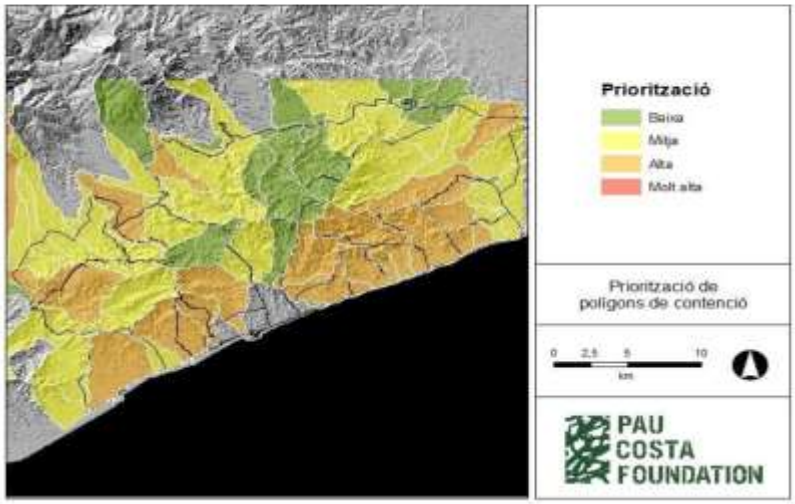
The Catalan Climate change office has concluded that we have increased by 1,7ºC since 1950 and 0,35ºC in summer. Impacts of climate change in vulnerability Mediterranean forests are affecting their resilience. In the Mediterranean, temperature increases and heatwaves. The

result is irregular precipitations with a higher amount of rain in less time or increasing erosion in vulnerable areas. Multifunctional forest management has an important role to mitigate climate changes.

5.1. Disturbances.

5.1.1. Fires.

After the 90's, the newest fire generations cannot be suppressed by traditional methods. A fire prevention plan is significant for the approach planning of Mediterranean management. According to the risk of wildfires, priority prevention maps give models to stop the continuity of fires in forests stands.



Picture 34. Fire prevention plan prioritisation in Montnegre-Corredor.

Polygons in different colours mean different areas of contention of fire. Red coloured areas have priority in fire prevention management.

5.1.2. Diseases.

Because of climate change, many stresses affect the Mediterranean forest stand. Diseases are one of the most focal points to balance the resilience and adaptability of species. In Montnegre-Corredor, many diseases affect the Mediterranean Forest. Warm temperatures, high humidity and continuity of the stand are perfect conditions for pests and diseases.

Picture 35. Disease's affection in Montnegre-Corredor.

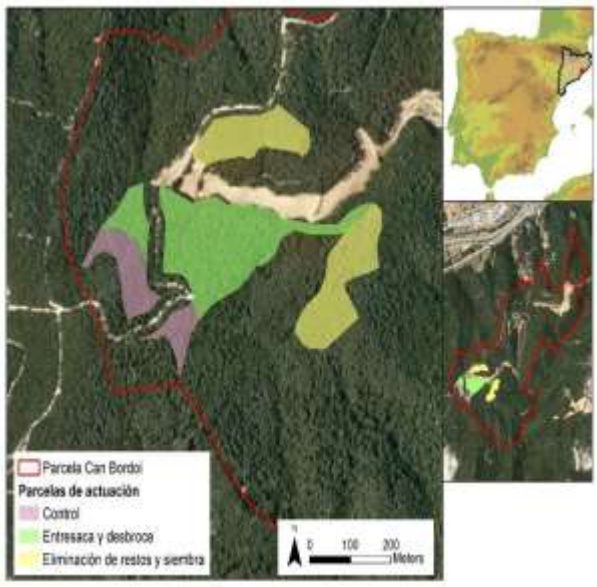
5.1.3. Storms.

After snowfalls in 2009 or high-intensity windstorms, the Mediterranean forest suffers windblown or canopies breaks. All these injuries leave stands susceptible to disease attacks.

Pictures 36. Snowfall in 2009.

5.2. Example of different actions that have been developed in Montnegre-Corredor.

5.2.1. Can Bordoi: Implementation of a Fire Strategic Area.



This site is in the litoral mountains, on the north face in front of the sea. In Llinars del Vallès at 30 min drive from Barcelona. Can Bordoi is part of a Interreg Sudoe project called Montclima.

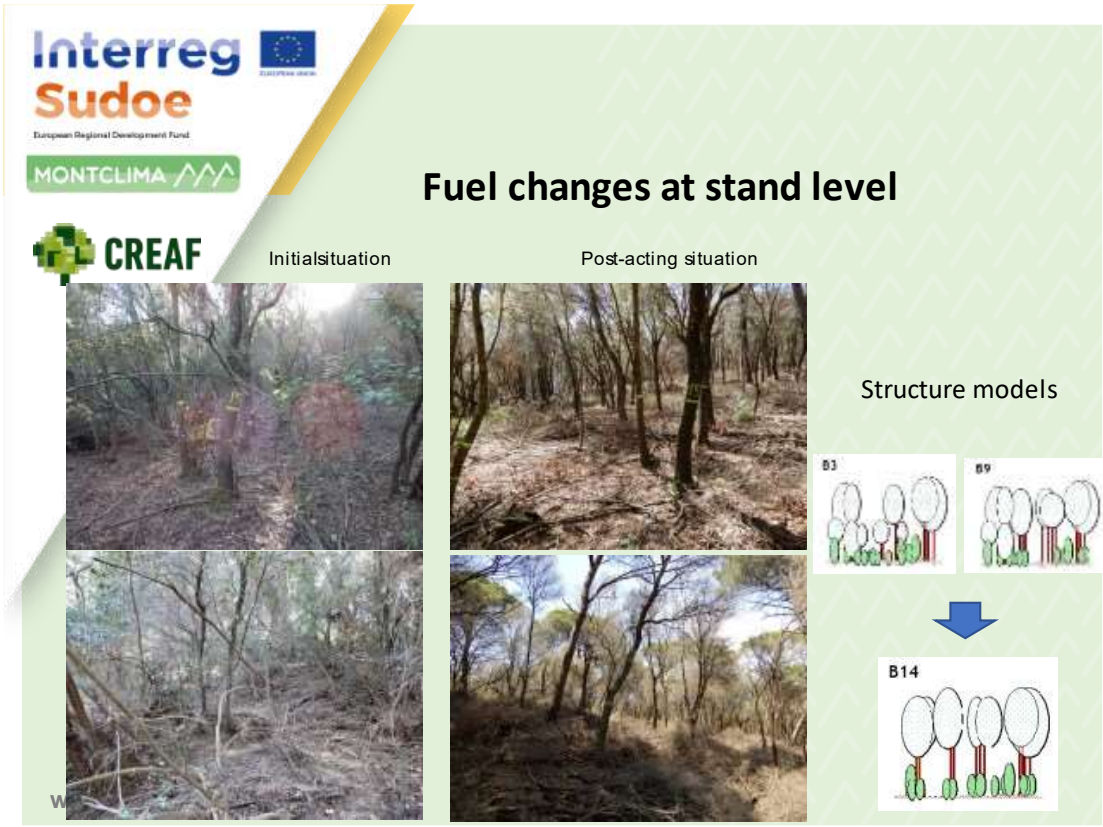
This mixed pine and holm oak stand has been affected by diseases in the last years. *Pinus pinaster* plantations were affected by Matsococcus feytaudi, *Pinus pinea* by Tomicus destruens. Mediterranean pine's forest has high level of stress, and the result is a high mortality. *Quercus ilex's* density is very high, and the production of pasture is low.

Picture 37. Map of Can Bordoi.

The main objective is to create an opportunity to fight a high-intensity fire, generating a fuel discontinuity in the area.

The secondary objective is to control diseases in pine's forests also improve and open pastures in oak's forests. Resilience was a consideration in these objectives. Humidity in fuel and soil moisture controls in demonstrative and new silvicultural model areas.

Two levels of operations in the demonstrative area are significant to create a fuel discontinuity. At the stand level thinnings, debrushings and improving mixed forest were executed. On the landscape level, a mosaic has fostered the creation of new open spaces used for pastures.



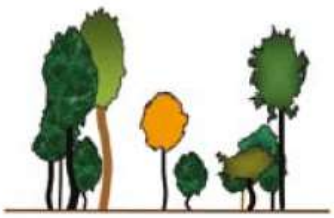
Picture 38. Fuel changes at Can Bordoi at stand level.

Picture 39. Changes at lanscape level.

5.3. Can Casas: Improve rentability and compatibility with conservation goals.

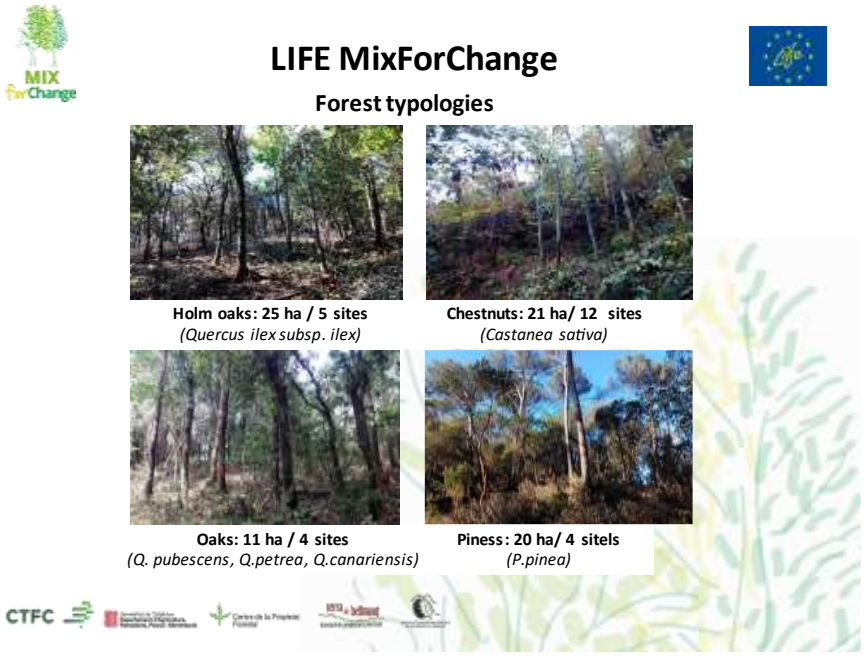
This site is part of a Life project called MixforChange project. The stand is composed of oaks and lush vegetation like *Quercus canariensis*, *Quercus ilex*, *Quercus suber*, *Prunus avium.* This is a quality and conserved (capitalized) site with high-quality products opportunities.

Improving forest resilience by new forest management techniques is the main objective of increasing revenues (new commercial opportunities). Irregular or semi-regular management from the mixed mass.

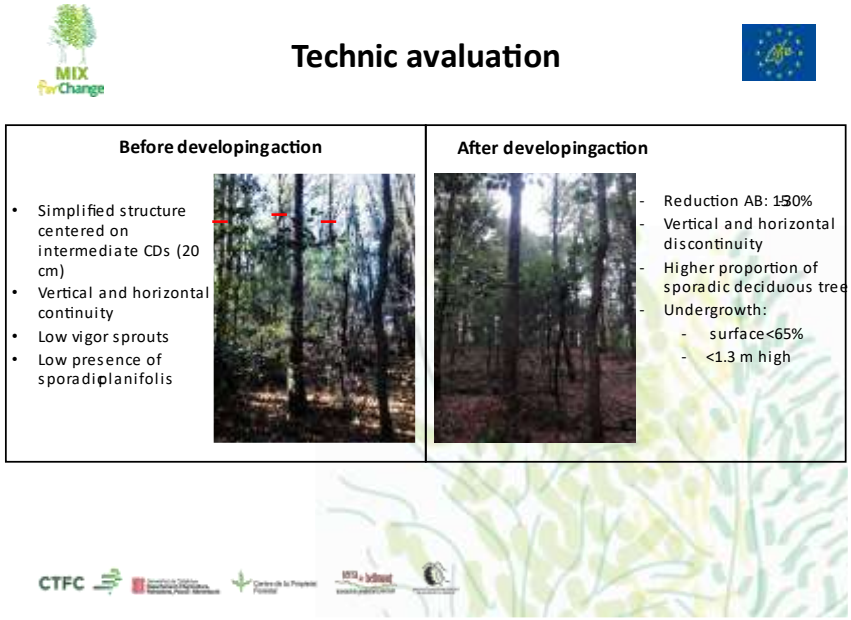


Picture 40. View of Can Casas managed forest.

The proposed management for a mixed mass ORGEST has more complexity, proposes less density to regulated water stress, selecting the most vigorous and vital trees (more resistant to pathogens). The selection is made at individual trees for wood quality, seeds (few species) and biodiversity.



Picture 41. Can Casas forest typologies.



Picture 42. Comparaison before and after actions.

Mixed management creates new commercial opportunities like quality wood combined with traditional firewood or biomass and cork. A worthy chance to invest in the forest in tracks construction.

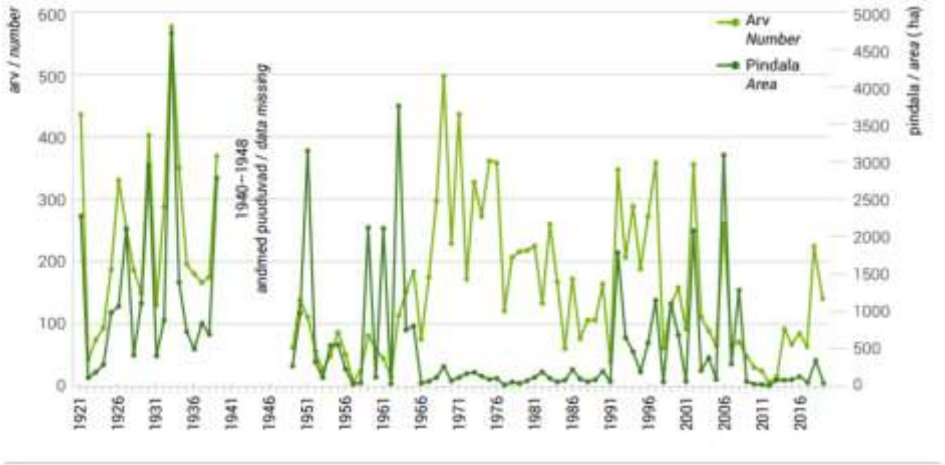
Picture 43. Good quality wood production.

Pictures of Can Casas. Picture 44 - Cork extraction (top left), Picture 45 - Biomass porduction (top right), Picture 46 - Tracks construction (bottom left) and Picture 47 - Final result (bottom right).

6. FOREST FIRES AND THEIR PREVENTION IN ESTONIA.

6.1. Wildfires in forest areas in the last period.

A forest fire is a burning in a forest area that is not under human control. Strong fires can destroy an entire forest community. If all wildlife habitats fall into the fire, the forest must start its life cycle from the beginning. From open areas, the wind carries ash and preserved soil away and then erosion occurs.
The causes of forest fires are divided into two: man-made and natural – not cause my humans. About 99% of fires in Estonia are caused by humans. Most of the reasons are smoking and careless firing, less often agricultural and forestry work, transport, power lines, firearms and ammunition. In 2019, 50 ha of forest burned in Estonia, in 2018 340 ha. The largest fires of the 21st century in Estonia took place in 2002 (2080 ha), 2006 (3090 ha) and 2008 (1280 ha of forest fires), the damage of the latter amounts to 14 million euros.



Picture 48. Number and area of forest fires 1921-2019 (Yearbook Forest 2019).

6.2. Fire prevention measures.

As a result of climate change, longer droughts are increasing in Estonia, which makes our forests more flammable. The risk of fire is usually higher in forests where there is a lot of flammable material - for example, dried undergrowth and bushes. Spruces that are damaged by bark beetle also increase the level of danger. In the case of coniferous forests, open areas and reforestation are the most flammable, ie forests where the branches and the ground are close to each other. The controlled deliberate burning method is not allowed in Estonia.
Forest management gives better resistance to various disturbances, including forest fires. Maintaining forest water intakes, forest roads and forest targets can extinguish fires more effectively and help prevent them from spreading.
Everyone, that spends time in the nature, has an important role to play in fire prevention, and maintenance alone does not protect against forest fires. For more information on forest management, contact forest owners at local forest associations.
Support can be applied from Estonian Private Forest Centre for through forest associations to prevent forest fires. The eligible activities are:

- purchasing and installation of a fire alarm sign and poster and the marking of the fire water intake and the access to the water intake
- maintenance of the fire water intake point, the water intake access point and the vehicle stopping place
- construction and maintenance of a fire protection strip or zone
- construction and marking of smoking and campfire sites

Fire protection strips (strips in forest which have all the vegetation been removed a few meters wide) are helping to stop fire that is moving along the ground. Below on the picture there is an example of such a long strip of sand or soil running between forests in Läänemaa, Estonia. The fire protection strips that are being built in Estonia are 2.5 m wide and the scarification should be repeated once a year.

Picture 49. Long strip running between forests.

In Estonia for **monitoring and preventing** fires there are also being used fire observation towers (working radius up to 25 km), electronic surveillance (cameras with a radius of up to 20 km Nõva-Vihterpalu), air surveillance (Border Guard Aviation Squadron) and co-operation with Finland (early detection of forest fires by satellite). Also an occasional passer-by can be great help in reporting a forest fire.

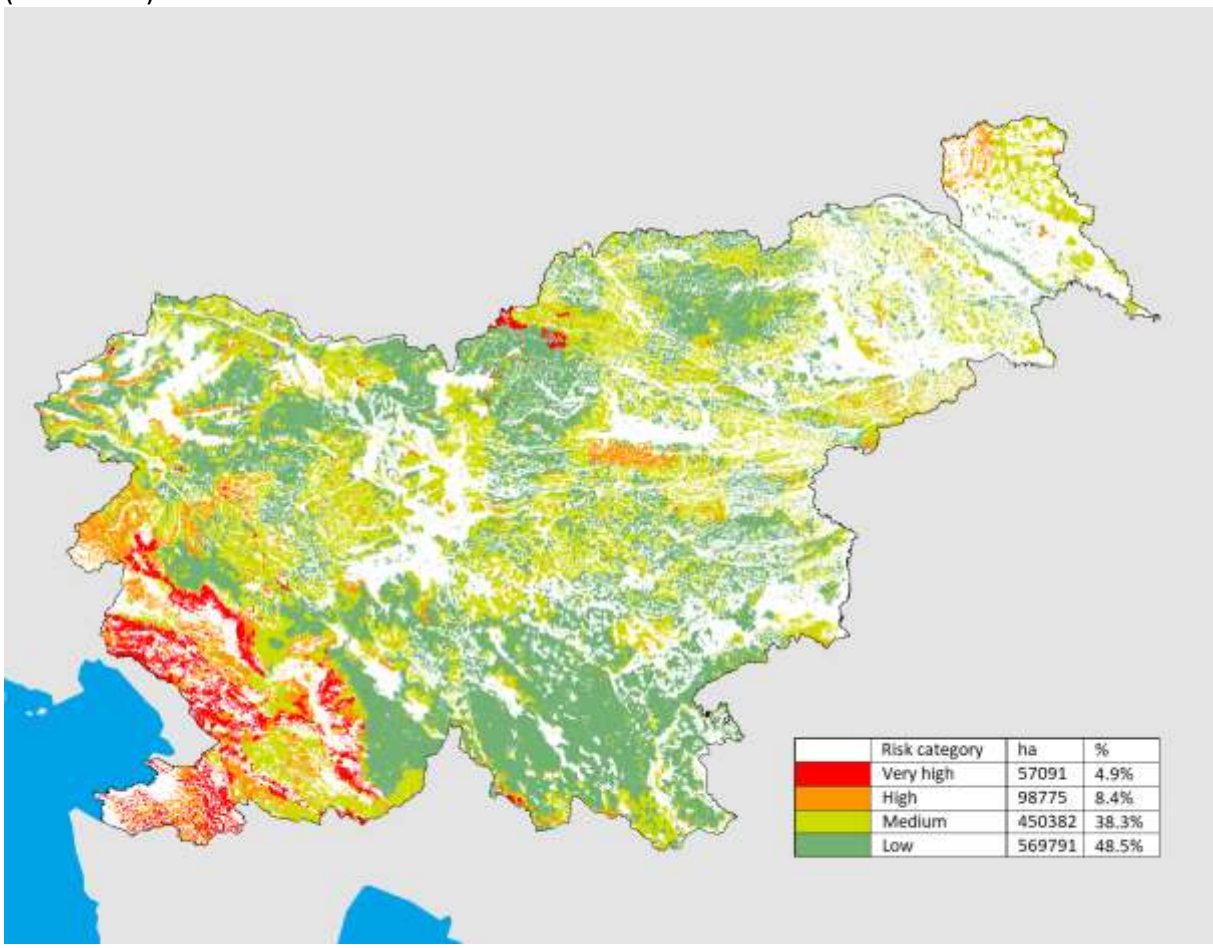
Literature:

- Yearbook Forest 2019 file:///C:/Users/livia.poslin/Downloads/mets2019_0%20(3).pdf
- Rohegeenius Roheportaal https://rohe.geenius.ee/blogi/eesti-loodus/metsatulekahjud-eestis-ja-valismaal-kuidas-uks-mets-polema-laheb/

7. WILDFIRES IN SLOVENIAN FOREST AND RURAL AREAS.

7.1. Risk against wildfires in Slovenian forests.

Slovenian forests cover an area of 1.17 million hectares. Considering climatic and geological characteristics, forest structure (or the amount and moisture of burning material) and the proximity of potential fire sources, forests are classified into four forest fire risk categories (Picture 50).



Picture 50. Risk against wildfires in Slovenian forests (SFS, 2020).

Most forests with high or very high forest fire risk are located in the southwestern part of Slovenia, which has a sub-Mediterranean climate. In this part, about three quarters of all Slovenian forest fires took place in the last decades. In other parts of Slovenia, there is a higher forest fire risk associated with rare dry steep southern slopes with termophilic tree species.

7.2. Wildfires in forest and rural areas in the last period.

The Slovenia Forest Service (SFS) keeps detailed records of past forest fires. Their statistics include forest fires that affected at least a few hundred m^2 of forest area. During the period from 2003 to 2019, there were an average of 95 forest fires per year that spread to 266 ha of forest and 144 ha of other land. The average forest fire burned an area of 4.3 ha. Reasons for 43 % of these fires remained undetermined, 25 % were caused by train, and the remaining 31 % were caused by other defined mostly human reasons (SFS, 2003-2019).
During the same period, 8 forest fires superseded 100 ha. The largest of these was in 2003 (1049 ha), and the second largest in 2006 (950 ha). These two wildfires have contributed to further improvement of the organization, equipment, and prevention in the protection against wildfires in the coming years.
The Administration of the Republic of Slovenia for Civil Protection and Disaster Relief (ACPDR) keeps records of all wildfires and other fires in open areas. In the period from 2005 to 2020, there was an average of 1717 fires that burned 934 ha of forest, agricultural, and other open areas annually (ACPDR, 2021).

7.3. Firefighting measures.

Several measures have been taken in Slovenia to reduce the risk of wildfires. We have classified them into the following four groups:
Construction and maintenance of fire roads

- In forests with high or very high fire risk, fire roads allow firefighters quick access to the fire and provide the starting point for defensive lines. In total, there are 835 km of fire roads that are opening the forests which are not opened by other roads. 494 km of 1st category fire roads are suitable for all firefighting vehicles for forest fires, and a further 341 km of 2nd category fire roads are only suitable for smaller vehicles for forest fires (SFS, 2020).

Equipping and organizing firefighting troops

- Slovenian fire fighting troops are quite well equipped for fighting forest fires. In Slovenia there are a total 35187 volunteer and 630 professional firefighters ready to fight wildfires (and other fires). Volunteer fire troops (we don't have data for professionals) are equipped with 162 small purpose vehicles for wildfires (water tank up to 800 l), 71 larger purpose vehicles for wildfires (water tank from 800 to 10000 l), 948 universal larger vehicles (water tank from 1500 to 14000 l), which can also be used for fight of support at wildfires, and several other logistic vehicles without water (Kongres GZS, 2019). Since year 2010 helicopters of the Slovenian Armed Forces have been used in an average of 4 wildfire interventions per year (ACPDR, 2021).
- For better orientation in the terrain, in 2009 the SFS prepared special maps with all reliable infrastructures that can be used during wildfire intervention or are relevant for fire fighters (Saražin, 2017). In 2021, the maps were updated within the Interreg

project and created together with Italian colleagues in order to better cooperate in the bordering area. During large wildfire interventions special maps are printed at the place.

Reducing the risk of wildfire

- As pure pine monocultures are more hazardous for wildfires in sub-Mediterranean region, there is a strong tendency to change the structure of these forests into mixed forests with an increasing number of autochthonous broadleaved tree species.
- On a few hectares per year in higher risk areas (along the railway), fire fighters reduce the combustible material through prescribed burning in well controlled conditions (Jereb and Turk, Ujma 2014).

Monitoring and rising public awareness

- In order to raise awareness of risk of wildfires, warning signs are installed in more hazardous forests.
- Any controlled burning in the wild should be reported to 112 before ignition.
- When the orange or red alert for wildfires is triggered, all fires in nature are prohibited and additional fire watches are organized to monitor the area.
- There was also established the system of cameras that can detect wildfires.

7.4. Conclusions.

Sub-Mediterranean southwestern part of Slovenia is more endangered by wildfires than the rest of the country. Two large wildfires in 2003 and 2006 led to better organisation and preparation for wildfires. Since SW Slovenian rural area is quite densely populated (no waste empty spaces), the goal is to: (1) notice the wildfires, (2) reach them with vehicles, and (3) fight them as soon as possible when they are still small and easy to fight. Preventive measures against wildfires include: (1) construction and maintenance of fire roads, (2) equipping and organizing fire fighting troops, (3) reduction of the fire hazard in vulnerable places, and (4) monitoring rural area and public awareness.

Literature:

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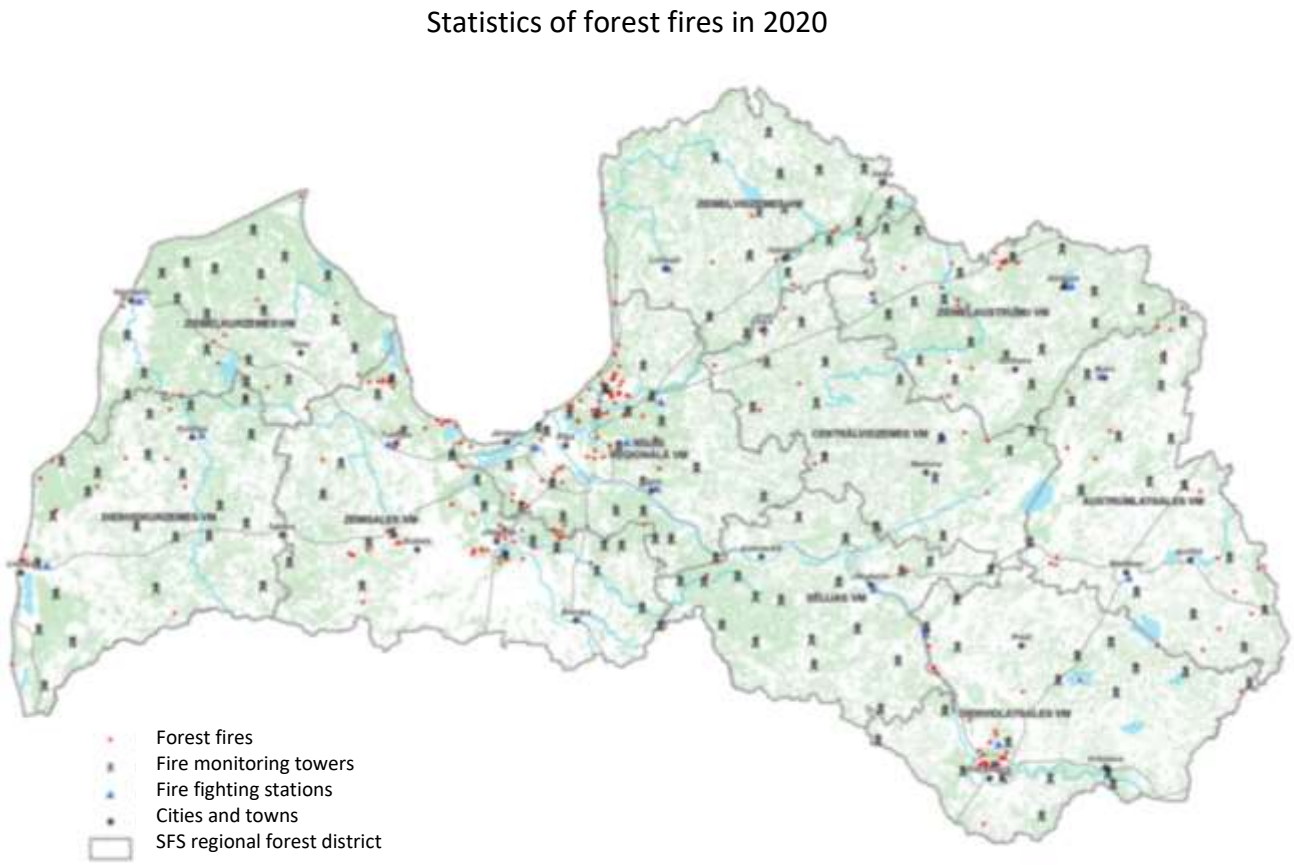
- GZS (Fire Fighting Association of Slovenia). 2019. Work report 2013-2018. XVII kongres GZS.
- Jereb and Turk. 2014. Introduction of New Preventive Measures for the Limiting of Wildfires. Ujma 28: 236-244.

- Saražin. 2017. Fire Roads and Special Purpose Vehicles for Fighting Forest Fires. Ujma 31: 207-214.
- **SFS (The Slovenia Forest Service). 2003-2019. Yearly reports of Slovenian forests (2003-2019).**
- **SFS (The Slovenia Forest Service). 2020. Geospatial data of Slovenian forests.**

8. FOREST FIRE MONITORING IN LATVIA.

Forest fire monitoring is implemented throughout all the forests, including every type of ownership and belonging, by the State Forest Service (Valsts meža dienests). The forest fire monitoring system is organized so that any forest fire would be discovered and brought under control promptly. To determine the place of fire as soon as possible, during the forest fire hazard season, constant surveillance of surroundings is arranged from the forest fire monitoring towers (181 towers in total around Latvia). The first one was set up in 1898. The majority (80% of forest fires) is identified within thirty minutes since breaking out, and the corresponding forest fire fighting station sends a fire truck with a fire fighter team to the place of fire. By extinguishing a forest fire on a promptly basis, the area affected by the fire does not extend over 1.5 hectares. The State Forest Service is gradually replacing its fleet of forest fire fighting trucks with more advanced equipment, in order to carry out their forest fire fighting assignment efficiently. The forest fire fighting equipment is located in 14 forest fire fighting stations.

Frequency and intensity of forest fire fighting depends on the weather. The drier and windier season, the more frequent fires start in forests. Many fires occur at springtime, especially during the period of burning the last year's grass, and also during the second half of summer when there are berries at forests, as well as in dry autumns. Forest fires are most damaging to young forest stands; even if the trees are just scorched, their needles never grow back and the young trees perish. Around 584 forest fires start per year. The average area affected by fire is 385 ha. Forest fires incur losses of around 660 thousand euros each year. The highest number ever recorded of forest fires was in 2006, with 1929 fires in total with the affected area of 3790 ha. The largest forest fires stormed in Latvia 26 years ago, in July 1992, when the forests of Slītere National Park were burning at the same time – in swamp of Baži, as well as the forests in Garkalne were on fire.
In Slītere, fire covered 3312 hectares, while in Garkalne – 3000 hectares.
The main reason why forests catch fire is still related to humans – their conscious or unconscious actions, irresponsibility or inattentiveness with fire. Most often forests are on fire because people leave campfires still burning instead of putting them out completely. During drought periods one tiny spark is enough to start a forest fire. Only 0.1% of forest fires are caused by other reasons, such as lightning or a tree falling on high-voltage cables. Forest can catch fire even from a cigarette butt, dropped on the ground carelessly. During springtime, forests often are on fire because of people burning the last year's grass.
In order to limit the risk of breaking out forest fires, each spring a season of forest fire hazard is declared in Latvia. It is announced by the State Forest Service depending on the weather that year (usually from early May till September). During the forest fire hazard period, every habitant of Latvia has to follow fire-safety requirements, when staying in forests.



Picture 51. Statistics of forest fires in Latvia in 2020.

8.1. How fires affect forests.

A puzzle-like landscape within tree forest tracts and individual stands is formed as a result of various conditions, though fire has a great role in it. A great part of vegetal diversity typical for a coniferous tree landscape in natural conditions is created thanks to periodic fires.

When not burning, forests accumulate a thick layer of humus and a substrate of decayed wood in different degrees of decomposition that is changing the general vegetation content gradually. Considering succession in coniferous tree forests is slowly tending towards forming fir forests, lack of any fire in such forests contributes to fir prevalence. This causes also microclimatic peculiarities in the particular area – shading is growing, temperature fluctuations and humidity mode become more stable.

There, the range of animal and plant species typical for a dry pine forest is losing its natural habitat. Without human influence, coniferous tree forests burn once a period of 40 to 200 years depending on the soil type, topography, exposure; and many species of plants and animals, that live here, exist at the mercy of such disturbances. In places affected by fire there are species of plants and animals that “arrive” there due to these conditions created, as well

as other species of plants keep their existence, as they have been saved and have survived in terms of their spore, seed and subterranean part. Following a fire, these species are spreading quickly, covering the burnt-out area.

Plants that form seed banks at forests, can keep their seeds in stand-by condition, while saving their ability to germinate from one major disturbance till the next one. Once a possibility arises, they "explode" and spread within the open area. After some period of time, when the micro-environment has changed, these species disappear, while actually leaving soil full of their seeds and waiting for the next opportunity to come. A great example is Orchid Blue (Geranium Bohemicum). The plant distributes throughout a burnt-out area of forest two or three years following the fire, because in order to germinate, the seeds need to be heated up to a certain temperature, that is difficult to be reached in our natural climatic conditions.

Burnt-out places are significant not only to plant species. For instance, black fire beetle (Oxypteris acuminata) organizes its living space under a burnt pine-tree bark. Unlike firs, pine-trees are more resilient under fire exposure and are able to survive several fires, thanks to the thick bark and high canopy they have.

Firs are killed by fires, while pine-trees, at least a part of them, survive fires of almost any intensity. Meanwhile, insides of decaying thick trees provide a stable microclimate, thus creating living conditions for various organisms.

Following fires, while the areas are reviving slowly, a young forest stand is formed of various ages, with very old trees and thick dead wood present in the forest stand. The fire place is first "populated" by such tree species as aspens, birches, pine-trees, that is, species accommodated to light and spacious environment, while also able to produce numerous seeds. After a while, firs come in gradually – a tree species that loves shade.

In a way, we imitate fire affect in such forest, when making a clear-cutting in a dry pine-tree stand.

Sources.

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https://www.tvnet.lv/5792056/gadsimta-ugunsgreks-latvija

9. WILDFIRES IN SWEDEN.

Sweden's forest landscape has had a long history of wildfires where forest fire, historically, has been an important factor for the boreal forests succession. Reoccurring wildfires have transformed the landscape over time, where drier land exposed to frequent fires evolved into Pine and lichen types of forests (Engelmark, 1987). The boreal landscape was exposed to less frequent but large wildfires in historic times but in the mid-1600s, the frequency of wildfires starts to increase due to changes in culture and increases in permanent settlements in northern Sweden. The increase in number of fires peaked in the mid-1800 followed by a rapid reduction during the late 1800s and early 1900s (Niklasson & Granström, 2000). During the 1900s, wildfires have not been a major concern for Swedish forestry but due to climate changes, wildfires are a rising concern (e.g. San-Miguel-Ayanz, 2018). According to data from Swedish Civil Contingencies Agency's statistical database (IDA) the two years during the last decades with most forest fires in Sweden where the year 2014 and 2018 with 14 663 ha and 24 294 ha of burnt land respectively (Figure 1). The total area burned during these years differs dramatically from the average area burned during the same period (1998-2020) of 3 234 ha/year. The number of emergency agency responses on the other hand remained fairly close to the average number of responses; 4672 number of responses in average during 1998-2020, 4323 numbers of responses in 2014 and 7980 responses in 2018 (Swedish Civil Contingencies Agency, 2021).

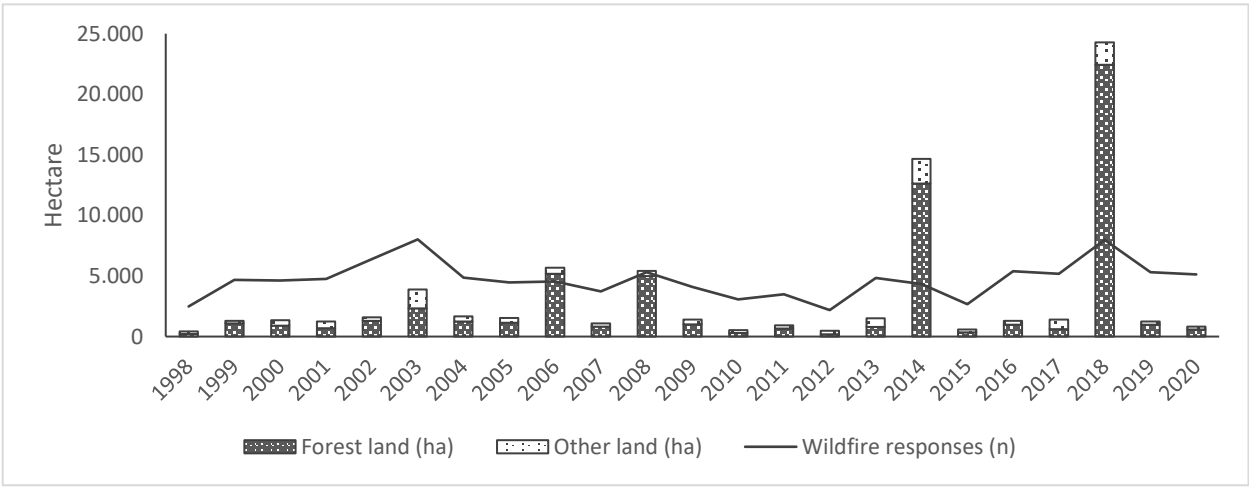

Figure 52. Area burned in wildfires and the total number of emergency responses to wildfire reports from 1998-2020. Data received from MSB [Swedish Civil Contingencies Agency] (Swedish Civil Contingencies Agency, 2021).

The weather during these two years and especially 2018, was characteristic by unusual warm weather and summer drought (Sjökvist, Abdoush, & Axén, 2019) resulting in unusually difficult condition to fight the wildfires. During the 2018 wildfires, 18 fires reached over 100 ha in size and three of the major fires burned in total 9 500 ha of forestland in the same direct area (San-Miguel-Ayanz, 2018).

Figure 53. Area burned in wildfires from 1998-2020. Data received from MSB [Swedish Civil Contingencies Agency].(Swedish Civil Contingencies Agency, 2021).

År ▼	Forest land (ha)	Other land (ha)	År ▼	Forest land (ha)	Other land (ha)
1998	201	221	2010	289	239
1999	1,084	222	2011	651	284
2000	909	437	2012	194	289
2001	695	555	2013	792	711
2002	1,290	304	2014	12,621	2,042
2003	2,318	1,572	2015	352	244
2004	1,246	431	2016	969	324
2005	1,138	407	2017	600	811
2006	5,184	505	2018	22,429	1,865
2007	830	255	2019	986	249
2008	4,992	433	2020	584	228
2009	1,013	393			

It is possible that what was seen during 2014 and 2018 was an indication of the climate changes increases the risk of large areas burned by wildfires in Sweden. Where the increase in average temperature and local changes in precipitation during the summer months can substantially increase the future risk of sever wildfires (Krikken, Lehner, Haustein, Drobyshev, & van Oldenborgh, 2019; Sjökvist et al., 2019).)

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10. FINAL CONCLUSIONS.

Together we've discussed about the new upcoming climate challenges and showed our actions regarding this problem. Every specific forest requires its own management systems, but facts like mixed forest and continuous forestry management are key actions to be applied all around Europe. That means reducing the fuel available, fight the forestry abandonment, protect the timber sector, act for promoting high quality stands, boost local economies and rural areas allowing people keep the forests active (shepherds, collectors, tourists, etc.). One of the main threats which we all are facing in Europe are the great wildfires. It has been show that prevention is much more effective than extinction, maintaining the mosaic landscape as one of the main objective to be accomplished during the next decades. Also post-fire interventions need to be done according to the forest which we will need in the future. They must be resilient and resistant, mixed and diversified, with the opportunity to allow great biodiversity while maintaining its economic and environmental functions. Decisions taken today will configure the upcoming forest in the next 20-100 years so it's a shared effort between actors such as scientists, forestry engineers, forestry workers, teachers and academies, firefighters, politicians and EU policies, together with local farmers, shepherds and all rural actors involved in the forestry management sector.