FIRE-RES

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

D5.12 Tools to properly communicate scenarios during the EWE crisis

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Abstract: The high-intensity and unpredictable nature of Extreme Wildfire Events (EWE) requires real-time information sharing and effective communication strategies. Web portals and GIS platforms, traditionally used in emergencies, must be adapted for EWE' specificities to enable collaboration among diverse organizations.

Based on the outcomes which have emerged from discussions, workshops and deliverables previously developed in the FIRE-RES project, this document proposes new adaptations to existing communication tools to improve response and preparedness to EWE.

By adapting existing communication tools and following the recommendations outlined in this document, organizations can better prepare for and respond to EWE.

Key words: EWE, GIS, Communication, Web portal, emergency management

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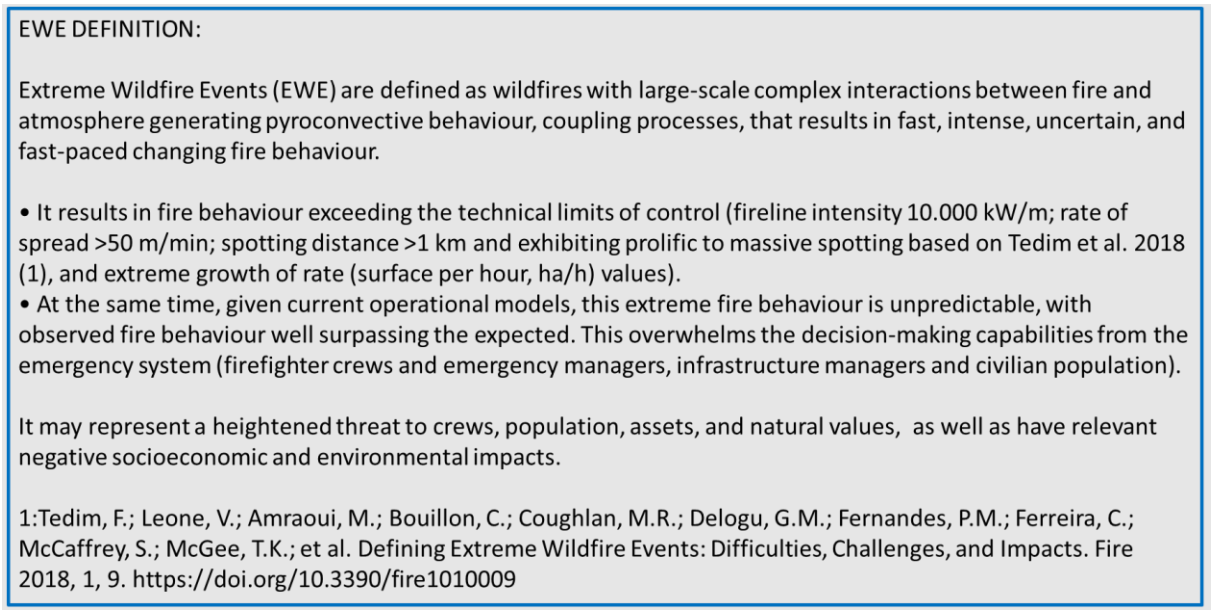
1 Introduction / Needs

It is well-established that emergency organizations occasionally encounter particularly complex and challenging situations. These emergencies are characterized by a high flow of effort in hostile environments, high impact, low occurrences, a multi-agency and multi-leadership environment, and a high degree of uncertainty[1].

Figure 1. Specific characteristics of extreme and complex emergencies. Source: Adapted from Section 3 Recommendations and policy implications from FIRE-IN project, Deliverable D1.4. Report on current and future common capability challenges (CCCs and FCCCs)

Organisations that are in charge of dealing with these particularly complex emergencies are the ones that implement specific solutions in order to improve the effectiveness of the response and diminish the effects of the crisis.

The Extreme Wildfires Events (EWE) are one of these types of emergencies as they match all the needs and particularities of other emergency complex situations. Some particularities, however, have been identified.



EWE DEFINITION:

Extreme Wildfire Events (EWE) are defined as wildfires with large-scale complex interactions between fire and atmosphere generating pyroconvective behaviour, coupling processes, that results in fast, intense, uncertain, and fast-paced changing fire behaviour.

- It results in fire behaviour exceeding the technical limits of control (fireline intensity 10.000 kW/m; rate of spread >50 m/min; spotting distance >1 km and exhibiting prolific to massive spotting based on Tedim et al. 2018 (1), and extreme growth of rate (surface per hour, ha/h) values).
- At the same time, given current operational models, this extreme fire behaviour is unpredictable, with observed fire behaviour well surpassing the expected. This overwhelms the decision-making capabilities from the emergency system (firefighter crews and emergency managers, infrastructure managers and civilian population).

It may represent a heightened threat to crews, population, assets, and natural values, as well as have relevant negative socioeconomic and environmental impacts.

1:Tedim, F.; Leone, V.; Amraoui, M.; Bouillon, C.; Coughlan, M.R.; Delogu, G.M.; Fernandes, P.M.; Ferreira, C.; McCaffrey, S.; McGee, T.K.; et al. Defining Extreme Wildfire Events: Difficulties, Challenges, and Impacts. Fire 2018, 1, 9. https://doi.org/10.3390/fire1010009

Figure 2. Definition of Extreme Wildfire Event. Source: extracted from FIRE-RES D1.1 (Castellnou, M., Nebot, E., Estivill, L., Miralles, M., Rosell, M., Valor, T., Casals, P., Duane, A., Piqué, M., Górriz-Mifsud, E., Coll, L., Serra, M., Plana, E., Colaço, C., Sequeira, C., Skulska, I., Moran, P. (2022). FIRE-RES Transfer of Lessons Learned on Extreme wildfire Events to key stakeholders. Deliverable D1.1 FIRE-RES project. 119 pages. DOI: 10.5281/zenodo.10260790 10.5281/zenodo.10260790)

As the limits of fire suppression-centred strategies become evident, practitioners, researchers and policymakers increasingly recognise the need to develop novel approaches that shift emphasis to the root causes and impacts of EWE, moving towards preventive landscape and community management for greater resilience[2].

FIRE-RES is a 4-year project (2021-2025) funded under the European Union's H2020 research and innovation programme. FIRE-RES will develop a holistic and integrated fire management strategy to efficiently and effectively address Extreme Wildfire Events in Europe.

The present document is part of the work developed in FIRE-RES and is a follow-up to the work developed in the framework of the project which identified the challenges to be addressed by the EWE.

Over the development of the FIRE-RES project, particularities regarding emergency and fire management on an EWE have been identified. These have been held through several workshops carried out with experts and practitioners that have been already involved in EWE situations.

The conclusions of these workshops and experiences have been collected in the document: D1.1 (hereafter): FIRE-RES Transfer of Lessons Learned on Extreme Wildfire Events to key stakeholders. Deliverable D1.1.[2]

Regarding the communication challenges detected on the D1.1 of the FIRE-RES project[3] the following have been identified:

1. Internal communication should assure that emergency service knows about the current fires, the strategy, and tactics, when they are active or before a shift, and make them able to develop their work but also inform the population if necessary.
2. External communication with other agencies should contribute to avoid collapse by looking for external help but also to build trust and interact with other agencies.
3. External communication with society:
    1. Organizations must be able to manage the communication while coping with the EWE.
    2. Information must be translated to be understandable by other groups, and it is important to avoid noise.
    3. Boosting transparency and trust.
    4. Communication during the preparation phase is highly important.
    5. The consideration of different communication channels to reach all the population.

In this document tools to address a properly crisis communication scenario to specialised stakeholders, 1st and 2nd challenge, and to the society, 3rd challenge, during EWE will be presented.

2 Antecedents. Solutions that already exist

In the world of emergency management, two tools that are widely developed and have shown their effectiveness in crisis communication to the population and showing real-time events of incidents, whether earthquakes, floods or wildfires, are:

1. Specific websites on risks relevant to civil protection, with risk indexes and recommendations for the population,
2. Platforms with updated geographic information systems.

These tools are essential for effective emergency management. They help to ensure that the population is aware of potential risks and that emergency responders have the information they need to make informed decisions.

Specific websites on risks relevant to civil protection provide information about the types of hazards that a region is prone to, as well as the risks associated with each hazard. This information can help people to take steps to protect themselves. The websites can also provide recommendations on what to do in the event of an emergency.

Platforms with updated geographic information systems provide real-time data on the location and extent of an emergency. This information can be used by emergency responders to track the progress of an incident, to make decisions about where to deploy resources and to share information among other emergency organisations in order to get advice and feedback. The systems can also be used to provide the public with updates on the situation.

All these tools are already considered strategic tools once the organisations have to deal with complex emergency situations, but regarding EWE some considerations and adaptations should be put in place, in order to adapt these tools to the specificities of the EWE.

In the following sections some of the already existing tools have been collected and described.

2.1 Websites for dissemination and awareness

Many examples can be found regarding websites that communicate about risks, daily danger, prevention measures, and action guidelines. However, it should be mentioned that few of these websites provide real-time data on the emergency. This is a problem because it can make it difficult for people to stay informed about the latest developments in an emergency.

Also, those websites have not updated their messages about the scenarios of the emergencies created by EWE. This is also a problem because it can lead to confusion and misunderstanding about the risks involved in an emergency.

EWE introduce entirely new scenarios that require novel approaches for resolution. Consequently, new messages may contradict existing ones. This shift can render traditional messages outdated or inaccurate, potentially leading to catastrophic consequences.

We could highlight one example to illustrate this new situation. For instance, consider the recommendation for preventive self-evacuation during a nearby fire. Traditionally, the prevailing advice is to evacuate before the fire encroaches too closely. However, in the context of EWE, is much recommendable advocating for secure sheltering, reserving evacuation only for situations explicitly mandated by authorities.

Finally, these websites usually do not share updates on level of exposure to risks such as smoke toxins in real time and action guidelines in this area. This is an aspect that is gaining notoriety as it can put the health and safety of the population at risk.

The following compilation highlights existing websites that currently serve as illustrative instances of tools implemented for the dissemination and creation of awareness within society. These platforms exemplify ongoing efforts to establish effective communication channels. Analysing these websites has allowed us to set the basis to propose the development of a more comprehensive and efficient tool for this purpose.

Table 1. Existing websites that currently serve as illustrative instances of tools implemented for the dissemination and creation of awareness within society.

Area	Name of the governmental organization responsible for wildfire crisis communication	Link to the official website or portal where wildfire communication is made	Other websites or communication channels that are particularly well-regarded in the Living Lab for their accurate and timely information

LL Greece	Ministry of Climate Crisis and Civil Protection	General Secretariat of Civil Protection Fire Brigade of Greece	Regional Fire Brigade of the North Aegean Regional Fire Brigade of Peloponnese Forest Office of Kassandra, Chalkidiki Καλώς ήρθατε στο AEGIS+ RISK
LL Galicia (Spain)	Consellería do Medio Rural, of the Xunta de Galicia	Twitter: @incendios085	Medio.rural.xunta.gal
LL Portugal	ICNF. Institute for Nature and Forest Conservation AGIF. Agency for Integrated Rural Fire Management ANEPC. National Emergency and Civil Protection Authority IPMA. Portuguese Institute of the Sea and Atmosphere	Fogos ICNF AGIF ANEPC IPMA	European Forest Fire Information System (EFFIS) Instituto Dom Luiz Safe communities Portugal European Forest Institute (EFI) International Association of Wildland Fire (IAWF) Centro de Estudos Florestais (CEF) Centre for Applied Ecology "Prof. Baeta Neves" (CEABN) Forestwise
LL Norway-Sweeden	Norwegian Directorate for Civil Protection (DSB) DSB Information	Norwegian Directorate for Civil Protection (DSB) DBS Fire information at DBS Skogbrand	Swedish Civil Contingencies Agency
Australia	The Australian Bureau of Meteorology (BoM) Fire Weather (bom.gov.au)	National Messaging System The Australian Warning System AFAC	AFDRS – Australian Fire Danger Rating System ABC Emergency Digital Earth Australia Hotspots (ga.gov.au)

			MyFireWatch - Bushfire map information Australia (landgate.wa.gov.au) Bushfire data hub | Esri Australia Victoria Estate: Incidents and Warnings - VicEmergency
LL Bulgaria	Regional Directorate "Fire Safety and Protection of the Population" at the Regional Directorate of the Ministry of Internal Affairs in the city of Stara Zagora	Regional Directorate "Fire Safety and Protection of the Population"	Stara Zagora Regional Directorate of Forestry (government organization)
LL Aquitaine (France)	SDIS, gendarmerie, DFCI, DREAL.. COD	Accueil - Les services de l'État en Gironde	Copernicus Aquitaine
LL Catalonia (Spain)	Civil Protection and Catalan Fire Rescue Service (Bombers)	Incendis forestals. Departament d'Interior (gencat.cat) Twitter: @bomberscat	Incendis forestals. Departament d'Acció Climàtica, Alimentació i Agenda Rural (gencat.cat)

The main examples coming from the FIRE-RES Living Labs (LL) are sourced from various FIRE-RES project partners representing different LL involved in the project.

2.2 GIS platforms for remote and collaborative work

In recent years, tools have been developed to work collaboratively in decision-making during an emergency. Fire services typically integrate this ability to make decisions collaboratively into their internal command structures. For example, to share information between the planning and operations areas, they are equipped with their own GIS platforms that are suitable for managing their resources, tracking operations, and predicting emergency scenarios.

Examples of existing Geographic Information System (GIS) platforms that can be used during remote assessment:

- GWIS (Global Wildfire Information System) is a web-based platform that provides real-time information about wildfires worldwide. It includes maps of active wildfires, as well as information about the location, size, and severity of the fires. GWIS is also used to track the movement of wildfires and to predict their potential impact. https://gwis.jrc.ec.europa.eu/

- EFFIS (European Forest Fire Information System) is a platform that provides real-time information about wildfires in Europe. It is a collaborative project between the European Commission, the European Forest Institute, and the European Space Agency. EFFIS includes data from a variety of sources, including satellites, aircraft, and ground sensors.

- Inciweb (Incident Information System) is a web-based platform that is used to manage wildfires in the United States. It is a collaborative project between the National Interagency Fire Center (NIFC) and the Forest Service. Inciweb includes information about active wildfires, as well as information about the resources that are being deployed to fight the fires.

- FIRMS (Fire Information for Resource Management System) open data source provided by NASA.

With the increasing complexity of the new emergency scenarios that climate change is causing, and with the improvement of technological tools for communicating and working collaboratively remotely, some organizations have begun to participate in remote consulting and collaborative work, even between different countries.

These real-time collaborations between different organizations using the same platform to view and manage operational information have been made possible thanks to the growing use of appropriate tools for collaborative work.

It is a pending challenge to improve these tools to communicate the scenarios adequately during EWE, both web spaces and GIS platforms for collaborative work, and to be able to use them widely in a feasible way during EWE.

This challenge must be jointly addressed by the developers and users of the tools: the emergency management organizations responsible for communication, the Fire Analysts (FA) and Incident commanders (IC). Collaboratively, the participants in the decision-making of emergency management work with the technological developers to guarantee capable and easily usable tools at an international level.

Special attention must be given to the guidelines for remote assessment units established by the AFAN project[4] in the context of remote assessment. This project has compiled recent European examples in this regard.

1. Worth mentioning are two examples compiled by AFAN project: Forest Fires Assessment and Advisory Team (FAST): this team is available to support countries or organizations in the following situations:
    - Specific advice during ongoing forest fire emergencies.
    - Evaluation and general advice on extinguishing, risk assessment, prevention policies, training, or research, among other areas.

Special attention to the latest Missions Spanish experts from FAST team:

- Chile 2022.

- Canada 2023.

2. Expert Group on Forest Fires (EGFF). Set up in 1998, this group includes experts from the national environmental or forestry administrations and representing over 40 countries from the EU and its Eastern and Southern neighbourhood. The group is a key forum for the Commission to review the current trends to more frequent and catastrophic wildfires, and to help determine adequate and effective European responses.

2.3 Interoperability transferring and sharing data

There are already existing solutions related to web portals and GIS platforms that provide open access to information to the society and ensure interoperability of information among agencies. This interoperability is a crucial factor to guarantee the effectiveness of the tools and must be ensured in the proposed solutions.

In order to facilitate comprehension and avoid misunderstandings, interoperability is defined as ensuring accessibility to the information. According to the INSPIRE Directive[5] Union consistently, without requiring specific efforts from humans or machines. It is essential to emphasize that achieving interoperability may involve either harmonizing existing datasets or transforming them through services for publication in the INSPIRE infrastructure. The goal is to reduce the time and effort users spend on understanding and integrating data when building applications based on INSPIRE-compliant data. essential to emphasize that achieving interoperability may involve either harmonizing existing datasets or transforming them through services for publication in the INSPIRE infrastructure. The goal is to reduce the time and effort users spend on understanding and integrating data when building applications based on INSPIRE-compliant data.

Additionally, it is important to take notice of the EU Open Data directive[6]. This requires that data to be shared with the society can be easily spread across different platforms and can easily become part of products produced by the press or private agencies, for example.

3 Objectives of the deliverable

Based on past experiences and on solutions implemented, collected already during the D1.1 development in the FIRE-RES project, external communication is a key challenge during an EWE.

Therefore, the objectives of this deliverable are to describe tools and their adapted contents that will respond to the needs of external communication challenges during an EWE. In order to confront the challenge of external communication two aims are formulated with 2 tools:

1. To describe the adapted functionalities for an EWE crisis in a web portal, which can be used to disseminate specific key messages and information to the public during the crisis.

2. To describe the EWE-adapted functionalities of the GIS platform, which can be used to facilitate collaborative work between different organizations during an EWE and describe the operational information that should be shared by FA-IC with the GIS platform in order to help decision-making during an EWE.

4 Framework

The tools included in this deliverable have been defined to address the existing EWE challenges identified in D1.1. Section 4.1 describes the identified challenges and how the tools contribute to overcome them.

4.1 EWE specific aspects to be considered

To propose necessary adaptations of existing tools, it is essential to consider specific aspects of the EWE related to emergency management and external crisis communication. This involves taking into account insights gathered in the D1.1 document of the FIRE-RES project:

1. Uncertainty: we do not know how the fire will behave, with sudden changes in speed and direction. This implies, for example:
   - Evacuations need to be resized and revised in terms of time, distances, and the number of people.
   - Confinements must be secure considering the new fire behaviour[7]: rate of spread >50 m/min; spotting distance >1 km and exhibiting prolific to massive spotting.
   - Crisis communication strategies for risk awareness and situational status need adaptation. Maintaining credibility is crucial, but it's challenging when you don't know what will happen.
2. Coupling processes between fire and atmosphere: there is a need to expand monitoring to key variables in this new interaction at a Pyrocumulus (PyCu) to Pyrocumulonimbus (PyCb) level. What to observe to anticipate different phases, what thresholds to monitor, and what scientific knowledge allows us to analyse what we are learning from observing fires.
3. Emergency system collapse: we have already had to face the possibility of the emergency system collapse, previously referred to in the Fireparadox[8] project study carried out in 2011 as 5th generation of fires. EWE exceeded the emergency management capacity of the system, leading to a general collapse, affecting not only firefighting but also local authorities, police, civil protection, etc. EWE threaten the entire system, not just the ability to extinguish the flames.
4. Impact at landscape level: It is not just about burning large areas of tens or hundreds of thousands of hectares. Extreme wildfire events (EWE) are having a severe impact on entire ecosystems, as seen in Australia and Canada. Assessing the impact, restoring, and adapting ecosystems is on a different scale, and it is necessary to define the values society attributes to it, not individually but with a common good overview.

As accorded in the FIRE-RES project the present document should help improve existing tools wherever they are, so that cases where these tools are already being implemented but have not yet been updated to respond to the EWE phenomenon are consolidated and strengthened.

4.2 EWE crisis management challenges

The tools included in this deliverable address the next challenges identified in the FIRE-RES D1.1.

Distinction between information and noise: Communication during emergencies

During the FIRE-RES initial Workshop (WS) it was detected that in EWE, "Sometimes when the information arrives, most of the information is outdated, and the situation has changed completely. It is important to shorten the flow of information, to be able to know at each moment where the fire is and detect changes."

Leading the communication during the emergency facilitates the avoidance of boosting noise, especially when the population is required to apply certain self-protection measures in a clear way.

The creation of a communication channel of reference with clear messages about the specific situation of EWE as well as the location of affected areas clearly contributes to addressing this challenge (see Section 5.1 Web portal).

The solution proposed in this deliverable to address this challenge is the web portal, complemented by the formulation of key messages for EWE. Well-defined and key messages play a crucial role in minimizing information noise, especially when there is existing trust between the population and the organization. These key messages need to be defined in a comprehensive way according to the culture, society and target that will receive them.

During a crisis situation, trust can be further reinforced by providing clear explanations of what is happening, the approximate locations affected, recommended measures, and potential consequences. (see Communication section p. 49 FIRE-RES D1.1)

Interoperability

Interoperability was identified as one of the challenges of the emergency management in EWE (FIRE-RES D1.1, Section Emergency management) not only with reference to tools but also to teams and data. The work developed in the shared GIS platform (see Section 5.2) contributes to this challenge.

Specifically, the design of the tool for international collaboration through shared operational information for specialized stakeholders, contributes to facilitate the work on way.

The platform aims to be interoperable, as described in the section 2.3, not only from the technological point of view but also from the perspective of data, symbology, knowledge, analysis language, etc., and also teams (fire analysts) as it aims to achieve the combined work of different forest fire analysts in one place.

Sharing data at international level to facilitate the collaborative work of fire analysts needs this interoperability and boosts it.

Skills and capabilities for EWE

To avoid the collapse of emergency management systems, organizations can call for help from other organizations [FIRE-RES D1.1, p.50, External communication with other organizations]. This external help can include working with fire analysts from other locations as a team. The shared GIS platform (see Section 5.2) that can be used during EWE to work on the shared analysis of the situation ahead can contribute to address this challenge.

During EWE, it is important to facilitate the Fire Analyst (FA) team to be focused on looking forward, foreseeing what can happen in the next hours and assessing the actions required (evacuate populations, protect some houses, stop, and wait to work into another opportunity, etc.). So, it is important to maintain this future vision and not try to respond to everything. It is important to be strategical and sometimes accept that nothing can be done at that moment and wait until the next window of opportunity. Working with this vision improves the safety in the emergency, both for the firefighters and the population." (p. 49, D1.1, Section Guidelines. Incident commander and fire analyst capabilities).

Tools that facilitate the mentioned shared work with other organizations improve the capacity of the organization of being focused and receive input from external expert analysts who can help define the strategic vision needed. This should always be under the concept of the Fire Analyst integrated in a response organization (as defined in AFAN project Guidelines of fire analyst competencies and skills. Section 2.1.2[9]).

This shared GIS platform used by fire analyst teams, working together with the incident commands, can make it easier for them to share their expertise and contribute to create a shared vision of the situation. FIRE-IN project (Results | FIRE-IN) remarked the need to '*Maintain a broad vision of the scenario ('zoom out') but while considering specific areas and experts ('zoom in') that can provide a new perspective of the problem, sometimes even coming from different fields of expertise. Focusing on specific matters (e.g., manoeuvres) without having the long-term space-wide vision can lead to a biased view of the situation*' (FIRE-IN Project)[10].

Coping with uncertain scenarios with low predictability

The tools included in this deliverable contribute to approach the challenge of coping with uncertain scenarios with low predictability identified in the D1.1 by facilitating tools that can help on the decision-making process during EWE.

This was reinforced during the EWE definition process in the initial workshop (WS) of FIRE-RES. EWE definition (See Figure 1. Extract from Fires-RES D1.1) focuses on fire behaviour and operational predictability (uncertainty). During the process of the definition in the initial WS of FIRE-RES it was remarked that creating tools that can help emergency services to detect sources of uncertainty and methodologies for dealing with uncertainty

can help to take the initiative in such situations (D1.1, Section 'Uncertainty: predictability and explanation', Annexes, EWE definition process).

But not only this sort of tools can help to front this challenge. Unpredictability was defined with 2 scopes: the collapse of the decision making and the collapse of credibility (FIRE-RES D1.1, 'Section Emergency management discussion', Annexes, EWE definition process).

In the first case, it was discussed that the collapse of the decision-making means that 'there's no anticipation, command and control collapses, etc. and at the end the response system is not there when the things happen, and the firefighters are in an environment where their decisions are not safe because their decisions need a certain amount of predictability to be safe.' The shared GIS platform (see Section 5.2) offers a tool to help on the anticipation mentioned at that point.

In the second case, it was mentioned that the collapse of credibility is a huge issue for emergency services. Dealing with the noise problem (see above in this Section 4.1), building trust with society (see prerequisites at Table 2) and being able to communicate in real time during the emergency in an appropriate manner can help to address this problem.

As mentioned before, both the adaptation of a web portal to the EWE specificities and the development of EWE specific key messages (See the example for the LL CAT in the Annex) can help to develop a proper communication that maintains the credibility that will have been previously created (see Table 2 requirements) and takes advantage of the critical situation to reinforce it.

This was one of the challenges detected in the FIRE-IN project for highly uncertain scenarios: 'Credibility is built, with transparency on the decisions to be made in such scenarios and achieving the results. Engaging society and key stakeholders on the decisions to be made. Prepare and be clear about the messages that are going to be issued in different scenarios, to transmit the same vision, even if it is through different messages but all along the same lines, and a speaker. To this end, it is useful to have previously worked on communication management (communication plan, trust in the organisation, human factor, etc.).' (FIRE-IN Project: D1.4. Report on current and future common capability challenges (CCCs and FCCCs)[11]. Results | FIRE-IN).

4.3 Previous requirements to implement the adapted tools

The prerequisites to be able to develop successfully the tools proposed in this deliverable are described in Table 2. [12]

Table 2. Prerequisites that must be in place before addressing the adaptation of the web platform and GIS Portal to the EWE.

Tool	Requirement	Description
Web Portal	Fire Analyst	It will be necessary to have a Fire Analyst in order to indicate which zones will be affected in the EWE. The work that will be required it is not a simple check of the

		available information on the location and status of the fire but requires having a figure that can analyse the behaviour of the EWE.
	Web portal already in use	It is necessary to already have a web portal to communicate with the population currently operating before the implementation of the adapted part for EWE.
GIS platform	Fire Analyst in the decision-making process	For the task of sharing geographical information and incident information in real time to improve collaborative work between fire analyst teams and incident commanders, it is strictly necessary that both organizations have developed these capabilities in their emergency system, so that they can communicate and understand with the same knowledge and technical language.
GIS platform	Basic previous shapefiles/information available	The minimum information to allow a collaborative work between Fire Analysts is as follows: - The starting point of the wildfire. - The phase (active, stable, controlled, supressed) of the wildfire.

It is advisable to be already able to count on the possibility of locating fires (not only EWE) through both, the GIS platform and the existing web platform. In this way, it will be easier for the population to understand to which specific wildfire the EWE information is linked, especially in cases of simultaneous wildfires. This prior availability of information on the web, not only specific to EWE, also allows to maintain the awareness among the population.

5 Tools description.

The objective of this section is to provide recommendations on how to adapt existing tools and sources for external communication during EWE scenarios, allowing the sharing of information among society and specialized stakeholders.

The following tools can be implemented individually or in combination, as certain information may be found in the different tools presented.

So, in the following sections the necessary requirements will be described in order to adapt web portals and GIS platforms to the EWE, that will imply:

1. Detail the functionalities of the web portal, intended for disseminating essential messages and information to the public during an EWE. This involves identifying key

messages essential for effectively communicating emergency scenarios resulting from EWE.
2. Explain the functionalities of the GIS platform, designed to facilitate collaborative efforts among different organizations during an EWE. Also, describe the operational information that Fire Analysts (FA) and Incident Commanders (IC) should share with the GIS platform to aid decision-making in the midst of an EWE.

5.1 Web Portal

The primary goal of web portals that intend to be a useful tool for communicating in EWE scenarios is to provide the society with guidelines for action, advice, and a description of the risk scenario so that it can act in a manner consistent with the needs of the emergency management system.

However, following discussions from the experts in the first workshop of Task 1.1, for an existing web portal to be useful even in the new scenarios created by EWE it must be adapted to the innovations that EWE scenarios imply. Therefore:

- Public information should be provided in real-time.
- Guidelines for proper action during this phenomenon should adapt to this new situation.

Obviously, this task of dealing with an EWE scenario must not only be carried out during the event's progression but, crucially, beforehand. This proactive approach serves as a tool for preparedness, creating an environment within society that fosters a better understanding of the event and the decisions made by event managers.

In order to adapt existing web portals to EWF scenarios, it is necessary to take into account the following:

The Target audience

The target audience is generally society as a whole. From citizens to policy makers, local authorities and response system volunteers. The web portal should provide information and guidance to the general public to help reduce vulnerability during EWE emergencies, and also as a guidance for appropriate participation accordingly in the management of such situation. situation.

To establish a trust relationship between the emergency system and society (Communication guidelines p.52 FIRE-RES D1.1), it is crucial for the web portal to possess the following attributes:

- Credibility: All information presented, including messages, recommendations, or data, must originate from official sources.
- Accessibility to Society: It should be freely accessible and user-friendly, ensuring that the public can easily navigate and comprehend the content.
- Utility for Real-time Monitoring: The portal should serve as a useful tool for monitoring an uncertain and unpredictable emergency in real time.

Functionalities of the Web Portal

A web portal usually incorporates the following functionalities:

- Public Service Information: Regulation of activities and mobility restrictions.
- Risk and danger Level.
- Risk awareness contents and recommendations.
- Recommended Actions during response.

However, to adapt the web portal to what an EWE scenario entails, following the guidelines collected in D1.1 and also according to the extracted conclusions of the workshop discussions obtained in Task 1.1, collected in D1.1, the following functionalities are proposed to be incorporated:

- Real-time Situation Awareness: The capability to know in real-time the emergency situation and the potential impact or vulnerability of infrastructure and the population in the territory. This is essential for communicating all news, both positive and negative.
- Access to Specific Messages: Access to targeted messages designed for EWE scenarios, offering guidance on actions to be taken during the emergency. A compilation of messages used by the Catalan Fire and Rescue Service is provided in the annexes, along with specific examples of messages conveyed through communicative actions.

All of these functionalities require real-time updates. Therefore, once a decision is reached by the event managers, it should be automatically updated and transmitted to the portal. This not only contributes to the credibility of the tool but also enhances its reliability as a source for both society and other non-governmental agencies, as well as the press.

In order to facilitate this real time, update is important to implement as much as possible automated updated process that comes directly from the application used by the emergency manager. In order to avoid incongruences between real time communication and other more traditional ways to communicate (press release, political statement, etc.), a manual validation process could be implemented before the information is automatically published. published.

These functionalities must be integrated with other tools, as GIS platform, to create risk awareness and disseminate guidelines through public and general channels.

A specific example of this integration of functionalities is the “Red Button” by CONAF (https://storymaps.arcgis.com/stories/c3abb6aeb9fe443cbb4bff3efc6b0d08). This GIS platform application triggers a specific communicative action regarding the risk to the population.

Figure 3. Botón Rojo (Red Button) is a GIS platform managed by CONAF. Source: CONAF Botón Rojo - CONAF (arcgis.com)

This communicative action of the "Red Button" also provides real-time data on open risk scenarios to the population, enabling the adaptation of prevention policies at the regional and local levels.

Figure 4. Interface to show the statistic parameters in "Botón Rojo" platform. Source: CONAF Reporte Botón Rojo - SNASPE (google.com)

Web Portal Management

The organization responsible for overseeing the event's operations should be in charge of managing or supervising the web portal or, at the very least, play a significant role in its management. After 30 years of experience, the CFRS press office has identified that the web portal serves as a crucial tool for explaining risk scenarios and providing appropriate behavioral responses. Therefore, it is imperative for the emergency system to manage the content of the web portal to ensure alignment with operational requirements.

The multi-agency web portal should serve as the official channel for communicating with society, making it a key tool in emergency resolution efforts.

Content Providers

All relevant official agencies involved in various stages of the event, including preparation and restoration, should contribute content to the web portal. This ensures a harmonized dissemination of messages to society and enhances the credibility of the information. (FIRE-RES D1.1).

On-time public operational information

On-time useful information is mandatory for the society to follow how the scenario evolves and anticipate the guidelines and recommendations of the authorities, adapt the planned activities to avoid entering risky places and suffering the effects of mobility restrictions.

In this case, this information is typically provided through specific map viewers hosted on official web portals. However, there are also private agencies making official information visible through websites.

Most commonly, the information includes:

- Wildfire phase (referring to the phase of the fire).).
- Fire location.
- Deployed firefighting resources.
- Impacts on properties.
- Effects of fire smoke on the population.

Some examples of websites with relevant information to raise awareness of the emergency scenario and provide real-time monitoring of the impacts are presented below (Figure xx, xx...).

In the case of EWE, it is crucial that this tool lets the society identify currently active fires, allowing the person making the enquiry to identify which fire is the one affecting them, and consequently determining which messages affect them.

The following Figure 5 presents the CALFire Current Emergency Incidents viewer, which includes information on smoke and impacts on people (fatalities) and affected building structures.

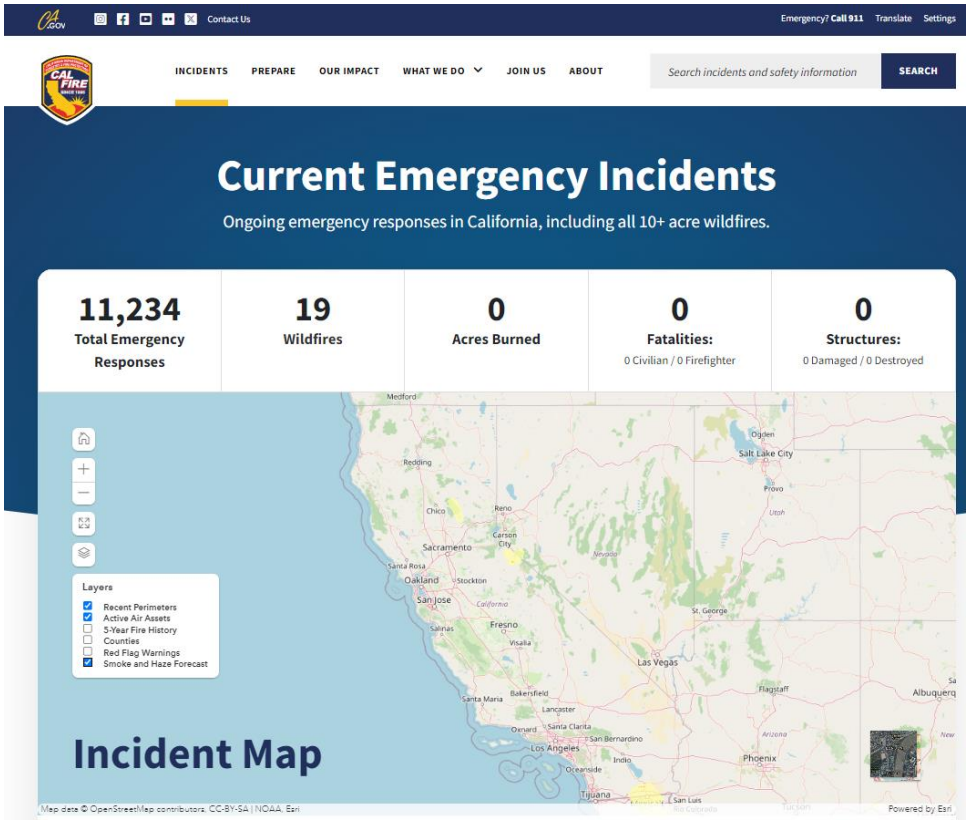


Figure 5. CALFire Current Emergency Incidents viewer. Source: https://www.fire.ca.gov/incidents

The following Figure 6 presents the French forest fires, a private agency that provides the position of the incident and a repository of published news.

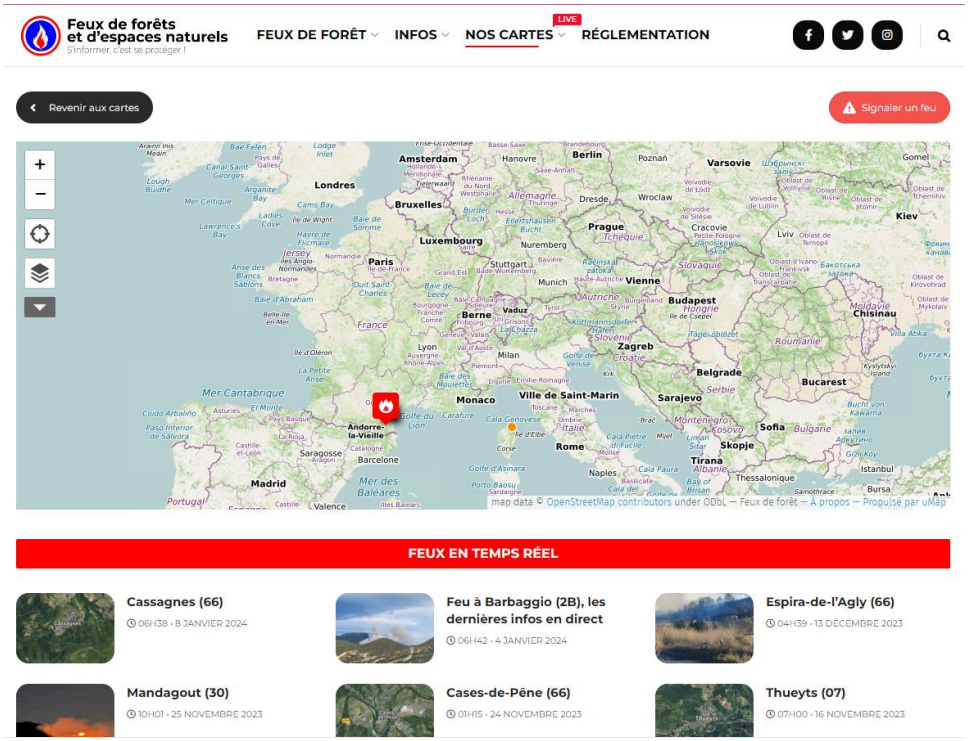


Figure 6. French Forest Fires website. Source: https://feuxdeforet.fr/cartes/feux/

The following Figure 7 presents the VOST Portugal, a web managed by a Non Governmental Organisation (NGO) with detailed information on the resources associated with each fire and the phase of the fire (active, stabilized, controlled, or extinguished).

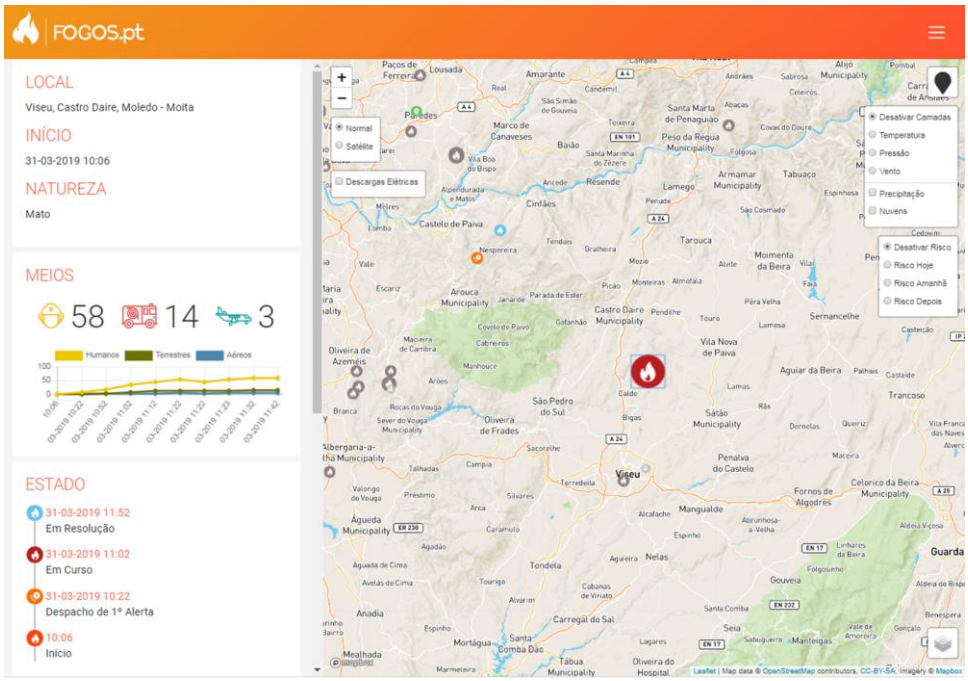


Figure 7. Fogos Portugal webpage. Source: www.fogos.pt

The following Figure 8 presents the Catalan Fire and Rescue Service ongoing incidents viewer: Featuring a common operational map as the base layer of the viewer to streamline the tasks of all agencies involved in the emergency system. It includes a list of assigned resources and the phase of the fire (active, stabilized, controlled, or extinguished).

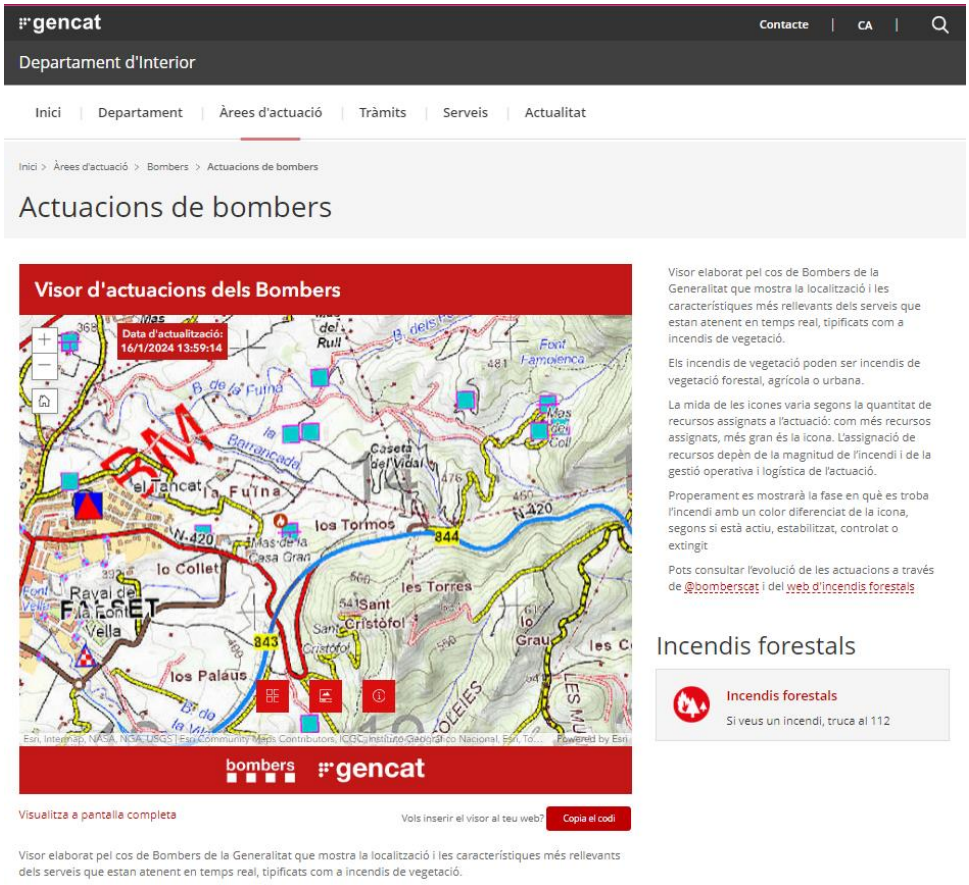


Figure 8. Wildfires localisation map, connected to a GIS platform. CFRS web page Source: https://interior.gencat.cat/ca/arees_dactuacio/bombers/actuacions-de-bombers/index.html

Ensure the interoperability of the information

In this context, ensuring interoperability implies guaranteeing real-time information and messages addressed to the population by various agencies involved in the emergency system.

5.2 GIS platform

As mentioned earlier, this tool's main goal is to enhance collaborative efforts among various organizations during an EWE. It aims to outline the operational information that Fire Analysts (FA) and Incident Commanders (IC) should share on real time operational information and EWE scenario description with the GIS platform to aid decision-making throughout the event.

The shared GIS platform for collaborative work should be accessible to the Fire Analyst-Incident Commander (FA-IC) team managing the emergency, allowing them to integrate contributions from other teams into their decision-making process. team managing the emergency, allowing them to integrate contributions from other teams into their decision-making process.

To achieve this, the following key factors must be taken into consideration:

Target audience

The primary target audiences are the first responders, FA, and IC. The objective is for the shared GIS platform to furnish information and tools that facilitate collaborative discussions, offering crucial operational insights for an improved response to EWE emergency. This information should encompass the considerations that were discussed within the experts who participated in the initial introductory workshop of Task 1.1 of the FIRE-RES project, namely these actors (FA and IC) should be able to operate within an environment characterized by:

- Discretion: The information they share is reserved for emergency managers involved in strategic decision-making.
- Trust: Shared elements, discussions, and products utilized subsequently during emergency resolution will not be disclosed outside of this collaborative workspace.
- Certainty: The shared information originates from reliable sources, whether predictive models or simulations. It is essential to be aware of the responsibility associated with its use, and therefore, the provider must be a trusted source.

What functionalities should it have?

To analyse and describe EWE scenarios, the minimum information needed by emergency services during EWE management was discussed and outlined in the first introductory workshop of Task 1.1 of the FIRE-RES project. This information was documented in Deliverable 1.1, "Transfer of lessons learned on Extreme Wildfire Events to key stakeholders."[13]

Real-world examples, such as Pedrógão Grande 2017 in Portugal[14], Santa Ana - Bío Bío 2022 in Chile[15], and Santa Coloma de Queralt 2021 in Catalonia[16], illustrate the types of information shared and its purpose. These examples help identify information shared and understand its utilization for scenario analysis and decision-making proposed by Fire Analysts (FA) for Incident Commanders.

General functionalities of Fire Analysts' work in such incidents are described in the AFAN project's 2021 Deliverable on Guidelines of fire analyst competences and skills.[17]

Specific functionalities shared in the first workshop of Task 1.1 and documented in the mentioned Deliverable 1.1 include:

- It should provide the possibility to create different resolution scenarios based on new key variables, as for example the energy released that will conditionate the options to trigger the coupling processes fire-atmosphere. This should help to

cope with the uncertain scenarios with low predictability, that appears on EWE situations. (pp. 33 FIRE-RES D1.1).

- Have the ability to compare the different resolution scenarios proposed by supporting Fire Analysts (FA). This comparison of various resolution scenarios through the grouping of fire potential polygons (Deliverable 1.3, "Piloting the adaptation of methodology of forest fire potential polygons to improve decision-making on EWE events" (2023))[18] allows the local FA to identify undetected uncertainties and consider them in decision-making. Two examples of the schemes used in decision-making are explained in mentioned Deliverable 1.3: El Perelló fire 2019 (page 17) and Santa Coloma de Queralt fire 2021 (page 19).
- Predicting and tracking the impact of the smoke column's fall, as the processes of smoke column descent, when cooling at high altitudes in the atmosphere, have such a broad scale, spanning tens of kilometres, that it is necessary to monitor and identify its territorial impact.

GIS platform Management

In this case it is not mandatory that the same organization responsible for overseeing the event's operations should be the one that manages the GIS platform, as this platform can be provided by an external organisation.

Of course, the organisation dealing with the event in its territory should have a role on the GIS platform accessibility, that will allow enough permissions to the external colleagues (FA-IC or other agencies) that can give external support, to build and gather the operational information necessary to make the tool useful.

The ideal scenario involves teams integrating into the platform during peacetime, contributing and receiving information.

It may be the case that the host territory lacks an own managed GIS platform, in this case external advisory groups must introduce the host territory's data in an external managed GIS platform.

What information is shared?

Emergency services utilizing GIS platforms typically share similar operational information to describe:

- Fire location: perimeter, starting point, propagation isochrones, etc.
- Wildfire phase (referring to the phase of the fire: active, stabilized, controlled, or extinguished).
- Location of firefighting resources: vehicle and unit positions, planned and implemented manoeuvres, etc.
- Emergency scenario: work zone, access points, firefighting resources, risk elements, heliports, etc.
- Assets to protect human settlement, houses, industries, transportation infrastructures, energy facilities, etc.
- Fire behaviour characteristics: isochrones, perimeter, propagation axes, alignments, secondary focuses, fire severity, etc.

Emergency operative base cartography and Earth Observation (EO) data sources (Copernicus, Sentinel, MODIS, GOES, etc.) can be added. There is a minimum dataset available globally through open data. However, it is important to note that individual territories have the flexibility to enhance and customize their databases based on specific needs and requirements.

Following the discussions and examples gathered in Deliverable 1.1 during the analysis of EWE scenarios, it is necessary to incorporate new elements that allow describing the uncertainty of the scenario, the way it propagates, which depends on atmospheric factors at altitude rather than just the surface, and the extent of its impact.

With the current knowledge, the new elements that the shared GIS platform must integrate to be useful in EWE management are:

- Layer or a group of layers that would provide the ability to compare different strategic scenarios made by external Fire Analysts: graphics or schemes of fire potential polygons[19] and fire flow probabilities to evaluate the various possible resolution scenarios in decision-making.
- Territorial polygons of potential energy-released. It is necessary to identify those polygons that, due to the state of the fuels and the way in which fire could reach them, could emit sufficient energy to trigger the transition from Pyrocumulus (PyCu) to Pyrocumulunimbus (PyCb). This means that the territory is polygonised based on the potential to emit sufficient energy per unit of time to allow the transition from pyroconvection behaviour to the upper layers of the atmosphere.
- Probable area affected by the downburst process: the fall of a smoke column is a violent, erratic, and complex process[20]. Scientific knowledge is still analysing this process. In terms of impact on emergency management, as described by emergency services that have experienced it, it is characterized by very strong winds, on the order of 100 km/h, with massive secondary focuses and a territorial scope of several kilometres.

The way all this information is displayed can follow different methodologies, but the common contents are very similar. Below are some examples of relevant operational information and examples of the symbolism used to display all this information.

Implementation examples

The European Forest Fire Information System (EFFIS) (https://effis.jrc.ec.europa.eu/) provides near real-time and historical information on wildfires. Its Current Situation viewer offers the most up-to-date information on the current fire season in Europe and the Mediterranean area. The Rapid Damage Assessment contains information on the fire line, using Earth Observation (EO) data, the Human settlement layer, and Fire Severity. These inputs are depicted using the following legend.

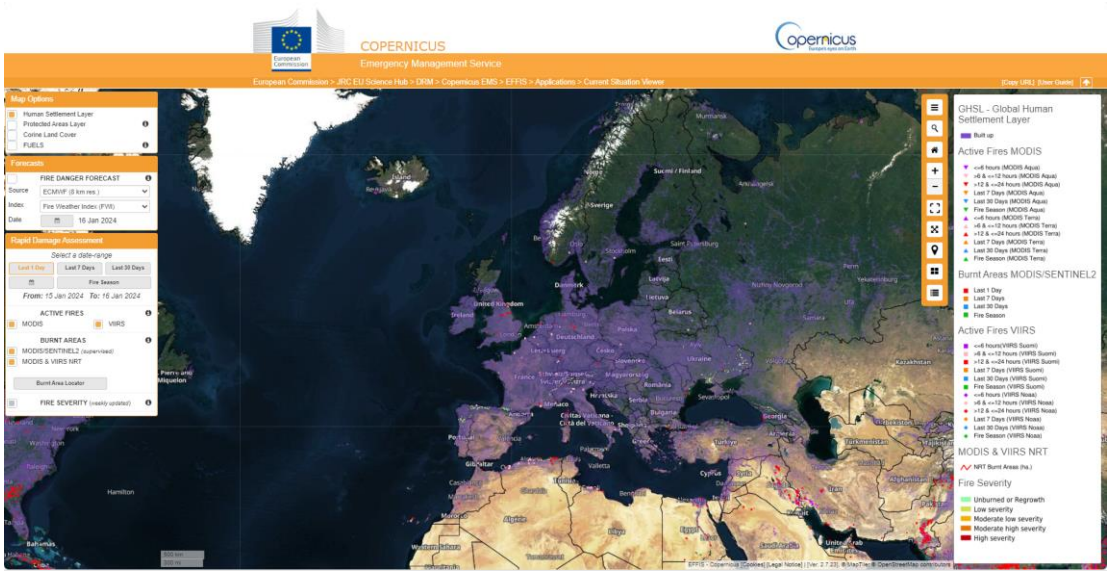


Figure 9. Copernicus-EFFIS web page. Source: EFFIS - Current Situation (europa.eu)

Pau Costa Foundation - CONAF collaborative GIS platform has developed an adapted symbology for the management of the Chilean EWE during the two fires seasons (2021-22 and 2022-23) as a tool for Equipo de Gestión de Incendios Forestales (EGIF)[21] project (https://www.paucostafoundation.org/segunda-fase-del-programa-egif-en-chile/). This platform allowed different international teams to work together and, for example, included the layer on energy emitted by fires as a key variable to analyse EWE.

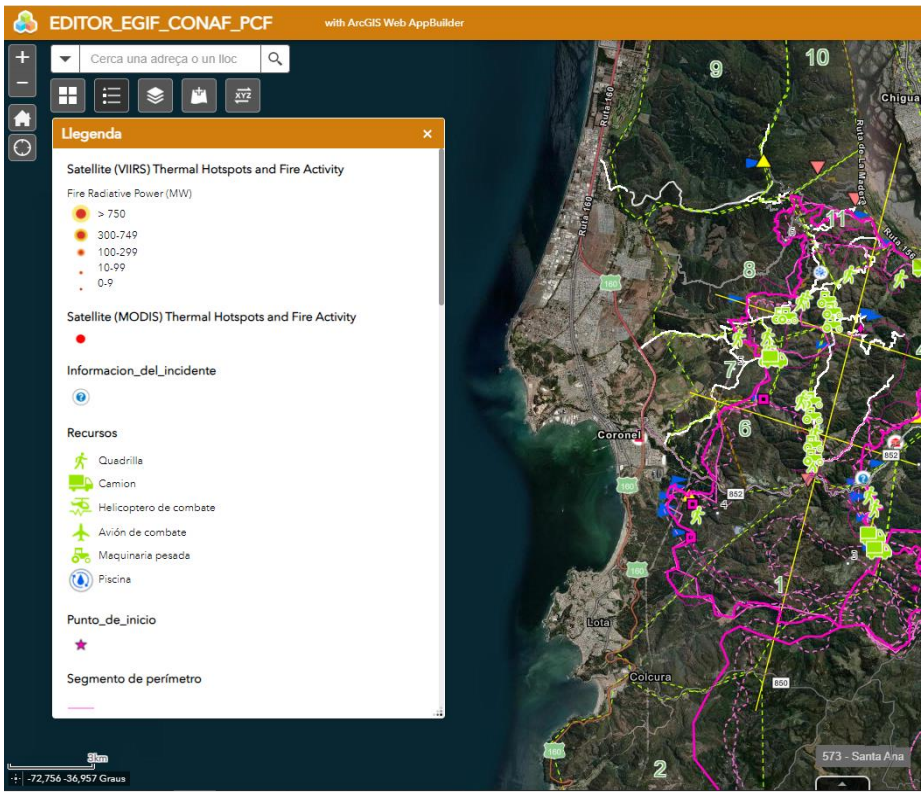


Figure 10. ARCGIS project from the EGIF program. Pau Costa Foundation- CONAF, Corporación Nacional Forestal de Chile. Source: Programa EGIF - Pau Costa Foundation

Recently, in the framework of the European project STRATEGY (https://strategy-project.eu/cen-workshop-agreement-on-management-of-forest-fire-incidents-sitac-based-symbology/) a proposal for forest fire incident management symbology based on SITAC French methodology has been worked out. This could be especially useful in cross border collaboration or in cases of activation of the EU Civil Protection Mechanism, where modules are sent from different countries, and therefore language barriers are often a problem. But it does not take into account the need to adapt to EWE and their new processes of fire and smoke behaviour and uncertainty in predictions and impacts. However, it proposes a standardisation of the most common symbols of forest fire incidents that can be taken into account when designing the new symbology adapted to the EWE.

At the international level, the symbology of the US National Wildfire Coordinating Group (Symbology | NWCG[22]) is widely used. This symbology also does not have any specific elements for the new EWE behaviours.

Within the FIRE-RES project, specifically in the Catalan Living Lab, the GIS platform of the Catalan Fire and Rescue Service is customizing its symbology to accommodate newly identified variables linked to the EWE. The symbology employed by CFRS incorporates components from the French SITAC and the NWCG. To date, this symbology has been utilized for wildfire remote assessment in Spain and to monitor EUCPM FAST module missions during EWE situations in Chile, Canada and Greece 2023[23].

In the context of Innovative Action 5.9 of the FIRE-RES project, efforts are underway to create new symbology tailored to EWE.

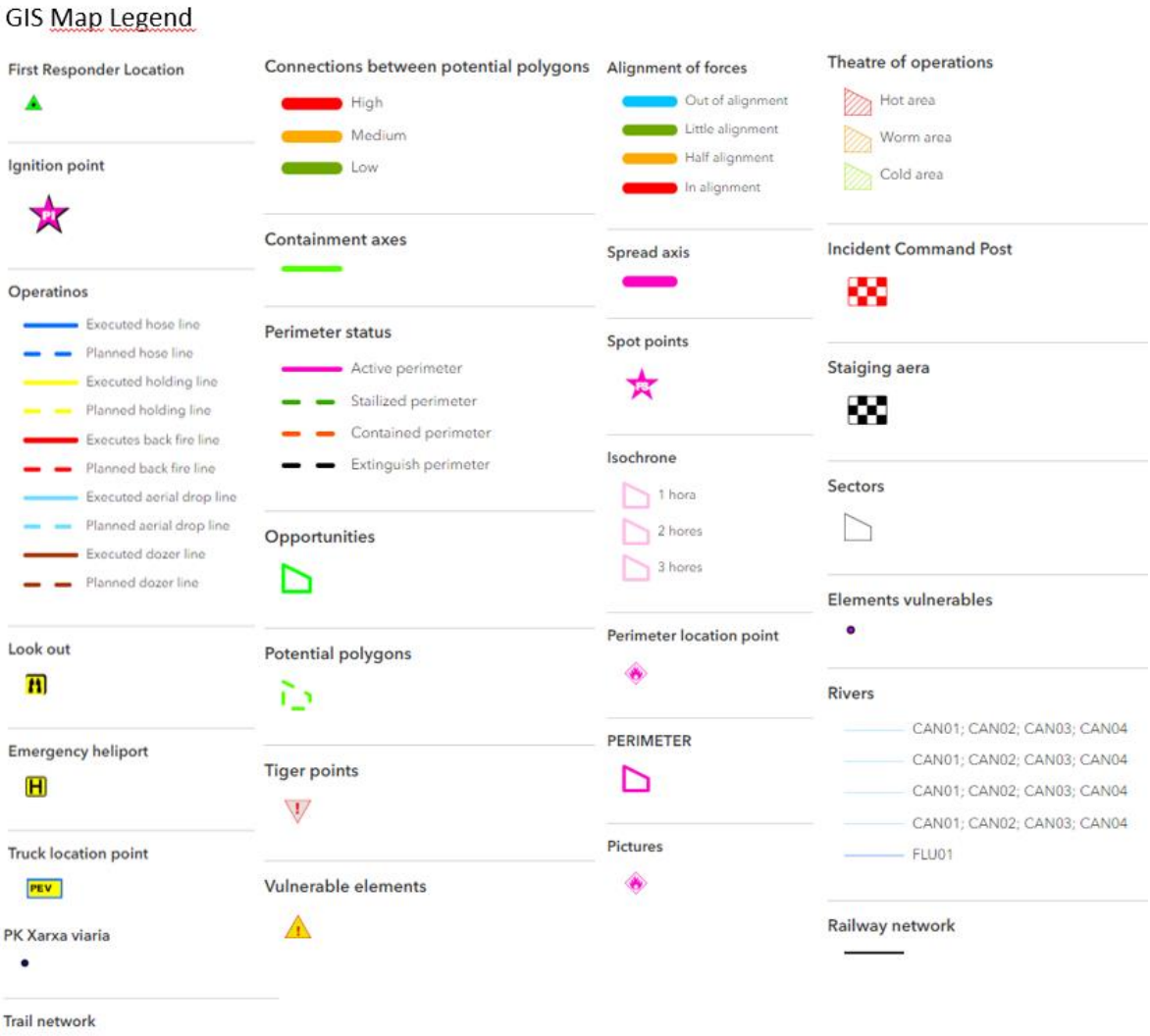


Figure 11. Source: Symbology used in the GIS platform of the CFRS (Bombers de la Generalitat de Catalunya).

Ensure the interoperability of the information

In this context, the tool should ensure interoperability in the use of information and the creation of products for decision-making by IC, derived from the shared analysis conducted by FA from different agencies.

It must be conceived as a GIS Social Network, where everyone can receive and input information in a collaborative way, allowing users who generate data to share it through the platform. All this process should be able to be performed in real-time, as operational information is crucial. For example, there should be tools available for importing and exporting information in various formats (as for example Keyhole Markup Language (KML), Keyhole Markup Language Zipped (KMZ), Shapefile (SHP)) and an Application Programming Interface (API) gateway with standard formats is essential to serve information, enabling integration into external platforms using international GIS

communication and information standards. That allows to connect directly to other platforms and sources of information.

6 Implementation plan in the FIRE-RES project

The proposal presented in this document is meant to be implemented during the development of the FIRE-REs project through the Innovation action 5.9 in the Catalan Living Lab.

In order to achieve a successful implementation, the following implementation plan have been proposed:

1. Design and develop new data and information content adapted to the realities of EWE management.
2. Adapt the existing tools (web portal and GIS platform) to the requirement presented in this document.
3. Disseminate and educate stakeholders with this new content so that they are aware of it before the next crisis occurs.

6.1 Design and develop new data and information content adapted to the realities of EWE management

During this phase, it is necessary to prepare the information and data needed for Extreme Wildfire Events (EWE) management. This includes designing and developing operational data and information tailored for collaborative work among Fire Analysts and for effective communication between command systems and society. Specifically:

- Existing Operational Data to be shared with the society: Organizations involved should decide according to the legal requirements and technical priorities, which information that is already available could be made public. A reflection process should be done by all the organizations involved in the different phases of the emergency to update and create the necessary key messages.
- Operational Data for Fire Analysts (Restricted Access): the organization responsible for the analysis and suppression duties during the EWE, should review which data is already produced and which data should be newly created for the analysis during the EWE. This should encompass fire potential polygons, fire analysis data, GPS resource locations, fire suppression operations, emergency organization details, critical infrastructures, key assets, etc.
- New Extreme Wildfire Events (EWE) Specific Operational Data for Fire Analysts: In case that some data is not available and in the previous step is decided to be needed, a process to create or dispose of this data should be implemented. This may include data on smoke plume impact zones during Pyrocumulus (PyCb) and Pyrocumulunimbus (PyroCb) processes, forest areas with the potential to trigger PyCb processes, and other relevant information.

Additionally, guidelines for action and key messages during Extreme Wildfire Events (EWE) crises must be adapted.

6.2 Adapt the existing web portal and GIS platform to the requirement presented in this document

Each organization shall determine and drive the internal processes necessary to update the existing tools for Extreme Wildfire Events (EWE) crises. In the case of Catalan Living Lab, this involves updating data and channels for sharing public data (via a public viewer on the web portal) and restricted data on the shared Fire Analyst GIS platform. This ensures that the current system and GIS project architecture meet the new requirements.

In the following diagram, the flux of information and data that should be achieved in the Catalan Living Lab is illustrated.

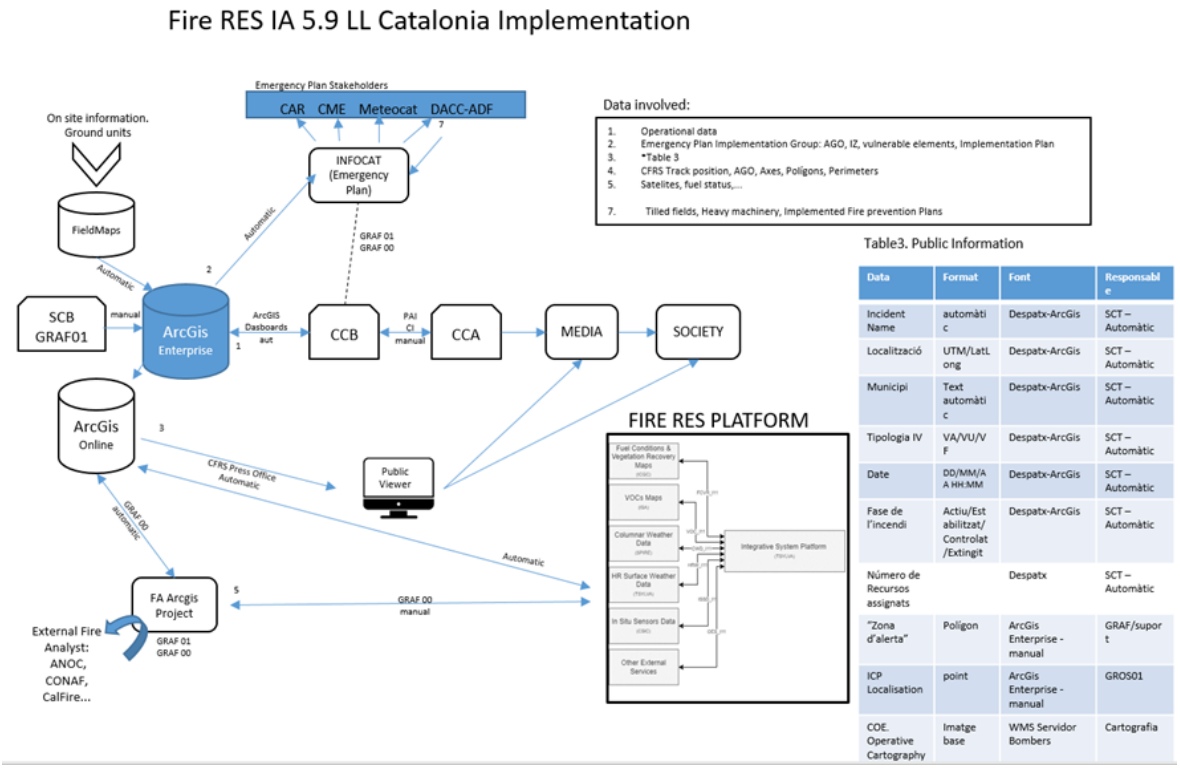


Figure 12. Flux of information and data that should be achieved in the implementation of the FIRE-RES innovative action 5.9 on the Catalan Living Lab.

In the case of the Catalonia Living Lab, to achieve the adaptation of the existing tools, the following steps should be carried on:

a. Web portal:
    a. Found an agreement between the organisations that were already participating in a multi-agency web portal for forest fires, to adapt this portal to the EWE.
    b. Adapt the portal structure to the key messages that should be disseminated.

c. Create a webmap tool that will allow the possibility to automatically publish on the web portal information produced by the Fire and Rescue Service during the EWE.
d. Start to work on create new dissemination resources as video, infographics to disseminate the new or adapted key messages.
e. Publish the web portal: (https://interior.gencat.cat/ca/incendis-forestals/index.html)
f. During 2024 fire season the web will be fully implemented and will run and be used at operational level.

b. GIS platform:
   a. Readapt the existing GIS project to incorporate new layers needed for the EWE.
   b. Discuss and decide security requirement in order to share information with external agencies.
   c. A test will be published with minimum data in order to ensure the acceptance of the security requirements stablished by the fire service. https://experience.arcgis.com/experience/f6172fd2d6974bc0a8c51e3a6bc2a735
   d. Create a new project to be shared with external Fire analyst.
   e. Test the viability to work as an external with part of the CFRS data.
   f. During the 2024 Catalan Fire Season, the platform will be used at operational level.
   g. At the end of the season, if needed improvements and updates will be implemented.

6.3 Dissemination

Finally, each organization will develop its communication actions to disseminate the new specific content for Extreme Wildfire Events (EWE) emergency scenarios. This involves three levels of dissemination and explanation:

a. For Fire Analysts: Conducting specific webinars with teams from each organization.
b. For Emergency System Stakeholders: Organizing specific meetings with agency representatives to facilitate internal implementation.
c. For Society: Issuing press releases and social media campaigns.

7 ANNEX

EXAMPLE: Key messages adapted to Extreme Wildfire Events (EWE) in the Web Portal of LL CAT

To develop the adaptation of a Web Portal to EWE it is advisable to have previously worked on communication with the population through an internal team or resource inside the organization, both through an existing Web Portal or through other mechanisms.

As mentioned in section 5.1, a key point is to generate trust in the organization so that the communication elements used by the organization (web, social networks, TV, etc.) are taken into consideration and are the source to which people turn to on a regular basis. Once this linkage has been created (wildfire divulgation has been done, situational awareness has been created and a common language has been established) the key messaging part of EWE can be addressed.

These key messages are a part of a very larger context that implies EWE, so it would be rare to address it without having previously worked on the rest of the elements. It is important to have worked in building trust involving communities and key stakeholders in risk management permanently. As large emergencies are infrequent, people rely on luck and responders to protect them. Preparation of scenarios, to discuss decisions and behaviour during the emergency, verifications, drills and exercises. This reduces the distance between expectations and reality between responders and communities[24] ..

The aim of these work on communication is to improve the community involvement that can be crucial in an EWE, where there is a risk of collapse of the emergency systems. Therefore, the population will be asked to take some actions to try to reduce the consequences and damages that an EWE can have.

It will be important to have previously developed public self-protection and awareness, through [1]:

1. Training / educating / involving general population in risk awareness and self-protection starting from scratch, in a basic and easy way.
2. Proactively maintaining the citizens continuously informed during all the duration of the emergency.

It will also make a difference to have previously involved communities and key stakeholders as active actors in risk management, through working on[25] :

1. Involving communities into driving a change of paradigm for society, from victims to actors in the emergency.
2. Involving key stakeholders, encouraging them towards an integral culture of risk awareness and resilience.
3. Investing in credibility in the communications during the emergency.

Furthermore, it is advisable to be able to negotiate with communities and key stakeholders before the emergency on the scenario of resolution[26] .

Below is a proposal of a set of key ideas aimed at encompassing the necessary concepts to communicate to society about the implications of the new situation due to EWE.

To effectively communicate these messages to the specific population of a territory, they must be adapted to the social and cultural reality of the receiver. This adaptation is essential for generating headlines and foundational materials that can contribute to the creation of new communicative products.

There are Two major areas to group specific messages for EWE:

1. EMERGENCY MANAGEMENT OF AN EWE

Reality to be assumed, a complex scenario will be created by the combination of several factors:

- Fire Suppression Capacity: Due to the increase in intensity and velocity, there is a threshold of energy released by the fire beyond which firefighters cannot operate in front of the flames—10,000 kW. This implies that the execution of a significant portion of manoeuvrers is not feasible, thus indicating that the fire exceeds the extinguishing capacity.
- Emergency System Collapse: To prevent the collapse of the emergency system, efforts are concentrated on analysing the situation and implement a decision-making process based on selecting the appropriate moments and locations where the efforts should be focused. Special attention should be given to cases of simultaneous incidents.
- Risk of emergency system collapse: for instance, the potential saturation of the 112 and local authorities phonelines, coupled with the possibility of receiving conflicting messages from different agencies.

Messages for BEFORE:

- Emergency managers should plan and execute evacuations with sufficient time and safe routes, considering the extent of the impact of EWE.
- Citizens should be prepared for confinements: both inside and outside the home. As due the extreme conditions created by EWE evacuations should only be done under the guidance of the emergency managers.
- Raise awareness and educate about this type of fire:
  1. It cannot be predicted or anticipated.
  2. These types of emergencies are a social responsibility, they have to be addressed from multiple perspectives not only from the emergency management.
  3. These fires will exceed the capacity of emergency services and will be left to a free development, with interventions only to minimize damage and impacts.
  4. These fires are one of the consequences of the evolution of the climate change.

Messages for DURING the incident:

- Conditions you will experience when the extreme wildfire overpasses your home: dense smoke plus strong wind plus massive spotting. .
- Report updates or severe collateral emergencies appeared during the passage of the fire front in conditions of simultaneity and emergency system collapse.
- Stay informed through official channels; the scenario is complex, changing, and unpredictable.
- An EWE implies a situation that makes impossible for firefighters to support citizens at the same level as in a normal situation. So, the society should prepare homes to the passage of an extreme wildfires: at the same level as in a normal situation. So the society should prepare homes to the passage of an extreme wildfires:
  - There won't be a fire truck in front of your house.
  - Prepare your home for self-protection.

2. PROMOTING SAFE AND RESILIENT LANDSCAPES

Reality to be acknowledged: For an Extreme Wildfire Event (EWE) to occur, favourable atmospheric conditions triggered by the amount of energy released by a stressed forest landscape. Managing "normal" fires is an opportunity to create resilient landscapes under new conditions. These landscapes, when burned, release energy below the threshold required for atmospheric coupling. This promotes the burning of existing fuel and gradually shapes a mosaic landscape with reduced biomass available for energy conversion.

Messages on FIRE - ATMOSPHERE - UPPER LAYERS Interaction:

- EWE respond to the meteorology of the free atmosphere, not to the meteorological conditions at surface level.
- Atmospherically, the variable related to atmospheric dynamics is energy. Therefore, landscapes should be viewed as energy emitters when burned.
- Biomass, translated into available fuel, must be managed to avoid emitting enough energy to boost the coupling with the atmosphere leading to an EWE behavior. Managing biomass is the only parameter that we can affect in order to avoid the coupling trigger
- Allocate measures for the prevention of this process at the level of reducing tons per hectare of available fuel to thresholds that prevent the emission of this trigger energy.
- We are understanding landscapes as reservoirs of energy, and this requires public and private actions, as well as large-scale sectoral policies.

Messages on STRESSED/DECAYING/OUT-OF-PLACE Landscapes:

- Forest ecosystems normally need thousands of years to transform and to adapt to changes. Climate change is instead encouraging the migration of animal and plant species, with drastic changes on forest ecosystems within decades. This means that the landscapes become displaced and lacking the resources they need, to face this adaptation.

- Stressed landscapes are dry, unhealthy, and lack growth. This makes them highly vulnerable to fire due to reduced moisture content, burning through more intensely and rapidly fire behaviour.
- Accept that ecosystems are changing, and they need to move to adapt. Pests, fires, or drought are disturbances that eliminate and renew them.
- Learn to coexist with wildfires due to climate change. Ecosystems are evolving and adapting; we must be part of this evolution.
- The arrival of new ecosystems due to the departure of others with climate change requires understanding and facilitating their establishment for biodiversity, soil protection, and economic opportunities. Climate change accelerates the emergence of new ecosystems over the old ones. We need to understand and facilitate their establishment through enabling the ecosystem dynamics and changes to achieve a proper and realistic biodiversity and soil protection. This can also bring new economic opportunities
- Accept the renewal process of forest ecosystems and adapt our economy and land use, or we will also become displaced. Even worsening the effects of these process.
    - The EWE dimension implies that society cannot avoid the engagement in the new scenario created by these EWE.
    - Land management need to be done from an economic model where all possible actors involved in land management should participate and at the same level assume their responsibility.
- We need a real commitment from society to the territory, in how we consume products and enjoy the uses of land, so that the territory is alive, economically and socially activated, and can maintain and enrich the forest landscapes to the benefit of the entire society.
- We need reliable/safe/wise landscapes to allow the firefighters to work securely.

Messages on FIRE MANAGEMENT

- We must leverage small fires by managing them instead of suppressing them. This involves creating patches in the landscape that will prevent the possibility of future Extreme Wildfire Events (EWE).
- Managing fires is not about letting them freely burn; it is about guiding their burning under predetermined conditions and objectives. This transforms an undesired event into a favourable impact on the ecosystem.
- Fire is a component of the landscape—a player and a process—not limited to the Mediterranean forest ecosystem. Achieving a resilient landscape capable of incorporating the effects of a fire is crucial. Otherwise, unexpected and catastrophic situations may always arise.

These messages should also be tailored to the specific needs and interests of the target audience. For example, messages for children should be clear and concise, and they should use simple language. Messages for people with disabilities should be accessible and easy to understand.

The messages should also be coordinated with the other phases of emergency management. For example, messages about prevention should focus on helping people to reduce their risk of being affected by an EWE, and in which way they will differ to the ones related to a wildfire. Messages about preparedness should focus on helping people to be ready to respond an EWE, especially on those recommendations that will be different to the ones made until now.

Also, in FIRE-RES D1.1, on page 52, a summary of the previous pages is provided, specifically focusing on emergency communication. It distinguishes between internal communication within the emergency organization and external communication directed towards the broader society. The summary offers key strategies and best practices to ensure transparent and impactful communication during emergency situations.

The table below shows an example of key messages, specifically tailored to align with the social and cultural context of Catalan society. Those messages were effectively disseminated through a prime-time documentary titled "The Incandescent Threat" ("L'amenaça incandescent" in Catalan) on Catalan public television, and the documentary aired on June 30, 2020, with subtitles in Catalan (CAT). Additionally, another documentary titled "Incendis de 6a generació: els incendis que venen" ("6th Generation Wildfires: The coming Wildfires") was released on YouTube on October 30, 2020.

Table 3. Example of Key Message Implementation in a Specific Living Lab in Catalonia. Source:"The Incandescent Threat" ("L'amenaça incandescent" in Catalan) . MEANINGLESS The incandescent threat - SENSEFICIÓ L'amenaça incandescent 30/06/2020 (1h sub in CAT). And the documentary: Incendis de 6a generació: els incendis que venen ("6th generation Wildfires: the uncomming wildfires) on youtube 30/10/2020.

Example of implementation of key messages in LL Catalonia	
1	Catalonia meets the ideal conditions for experiencing large wildfires. The scale of such fires is so significant that society has no choice but to get involved.
2	The challenges to address climate change cannot be solved solely by the firefighting force. Advocacy for investment and landscape management policies is necessary, requiring a collective response.
3	Land management must be approached through an economic model that involves all possible stakeholders, where everyone assumes their responsibility.
4	Climate change will compel us to learn to coexist with fire. Ecosystems and forests will adapt, and we must be part of this evolution rather than in opposition to it.
5	Achieving a resilient landscape ready for the passage of fire is crucial. Otherwise, there will always be the possibility of unexpectedly facing situations of great catastrophe.

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