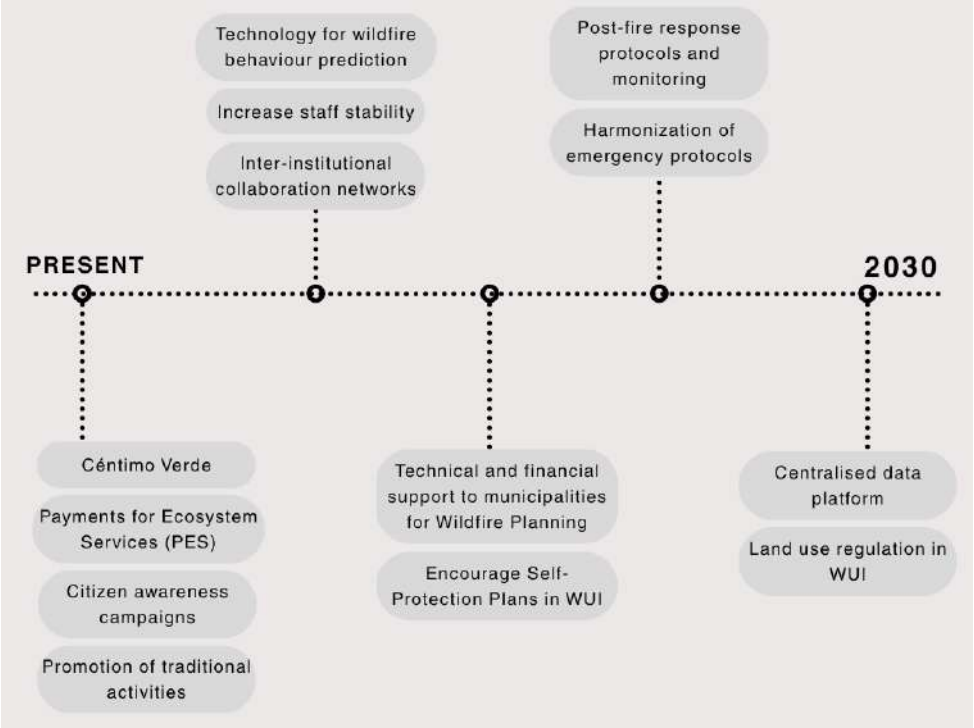


*Figure 24: Gran Canaria LL Roadmap towards 2030.*

## 5.5. CWI feedback

After the 1st CWI meeting, the organisers distributed a feedback form with 15 Likert scaled questions ranked from 1 (fully agree) to 5 (fully disagree), and 4 open questions. The Likert scaled questions aimed to receive feedback from the organisation of the event, while the open questions aimed to receive suggestions to improve future CWI meetings.

According to questionnaire results, meeting attendants were pleased with the organisation of the event (1.33 ± 0.47) and time management (1.44 ± 0.68). They found the quantity of information provided (1.50 ± 0.71) and the clarity of the objectives (1.50 ± 0.71) to be appropriate. CWI participants also expressed that discussions would be helpful for their future work development (1.44 ± 0.96). Overall, their expectations were fulfilled (1.63 ± 0.70), and they are willing to join the next CWI event (2.00 ± 0.87). The three discussion sessions were positively evaluated, being the first session "Diagnosis and challenges" the best ranked (1.44 ± 0.68; 1.78 ± 0.92; 1.56 ± 0.68).

In relation to the open questions, some participants expressed that the debate was engaging and emphasised that the diverse range of actors involved would enrich future decision-making processes.

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# 6.Catalonia (CAT)

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## 6.1. Wildfire context

### 6.1.1. Fire regime, socio-ecological context, and impacts

The statistics in Catalonia typically represent two variables: the number of fires and the area burned. According to this information (Fig. 24), a trend towards fewer fires is observed, with an average forest area burned annually (2011-2023) of 2,066 ha (median: 1,827 ha). These data, however, do not indicate extinction variables (difficulty/safety or resources), nor the impacts of the fires.

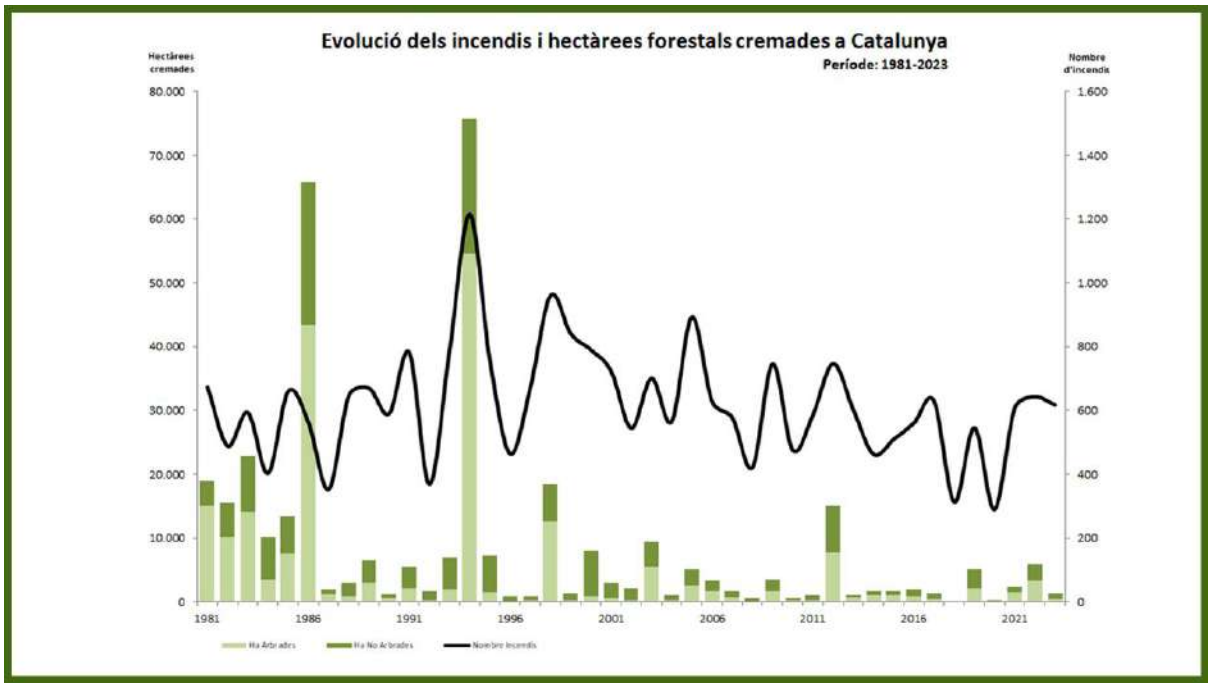


*Figure 25: Evolution of the number of fires and forest area burned 1981-2023. Source: DACC*

The impacts of the fires are (roughly):

- For **people**: health impacts (smoke inhalation, psychological effects), deaths (fortunately few), changes in plans (evacuations, activity restrictions).
- In **homes**: totally or partially damaged houses - especially at the urban-forest interface, burnt surroundings (aesthetic and cultural effect/local identification).
- In the **primary sector**: damage to fields, animals, and associated infrastructure. With almost 80% of the forest area in private hands, very few forest owners have insurance – this is not a custom in the agricultural sector either. With this dynamic, losses in the primary sector are hardly compensated.
- To **other businesses** in the rural area, for example, loss of tourist interest during a period.

- **Intangibles**: loss of cultural heritage, reduction in ecosystem services such as protection against erosion, loss of biodiversity (especially in protected areas, although with small fires sometimes the impacts are positive).

### 6.1.2. Wildfire governance

At a synthetic level, the general organization of risk management is presented. The main strategy for wildfires is currently the INFOCAT Plan (Civil Protection, 2024) which organizes the roles especially around the emergency response phase. Here we present lines of intervention in the landscape before the fire, during the fire, and after the fire, trying to highlight the institutions that have competences, and/or have lines of support to implement certain measures.

*How is the wildfire preparedness organised?*

The actions **before the fires** (prevention of ignitions and preparation of the landscape) involve a multiplicity of sections of the Generalitat, as well as the local level (provincial and city councils), more or less coordinated. These include:

- Citizen awareness, both in the field of prevention (avoiding ignitions due to bad practices or carelessness), and self-protection (e.g., taking care of certain variables in housing estates or farms), and preparing them on how to act in case of emergency. These actions are typically carried out by the Civil Protection, the General Directorate of Forests, and the Provincial Councils. Occasionally, the Forest Defence Associations (ADFs for its initials in Catalan) do some local campaign, and the Corps of Rural Agents has a specific programme of environmental education in schools (eduCAR) in addition to multiple awareness and dissemination campaigns.
- Planning of the territory towards the risk of wildfire:
    - Priority Protection Perimeters (PPP): PPPs are of a supra-municipal scope and are drawn up by DG Boscos. They plan the basic infrastructure (areas with low fuel load, strategic forest tracks and water points) in areas with high risk of large wildfires.
    - Supramunicipal: The Partial Territorial Plans (PTP) are for the area of *vegueries*, the current ones last until approx. 2026, and its drafting is led by DG Urbanism. Being of a supra-municipal scope, this instrument modulates the POUMs. The PTPs until now did not include the risk of fire, an area that is intended to be corrected in the next generation of PTPs (as a pilot, the Penedès PTP has not yet been approved). In the area of protected spaces (PEIN), these spaces must have an instrument for organizing uses – e.g., PRUG (natural and national parks), Protection plans according to the planning law (Barcelona Council network), Special plans for the protection of the natural environment and the landscape. These regulations sometimes restrict spatial priorities for fuel management or other fire prevention measures.

  - Municipal: councils have the obligation to draw up a series of municipal plans:
    - Fire Prevention Plan (PPI). Municipalities classified as having a high risk of wildfire are required to have one PPI (according to the Law 6/1988, Decree 64/1995) which is approved by DG Forests. They must have supra-municipal coherence with the PPP Plans, and they must meet the requirements of safety zones for urbanizations (Law 5/2003).
    - Unique Municipal Civil Protection Document (DUPROCIM) for all risks in the municipality. It includes the actions to guarantee the operability of the municipality's human and material means in the management of an emergency.
    - Municipal Urban Planning (POUM) is approved by the Territorial Planning Commissions. The POUMs so far only mention PPI, without further operational integration, nor do they consider aspects of PPPs. This often involves obstacles for the realization of breaks of interest due to the generation of discontinuities because this change of use was not contemplated in the POUM, and therefore it is required to process a modification of the POUM.
  - At the forest plot level: Forest Management Plans (*Instruments d'Ordenació Forestal*) are technical and administrative documents to regulate the management of forest estates. When they are on private plots of >25ha they are the Technical Forest Management and Improvement Plan (PTGMF) and for smaller plots they are the Simple Forest Management Plan (PSGF), which is approved by the Forest Property Centre (CPF). In public estates they are Planning Projects (*Projectes d'Ordenació*). These plan the work to be carried out on the farm for 10 years (undergrowth clearing, cutting, road repair...), and include a fire prevention plan. When they take place in PEIN areas, they must have an environmental report of the DG with competences in the preservation of biodiversity.
- Insurance: Interested/aware primary producers (farmers, ranchers, foresters) contract and pay the insurance premiums. To facilitate this, there are grants from the CPF for some types of private foresters.
- Fuel management: In some areas, interventions are made to reduce the load of available biomass (by removing trees and/or bushes, mechanically or by alternative means such as livestock or prescribed fire), or to modify the structure of the forest. These can be done at the initiative of forest owners (private or public) or at the initiative of councils in forest-urban interface areas. A series of priority management areas regarding fuel management have been determined:
  - The perimeter strips of urbanizations (IUF) to protect houses and avoid ignitions
  - The Strategic Management Points (PEGs) to facilitate fire extinguishing (pre-extinguishing)

  - The Management Promotion Areas (AFG) where not only the behaviour of the fire is affected in situ, but also in nearby areas
  - Road protection strips, such as low fuel load zones, parallel to both sides of strategic traffic routes to ensure evacuation, the safe movement of vehicles and avoid ignitions. They are the responsibility of the road management body.
  - Strips under the high voltage power lines, responsibility of the power company

There exist aids through the CPF (DG Forests) or Provincial Councils to treat fuels in PEGs and AFGs, or on forest surfaces in general. The GEPIF of Forestal Catalana (DG Boscos) with the collaboration of the Corps of Rural Agents, as well as the Fire Department, make prescribed burns that also serve to train staff in the face of extinctions.

- Infrastructure for extinction: Creation of strips to allow the intervention of the response teams, creation and maintenance of water points and/or paths of the basic wildfire prevention network, acquisition of equipment for the response (trucks, Personal Protective Equipment, radios). There are grants from DG Forestry and different Provincial Councils for foresters and ADFs. The Corps of Rural Agents carries out inspections throughout the year to assess its operation and informs the persons responsible in the event of an incident. The GEPIF of Forestal Catalana (dependent on DG Forests) carry out maintenance tasks for this infrastructure.
- Training of response teams. The Institute of Public Security of Catalonia provides training to Firefighters, Civil Protection agents, the Corps of Rural Agents and members of the ADFs to ensure that human resources have sufficient knowledge to be able to subsequently participate with safety and coordination during the emergency.
- Limitation of activities due to fire risk: Based on the daily index and the level of the Alpha Plan of the Corps of Rural Agents, certain activities may be subject to restrictions. The recreational use of natural areas (e.g., protected areas) or certain activities such as cereal harvesting or forestry interventions with machinery that may cause sparks may be restricted. The Rural Agents take fortnightly vegetation measurements to be able to identify the drought index. This serves the Fire Service (DG Boscos) to prepare the daily fire danger index. The Corps of Rural Agents, with the help and participation of the regional police (*Mossos d'Esquadra*), and also at the informational level of the PVI of the DiBa, the GEPIF and the Forestry Agents of the DiBa and the personnel of natural parks brigades can execute and monitor these restrictions. The DG Agriculture/Forests process permits for burning agricultural residues based on the feasibility report issued by the Rural Agents Corps. The Rural Agents and/or *Mossos d'Esquadra* control all the activities that take place in the natural environment that increase the risk of fire or its management, among others, that visitors to the natural environment park correctly allowing access to emergency vehicles.

- Intersectoral coordination: The technical committee for monitoring the risk of wildfires is convened when there are favourable weather conditions for large wildfires, or when there is extreme risk in the INFOCAT. They analyse and assess the risk, monitor and control the risk, and assess the consequences arising from the risk of wildfires. They include firefighters, DG Forests, Police, Civil Protection, Rural Agents, meteorological service, SFADFs, 112, Traffic, and Red Cross.

*How is the response organised?*

Actions **during the emergency** have as main actors the Fire Brigade of the Generalitat (in the area of wildfire extinguishing) and Civil Protection (in the area of human and property safety). The City Council leads the Municipal Emergency Committee for actions at the municipal level. Additionally, the ADFs play a relevant role at the local level, especially for the first attack and capability in cases of simultaneity, subsequently supporting the corps:

- Detection of ignitions: Via the surveillance of the GEPIF (DG Forests) of the Corps of Rural Agents, of the *Mossos d'Esquadra*, and of the PVIs and Forestry Agents of the DiBa or via alerts detected by the civilian population and reported (112).
- First attack: It is carried out by the first agent who is activated and can reach first the point of fire. They can be the Firefighters themselves, or the GEPIF (DG Forestry) or the ADFs at municipal level or the Corps of Rural Agents.
- Attack: The Intervention Group is led by the Fire Brigade, and they coordinate with the various bodies that work there (professional and volunteer firefighters, accredited ADFs, Rural Agents, GEPIF, and BRIF/Ministry and/or Army if applicable). The assessment group for wildfires and associated risks (Firefighters, DG Forests, Rural Agents and Meteorological Service) analyses and advises.
- Communication to citizens: The Civil Protection Communications and Press office use its own channels (social networks, web releases) to communicate about the emergency and its evolution to the media. The local councils channel the information to their population.
- Evacuations, confinements, and other health measures for local population: These actions are coordinated between Civil Protection, Medical Emergency Service, affected councils, and police/*Mossos*/Rural Agents Corps if applicable.
- Order: *Mossos d'Esquadra* are responsible to guarantee traffic and security in general in coordination with local police and Rural Agents.
- Investigation of the causes of the scope and the alleged perpetrators: The Corps of Rural Agents are responsible of this investigation.
- Logistics: The mobilization of means and resources is necessary to serve the population and the attack group. It is led by Civil Protection who coordinates town and county councils, local Civil Protection volunteers, Red Cross, managers of protected and forest areas, basic service companies etc.

*How are the post-fire actions organised?*

Actions **after the fire** refer to:

- Damage inventory: First estimate by the Forest Fire Assessment Group and the associated risks. The Recovery Commission made up of representatives of the Generalitat and local administration (and the State if applicable) identifies and quantifies damages through the Recovery Plan. The Generalitat and/or the town councils can request that the area to be declared "catastrophic", which is approved by the Council of Ministers (State Government, Law 17/2015), who can adopt extraordinary measures such as aid to individuals.
- Statistics: The Fires Section at DG Forests together with the Fire Department are responsible of the statistics of the Forest Fire Prevention Service, which reflect the perimeter and typology of burned surface. This statistic is based on the data on the fire and its perimeter provided by the Corps of Rural Agents.
- Recovery actions: In some cases, immediate or medium-term measures are planned. The Recovery Commission has the objective of coordinating the measures and establishing the aid, the application procedure for these and also the procedure for their materialization. This Commission has the function of assessing the removal of the burned remains as well as the possible repopulation of the affected areas. DG Forests declare Urgent Action Zones (ZAU). Their funding often comes from DG Boscos or others (e.g., Provincial Councils). Aid to private foresters comes from the CPF. Occasionally, some measures come from the ADFs or different citizen groups. In cases of catastrophic areas, there is aid from the State to guarantee post-fire regeneration.

## 6.2. Vision for wildfire-resilient landscapes in 2030

### 6.2.1. A 2030 wildfire-resilient landscape in Catalonia

In Catalonia, a wildfire resilient landscape is understood as broad and inclusive and among others includes the following aspects:

- **Strategic Landscape Planning**. Definition of a territorial and land use dynamics for the creation and long-term maintenance of landscape structures and agroforestry mosaic that take into account the demands of the inhabitants, the socio-economic conditions and possibilities of the territory and the operational needs of prevention, emergency management as well as the appropriate restoration mechanisms.
- **Heterogeneity of forests and land uses**. The diversity of forest species, forest structures, crops and the combination of open and closed spaces contribute to avoiding the continuity of biomass, building a diversified rural bioeconomy and generating complementary habitats for greater biodiversity. Forest management and the mobilization of forest products, extensive livestock farming as well as the use of fire are tools that can contribute to this objective. Forests and landscapes that are better adapted to the impacts of climate change offer better guarantors of the provision of ecosystem services and contribute to fulfilling Catalonia's climate agenda.

- **Active rural bioeconomy**. Promoting economic activities based on wood products (wood for construction or furniture, etc.) and non-wood products (mushrooms, aromatic and medicinal plants, etc.) as well as livestock contributes to the fixation of the population in the territory and the maintenance of the dynamics of the territory, while fulfilling the rural and urban agendas of Catalonia.
- **Restoration of resistant and resilient ecosystems and biodiversity**. Adapting ecosystems to natural/anthropic fire regimes as well as to new risk scenarios makes it possible to meet the objectives of nature restoration while intervening in the reduction of fire risk. This includes, among others, identifying the species of flora and fauna existing in a territory and adapting its planning considering its needs, for example, maintaining or creating corridors for the migration of species.
- **Adequate density of passable access roads**. A sufficient density of access roads, when necessary restricted, preserved in good accessibility conditions contribute both to the management of the territory and to the management of the emergency and control of the spread of fires.
- **Well-managed urban-forest interfaces**. The maintenance of urban-forest transition areas with a reduced accumulation of biomass and the use of fireproof materials in the constructions of the most exposed buildings is important to reduce the risk of properties and their inhabitants. This involves expanding the protection capacity of managed areas beyond the strip, when necessary, to adapt to more severe fire behaviour. Spatial planning and urban planning can guide new developments and activities in the territory, considering risk scenarios, reducing new exposures or integrating measures to reduce vulnerability into projects.
- **Use of innovative technologies**. Technologies are constantly evolving in the monitoring of climatology, the state of the forest and fires, in the modelling of the behaviour of fire and the pyrocumulus it generates, in communication between emergency teams and with society, and in information representation techniques, among others. It is important to use new technologies to ensure efficient and effective risk management, especially in the face of risk scenarios of massive and simultaneous fires that can generate multi-emergencies simultaneously.
- **Integrated fire management**. Fire is part of many forest ecosystems, especially in the Mediterranean context. Sometimes, a low-intensity fire under control can contribute positively to the ecosystem or directly the health and vitality of some habitats can depend on the presence of fire or equivalent disturbances. Fire can also be used as a tool to reduce biomass build-up through prescribed burning, or for firefighting through counterfires.
- **Robust emergency systems**. The coordination and continuous training of the different emergency services is key to efficient emergency management in situations of great complexity and uncertainty, using the knowledge generated from each extreme wildfire. Collaboration with society must also evolve to adapt to the new reality of fires.
- **Society and local communities sensitized and prepared**. We need to move towards a better prepared society, with citizens who are well informed about the

risk, people, local authorities and businesses with sufficient resources to manage the risk and with pre-defined and agreed patterns of behaviour in the event of a fire. At the same time, fire culture and responsible behaviour to avoid ignitions are a fundamental pillar as the basic danger of fires increases in new territories.

- **Mechanisms for the recovery of the affected land**. Despite improvements in the prevention and management of the emergency, in a context of extreme fires, it is necessary to foresee severe impacts of fires on agroforestry property, homes, businesses and the economy that cannot be avoided. It is necessary to enable the appropriate mechanisms to restore the socio-economic dynamics of the territory as quickly as possible.
- **Equity and social justice**. Risk management policies and the opportunities to implement resilient landscapes revert to citizens on equal terms, accompany the most vulnerable populations and consider the rights and duties of public bodies, land ownership, private actors and citizens in general, as well as the compensatory measures necessary to promote co-responsibility in risk management.
- **Coherence between policies**. Sectoral policies and between the different levels of the administrations promote actions in the territory and integrated fire risk management in a synergistic way, favouring the financial sustainability of medium and long-term mitigation and adaptation policies in a context of growing risk.
- **Collaborative and adaptive governance**. The governance system includes the participation and monitoring of all administrations, landowners and private actors involved in the implementation of resilient landscapes and integrated fire risk management. Governance models co-evolve to deal with uncertainty and the need for continuous adaptation.

### 6.2.2. Resilience in fire preparedness and prevention

Main challenges foreseen for 2030 in the LL of Catalonia regarding preparedness and prevention are:

- A variety of forests adapted to the new expected climatic conditions which create a **resilient landscape**.
- There is a **common regulatory framework** coordinated between different administrations and actors involved to achieve prevention and protection planning against the risk of wildfires that is operational and viable throughout the territory, including priority areas and urban-forest interfaces. Follow-up measures are defined to minimize the risk of goods and services being affected by wildfires.
- There is a unique online platform where all **technical data** related to wildfire risk prevention and management is collected and shared in an up-to-date manner.
- Effective **infrastructures** are available to fight all types of fires.
- An **economically profitable model** is reached where forests are capitalized creating resilient landscapes.

- Society in general and the competent administration in particular is **informed** about the real management needs of Catalonia's forests to reduce the risk of the 6th generation of wildfires.
- The **inhabitants of rural areas**, despite not being directly linked to farming, are linked to the necessary instruments that allow forest management with the aim of reducing the risks arising from wildfires.
- The **external services** (security service, landscape discontinuity etc.) offered by professions in the rural world (farming, active forest management etc.) are compensated.

### 6.2.3. Resilience in wildfire emergency management

Main challenges foreseen for 2030 in the LL of Catalonia regarding the emergency phase are:

- There is **effective coordination** framed under a clear legal framework between extinction groups at regional, state and European level that allows decisions to be made following shared criteria.
- There is a standardized **flow of information** between the emergency bodies which improves their coordination and operational capacity.
- Extensive **knowledge** of extreme wildfires is available, and training is facilitated for all technical, political and social sectors.
- There are efficient and consistent **regulations** that:
    - Include criteria agreed between the main actors to define the order of prioritization when it comes to protecting the different assets at risk.
    - Collect the responsibilities of the actors involved in the management of the emergency and supports their action.
    - Simplify administrative processes by adapting them to the needs arising from an emergency.
    - Include innovative strategies for wildfire management, for example, the "let it burn" strategy.
- If necessary, the **evacuation or confinement** of the local population can be carried out effectively and the criteria for establishing them are clear.
- The **working conditions** of the workers of the emergency organizations are suitable for their execution.
- Those responsible for making decisions have new **technologies** that provide information related to the prediction of the evolution of the fire as well as the identification of the most effective and safe strategies to minimize the impact of fires.
- **Civil society** is aware of the risk posed by the 6th generation of wildfires, of the strategies used by firefighting agencies ("let it burn", prioritizing common goods etc.) and of the existence of a regulatory framework that regulates them.
- The risk of suffering effects from **overexposure to smoke** is minimal.

#### 6.2.4. Resilience in post-fire management and adaptation

Main challenges foreseen for 2030 in the LL of Catalonia regarding the post-fire management and adaptation phase are:

- To have **information on silvicultural practices** (identification of non-native species, genetic diversity, clearing, regeneration, etc.) adapted to the new climatic conditions expected for Mediterranean climates.
- Having defined agreed **territorial objectives** at an economic, social and ecological level to face the challenge of large wildfires in the medium to long term with better conditions. This is a transversal work that must be carried out between the different departments of the competent administration and relevant actors for the benefit of the public interest.
- Have **flexible regulations** adjusted to local situations and needs as well as to the uncertainty inherent in wildfires to facilitate the implementation of the necessary actions to achieve the established objectives (changes in land use to reduce the available biomass, creation of new housing to facilitate the establishment of population in rural areas etc.).
- Have **sufficient public funding** to recover the natural spaces affected by fires without the need to redirect existing resources or depend on European funding.
- **Optimize available resources** according to their effectiveness and impact measured periodically with quantitative and qualitative indicators with a scientific basis.
- Have a **systematic and independent assessment of fire management** to assess the actions taken, increase knowledge and be able to improve future actions.
- Have **effective mechanisms to help society** recover psychologically after a fire.
- Communicate adequately **verified information** with a scientific basis so that the population understands the actions in the territory and the justification for the change in regulations.

## 6.3. Gaps to reach that vision

### 6.3.1. Preparedness and prevention phase

Main gaps for the preparedness and prevention phase identified in Catalonia are:

- There is no **active forest management**. The exploitation of wood in Catalonia represents only 30% of the annual growth of forests, which are concentrated in 10% of the territory.
- The **competence of fire prevention planning** (the Forest Fire Prevention Plans (PPI)) belongs to the town councils. These, especially the small ones, do not have sufficient resources to develop this competence which ends up becoming a heavy bureaucracy that is neither feasible nor practical.
- **Rural abandonment**, particularly of the farming activity, which entails:

  - Loss of the agro-forestry mosaic through the expansion of the forest towards previous agricultural plots - which due to fires implies a greater **continuity of fuel**,
  - An increase in biomass within the forest - which, due to fires, means **more fuel**,
  - Loss of the **indirect services** they provide: ignition monitoring, infrastructure maintenance and discontinuities, and
  - Reduction of complexity in **evacuation** in risky situations.
- The **technical documentation** necessary for wildfire risk prevention and management is not readily available even though there is a technology created expressly for the exchange of data between the agents involved (Cooperem platform).
- Many urbanizations have a high risk of suffering damage and other consequences such as human impacts caused by wildfires due to insufficient management of the **wildland-urban interface**.
- There is an unresolved problem to manage the territory in the face of the fires we have suffered so far, for example, the wildfire of Santa Coloma de Queralt in 2021 or Torrefeta and Florejacs (La Segarra) in 2025. Extreme wildfires add **new challenges** that will have to be addressed in parallel to the ones we already have.
- Existing **infrastructures** used by fire brigades may become obsolete in the face of the 6$^{th}$ generation of wildfires. For example, it is not known whether the current water points will be useful in future scenarios with more drought or, sometimes, it is not known who owns the land where this type of infrastructure is located.
- The agricultural fields in the landscape create discontinuities in the fuel that provide a **security service** to other parts of the territory. Currently, this externality is not recognized, nor accounted for, nor rewarded. The lines of subsidies in agriculture still reward productivity, leaving aside external services like this.
- There is a **lack of knowledge** on the part of civil society about the phenomenon of fires which generates problems related to the lack of prevention and maintenance tasks in the most sensitive forest areas.

### 6.3.2. Detection phase

No gaps are identified in the detection phase in Catalonia. This is because it is a highly populated area, and wildfires are detected by the local population and communicated to the emergency services through a 112 call. Also, a network of watch towers and field teams contribute to localize the exact situation of the wildfire.

### 6.3.3. Response phase

Main gaps for the response phase identified in Catalonia are:

- There is a lack of evidence and regulations on the **common good** to be able to manage the fire and prioritize the assets to be protected by the extinguishing bodies.
- In emergency situations where **quick decisions** must be made, priority is given to the criteria of professionals based on their knowledge and experience. In a situation of paradigm shift, this knowledge and experience may become insufficient, but existing fire spread simulators are slow and not always reliable.
- **Emergency management strategies** are limited due to an increase in the risk of simultaneity in a context of climate change and the difficulty of predicting the behaviour of the 6$^{th}$ generation of wildfires.
- There is a **lack of knowledge** about the behaviour of wildfires, especially those of the sixth generation, and more so in a context of climate change, where the observed behaviours do not have historical records.
- **Wildfire monitoring tools** are not effective.
- The **coordination and collaboration** between the different actors involved in emergency management (emergency bodies, farmers, local population) is neither sufficient nor optimal. This fact, together with the lack of tools that allow the sharing of information in real time between the actors involved in the management of a wildfire, means that the **operational capacity** of the bodies that do not work directly in the decision-making of extinction (Forest Defense Groups, Rural Agents, Police, etc.) is lower than its potential. There is a feeling of "bunkerization" of information and decisions between the different bodies.
- There is a **lack of knowledge from the civil society** about the phenomenon of wildfires which creates problems in the organization and collaboration between it and the extinguishing bodies during the emergency. There is a lack of trust between society and the emergency services, and also between them.
- There is a risk of **labour accidents** on the part of the emergency services, one of them which is not well studied or monitored is due to **smoke exposure** mainly by the extinguishing equipment, but sometimes for nearby towns.
- The existing **regulations** are complex and sometimes inconsistent. This fact makes it difficult to know the legal framework that protects the action of the different actors involved in the **management** of the emergency and therefore, its application and the definition of **responsibilities**. In addition, excessively long **administrative processes** do not fit the urgent needs that arise in an emergency.
- There is a lack of **territorial mapping** (urban planning, infrastructure, biodiversity etc.) at the level of Catalonia that facilitates decision-making in the event of an emergency.
- There is a lack of greater **awareness and education** about the realities of wildfires that lead to greater self-protection, key in the emergency phase. This awareness must be adapted to the type of target society: rural, urban, urban-forest interface.
- We are at a time when emergencies are global (mobilization of international aid, large-scale smoke effects etc.) but many times the responses are national or

regionalised. The vision of scale and the improvement of **interoperability** between regions and countries is missing.

### 6.3.4. Restoration and adaptation phases

Main gaps for the restoration and adaptation phases identified in Catalonia are:

- Wildfires generate relevant and diverse **impacts** such as increase in soil erosion (with the help of intense rains), reduction of the seed bank, increase in depopulation in rural areas, loss of heritage (cultural, property, populations protected at European level etc.) or psychological impacts on the local population that are not adequately addressed.
- There is no **land planning** that plans ex-ante post-wildfire measures that improve the territory's resilience to wildfires in economic, social and environmental terms.
- There is **limited knowledge** on technical aspects such as the recovery of ecosystem services (natural dynamics vs. forestry actions) or on administrative aspects such as ownership of small plots (absenteeism).
- Current **regulations** make it difficult or limit possible actions to improve restoration and post-fire adaptation. For example:
    - The special emergency plan for wildfires in Catalonia (INFOCAT) has a very underdeveloped recovery phase (Recovery Plan),
    - It is difficult to act in private forests to create resilient forests even if it is planned and budgeted, or
    - It is difficult to make changes in the land uses to achieve resilient landscapes (a forest that has grown in an abandoned field cannot return to agricultural use). There are exceptions if you are in a PPP or a PEIN, but the procedures are so many and so complicated that they end up not being done.
- **Insufficient resources** make it difficult to achieve set objectives. For example, it is not always possible to:
    - "Recover" ecosystems adapted to the new conditions of climate change,
    - Identify the wildfire causes,
    - Analyse wildfire evolution and diagnose the severity of the wildfire, or
    - Generate knowledge for improved future land management
- **Optimization of resources**. Sometimes, the opportunity that a wildfire gives to generate a fire-resilient territory is wasted by repopulating with species that were there and that are not adapted to the new conditions expected due to climate change.
- **Communication** about the post-fire phase is insufficient or poor. On the one hand, the post-fire problems that arise and the forest management needs that may arise from repopulations are not well communicated to society. On the other hand, the guidelines for sustainable forest management that are given to owners are confusing.

## 6.4. Steps and milestones: the roadmap

### 3.4.1. Progress achieved during the project (at CWI level)

The Community of Wildfire Innovations (CWI) in the Catalan Living Lab (translated to Catalan as "*Comunitat d'Innovació en Incendis Forestals a Catalunya*", CIIFCat) is made up of 37 departments belonging to 24 entities that were selected because of their competences and responsibilities or because how they are affected by the wildfire management activities. Most departments (20) belong to entities from (5) regional and (5) local public administrations with competences on landscape management, civil protection and emergency bodies, rural development and nature protection. However, (5) private, (6) scientific and (3) social entities representing the four-helix of innovation participated in all meetings as well. The whole community has engaged four times during the FIRE-RES project, and several preparation meetings were held with key entities.

The **1st CWI meeting** was held in Solsona on 24/10/2022 with the objectives of 1) establishing the CWI at the Catalan LL, defined as a group of relevant actors in Catalonia to discuss extreme wildfires in Catalonia and establish a roadmap, 2) identifying the current situation and anticipated critical factors for integrated fire management and wildfire resilience, 3) agreeing on a common vision and key areas of intervention to achieve resilient landscapes in Catalonia by 2030, and 4) predicting what gaps and solutions are necessary to optimize available resources and achieve the defined objectives. In total, 36 persons attended the meeting in representation of 19 entities or departments. The results of this meeting contributed to complete sections 6.2 and 6.3 of this report.


*Figure 26: CWI group picture during the 1st meeting in the CTFC headquarters in Solsona (24/10/2022).*

The **2nd CWI meeting** was held in the Environmental Education Centre Can Coll in Cerdanyola del Vallès (Collserola) on 22/05/2024 with the objective of discussing the implementation in Catalonia of solutions developed within the framework of the FIRE-RES project. In total, 60 persons attended the meeting in representation of 29 entities or departments. In total, 11 FIRE-RES Innovation Actions implemented in the Catalan LL were

presented, and, for each of them, the questions of "*When?*", "*How?*" and "*Who?*" regarding the full implementation of each Innovation Action was discussed.


*Figure 27: CWI group picture during the 2nd meeting in Can Coll, Cerdanyola del Vallès (22/05/2024).*

The **3rd CWI meeting** was held in Solsona on 04/10/2024 with the objective of identifying measures to enhance synergies between sectoral policies. In total, 47 persons attended the meeting in representation of 27 entities or departments. The meeting started with the presentation of 3 FIRE-RES Innovation Actions related to the policy coherence workshop that followed. This workshop was organized on 4 areas: 1) Implementation of resilient landscapes and the agro-forestry bioeconomy for wildfire risk reduction, 2) Integration of wildfire risk in territorial and urban planning, 3) Improving the protection of the population against the growing risk of wildfires, and 4) Management of wildfire risk in conservation and restoration of forest ecosystems. Discussions in each area was driven by a mentor from the public administration with administrative competences on the area. Previously, preparatory meetings with the mentors were organized for each area to identify relevant topics where to focus the discussion. The initial draft of the roadmap presented in section 6.4.3 of this report was built from the results of this discussion.


*Figure 28: CWI group picture during the 3rd meeting in the CTFC headquarters, Solsona (04/10/2024).*

The **4th CWI meeting** was held in Mon Sant Benet, Sant Fruitós de Bages, on 13/05/2025 with the objective of presenting and discussing the draft of the roadmap for resilient landscapes to extreme wildfires in Catalonia (a preliminary version of section 6.4.3 of this report). In total, 53 persons attended the meeting in representation of 19 entities or departments. This meeting and the following weeks were an opportunity for the CWI members to provide comments on the roadmap text draft delivered before the meeting. All comments received during the meeting and the following weeks contributed to the roadmap final version (section 6.4.3).


*Figure 29: CWI group picture during the 4th meeting in the Mon Sant Benet, Sant Fruitós de Bages (13/05/2025).*

### 3.4.2. The IA demonstration results at LL level

*IA1.1 Forest Fire Potential Polygons methodology to improve decision making*

In Catalonia, the methodology of Forest Fire Potential Polygons was tested by the Catalan Fire and Rescue Service (CFRS) during a number of significant wildfire events. Notably, it was applied to the Santa Coloma de Queralt fire in 2021, which marked one of the first EWE in the region. This methodology was used to incorporate EWE behaviour into the scenario, allowing for more accurate decision-making. The approach was also extended to other incidents such as the Montgrí (2021), Castellví de Rosanes (2021), and Pont de Vilomara (2022) wildfires in subsequent years. The adaptation has helped enhance predictive capabilities and operational planning during EWE conditions.

*IA1.2 Key inputs for atmospheric data analysis*

Due to limitations in available radar tools and data, only partial implementation of the full methodology outlined in D1.4 was possible. In the Catalan LL, radiosondes were introduced in Catalonia to capture key atmospheric parameters associated with pyroconvection phenomena during wildfires. Their initial deployment occurred during the Santa Coloma de Queralt fire in 2021, using the Windsond S1H3-R model. Nevertheless, the radiosondes provided valuable insights and were used again in 2025 during the Torrefeta i Florejacs wildfire. This technology has since been integrated into CFRS protocols for monitoring wildfires with potential extreme behaviour.

*IA1.3 Early-warning indicators of EWEs*

Accurate and timely warnings are essential to prevent and mitigate the impacts of EWE. In IA1.3 we used advanced probabilistic modelling to forecast the daily occurrence of EWEs at an 8 km resolution across Europe up to 9 days in advance. Our model significantly improved the current estimation of EWE probability while providing key insights into the environmental and climatic drivers of EWEs. Compared to the Fire Weather Index (FWI), our model increased precision by a factor 5 for EWE predictions at the NUTS3 level and by a factor of 10 at 8km resolution. To assess further assess it operational relevance, we evaluated the model's forecasting skill in a test area. Our results demonstrate that EWE forecasts up to nine days in advance outperformed FWI- based nowcasts, emphasizing the model's potential for operational use and its superiority in anticipating EWEs compared to current fire danger rating systems

*IA1.4 Integrated fire management model*

Catalonia advanced its Integrated Fire Management (IFM) model by focusing on strategic landscape planning and the implementation of planned actions. This included the regular use of prescribed burns, particularly in sensitive or novel ecosystems such as those dominated by *Pinus uncinata*. These practices supported not only fuel management but also community training, cross-agency coordination, and testing of technologies. In addition, Catalonia showed examples of strategic fire management plans, such as the one in Vall d'Aran, which blends conventional prescribed burns with selective wildland fire use. The region also compiled a collection of management plans and landscape protection initiatives that guide sustainable fire regimes.

In addition, to enhance knowledge sharing on prescribed burning, FIRE-RES launched an online database to gather information on its ecological effects across Europe. This platform, available at https://rxburn.ctfc.cat/, supports both researchers and fire managers. In parallel, CTFC is leading the development of a handbook on sustainable fire management practices. The guide draws from experiences across various countries, including Spain, France, Portugal, and Italy, and is intended to support fire-inclusive strategies, including legal frameworks and public engagement.

*IA1.5 Post-fire restoration and adaptation strategies*

Preventive and post-fire restoration actions to mitigate EWEs impacts were implemented in the LL Catalonia. As a preventive measure, silvicultural treatments with a twofold goal of preventing EWEs and improving pastures were carried out on 18 ha of Pinus sylvestris forests in Soriguera, a new fire area located in the Pyrenees. Treatments consisted in two thinning intensities (high, with final canopy cover of 50%, and very high, with final canopy cover of 30%), using the stem-only harvesting technique for tree removal. The understory was cleared with mechanical tools when its cover exceeded 30%, and woody residues were cut into pieces no longer than 1 meter. Fire behaviour simulation models were used to assess the reduction in wildfire impacts following treatments. A subsequent slash burning treatment is planned. As a post-fire restoration measure, approximately 2,600 Aleppo pine (*Pinus halepensis*) seedlings were planted on a slope affected by a wildfire that had burned three years earlier, to support vegetation recovery and prevent soil loss. To ensure successful regeneration and restore forest cover, assisted migration actions were implemented using different Aleppo pine provenances, with the aim to explore their adaptation to the anticipated local climate aridification. Seedling were planted across 4 ha of the wildfire perimeter.

*IA2.1 Data acquisition for landscape design*

The main goal of IA 2.1 has been to provide innovative methodologies based on Earth Observation data, to generate scalable key geoinformation to take preventive decisions, about the state and changes of the forestland related to clearcuts, damages, WUI, pathways or fuel:

- Innovative results have been carried out on the use of new LiDAR data and a new model for fuel determination from identification of different forestland morphologies at Catalonia Living Lab.
- With the use of new high density airborne LiDAR data has been feasible to elaborate models to obtain key metrics of the forestland state and changes of WUI or trafficability of firefighters' pathways. The results of the validation with the 2025 field campaign will be further documented in D2.10 to be finalized in October 2025 (M47). These results offer us the possibility to develop a different approach to evaluate key metrics of the WUI, avoiding LIDAR datasets, in terms of cost, availability of costly sensor and operational constrains or flight campaigns, not always viable. This new approach uses more accessible and

viable in terms of cost data inputs, from satellite and photogrammetric derived products to derive state of WUI.

*IA2.2 Novel management practices - Component 2*

The main objective was to provide a methodology to facilitate the implementation of cost-effective management practices at stand level aimed at creating resilient landscapes to EWE. Forest management options were parameterized based on general recommendations and concepts developed within WP1 and specific forest management guidelines/silvicultural models available for main forest species. The methodology included the selection and monitoring of parameters and indicators (e.g., stand density, forest cover, understory cover, etc.) that needed to be (i) linked to management options and pre- and post-treatment conditions, and (ii) integrated into fire simulators and decision support systems (DSS) for cost-effective evaluation of novel management alternatives. To that end, forest types, management scenarios, and dasometric parameters of forest structures were first defined. Then, pre- and post-treatment structures derived for all management scenarios and forest types were used to simulate fire behaviour and incorporated in a DSS to evaluate the most cost-effective treatment at each forest type.

*IA2.2 Novel management practices - Component 3*

The in-field activity in LL CAT focused on fuel reduction operations in Mediterranean forest stands with innovative light multipurpose machinery. Namely, a Malwa Combi 560C has been selected due to its flexibility (a single machine can harvest trees down to 2 cm in diameter and forward the produced timber) small size (with less than 2.5 m) and safety. The machine was tested and demonstrated on three *Pinus halepensis* stands with variable density, representing the different post-fire regeneration stages for this species. Comparison with the current work system resulted in cost reduction up to 75%. Overall, 66 persons participated to the public demonstration.

*IA2.3 Recommendations for improving security on WUI Component 2 (Creating barriers to fire spread)*

In our study, we focused on the northwestern region of Catalonia, a mountainous area divided into eight zones with similar fire regimes and weather conditions. The landscape we worked with is mostly forests (53%), shrublands (15%), and grasslands (14%), based on the Spanish forest map (MFE25). We used 61 dynamic weather scenarios from the Previncat server, selecting those that represented the most extreme historical fire conditions. We also identified key values at risk, including urban areas, archaeological and paleontological sites, and Natura 2000 zones with important flora or fauna. To estimate wildfire behaviour, we ran 5,000 wildfire simulations using the Cell2Fire-SB system. Each simulation included a random ignition, weather scenario, and fire duration ranging from 6 to 36 hours. Our methodology began with 10,000 stochastic fire simulations. We calculated burn probability and DPV (Downstream Protection Value) using a risk exposure layer, selected high-risk cells for treatment, and then ran new simulations to assess how well the treatment reduced risk. We created three risk instances: R1 considered only the burnt area; R2 added urban zones; and R3 included five risk types—burnt area, urban zones, floristic zones, and archaeological and paleontological sites—to better evaluate

different prioritization strategies. The results showed a reduction up to 36% in combined risk (R3) loss using only 5% of the available fuels treated.

*IA2.4 Landscape and fire management policies to minimize expected losses - Component 1 (Fuel Treatment Optimization Study)*

The wildfire fuel treatment analysis in Catalonia evaluated 1.06 million hectares across 43 Comarques (administrative level) to assess how spatially optimized interventions can support six key objectives: reducing fire exposure to communities and protected areas, lowering ignition probability, mitigating wildfire hazard, retrieving biomass, and protecting carbon stocks. Spatial optimization clearly outperformed conventional allocation methods. When 250,000 hectares were treated, optimized plans reduced community exposure by 25%, protected areas exposure by 31%, and ignition probability by 11%, while non-optimized methods achieved only 3–8% across these objectives. Three 10-year strategic plans were developed. The community exposure plan (255,000 ha) reached 25% attainment, also yielding the same results for protected areas sources, 13% for carbon, 10% for ignition and hazard, and 8% for biomass. The protected areas sources plan (272,000 ha) achieved 30% for its main objective, 18% for community exposure sources, 14% for carbon, 12% for hazard, and 10% for biomass and ignition. The ignition probability plan (511,000 ha) produced 18% for ignition, with co-benefits including 27% for carbon and 22% for biomass, plus 20–24% for community and protected areas exposure sources. Roughly 120,000 hectares met at least two objectives and 30,000 met all three, providing opportunities for efficient multi-benefit planning. An equity-based allocation where all Comarques received the same treatment area achieved 18% for community exposure sources, 22% for protected areas exposure sources, and 7% for ignition probability. Some Comarques, such as Vallès Occidental and Baix Empordà, still performed well. Trade-off analyses revealed moderate to strong conflicts, especially between community exposure sources and biomass, or against protected area sources, while fire hazard vs. ignition probability revealed very strong trade-offs.

*IA2.5 Strategic networks of managed areas*

The proposed methodology was applied at two different scales, one at regional level, and another at local/county level. For the regional case, that defined the overall search of indicators, 12 stakeholders participated on the initial meetings. Five criterion groups were selected, being 22 the indicators that defined them. While the general groups related to fuel hazard, fire behaviour, exposed values, and accessibility of firefighter was common to other living labs, in this case large scale indicators associated to the spatial aggregation of fuels and fire regimes was considered relevant. From all the criterion, fire behaviour was given more relevance than other drivers, and fire intensity was selected as the more relevant indicator to be considered. Similar to Portugal, the accumulation of shrubs was also an important issue, meaning that management based on shrub removal, and probably though the use of prescribed burning had to be considered in many areas. While the regional level may be relevant for policy making, and allocation of strategic budgets, when defining where and what management has to be implemented, a more local approach has to be considered. When prioritizing the management areas on La Garrotxa

d'Empordà, with a smaller decision group, two relevant results appear. First, that a refinement of data is required, and broad level data needs from some specific spatial assessment and update. Second, that goals and associated criteria are not the same on a smaller area, where problems and knowledge are more specific. In this case for example, the continuity criteria that is relevant for zoning a region, is not important at all at local scale. Other indicators can be eliminated of the study, as for example in this case, the fire intensity (the most relevant metric at regional level), distance to recreation areas, and road density, were considered of no relevance for the study.

*IA2.6 Post-fire restoration strategies*

The framework was first implemented in the case study of the Ribera d'Ebre wildfire, which occurred in June 2019 in the province of Tarragona. Key factors influencing post-fire regeneration—such as fire severity, soil erodibility, topography, and vegetation type—were identified through expert panel discussions. Each criterion and sub-criterion was assigned specific weights and utility functions. These elements were then integrated to produce a final priority restoration map, combining all factors to classify areas by restoration priority, from lowest to highest. The same procedure was subsequently applied to more than 20 wildfires that occurred in Catalonia over the past decade. These maps are intended to support decision-making following an extreme wildfire event (EWE). Once high-priority restoration areas have been identified, a restoration action plan must be developed, outlining the specific post-fire management strategies to be implemented. These interventions serve as the first line of defence, aiming to protect the soil, minimize erosion, and reduce surface runoff.

*IA2.7 Landscape design strategies (Soriguera)*

The impact of forest growth and management was evaluated in Soriguera (111 165 ha), focusing on ecosystem services: biomass, timber, and mushroom production; carbon sequestration; wildfire prevention (potential stand damage); and scenic beauty.

Three scenarios were applied to their impact on service provision and fire mitigation. The first scenario focused on the optimization of forest management without restrictions; the second to integrating spatially planned fuel breaks; and the third to combining biodiversity and pasture restoration objectives with fire prevention. While the first two scenarios were defined based on the combination of optimization goals, the third scenario included direct management recommendations based on the opinion of experts and stakeholders. Results showed differences between the results of the forest plans. Scenario 1 favoured the provision of several ecosystem services, but at the same time having a limited effect on the mitigation of fire risk. The selection of management alternatives by experts provided similar results as those of the scenario 1 where the yield of Ess was maximized. Scenario 2 was the only that had a big impact on reducing fire risk. Generating a method that removes fuel on strategic areas, where fire is more prone to spread should be the basis of limiting the impact of fires. Still, it has to be considered, that if the reduction of fire occurrence probability is not considered to adjust the provision of services, as it is in pour case, the loss of forest area and the cost of modifying

the land use, may reflect on a negative impact on services yield. Identify, potential land uses, that not only provide a fuel-break function, but generate additional services to the landscape, should be a goal to be active in the near future.

*IA2.8 Environmental Services trade-off assessment (Soriguera)*

Forest growth and yield simulations were conducted for a 111,165-hectare forest landscape in Soriguera, subdivided into 5,261 management units. Each unit was assigned a management alternative reflecting local silvicultural practices, including various thinning and harvesting methods. For each alternative, ecosystem services were quantified, including biomass and timber production, mushroom yield, carbon sequestration, wildfire prevention (through reduced stand damage), and scenic beauty. All data preparation is complete, and the formulation of a multi-objective optimization model using the Pareto frontier approach is currently underway. The trade-off analysis is expected to be finalized in the coming months.

*IA3.1 Fire wine*

IA 3.1 has been developed conceptually for the LL of Catalonia, Portugal, Aquitaine and Sardegna, yet its testing phase will take place in LL Catalonia. Through field visits, bilateral meetings, and stakeholder workshops in wine-producing regions that suffered fires, we defined a methodology to launch a trademark that is attractive for land managers and gives evidence of the positive externality they are producing for the landscape resilience. The initial exploratory, qualitative process involved 87 producers, local experts, and territorial catalysers. These findings a concrete proposal were contrasted through an online survey, which gathered 158 complete answers. That was the basis for a scientific article grounding the supply-side perspective (see Górriz-Mifsud, E. & al 2025). These insights are crystalizing in a set of requirements for usage of the label, as well as the corresponding business model -that aims at having a negligible burden for farmers while being economically feasible. A specific website and basic social media are active to further disseminate the advances.

Several national and international, both mass and specialized media, have referred to the FireWine label initiative. Presentation in different specialised congresses have been also done in France, Spain, Italy and Portugal. In 2025 the label has been registered at the EU level, and first contracts are expected during summer-autumn 2025.

*IA3.2 Financial incentives*

Wildfire prevention requires coordinated fuel management across large, continuous areas. However, in many regions (particularly in the mid and western South of Europe), forests are fragmented among multiple private owners, making it difficult to achieve an effective scale of intervention. To address this, the Innovation Action 3.2 has designed and tested an innovative subsidy design known as agglomeration bonus in LL Catalonia. This scheme offers landowners a base payment for applying fire-preventive forest management on their land, plus an additional bonus if adjacent landowners also participate. The goal is to create an economic incentive for coordination, increasing the likelihood of widespread, contiguous fire-resilient zones.

To study the adequacy of this subsidy, we conducted behavioural economics experiments with both forest owners and students to test five variations of this scheme. The results show a wide acceptance of the scheme, with more prominent coordination when wildfire risk is perceived and there are channels for direct communication among neighbours. In contrast, additional transaction costs (e.g., administrative hurdles) and uncertain eligibility (such as prioritisation criteria) reduce willingness to cooperate. Interestingly, the negative influence of a non-participating neighbour is stronger than the positive influence of a participating one. Also, higher bonus amounts consistently lead to greater cooperation.

These findings highlight the potential of well-designed incentives to improve collective action in fragmented landscapes, ultimately increasing the effectiveness of wildfire prevention strategies.

*IA3.3 Parametric solutions for insurance products*

A parametric fire insurance scheme, developed under Innovation Action 3.3: Parametric Solutions for Insurance Products, was tested in the Catalonia Living Lab. This approach employs a trigger mechanism based on a stochastic fire probability model trained on historical data, optionally enhanced with satellite observations. A calculation agent is integrated to estimate forestry-sector losses. During testing, fire probabilities from recent years were computed, identifying triggered scenarios across multiple regional forest assets. Results demonstrate that the generated triggers correlate with actual losses, suggesting strong potential for forest insurance applications.

A key advantage for this region is the ignition probability model's ability to account for fires undetected by satellites, which only capture events of sufficient duration and intensity. By incorporating data on smaller fires—common in Catalonia and capable of causing asset losses—the model provides a more comprehensive risk assessment.

The methodology's design, development, and testing are detailed in Deliverables 3.5, 3.6, 3.7, and 3.8. These findings highlight the methodology's potential as a reliable tool for parametric insurance products, offering rapid payouts based on predefined fire behaviour thresholds.

*IA4.1 Fire forums*

Catalonia hosted several Fire Forums to foster participatory decision-making in fire-prone areas. The l'Albera – Cap de Creus Fire Forum allowed full implementation of the methodology and directly influenced operational risk assessments through the Firefighting Operartional Emergency Sheets (FOER in Catalan) planning. In La Selva, the forum emphasized a long-term, strategic view but was only partially implemented, with further activities planned for 2025. The Alta Garrotxa Fire Forum engaged a community unfamiliar with wildfire impacts, serving as a prototype for regions transitioning into higher fire risk due to climate change.

*IA4.5 Policy clinics*

The IA 4.5 'Testing regional-level policy clinics for inclusive and coherent fire smart risk governance' applied to the LL Catalonia, identified proposals for adapting and improving the governance of wildfire risk in Catalonia in a context of increasing risk due to the impacts of global change. Key policy areas explored include civil protection, land-use planning, biodiversity conservation, forestry, agriculture, and livestock, while other thematic sectors also warrant consideration. Workshop discussions highlighted governance, legal frameworks, and communication as critical areas needing development, revealing more gaps compared to other aspects like technical resources and financing. A shared conclusion was the urgent need for better coordination among administrative bodies. Though not all policy areas could be addressed, concentrating on four main themes enabled the formulation of targeted recommendations. Catalonia, despite its leadership in risk management, faces new climate-related challenges, prompting the need for a strategic, policy-aligned response.

The IA4.5 results applied in Catalonia would pose the basis for structuring the Strategic Framework for Integrated Wildfire Risk Management in Catalonia, which is part of the WP8 results. It will be presented to the Catalan Wildfire Innovation Community at the end of the FIRE-RES project.

*IA4.6 Firewise planning platform and conceptualization tool*

The IA4.6 Fire-Smart Risk Governance and Planning Legal Framework and Tools introduced three instruments aimed at enhancing the integration of wildfire risk into spatial and urban planning across European landscapes. These tools are: (1) the FireXplorer platform, which provides both citizens and professionals with accessible, up-to-date knowledge and information related to wildfire risk; (2) the Guide for Planners, which outlines a structured methodology for incorporating wildfire risk management into landscape and urban planning; and (3) the Risk Assessment and Planning Application, a digital tool designed to facilitate the integration of wildfire risk assessments into planning processes.

In the context of the Catalan Living Lab, these tools have been tailored to support local needs. Firstly, the FireXplorer platform includes a wide range of Catalan-language resources—such as guides, technical documents and articles—targeted at land and urban planners, landowners, inhabitants, businesses, and public authorities. It also features materials from other regions and countries, offering Catalan users' valuable insights into diverse territorial approaches to wildfire risk management.

Secondly, the Guide for Planners contains dedicated sections marked with the "Living Lab Cat" icon, which highlight region-specific content such as risk assessment maps, regulatory frameworks, and planning recommendations relevant to Catalonia.

Finally, the Risk Assessment and Planning Application is fully available in Catalan and is being populated with real-case risk situations, supporting their management and governance processes.

*IA5.1 Integrative umbrella system for estimating EWE risk and impact*

The ISS application's main page highlights different LLs, including Catalonia. By clicking on this area, you access the implemented solutions and services for the LL. These include:

EUMETSAT and Copernicus services into the ISS to provide users with EWE conditions forecasts.

A pyroconvective simulation system (IA 5.2) from CNRS that includes two simulation tools, i) FOREFIRE wildfire surface spread model and ii) Meso-NH. FOREFIRE addresses the simulation of the fire and smoke behaviour of fires with high potential of EWE. It runs in the LL and has been tested on real wildfire scenarios in the LL.

Weather layers from the SPIRE weather forecast (IA 5.5) from the Basic, Upper-Air and Thunderstorm bundles.

Integration of the CSIC exposure sensors application (IA 5.7) that displays and allows to download the exposure data from sensors in Catalonia.

Integration with the CFRS external information sharing system (IA 5.9). CFRS provided the means to interchange operational information of ongoing wildfire incidents with the ISS.

Integration of the ICGC application (IA 5.3) that takes as an input temporal series over wildfires allocated over the LL by processing satellite images and returning as output indexes values (ICV, dNBR, NDVI).

Daily wildfire risk simulation solution (FireRisk) and an operational wildfire simulator adapted to EWE conditions (FireSim) in the approach of IA 5.2. The first, it provides a daily risk assessment forecast for each 3 hours, for a total of 96h of risk.

Daily creation of high-resolution weather data solution for the LL, a 96h high-resolution weather forecast (1-2 km spatial resolution) for 45 variables.

*IA5.2 Real-time EWE simulation and smoke spread*

A daily wildfire risk simulation solution, and an operational wildfire simulator adapted to EWE conditions have been developed in the approach of IA5.2 and implemented in the ISS, both implemented by TSYLVA. Regarding the first, it provides a daily risk assessment forecast for each 3 hours, for a total of 96h of risk forecast for the LL. It provides as output a set of layers corresponding to the calculated wildfire risk assessment metrics as well as territory fuel moisture metrics. Regarding the operational simulator FireSim, the implemented fire simulator features two main simulation modes, the standard fire propagation mode and a probabilistic simulation mode. The solution includes an EWE adjustment factor which is based on the inclusion of the forecast of the Lifted Index weather variable provided by SPIRE.

Both solutions make use of base data such as vegetation fuel maps, LL boundary maps, population and buildings data, among other, that has been gathered and provided by the addressed LL.

Also, it includes the generation of daily high-resolution weather forecast data for the LL, a 96h high-resolution weather forecast (1-2 km spatial resolution) for 45 variables.

Furthermore, the ISS integrates the pyroconvective simulation system from CNRS that includes two simulation tools, i) FOREFIRE wildfire surface spread model and ii) Meso-NH. FOREFIRE addresses the simulation of the fire and smoke behaviour of fires with high potential of EWE. It runs in the LL and has been tested on real wildfire scenarios in the LL.

*IA5.3 Advanced vegetation characterization*

The main goal of I.A. 5.3 has been to develop innovative methodologies to check forestland resilience, monitor post-fire vegetation recovery (e.g. geospatial wildfire contours, fire severity, CO2eq emissions, temporal series). An operational workflow has been implemented through a new code/API that takes as an input temporal series over wildfires allocated over Living Lab Cat and return automatized output indexes values (ICV, dNBR, NDVI):

- Development of an operational methodology to generate spectral indexes (referenced indexes and a new one developed-ICV) based on Copernicus data to build up temporal series and data fusion with Canopy High Model and land cover maps to evaluate C02 total emissions.
- Development of a code/API that takes as an input temporal series over wildfires allocated over Living Lab Cat by processing satellite images and return as output indexes values (ICV, dNBR, NDVI).
- Testing of an A.I. models to predict and readjust the evolution of forestland recovery post wildfire

*IA5.6 High Altitude Pseudo Satellites*

Catalonia's HAPS strategy involves no deployment in May due to a lack of historical fires, followed by a consistent assignment of one HAPS from June through September. In addition, there were up to 2 HAPS at Pan-European level to cover the peaks in the Southern Living Labs. The simulation of this fleet approach achieves in Catalonia 100% burnt area coverage, ensures HAPS arrive within less than 3-hour timeframe, and maintains the average burnt area of unmonitored fires below 100 hectares.

*IA5.9 Tools for international collaboration*

Catalonia also worked on improving tools that facilitate communication on EWE scenarios. This involved updating the CFRS public web portal with key messages and real-time data tailored specific for EWE and enhancing a GIS platform to support Fire Analyst collaboration to communicate and collaborate between them. In both cases, the goal was to make critical information available to stakeholders and the public in a timely and accessible manner. In the case of the public web portal, the target was the general public, and the information is shared publicly while in the case of the GIS platform the target are firefighters, and the information is shared internally.

*IA5.10 Pan-European system to define management priorities*

The innovation action "Pan-European System to Define Management Priorities for Mitigating Fire Impact" aimed to design a prototype system for identifying strategic fuel management priorities based on multiple criteria.

To develop this system, we began by defining a set of relevant criteria and assessing the need to model and map these variables. Among the most critical variables were fuel accumulation and potential fire behaviour, which, at the start of the project, were not adequately covered by existing information. During the initial years, the University of Padova mapped all fuel-related variables necessary to estimate fuel accumulation and simulate fire behaviour. This effort resulted in four scientific articles and the development of a server where the information is publicly available for download (https://www.cirgeo.unipd.it/fire-res/app/). Technosylva used this data to simulate high-intensity fire behaviour across the EU. Simultaneously, ISCI developed a multi-criteria decision support system calibrated to the generated data. This system can assign priority scores once the data is harmonized, and criteria are weighted accordingly. Currently, a strategic prioritization exercise is underway for the Iberian Peninsula, demonstrating the supranational capacity of this analysis and illustrating how large-scale, policy-oriented frameworks are most suited for this system. After the Iberian exercise is completed, the multi-criteria system, programmed as a QGIS plugin, will be publicly available.

Looking ahead, we plan to develop a dedicated server where users can easily download relevant data for such analyses. This platform will also store new data, especially concerning values and risk assessments, alongside existing datasets.

### 3.4.3. Next steps until 2030

A **strategic framework to implement resilient landscapes to EWE**, coordinated by the CTFC staff, is the main result of the four CWI meetings in the Catalan LL. This document defines the vision, mission, general objective, specific objectives, principles, and axes and areas of action to implement resilient landscapes to EWE in Catalonia. These axes offer a framework for working with all the actors on which to organize an effective short-term action plan that allows, over a 2030-2035 horizon, to consolidate the implementation of large-scale solutions in a cost-efficient and sustainable manner. The full document, originally in Catalan, has been translated to English and summarized in this section. Specific actions, defined in each area of action in the original framework, has been removed in the shorter version replicated here.

*Vision*

Move towards a Catalonia that is better prepared and more resilient to the growing risk of extreme wildfires by promoting disaster risk reduction strategies as an opportunity for the socio-economic revitalization of the territory, the conservation of forest areas and the natural environment, and the implementation of the climate agenda and sustainable development goals.

*Mission*

Consolidate the capacity to implement and maintain resilient landscapes against the risk of wildfires in Catalonia under the principles of integrated wildfire risk management and to ensure and protect human lives, social and economic development and the health and vitality of ecosystems.

*General objective*

Strengthen technical, financing and governance capacities for the design, development and maintenance of resilient landscapes with the active participation of all administrations and sectoral policies, the local community, private actors and society, allowing progress towards integrated fire risk management that is cost-efficient, sustainable and adapted to the context of extreme wildfires.

*Specific objectives*

1. Improve the coherence of policies and synergies to favour the development and maintenance of resilient landscapes and active management of the territory.
2. Promote the bioeconomy and forestry and agro-livestock management of the territory as a fundamental pillar in reducing the capacity of extreme wildfires to spread.
3. Develop the knowledge, tools and spaces for collaborative decision-making and the innovations necessary to adapt to the changing risk context and the management of uncertainty.
4. Guarantee the health and vitality of forest ecosystems in the face of natural, anthropogenic and changing fire regimes, aligning the restoration and conservation of ecosystems with the reduction of the risk of the spread of extreme wildfires and guaranteeing the provision of ecosystem services.
5. Develop sustainable financing schemes for medium- and long-term landscape transformation projects with public-private partnerships.
6. Define appropriate co-responsibility frameworks between administrations, the private sector and society in general, with the necessary accompanying measures.
7. Improve the economic sustainability of integrated wildfire risk management policies and increase the efficiency of resources dedicated to prevention, preparation, response and recovery.
8. Enhance synergies with wildfire risk management and the mitigation and adaptation of other climate and global risks such as drought, forest diseases and pests or floods.
9. Promote a society better prepared for the growing risk of wildfire, knowledgeable about the phenomenon and a better risk culture.

*Principles*

**Implementation**. Facilitate the transformation of agroforestry landscapes by applying solutions adapted to different scales.

**Sustainability and equity**. Guarantee environmental, economic, social and cultural sustainability in Catalonia in the medium and long term in a fair and inclusive manner.

**Participatory: interdisciplinary, intersectoral and multi-level**. Promote a dynamic and flexible process that includes the participation of multiple agents with competences over the territory, from different disciplines and sectoral areas.

**Effectiveness and efficiency**. Promote synergies and solutions with efficiency and effectiveness criteria to optimize available resources and maximize their impact.

**Innovation**. Encourage the development and access to new knowledge to implement the most optimal solutions to the challenges posed.

*Axes and areas of action*

Within the framework of the project activities, from the organization of the workshops to the implementation of the innovative actions, fifteen areas of action have been identified that are organized into four thematic axes and a transversal axis (Figure 29):

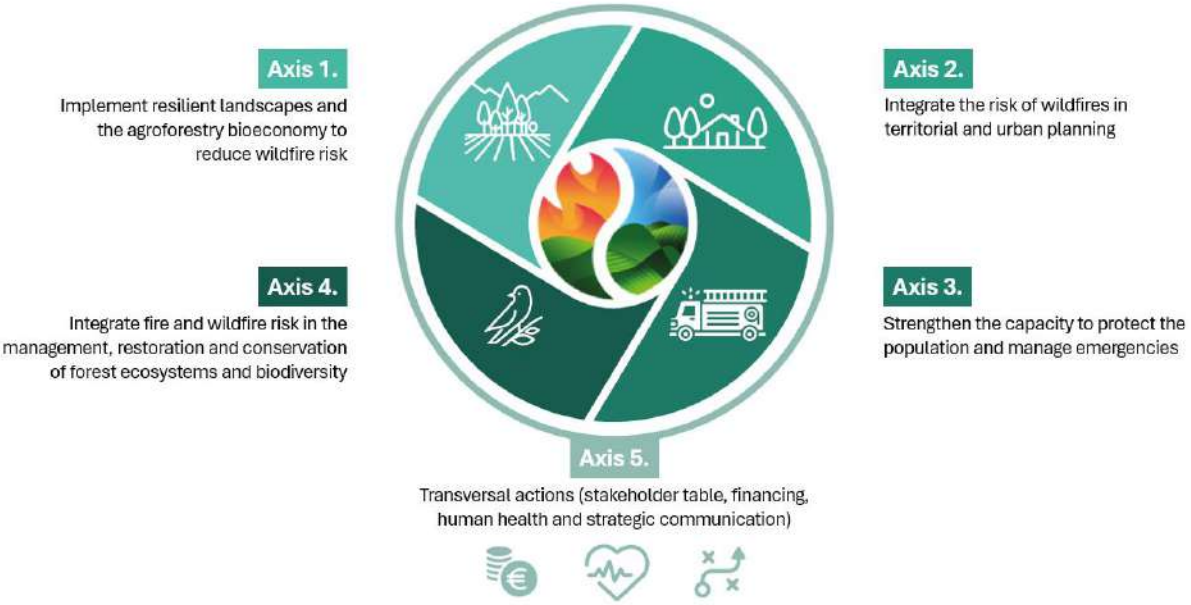


*Figure 30: Action axes in which the strategic framework for the implementation of resilient landscapes in Catalonia is structured.*

**Axis 1.- Implement resilient landscapes and the agroforestry bioeconomy to reduce wildfire risk**

Promote the creation of resilient landscapes and an agroforestry bioeconomy to reduce the risk of fires through inter-departmental coordination, stable financing, public-private involvement and assessment of livestock practices. It is necessary to integrate land uses, prevent risks and strengthen the territory with sustainable management and strategic planning.

- Action area 1.1: Expand the financial capacity to maintain and/or create resilient landscapes in the medium and long term
- Action area 1.2: Articulate synergies between the mosaic landscape and the different uses with risk management

**Axis 2.- Integrate the risk of wildfires in territorial and urban planning**

Adapt regulations, make planning instruments more flexible and promote living and resilient mosaic landscapes, with mapping, governance and active management tools for the territory to prevent and mitigate risks effectively and sustainably.

- Action area 2.1: Adapt sectoral and urban regulations to facilitate resilient landscapes and integrated fire risk management
- Action area 2.2: Integrate risk analysis and mapping in territorial planning
- Action area 2.3: Promote and maintain the mosaic landscape from the territorial planning

**Axis 3.- Strengthen the capacity to protect the population and manage emergencies**

Strengthen the protection of the population and emergency management through planning, flexible regulations, self-protection, education, institutional coordination and communication to promote a culture of risk, guarantee safety and adapt the territory to new climate challenges.

- Action area 3.1: Include the requirements of risk management and emergency management in the design and treatment of infrastructures, settlements and activities
- Action area 3.2: Promote the coordination and exchange of information within the framework of the planning and implementation of INFOCAT and the territorial model of civil protection and emergency management
- Action area 3.3: Strengthen communication and awareness to promote a risk culture adapted to current challenges
- Action area 3.4: Strengthen the extinction capacity through landscape and wildfire management

**Axis 4.- Integrate fire and wildfire risk in the management, restoration and conservation of forest ecosystems and biodiversity**

Promote the integration of fire as an ecological and wildfire risk management tool in the conservation and restoration of ecosystems. The aim is to change the social perception of fire, promote prescribed burns, coordinate policies and stakeholders, and promote integrated planning in protected natural spaces.

- Action area 4.1: Improve knowledge about the use of fire and its role in the health and improvement of ecosystems

- Action area 4.2: Integrate fire ecology and approaches based on natural processes and the use of fire as a management tool in agroforestry management practices, restoration and conservation of forest ecosystems
- Action area 4.3: Incorporate fire risk management and the management of the natural fire process into the planning and management of protected natural areas
- Action area 4.4: Improve governance and the flow of information between biodiversity conservation and risk management policies

**Axis 5.- Transversal actions**

Creation of an intersectoral table, new lines of financing for innovation, and the incorporation of human health and ecosystems as central axes in reducing fire risk, promoting a more prepared and resilient society.

- Action area 5.1: Create the executive commission of the main public and private actors of the highest political rank that establishes resilient landscapes as a country priority to address extreme wildfires
- Action area 5.2: Create lines and funding mechanisms dedicated to the implementation of resilient landscapes to address the transformation of landscapes in the medium and long term
- Action area 5.3: Promote R&D focused on the development of technological innovations and social, ecological and economic solutions to the challenge of extreme wildfires, and the exchange of knowledge and experiences
- Action area 5.4: Align fire management strategies with public and planetary health agendas
- Action area 5.5: Promote strategic communication to reinforce the culture of fire and wildfire risk, the importance of territorial management and to move towards a better prepared society

## 6.5. CWI feedback

After the 1st CWI meeting, the organizers distributed a feedback form with 20 Likert scaled questions ranked from 1 (fully agree) to 5 (fully disagree), and 4 open questions. The Likert scaled questions aimed to receive feedback from the organization of the event, while the open questions aimed to receive suggestions to improve future CWI meetings.

From the answers collected, we highlight that the CWI participants were very satisfied with the organization of the event (1.33 ± 0.22), that the objectives and messages were clear (1.86 ± 0.77 and 1.90 ± 0.68, respectively), the expectations were fulfilled (1.81 ± 0.48), and that the discussions were helpful for their future work development (1.95 + 0.63). Overall, the CWI participants are willing to join the next event (1.81 ± 0.77).

The three themes of the World Caffe implemented during the 1st CWI meeting ("*Diagnosis and anticipated challenges of wildfires in Catalonia*", "*Vision for 2030*", and "*Needs to reach the desired scenario*") were positively evaluated (1.62 ± 0.36, 1.71 ± 0.43, 1.81 ± 0.48, respectively), although in few (3) cases, the participants expressed a time limitation to further discuss the highlighted issues. Some participants (6) indicated that more actors could attend the meeting (e.g., public administration workers related with forest management or more researchers).

The main objective of the 4th CWI meeting was collecting feedback from the participants about the *Strategic framework to implement resilient landscapes to extreme wildfire events in Catalonia*, the main output of the collaborative work with all the community. This feedback was collected on site, and the audience was encouraged to further contribute sending their feedback from email ensuring that had the opportunity to provide the own point of view.

## 6.6. References

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# 7. Chile, Bío-Bío Living Lab (CL)

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## 7.1. Wildfire context

The National Forestry Corporation (CONAF) is currently the main agency in charge of wildfire management in Chile. It will be replaced by the National Forestry Service (SERNAFOR), a new decentralized public institution under the Ministry of Agriculture.

The National Disaster Prevention and Response Service (SENAPRED), created in 2021, integrates wildfire risk management within the broader national disaster management system.

The Chilean Wood Corporation (CORMA) is the main private-sector forestry association, actively involved in wildfire prevention through community networks, firebreaks, and fuel management.

Bomberos de Chile is the national volunteer firefighting organization, responsible for first response to both structural and forest fires across the country.

Carabineros de Chile is the national uniformed police force, supporting wildfire detection, patrols, and control of access during emergencies.

The Investigative Police of Chile (Policía de Investigaciones de Chile, PDI) is the national civil police force, specialized in scientific and technical investigations, including the determination of wildfire causes in coordination with CONAF.

### 7.1.1. Fire regime, socio-ecological context, and impacts

Over the past two decades, Chile has experienced a sustained increase in the occurrence, magnitude, and severity of wildfires. Between the decades 2005–2015 and 2015–2025, wildfire occurrence grew by 14%, while the total burned area increased by 163%, with a territorial shift toward new regions and an expansion of the critical fire season from six to nearly ten operational months. The recurrence of large wildfires, the simultaneity of multiple ignitions, and the consolidation of Extreme Wildfire Events (EWEs) since 2017 have transformed wildfire risk into a structural phenomenon. More than 90% of accumulated damage is concentrated in the wildland–urban interface (WUI), where housing, critical infrastructure, and high fuel loads converge, reflecting the growing vulnerability of the country to such emergencies. Within this scenario, regions such as Bío-Bío have emerged as epicentres of risk, combining high territorial exposure,