FIRE-RES

Innovative technologies & socio-ecological-economic solutions for fire resilient territories in Europe

D8.2 LIVING LABS ROADMAPS TOWARDS SMART FIRE MANAGEMENT AND ACHIEVEMENTS

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Abstract: This internal report presents the drafts of the roadmaps towards wildfire resilient landscapes and the integration of wildfire risk management in the FIRE-RES Living Labs and proofs the achievement of Milestone MS8.2.

Key words: roadmap, challenges, shared vision, forest fires, integrated fire management

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0. Acronyms

AQ: Nouvelle-Aquitaine

BUL: Bulgaria

CAN.IS: Canary Islands

CAT: Catalonia

CL: Chile

CTFC: Forest Science and Technology Centre of Catalonia

CWI: Community of Wildfire Innovations

EWE: Extreme Wildfire Events

FORESTAS: Agenzia forestale regionale de Sardinia

GAL: Galicia

GER-NL: Germany–The Netherlands

GR: Greece

IA: Innovation Actions

IEFC: Institut Européen de la Forêt Cultivée

IFM: Integrated Fire Management

ISA: Instituto Superior de Agronomia – University of Lisbon

ISCI: Instituto de Sistemas Complejos de Ingeniería

LL: Living Lab

NIBIO: Norwegian Institute of Bioeconomy Research

NOR-SW: Norway-Sweden

POR: Portugal

SAR: Sardinia

UAGEAN: University of the Aegean

UF: University of Forestry of Sofia

WU: Wageningen University

WUI: Wildland-Urban Interface

XUNTA: Conselleria do Medio Rural - Xunta de Galicia

1. Introduction – Towards wildfire-resilient landscapes in the FIRE-RES Living Labs

The overarching objective of the FIRE-RES project is to implement a holistic and integrated fire management strategy to efficiently and effectively address the Extreme Wildfire Events (EWE) and demonstrate it on a set of Innovation Actions (IA) that address the three interconnected fire management phases – preparedness/prevention, detection/ response, and restoration/adaptation, across a set of Living Labs that represent different environments in Europe (including EU Outermost regions, e.g., Canary Islands) and beyond (e.g. Chile).

The **Living Labs (LL)** are conceptualised as open innovation socio-ecosystems that operate in a territorial context (local, regional, national, or international) and integrate research and innovation processes within a public-private-citizen association[1]. LLs are co-creation spaces and include intervention zones to test domains to demonstrate and deploy FIRE-RES IAs on the territory, integrating different actors, in different areas and considering all phases of the Fire Management Cycle.

Owing to the eleven different regions involved in the project, covering different socio-ecosystems (e.g. land-use patterns, institutional arrangements, forest and biodiversity) but also fire regimes and fire historic experience (e.g. risk culture), it is understood that each territory will need to adapt the concept of resilient landscapes (the vision) and its operationalisation (the roadmap) to their particular context. Moreover, the related needs (challenges) will be heterogeneous, some of them being already covered by the project innovations, while others may require innovation outside those initially proposed by FIRE-RES -those benefiting from the cross-fertilisation with sister projects and from the opportunity of the Open Innovation Challenge (WP6).

This report builds on Deliverable D8.1 (Prokofieva et al, 2022[2]) and gathers the findings derived from the interactions with the Community of Wildfire Innovation (CWI) in each Living Lab, structuring those according to the following sections:

- **Brief context of the Living Lab**, meaningful for understanding the vision and challenges identified.
- **Vision for wildfire-resilient landscapes in 2030**, including the understanding of "resilient landscape" concept by the CWI, and the future targets they envisage.
- **Gaps to reach that vision**, as operational aspects that need to be tackled, solved and/or improved to reach the vision. It relates with the OIC (WP6).

[1] Zavratnik, V., Superina, A. & Duh, E.S. (2019), Living Labs for Rural Areas: Contextualization of Living Lab Frameworks, Concepts and Practices, Sustainability, 11 (14), 3797.

[2] Prokofieva, I., & Górriz, E. (2022). FIRE-RES D8.1 Living Lab Guidelines. Deliverable 8.1. FIRE-RES project. 25 pages.

- **Steps and Schedule**, as the desired evolution required to reach the vision in the agreed timeframe, taking into account interdependencies (sequential steps) and interaction with other ongoing processes in the region.

The contents of this report can serve as the basis for future scientific or technical articles, comparative analyses, policy documents, etc.

The implementation of the IAs within the LLs take place in specific intervention zones, and the type of stakeholders to involve there are most likely different, as they refer to specific competences and technical profiles. The LL concept in those means the transdisciplinary process to achieve more realistic and adjusted outcomes

2. Methodology

2.1. Overall approach

2.1.1. What is a roadmap?

A roadmap is a concept emerging from strategic management that metaphorically refers to the route or path employed to move from the current place to a future desired location. It compiles the sequence of activities or the evolution steps that will bring to a desired status.

This requires that the organisations know exactly where they are (diagnosis) and, specially, where they aim to go (ideal scenario, objectives). A roadmap is then an operative tool, that graphically intends to show the steps and resources required to achieve the strategic objectives.

In FIRE-RES, the LL will be the platform to co-create the future of a region/country in terms of wildfire-risk, being the final "product" the achievement of fire-resilient landscapes that apply integrated fire management approaches. Drafting the roadmap constitutes the kick-off of the co-creation process, given that such future ideal scenario needs to consider the aspirations, needs and challenges of the different actors with competences and responsibilities or affected by the final output (the "clients").

It will be beyond FIRE-RES the actual implementation and achievement of the roadmap - owing to the diverse administrative competences, political interests, and social conjunctures that are outside the scope of the partners. But the aim of FIRE-RES is to create the platform for its discussion, achieve a document shared by the diverse stakeholders, and find in which gaps our project can contribute to move forward to the desired status. It may also serve as basis for a future R+I agenda in the area, or as gaps observed as crucial to tackle by other stakeholders. The roadmap is also purposeful to manage change, to show progress to the target, and can serve as technical basis of work to develop beyond political cycles. The roadmap-building exercise can be useful as well to show interdependencies and bottlenecks among different stakeholders involved.

2.1.2. How to draft a roadmap in my Living Lab?

At the outset of the project, one of the main activities at the Living Labs level is the development of the roadmap for resilient landscapes employing an Integrated Fire Management (IFM) system. The overall process of roadmap development is outlined in Figure 1.

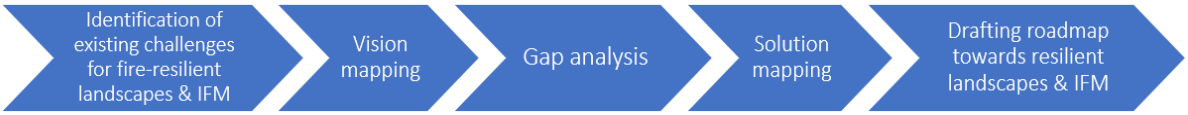

Figure 1. Living Lab roadmap development process.

Below, the different stages of this process are explained.

1. Identification of state of the art and **predicted critical factors for IFM and wildfire resilience**. The first step to develop a roadmap consists in having a current diagnosis and identifying the critical factors that will affect the landscapes that interact with wildfire risk in a certain time horizon (2030, 2050). This is: is my current LL wildfire risk management system prepared for the challenges to come? Is it sustainable with the foreseen changes? These challenges need to consider different stages of fire management – e.g. preparedness/prevention, detection/response, and restoration/adaptation, and furthermore, they must be validated with the CWI. It is important that the participants do not get the impression that they start in this meeting with a white sheet -especially in those LLs where many strategic documents have been developed in the field of wildfire risk management. Therefore, a brief setting of the scene is relevant but focusing on the future challenges.
2. After identifying the challenges[3] for IFM, a **common vision (ideal future, e.g. 2030-2050) for the resilient landscape** will be co-created with the regional CWI, with due consideration of the specificities and particularities of forest fires of each region. It is important to understand that this vision does not represent just one group's point of view, but the alignment of various stakeholders and interest groups within the territory of the Living Lab. This vision needs to be synthetized in some short statements that capture the narrative of the desirable situation, with key variables and indicators -if possible. In this framework, IFM is a holistic way to tackle the future challenges.
3. The third step is to identify the **needs and gaps**[4] that currently exist in the region, and which need to be addressed to reach and fully implement the vision

[3] Challenge (in this context) is an external factor that affects the current wildfire risk management system, or rather an internal factor that makes the current systems not working as desirable. *E.g a challenge in the Mediterranean is the progressive abandonment of mountain agriculture (and foreseen to increase further towards 2030) that previously created a mosaic landscape, and consequently facilitates larger wildfire spread. Another challenge is the long and complex bureaucracy for forest owners to implement their wildfire prevention measures.*

[4] Gaps and needs (in this context) are the required input to reach a final product. The Solutions are the particular tools/mechanisms to fill in these gaps. *E.g. related to the previous examples: 1)*

developed in the previous steps. Back-casting and Gap analysis serve as a prerequisite for developing the required solutions.

4. The fourth step consists of identifying **potential solutions** to close the gaps detected in the previous stage. The output of this step is the identification of **key areas for intervention**, as operationally as possible. Based on those, WP6 Challenge Design Workshops will delve further and detail the challenges (see WP6 Train-the-trainers). Once all the challenges defined by all LLs are compiled, a screening will take place. FIRE-RES IAs may fulfil some of these solutions, but it is not expected that the FIRE-RES IAs offer solutions to all the possible identified needs. It is also important to note that there is a broad scope for cross-fertilization activities across different LLs as well as with the sister projects through collaboration with the FIRELOGUE Coordination and Support Action (CSA) in the context and as an outcome of this step. For those needs not covered by the previous, WP6 will launch an Open Innovation Campaign in order to open the innovation potential to external actors, including experts, academia, start-ups, SMEs, and more. Discovering innovation by external stakeholders is crucial for maximizing the potential of innovation.
5. Finally, once a comprehensive assessment of the current situation, challenges, a vision for the region, and its related needs and gaps are clarified, the final step consists of drafting a **roadmap towards the 2030 vision**. This roadmap will serve as the main guidance document for activities within the Living Lab during the project lifetime, but also beyond it. The roadmap constitutes a Deliverable of the project (D8.2, Month 46). The intention is that this roadmap document could become a reference document – as per its strength of being the result of a widely participative process - in the respective region to trigger necessary changes or to introduce innovative approaches - e.g. a position paper, a white book or similar that can set the basis for a strategy or an action plan on the topic in case the stakeholders consider it appropriate. The roadmap will include periods, activities (considering the short, medium, and long-term), milestones, and a **prioritisation of the needed solutions**, in order to deploy resources in a meaningful order for the stakeholders.
6. In **follow-up CWI meetings** (expected at least one annually), the roadmap will be detailed and consolidated, and the FIRE-RES partners will show to the stakeholders which progresses are being done within the project that mean steps moving towards the desired vision. The stakeholders are then pushed also to engage in

need to find novel economic tools for a profitable mountain agriculture -> possible solutions: payment for their externalities, or crops with increased turnovers. 2) need to reduce the bureaucratic burden, reducing overlappings or incoherences across administrations -> possible solutions: procedures coordinated among two or more administration units where the bottlenecks usually emerge, crossing maps.

that roadmap and commit to advances in some fields. These CWI meetings are then conceptualised as a roadmap monitoring and group assessment tool.

2.2. Co-construction process with the CWI

A **co-construction process** implies that new knowledge is built together among various actors of different profiles. In practice, this implies that many views are engaged from the beginning, which operationalises the systems thinking, which helps in tackling complex societal challenges (as wildfires are), while also increasing the uncertainty on the results of the process. Thus, inclusive moderation is needed to invite all participants to share opinions, experiences, etc. For this reason, CWI needs to be comprehensive of the four-helix of the innovation system (Figure 2).

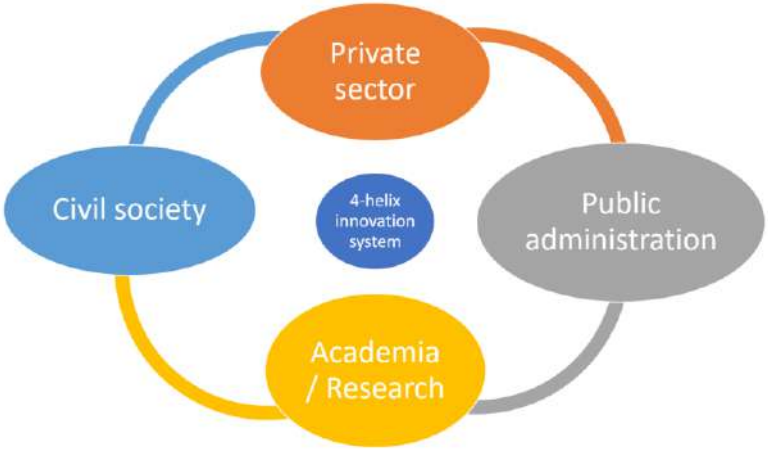

Figure 2: Four helix innovation system in the Living labs.

One dedicated workshop is envisaged with the CWI during the first year of the project to tackle the roadmap elaboration with the strategic stakeholders. The following years, follow-up meetings are planned to present the project progresses that are meaningful for that specific LL based on the roadmap exercise, which may consolidate it or adjust it. Despite this recommendation, each LL adapted the meeting with their community according to its own circumstances.

2.2.1. Fire risk cycle phases

We follow the wildfire risk phases as a way to systematically organise the discussion and information (Figure 3), but it is possible to structure it according to other possible dimensions -e.g. wildfire risk dimensions (Finney, 2005)[5], or Sendai framework action

[5] Wildfire risk at the landscape level encompasses three components: **hazard** (the likelihood of ignition and spread, affecting fire size and intensity), **exposure** (assets localized so that fire could

priorities (UN, 2015)[6]. The selection of these cycle phases responds to the LC-GD-1-1 structure precisely around them. Besides, such division is easy to understand by the stakeholders -while other transversal approaches may require more efforts to be explained and understood. In this block, the phases are refreshed to have a common understanding among all FIRE-RES Partners. Yet, the LL moderator needs to look beyond those frontiers and try to find the appropriate transversal links and interdependencies across phases to promote an Integrated Fire Management among the CWI.

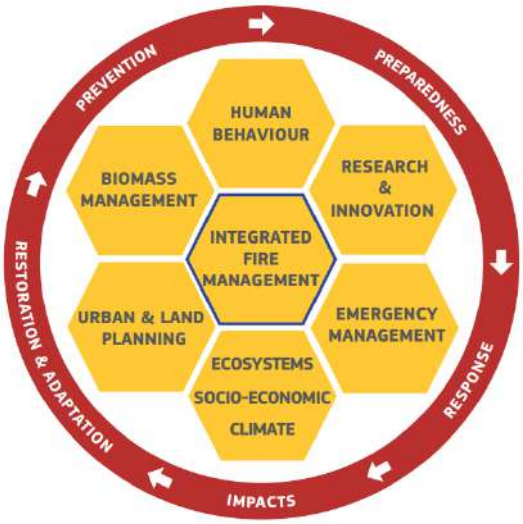

Figure 3: Integrated Fire Management concept and its dimensions within the Fire Risk Cycle phases. Source: (Rego et al., 2018)

Previous to the fire, we have the following stages:

- **Preparedness**: this is the period prior to any ignition, and consists of preparing the landscape (fields, houses, infrastructure, people's habits…) to reduce their exposure and vulnerability. *Ex. Fuel-reduction interventions in the forest or in the Wildland-Urban Interface (WUI), WUI gardens' design to avoid continuity, awareness campaigns alerting on how to reduce the potential damage, urban or infrastructure design reducing the WUI or the exposed locations, promotion and adoption of insurances.*
    - Some authors also include here the **pre-response** actions (while others locate these in the response phase directly), i.e. those actions that are

affect them), and **vulnerability** (susceptibility of fire-exposed assets to suffer damage) (Finney, 2005;

[6] The Sendai Framework for Disaster Risk Reduction 2015-2030 outlines four priorities for action to prevent new and reduce existing disaster risks: (i) **Understanding disaster risk**; (ii) **Strengthening** disaster risk **governance** to manage disaster risk; (iii) **Investing in** disaster **reduction for resilience** and; (iv) **Enhancing** disaster **preparedness for effective response**, and to "**Build Back Better**" in recovery, rehabilitation and reconstruction.

conducted prior to the contingency but are useful basically for the responders to attack the fire effectively and safely -not much to reduce the impact on the specific land where the actions take place. *Ex. Water points accessible for firefighters' tracks, mosaic/fragmented landscape in key fire spread areas, awareness campaigns on how to act in case of a fire, firefighters' training, maintenance of evacuation roads in WUI.*

- **Prevention**: deals with the reduction of the probability of the hazard; this refers to actions that prevent ignition. *Ex: dissuasive surveillance, prohibition of post-harvest residues burning during the fire season, dissuasive penalties, prohibition of visitors' access to some natural areas, vegetation cleaning under the power lines.*

During the fire contingency:

- **Detection**: refers to the systems alerting of the ignition and consequently triggers the response. *Ex. Heat-detecting sensors (satellites, earth-based devices), watchtowers, 112 emergency number alerting calls,*
- **Response**: includes the suppression of the fire and all the emergency measures implemented to save the population and its assets. *Ex. Civil Protection evacuations or messages to confinement, deployment of firefighters' (professional and/or volunteer) resources and strategy, investigation of the ignition causes, tracking of the wildfire progression (real-time or delayed), simulators the fire behaviour with forecasted atmospheric conditions, statistics of the fire, communication around the wildfire…*

After the fire:

- **Restoration**: actions to revert the impact of the wildfire and accelerate the recovery of assets and habitats. *Ex. Insurance payouts, actions replacing damaged assets, repairing and/or rebuilding valuable assets, follow-up of potential natural regeneration, accompanying measures to ensure natural regeneration, reforestation when the previous don't work, anti-erosion interventions, anti-plagues interventions, catastrophic declaration, land-use changes…*
- **Adaptation**: while it actually takes place during the whole fire risk cycle, it is of utmost importance in the case of restoring, foreseeing the future risks, this is, "building-back-better", not to the same initial point but to another more prepared to have a lower impact in future contingencies. *E.g. new urban or land-use planning, assisted migration.*

3. Nouvelle-Aquitaine (AQ)

Authors: Lana Coste (IEFC), Christophe Orazio (IEFC), Daphne Villain, (IEFC), Lucas Moreews (IEFC) with the contribution of Cécile Maris (CNPF), ex-Lieutenant Colonel Jean-Yves Pérez (SDIS40), Colonel Éric Duverger (SDIS40).

3.1. Wildfire context

3.1.1. Fire regime, socio-ecological context, and impacts

Wildfire frequency

In Nouvelle-Aquitaine, the Landes de Gascogne Forest is highly exposed to the risk of fires, particularly because of its very large areas of young plantations (2009). On a national level, this forest is ranked among the top 3 forest areas in terms of the number of fires.

Some examples of large fires in the area are:

- May 1880: 3,000 ha of pine trees destroyed
- September 1900: 4,000 ha burnt
- Period from 1937 to 1949: a total of 450,000 ha were burnt during this period:
  - August 1949: 50,000 ha from 500 fire starts (largest fire in France).
- 1989 and 1990: 7,000 and 10,000 ha burnt
- 1976: 11,000 ha
- July and August 2022: 32,000 ha.

Seasonality of fires: Historically, **spring** and **summer are the two critical periods** with a peak in the number and area of fires. This is due to the high flammability of dried grasses at the end of winter, wet soils (impenetrable for fire-fighting vehicles) and lightning strikes from dry thunderstorms in summer, accompanied by a strong increase in visitor numbers. The initially distinct boundaries of these two periods are merging. The most important fire risk periods took place in **summer, following several hot years** with **high temperatures** and **little to no precipitation**.

As for the **frequency of fires**, an average of **1,600 fires** is recorded each year in Aquitaine for 1,800 ha burnt (excluding exceptional fires).

Fire spread evolution factors

Typical factors for fire propagation are eastern **winds**, humidity below 10%, **plant fuel continuity** and the fact that **maritime pine is a good fuel**. The Massif is a production forest, with a regularly brushed understorey.

Presence of fire-adapted vegetation

Maritime pine represents 87% of the forested areas of the Massif. It has a certain resistance to low intensity fires (thickness of its bark, resistance of the needles to high temperatures, etc.). Cork oak, in the south of the massif, has the same characteristics. Apart from the coastal forest, the forest is rapidly reconstituted by plantation.

The Massif presents a large continuity of fuel (350,000 ha) at risk due to young pine stands: pine does not self-prune before reaching the age of 10 years.

Some scientists recommend mixed stands of sessile or cork oak, considered less flammable, alternating with pine plantations to reduce the risk of fire intensity. Deciduous forests are also considered to be less hot than pine forests (although this does not exclude the risk of fire).

Human exposure and vulnerability to wildfire

In France, 80% of fires start within 50 metres of homes. The Landes Massif is subject to strong demographic pressure and urban sprawl leading to growing numbers of high WUI level sectors (> 3 km of interface/km² of forest).
The Gironde and Landes Departments have identified 25 towns (out of 862) requiring a Forest Fire Risk Prevention Plan (PPRIF), of which 13 have an approved PPRIF.

Wildfire severity

From 1937 to 1949: 1,949 fires: 82 deaths

Summer 2022 fires: no casualties, 22 houses (out of ~2 800 exposed), campsites, photovoltaic panel fields, etc. were destroyed.

Changes in fire activity and fire patterns

This risk has increased in recent years with neo-rural populations unaware of forest fires. Another factor is the shortening of rotations in forest plots, leading to a decrease in the area of mature forests.

Meteorological and climatic changes amplify the spread of fires rendering them all the more complex to control. The fire season has grown from 6 to 8 months (March to October) in recent years.

With Covid-19, the frequentation of natural areas has increased, and with it, so has the risk of a fire outbreak of anthropogenic origin (for 94% of forest fire outbreaks in the Massif). The proportion of fire starts caused by lightning has decreased.

3.1.2. Wildfire governance

Strategic planning

The main tools for ensuring that the risk of forest fires is taken into account are:

- The **Forestry Code**.
- The **Interdepartmental Plan for the Protection of Forests against Fire** (PIPFCI) (2019-2029). Its aim is to list all the actions, schemes and plans involved in protecting forests against fire in order to study their consistency.
- The **Departmental Forest Fire Atlases**: inform and assist decision-making for government departments, local authorities and the general public. They determine the most exposed sectors in order to guide prevention decisions.

- **Forest Fire Risk Prevention Plans** (PPRIF): define conditions for urban planning, and prevention, protection and safeguard measures to be taken by communities.
- Urban planning documents[7] in general.
- The **Interdepartmental PFCI Regulations** (Prefectural Order): defines brushing legal obligations (OLD), and forest fire vigilance levels.

This strategy allows for transformative resilience as these plans and documents are regularly reviewed. However, key elements of the strategy, such as OLD, are not being implemented, as the success of the fight has led to a decrease in vigilance.

Wildfire preparedness organization

The defence of forests against fire (DFCI) is based on the Regional Association (ARDFCI), departmental unions and Authorised Syndical Associations (ASA) in municipalities. These structures are in charge of fire prevention.

The DFCI carries out three missions in consultation with the Service Départemental d'Incendie et Sécurité (SDIS):

- Develop the forest territory by carrying out work and maintaining DFCI infrastructure: tracks to facilitate access to plots for firefighters (and farmers), water points, ditches, bridges, etc.
- Informing the general public and professionals about the risk of forest fires and the correct behaviour to adopt with municipalities.
- To innovate by conducting studies and analyses contributing to the improvement of forest protection, and by producing high-performance technological tools.

The SDIS, also has a preventive fire-fighting system to ensure massive detection and attack of incipient fires using a network of rescue centres and equipment operating in forest areas. Operational risks are assessed daily via danger indicators and adequate means are prepped.
Reinforcements from various SDISs and provision of national resources are coordinated, if necessary, by the Zone Operational Centre (COZ) of the South-West.

Houses in the WUI

Houses in the WUI are mostly made of bricks, breeze blocks with wooden frames. The LL's campsites host plastic or wooden mobile homes. Historically, the area had diffused habitat (airiaux) either preserved or that have been transformed into inhabited areas, vulnerable to fire.

Response organization

SDIS fire brigades (professional and volunteer firefighters) are responsible for firefighting and real-time analysis of fire evolution. They are equipped with various vehicles: fire-

[7] It should be noted that the PPRIF is a town planning document, introduced by the Environment Code and taken over by the Forest Code.

fighting vehicles capable of going into contact with the fire, working with water or wetting agents and reconnaissance vehicles.

The CODIS determines daily risk levels and allocates resources to the various fires. Detection is ensured by watchtowers, surveillance at risk peak, varying according to the day's length. A command post organises the site, transmissions, operational management, logistics, coordination with other services intervening in the fire, staff relief, etc. Gendarmes may also participate in the event of major fires. Fire analysis is mainly carried out *a posteriori* to define the fires' origin.

Suppression strategy

Suppression strategy focuses on limiting the burnt area and therefore impacts. In an exceptional situation and failure of the strategy to attack incipient fires, the protection of human stakes is prioritised over environmental ones. Thus, impact limitation only takes place if the incipient fire attack strategy fails.

Field interventions are backed by aerial means depending on the risk level. Any fire must be tackled within 10 – 20 min of its detection.

The strategy consists of anticipation (forecasting stakes, mapping, modelling), mobilising resources to protect priority issues and adapting extinguishing techniques to the scale of the fire (use of civil engineering resources, such as bulldozers, to treat the edges).

The means of fighting large fires are different:

- Emphasis on anticipation in the broad sense: weather, modelling
- Use of tactical fires and creation of support areas (deforestation)
- Involve local DFCI and elected officials in logistics support and monitoring
- If insufficient means: support by state means (land, air) or other departments

Firefighters are trained in prescribed burning and can use the tactical fires and backfires.

The system has the capacity to uncover all the causes for ignitions thanks to gendarmerie brigades (a gendarme, a firefighter and a forester) trained in the search for the causes of fires.

Post-fire actions organisation

Damage is assessed to estimate the quantity of usable wood from burnt plots and the compensation to be paid to owners. In the Massif, only 20 to 30% of the forest is insured (which is higher than the national figure of 10%).
Once the harvestable wood has been exploited, the cleaning phase follows crushing unexploitable trees and replanting, carried out by professionals.
Each stage is subject to economic estimates by professionals.

In addition, feedback is organised to assess the effectiveness and implementation of certain control strategies and to identify systems to improve control in the future. This can lead to capacity building and funding at national or European level.

Insurances employed in WUI homes

Homes are insured against fire under home insurance policies, and 20-30% of the Massif's forests are insured.

Responsibility for restoration

At the plot level, each forest owner is responsible for forest restoration, to make sure that forest can regenerate one days. Land use change after a fire is not allowed and usual urban or farming regulation is applied in the case if the land owner wants to change the use of the land.

3.2. Vision for wildfire-resilient landscapes in 2030

3.2.1. A 2030 wildfire-resilient landscape in Nouvelle-Aquitaine

According to stakeholders, the prevention and control infrastructures (DFCI, SDIS) in place since the 1950s have proved their worth. They must be maintained and adapted to take into account new climatic conditions (tracks, breaks, roadside maintenance, application of OLD).

Silvicultural practices in regular high forestry since 1950 are good, based on young stands brushing, thinnings, etc. Emerging practices around continuous cover must be evaluated in relation to the increasing fire risk.

By 2030, the dimensioning of fire-fighting infrastructures could be reviewed by increasing the number of water points (currently 1 water point for 400-500 ha), boreholes, cisterns, etc.

In 2030, land use planning will be thought out in a coherent manner by integrating all activities taking place in the LL. Currently, spatial organisation does not take the risk of large-scale fires into account: each use and resulting land use is thought of in a silo manner (agriculture, solar panels, forest, urban areas, etc).

3.2.2. Resilience in fire preparedness and prevention

Our vision for 2030 is that, from a sociological point of view, the urban population as a whole (long-term residents, neo-urbanites, summer tourists, etc.) as well as their elected representatives have a good culture of forest fire risk.

At present, the clear increase in demography in the region (1 million more inhabitants in 30 years) and the annual tourist influx make it inevitable to deal with subjects such as the urban plans put in place by communes and inter-communalities, the risk culture (especially for new populations) in particular for the respect of OLDs and the prohibition of access to the forestry massifs. These OLDs - consisting mainly of brushing 10 m from departmental roads and 50 m around dwellings - are currently poorly implemented and monitored.

In this regard, some LL stakeholders are calling for changes in the way insurance works. This could take the form of linking OLDs to home insurances, binding owners subject to OLDs to provide proof of brushing, broadening the base of contributors who benefit from DFCI service, etc. Land-use planning and the DFCI network will take climate change into

account. Human stakes concerned will be self-protected or easily protected by firefighting (distance from the forest, fire-resistant building materials, etc.). Awareness campaigns on forest fires will be integrated into school curricula by the SDIS.

Societal commitment and the acculturation of populations will make it possible in 2030 to manage the reception of thousands of tourists during the high-risk season. Campsites and access to beaches will be safe, and people will be trained in fire prevention and good practices.

3.2.3. Resilience in wildfire emergency management

Most of the 2030 challenges are already current ones. In particular firefighters who have to face increasingly extreme weather conditions, with a lengthening of the season at risk. In addition, personnel are less and less trained in (forest) fire management as the majority of their activity is focused on helping people.

In addition, the challenge of maintaining the commitment of volunteers, who currently represent 78% of the national workforce, in a society that is supposedly increasingly individualistic.

In 2030, human, land and air resources will be adapted to foreseen, current and new risks. Professional and volunteer firefighters will be in sufficient numbers and trained in firefighting.

3.2.4. Resilience in post-fire management and adaptation

Challenges are largely related to forest management.

Social acceptance of the plantation forest must be addressed to reconcile its economic, public-receiving and biodiversity functions. Stand and species diversification can be explored, for the introduction of hardwoods (mixed stands, edges, riparian zones, etc.) for the benefits mentioned above. The European SUPERB project and its extension to the LL, aim to study the role of broadleaf hedgerows and riparian zones in the LL.

Fuel and understorey management must also be ensured.

The forest will thus have to ensure wood production to supply the local timber industry, provision of ecosystem services for the surrounding populations and biodiversity and be resistant to fire. This vision will be based on the implementation and results of the SUPERB-BOCAGE project.

3.2.5. Other resilience aspects

Diversification and species choice within the LL is limited by poor sandy soils (podzosols, acidic) which suffer from a summer water deficit with potential waterlogging in winter (if alios is present[8]).

This limited choice of species is linked to the challenges related to uses, since there are strong economic interests and local will to maintain the environment (deployment of significant DFCI resources) for the industry, tourist activities, etc.

The Landes de Gascogne Forest massif is recognised as a "biodiversity reservoir". Knowledge, protection and development of biodiversity are among the priorities of the actions carried out on its territory. Training and awareness-raising on biodiversity-related issues for forestry and wood industry stakeholders and elected representatives should therefore be considered. Such work on the LL territory is already underway thanks to a biodiversity study carried out by the Landes de Gascogne Regional Natural Park (PNR) and aimed at enhancing this knowledge among foresters and elected officials. On the other hand, the resilience of biodiversity in the face of fire needs to be studied in relatively "simple" ecosystems dominated by pyrophytic plant species.

In our vision for 2030, the LL area continues to be recognised and to play its role as a biodiversity reservoir.

3.3. Gaps to reach that vision

3.3.1. Preparedness phase

The challenges to be met are:

- Fire management training for firefighters,
- Establishing meteorological forest fire indicators taking into account new climatic context to evaluate the risk of megafires.
- Raising awareness of the population and elected officials, on fire risk by intensifying awareness campaigns at national and local levels.
- Reorganise landscape in case of extreme event.

3.3.2. Prevention phase

The challenges for prevention are:

[8] A level of ferruginous sandstone at a depth of 40 to 100 cm in the soil due to the accumulation of iron hydroxides and humic matter, often impassable to roots.

- Adaptation of DFCI infrastructures: assess the need to create new DFCI roads and tracks in sectors where the number of km / 100 ha of woodland remains low (< 3), increase the number of water points, ditches, etc.
- Assess areas to be submit to "Legal Obligation of weed control" and ensure they are implemented: this can be based on increased controls by the mayor, ONF agents or even the prefect (in the event of the mayor's failure to act), or by conditioning stand insurance on compliance with "OLD"s

3.3.3. Detection phase

Detection phase is not subject to any particular challenges, as it is already adapted using automatic detection cameras (in the Landes department) and (human) surveillance periods on high points in the 10km massif grid. Citizens can also warn firefighters of a fire outbreak through the phone.

3.3.4. Response phase

The efficiency of the first fire brigade unit present at the fire site would be an area for improvement, as the action of the first means / first unit engaged is decisive.

3.3.5. Restoration and adaptation phases

Currently, restoration faces the major challenge of ensuring seed availability, both through natural regeneration and seed production and provisioning. Indeed, many seed orchards have experienced a drop in productivity in recent years (climate change, some species do not bear fruit every year, damage by *Leptoglossus occidentalis* attacking conifers) and production requires 2 to 3 years while forest managers are required to replant within a year (especially in the case of the National Recovery Plan).

Some of the solutions mentioned are:

- For maritime pine, establishing additional seed orchards and the increase of classified areas for the conservation of the genetic resource
- Identification and classification of more stands for other species
- Support broadleaves hedgerows installation (SUPERB project)
- Adapt existing legislation to allow for this expansion

This would contribute to address social acceptance of plantations.

3.4. Steps and milestones: the roadmap

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

The stakeholders involved in the Aquitaine LL are described in table 1. They met five times as defined in tables 2-6.

Table 1: Table of community stakeholders

Entity name	Stakeholder type	Website	Description	Attendance in meetings				
Misso Groupama	Prevention	https://www.groupama.com/fr/fiche/groupama-forets-misso/	Insurer specializing in forest insurance against risks (fire, storm, etc.)	x		x	x	
Sybarval	Prevention	https://www.sybarval.fr/	Joint association bringing together the territories of three intermunicipal communities around the Arcachon Basin			x		
Parc Naturel Régional Landes de Gascogne	Prevention	https://www.parc-landes-de-gascogne.fr/	French regional nature park located in the Nouvelle-Aquitaine region	x	x	x	x	x
SDIS40	Firefighting	https://www.sdis40.fr/	Landes Departmental Fire and Rescue Service (Firefighters)	x	x	x	x	
DFCI	Prevention	https://www.dfci-aquitaine.fr/	Forest fire protection organization (risk prevention)	x		x		x
Pays Barval	Prevention	https://www.valdeleyre.fr/le-val-de-leyre/le-pays/	Project area, founded on the initiative of three intermunicipal communities around the Arcachon Basin (Nouvelle-Aquitaine)	x	x	x		
Commune de Mimizan	Firefighting	https://www.mimizan.fr/	Mimizan municipality – officials, technicians, etc.	x	x	x	x	x

Entity name	Stakeholder type	Website	Description	Attendance in meetings				
Société forestière Compagnie des Landes	Restoration		Group specializing in forest management			x		
INRAe	Prevention	https://www.inrae.fr/	Public research institute	x	x		x	
Centre National de la Propriété Forestière	Restoration	https://www.cnpf.fr/	Public institution responsible for guiding and advising stakeholders in the management of private forests				x	x
Commune de Belin-Béliet	Firefighting	https://www.belin-beliet.fr/	Belin-Béliet municipality – officials, technicians, etc.		x	x	x	x
SDIS33	Firefighting	https://www.pompiers33.fr/	Gironde Departmental Fire and Rescue Service (Firefighters)				x	x
POPSU Habiter les cendres	Prevention	https://popsu.archi.fr/projet/belin-beliet	Action research programme dedicated to five small forest and peri-urban towns affected by the fires of summer 2022					x