AFAN

D2.6.

Guidelines for remote assessment units

PAU COSTA FOUNDATION

bombers

D.R.E.AM. ITALIA

ENSOSP French National Fire Officers Academy

VALABRE

Gwasanaeth Tân ac Achub De Cymru
South Wales Fire and Rescue Service

Funded by
European Union
Civil Protection

Editors

Luca Tonarelli (D.R.E.Am. ITALIA)

Giacomo Sbaragli (D.R.E.Am. ITALIA)

Simone Scopetani (D.R.E.Am. ITALIA)

Enrico Magnani (D.R.E.Am. ITALIA)

Contributors

We are especially grateful to all persons and institutions who kindly have provided suggestions, comments, and materials for the compilation of this guide.

Andrea Albertosi (Tuscany Region - Agriculture and Rural Development Directorate. Regional Forest Fires Organization)

David Swallow (Wildfire Tactical Advisor of Hereford & Worcester Fire and Rescue Service UK)

Duccio Bacci (Union of Valdarno and Valdisieve Municipalities. Regional Forest Fires Organization)

Edgar Nebot i Hernandez (GRAF team. Catalan Fire and Rescue Service)

Fábio Silva (ANEPC Portugal. Special Civil Protection Force. GAUF team)

Francisco Javier Castelló Palazón (Technical Unit for Fire Analysis of the INFOCA Plan, Junta de Andalucía and member of the FAST team)

Francisco Senra Rivero (Analysis and Knowledge Management Area. Sub-Directorate for Forest Fires and other Environmental Emergencies. Environment and water agency of Andalusia)

Giacomo Pacini (Tuscany Region - Agriculture and Rural Development Directorate. Regional Forest Fires Organization)

Gianluca Calvani (Tuscany Region - Agriculture and Rural Development Directorate. Regional Forest Fires Organization)

Hugo Gonçalves (ANEPC Portugal. Special Civil Protection Force. GAUF team)

João Diniz (ANEPC Portugal. Special Civil Protection Force. GAUF team)

Jonathan Troncho (Pau Costa Foundation)

José Luis Soriano Sancho (Forest Fire Prevention and Analysis Unit UT902. Generalitat Valenciana and member of FAST Team).

Juan Caamaño (Pau Costa Foundation and member of FAST team)

Laia Estivill Gonzalez (GRAF team. Catalan Fire and Rescue Service)

Marc Castellnou (GRAF team. Catalan Fire and Rescue Service)

Marcos Campos (ANEPC Portugal. Special Civil Protection Force. GAUF team)

Mercedes Bachfischer (TEP - The Emergency Program)

Miguel Angel Botella (Forest Fire Prevention and Analysis Unit UT902. Generalitat Valenciana and member of FAST Team).

Núria Prat Guitart (Pau Costa Foundation)

Ove Stokkeland (Varabrannsjef at Skien kommune Norway)

Paolo Battelli (Tuscany Region - Agriculture and Rural Development Directorate. Regional Forest Fires Organization)

Sebastién Lahaye (SAFE Cluster)

Theodore M. Giannaros (National Observatory of Athens. Institute for Environmental Research and Sustainable Development)

Tiziana Manca (Técnico BF PEIF BRIF Cuenca)

Xavier Joseph (Pompiers des Bouches-du-Rhône of France)

We would like to thank all those who contributed and supported the realisation of this document, not only by contributing their expertise at a technical level but also through the management and organisation of the various events planned and implemented throughout the AFAN Project.

Cite this report: Tonarelli L.; Sbaragli G.; Scopetani S., Magnani E.; *Guidelines for remote assessment units*. AFAN Project (2022).

Table of Contents

List of Figures

List of Tables

List of Acronyms

AFAN	Advanced Fire Analysis Network
BEH	Fire behaviour
CPS	Campbell Prediction System
DREAM	D.R.E.Am. ITALIA soc. coop. agr. for.
FAA	Fire analysis and assessment: 'art & discipline'
FA	Fire Analyst: position
FAT	Fire Analysis Team
GIS	Geographic Information System
IAP	Incident Action Plan
IC	Incident Commander
ICP	Incident Commander Post
LVF	Large Vegetation Fire
MET	Impact of meteorology on fire behaviour
PAT	Fire spread patterns
POS	Fire position
RAA	Remote Assessment Analyst
RAT	Remote Assessment Team
RAWE	Remote Assessment during Wildfire Emergencies
SCA	Strategy and Scenario awareness
TO	Tactical Objectives
TP	Tactical Planning
WUI	Wildland Urban Interface

Executive Summary

The present document is intended to help identify the characteristics provided by remote assessment and analysis support during a wildfire or during simultaneous events, either within the same firefighting structure or between different organisations, and then subsequently facilitate the creation of a common framework at European level. The guide is part of the project's ambition to **help building a shared European framework for providing support with fire analysis and assessment between different organisations**.

In this context, the full range of fire analysis skills that fire-fighting organisations can develop to address key issues is identified, focusing on ways to improve decision-making during the response phase. Thus, topics that should be considered when planning remote support actions that a fire analyst, or a multi-person fire analysis team, can do are explored.

This document is to be considered as an initial work, a first step, offering a view based on existing real cases and experiences during the last few years.

The objective of this document is to help create a **common framework on the topics of remote assessment activities through analysis, in which different organisations can be included and then make the existing network of fire analysts visible and improve collaboration**. This framework should also enable EU countries and their regions to start training and learning about the opportunities offered by remote assessment and the possibilities that open up when it is possible to support or be supported by speaking a shared language and approach. It is necessary to establish a proper exchange of information always after precise requests have been made by the decision makers in the incident and, knowing that decisions should not be made for those in the field.

Remote assessment is mainly intended during emergencies caused by a complex wildfire, but it can also be a valid support option for situations with many simultaneous fires.

The identified framework analyses a number of issues that were discussed and debated between the project partners and the European fire analysts invited as external experts in the various project workshops, the technicians who spoke during the webinars and the technicians listened to during the many interviews that were organised throughout the project. These topics include: 1) communication flow and analysis translation to the IC: who sends and who receives, 2) basics information to ask and receive from the ICP, 3) support tools for remote analysis, 4) analysis products/outputs exchanged, 5) channels, 6) responsibilities, and 7) criticalities and lessons learned. Finally, references to past real cases are included, as well as integrated analysis in post-fire reports.

The next step will be to go down to the level of the specific needs of each organisation and territory. It should be borne in mind that this is not a closed process, as future needs and challenges may require expansion of the content of this guide, so this is an initial starting point.

This guideline corresponds to Deliverable 2.6 Guidelines for remote assessment units under Task 2.3 Harmonisation of fire analysis knowledge (WP2) within the AFAN project (Advanced Fire Analysis Network, https://fireanalysisnetwork.eu/).

This allows for the continuation of what was started with the other deliverables of the project and especially with D2.2 “Guidelines of fire analyst competencies and skills”.

1

1. Introduction

The guide's objective is to collect and make available what has emerged from current experiences of remote support during wildfire emergencies. A subdivision into useful themes is provided for an in-depth analysis of this activity, so that everything illustrated in this document can subsequently be used to create a useful and shared working methodology, at the same time providing operational staff with a framework for carrying out their support activities.

During the implementation phase of the AFAN project, it was planned to base the drafting of this guideline document focusing on the following remote support activity objectives:

- Provide specific and easy-to-use support for scenario analysis
- Increase capacity and speed of analysis
- Avoid input of unnecessary information and data for analysis (to avoid "in-fo-toxicity")
- Simple information for complex situations
- Mutual trust during emergency management
- Products made by operational staff for operational staff

In addition:

- To achieve better and broader cooperation
- To help gather better lessons learnt from real cases
- To consolidate 'good practices' that have already proved useful.

A specialised profile such as that of the FA has been observed to occupy different positions within the various organisation's charts (see D2.2 and Figure 3). Here we will deal with analysis units operating remotely, thus potentially being a single remote analyst (RAA) or a team of analysts operating remotely (RAT). The differences we can find between these two types of working structures will not be analysed in depth, because the decision to divide the document into subject areas was guided by the aim of making it usable both by organisations that have already structured themselves in a certain way for remote support (with RAA or RAT) and those that are not yet prepared to do so. Therefore, focusing the drafting of the document on the topics that independently drive the operational dynamics of this activity.

These remote assessment guidelines have therefore been constructed to fit into

an operational context in which technology is increasingly helping to carry out activities remotely (of any kind, not just for fire analysis). At the same time, more and more people are able to present their own opinions and their own analyses. But when this is done in an 'informal' manner and not through pre-defined operational procedures, it may not always be done in an integrated manner of what is actually happening in the field.

Other important purposes of remote support it's to make fire services understand why unexpected dynamics have occurred in the fire area, it has to fulfil the need to instil confidence and trust in the on-site personnel who are tired, exasperated by the amount of information and requests they are constantly receiving and who simultaneously have also to explain what is going to happen and also what has already happened.

Data and observations are available everywhere: the really difficult part is to find out how to identify and select it for transforming that into useful information to make decisions. Nowadays, there is a huge amount of different data available, but if we do not start from a solid basis of fire analysis, what is built is just 'noise', 'info-toxicity', not useful for making decisions. The ultimate goal is to help in managing uncertainty rather than exclusively in providing information (see Figure 1), selecting and not considering what will then be less useful for decision-making (Castellnou et al., 2019).

Currently, the **biggest gap in Europe is in the transformation of information from analysis to operations**. Those who do analysis must pass the information on correctly way and those who receive it must be able to understand it..

Given the increasing number of wildfire emergencies even in areas of Europe where until recently it was less of a problem (Forest Fires in Europe, Middle East and North Africa 2020. JRC), there is now an awareness that in certain situations it is not essential to bring in personnel from outside to tell local personnel how to operate: rather, it is necessary to ensure that in the immediate future those who are already there will be able to read and interpret what they have not yet faced on their own territory (in terms of wildfires), so that they will then know how to act.

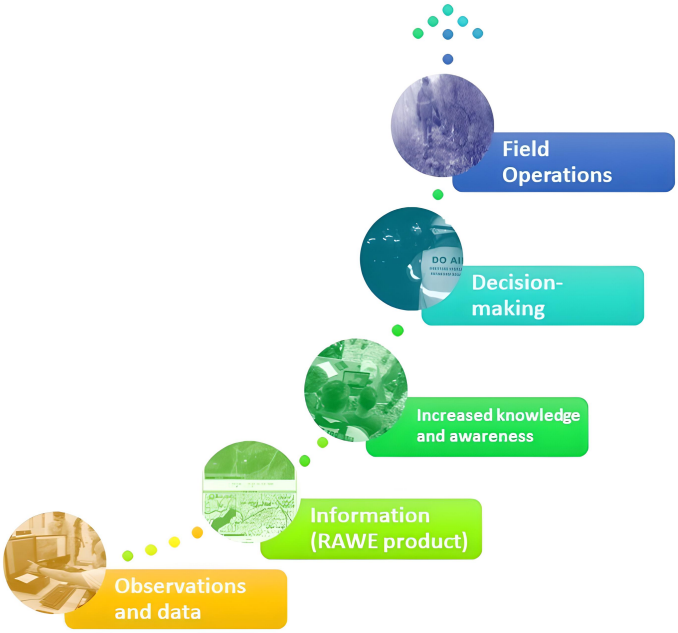


Figure 1. Schematisation of FAA remote support contribute to decision-making. Source: DREAM.

| 1.1 Aim of the guide

It is very important how is the interaction during RAWE (Remote Assessment during Wildfires Emergencies) with on-site team and what kind of information are provided them with. Nowadays, several fire services have decided to invest in the incorporation of different FAA skills and profiles. Although the topic of FAA is therefore becoming of increasing interest and application, **an approach aimed at harmonising FAA capacities** has always been maintained throughout the AFAN project, rather than seeking standardisation to be proposed in this context. This is also motivated by the fact, as already explained in D2.2 Guidelines of fire analyst competencies and skills (Castellnou et al., 2021): the ability of each organisation to integrate changes depends on the frequency of challenging scenarios faced in recent years, but also on the legal and socio-cultural context and the internal structure of organisations.

This document is therefore to be understood with this purpose: a thematic reference aimed at an explanation of the main characteristics of remote assessment activity. This can then be used to frame remote assessment activity between different organisations (and/or at the same time consisting of team from different organisations) or within the same organisations. Remote assessment activity means both the ability to be able to provide this level of analysis externally and the

ability to be able to receive and use it when **requested** or **offered without an explicit request** from the field.

The experiences of international RAWE that have been used in e.g. Bolivia (2018 and 2019) and California (2020 and 2021) can be a useful comparison, as in Europe RAWE is often still present as support at planning level. One objective is, through the AFAN project, to spread the construction of a harmonised approach in Europe when analysing and fighting fires, enabling work at a strategic level. The added value is to raise awareness among those on the ground of the existence of different options and scenarios, which would otherwise not be considered.

Figure 2. Critical day with a high number of simultaneous events in Tuscany Region (July 2017). Source: DREAM.

2

2. Remote Assessment during Wildfire Emergencies (RAWE)

| 2.1 RAWE definition

The definition of remote support activity is provided below. The term 'wildfire' in this case includes all types of fire, it is not selective between fires involving forest, shrub, agricultural and interface areas. It is therefore possible to link it to the definition of 'vegetation fire' as explained in D2.2 Guidelines of fire analyst competencies and skills. Please note that the following definitions are only useful for the explanation of concepts and to avoid confusion in the interpretation of the guide, so it is not recommended to use them for purposes other than the one mentioned above.

Remote Assessment during Wildfire Emergencies (RAWE): the remote assessment is a support action carried out by a fire analyst from remote to provide situational awareness following a request from decision makers involved in the incident (e.g. incident commander). RAWE leads to the development of products that are sent by the remote unit to the operational staff in the ground through dedicated shared channels.

Main definitions in RAWE terminology are:

- **Remote Assessment Analyst (RAA)**: is a fire analyst (FA) who provides remote assessment and responds to the requirements of the Incident Commander (IC) and/or to the fire analysts (FA) present on the ground or other operational personnel present at the wildfire, as well as assisting the RAT (if available).

- **Remote Assessment Team (RAT)**: is a multi-professional team providing RAWE

- **Remote**: a physical location situated not in the proximity of the fire but wherever the RAA or RAT is operating.

Remote assessment can be useful if it is simple in procedure and protocols. The term 'assessment' refers to the processing of an evaluation: a process that should not be too time-consuming, but which requires pre-established communication channels, following which the relevant 'feedback' will also be indispensable for the validation and subsequent updating of such processing.

In this document the terms "**Information**" (or "**RAWE product**") is referred to what is processed from remote using different kind of data and observations, and then is sent to the field personnel to increase their level of awareness and knowledge about the ongoing fire. For increasing awareness and knowledge, it's necessary

that field personnel are able to understand the Information/RAWE product contents (FAA topics).

| 2.2 RAWE position inside different organizations: examples

As explained in the guide on analyst competencies, fire analysts as specialist profiles can be included in the organisation charts in different ways. Using the example given for the ICS type structure, it can be assumed that the position of this type of activity is mainly included in the 'Operations section' and in the 'Planning section' (see Figure 3) i.e.: in a coordination or deployment centre, managing information and assessment of new alerts, setting priorities, balancing the whole scenario and providing remote assessment in the management of specific fires. Here are some examples:

- **Control Rooms**: This is where the RAA or RAT who support the operational staff in the field through RAWE are located.

- **Office or home**: There are cases where the RAWE is carried out by a single figure (RAA) on call who provides support action where he or she is using a digital electronic device (PC, tablet, etc.). Fundamental is the availability of Internet network coverage. This type of RAWE occurred mainly for remote support in informal modalities (Argentina 2021).

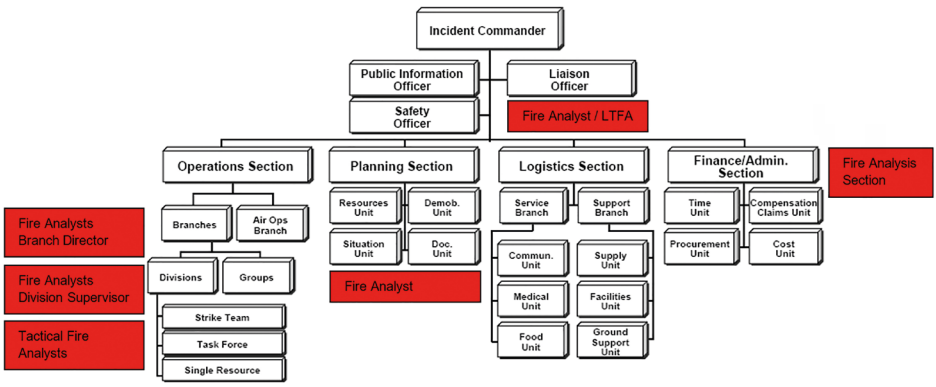


Figure 3. ICS diagram highlighting the positions that the FA can occupy in the organisational chart. Source: Castellnou et al., 2021.

It remains clear, however, that although the RAWE takes place outside the event area, it is still an activity carried out in direct communication with the operational team present on site and integrated in the other sections of the organisational chart. The figures through which this communication remains active and their position will depend on the choices made by each organisation to take advantage of this type of activity.

Experiences in recent years have contributed to the understanding of the importance of quick and effective support, as the cases of Portugal 2017, Australia 2019 and 2020, Greece 2021, Bolivia 2018 and 2019, Chile 2017, 2021 and 2022, California 2020 and 2021, Argentina 2019 and many others have shown. There are already many examples in Europe of fire services that have structured a local RAWE.

Each organization has its own procedures and often its own methods of working, which mainly exploit the needs of the organisation and the available observations/data. As starting point it's important to refer to current experiences. In many Spanish, Portuguese and in some Italian regions, local RAWE already exists and generally works with support provided by a FA in the control room, a FA in his office or a team of fire analysts gathering in a designated place. The objectives are always to provide technical support to personnel in the field. Sometimes it happens that this team gathers if there is an explicit request from the field (e.g. Tuscany Region), sometimes it happens that first information is sent without the need for a request because it is already foreseen in the organisation's internal procedures and the IC already knows how to use it (e.g. ANEPC GAUF Portugal). The fire analyst in the control room can act as a support to operations personnel on the single complex event but also by supporting the control room during simultaneous events to assess priorities.

In Europe, several organisations already carry out FAA in the early stages of the wildfire, even remotely, to understand the potential and expected behaviour of wildfires (e.g. UT-902 Generalitat Valenciana) with the purpose of analysing in advance situations that do not yet have decision-making personnel in the field.

However, there are clear differences between a local RAWE and a RAWE between different organisations:

1. Availability of data: usually all the data needed for detailed analysis are available for RAWE's activities at the local level. Current and predicted weather conditions, direct linkages to weather stations in the area, local websites that delve into current and predicted short- and long-term variables. But also, data on vegetation type, fuel patterns, fire history, as well as (unmeasurable) in-depth knowledge of the area. All this is not always guaranteed if RAWE takes place between different organisations, from the same country or even between different countries.

2. Knowledge of operational personnel and knowledge of the operational capabilities of the organization.

3. Language: speaking the same language, having the same technical terminology shared in training and exercises, allows greater flexibility and more effective ways of getting across what you want to communicate. This is easier at local level, more complex between different organisations.

Below are some examples of organisations that have defined FAA capacities position that can be applied both in the field and remotely. Having an organisational chart of operational staff that includes the FA presence opens the way to support or

be supported through RAWE, both nationally and internationally. This will probably be the first goal to be achieved on a large scale in Europe so that this support action can become a recurring and efficient practice, so that the personnel involved are able to translate, process and integrate what they receive remotely into their decision-making.

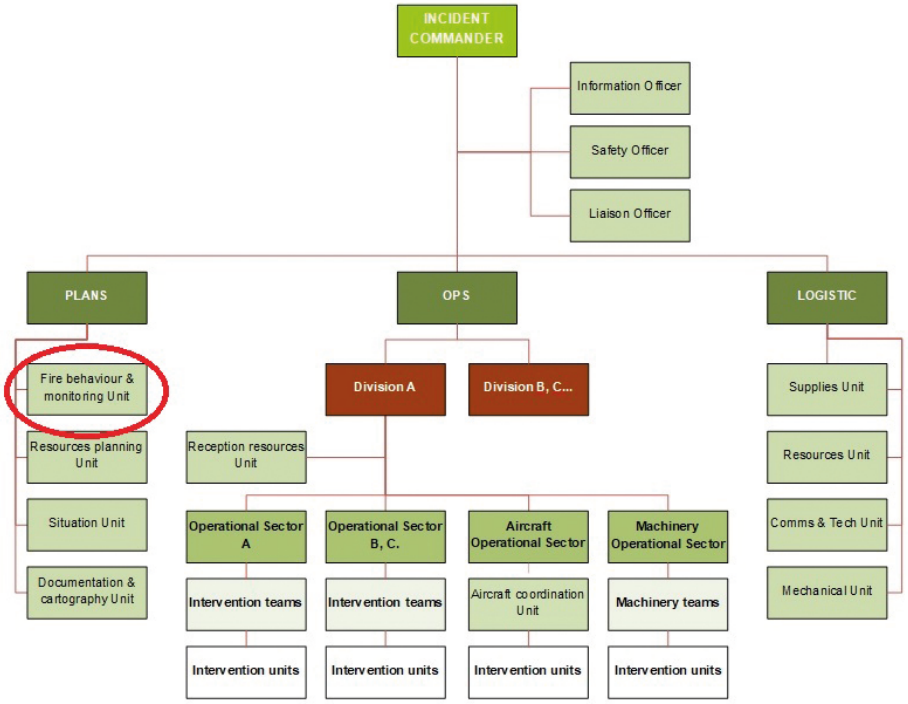


Figure 4. ICS Organization from Andalucia: the Fire behaviour and monitoring Unit is located in the Planning Section, Strategic Analyst provides remote assessment to the emergency from the Regional Centre. Source: INFOCA, Andalucia, Spain.

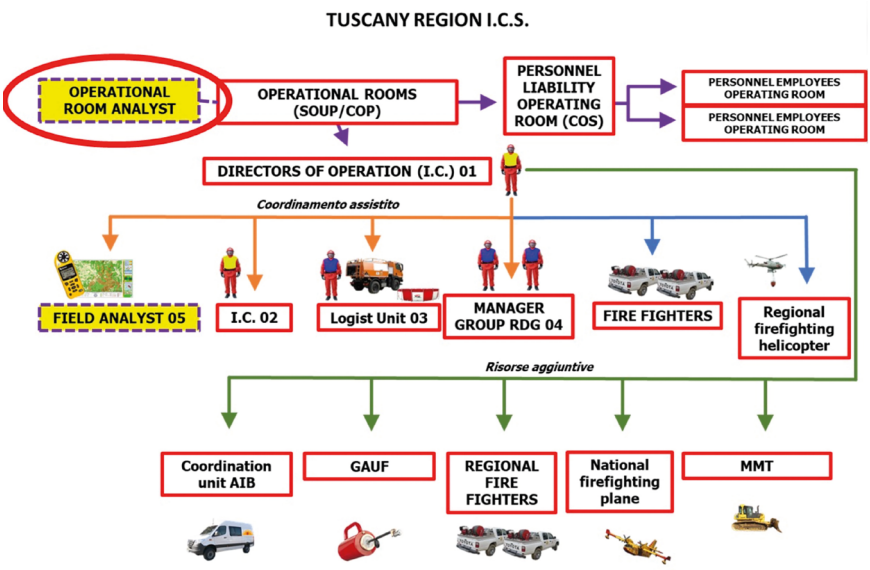


Figure 5. Organigram from Tuscany Region: Operational Room Analyst, in case of high and very high risk, is present to support by remote the field personnel or to support the Regional Operational Room (SOUP) coordinator by establishing priorities in case of contemporary events. Source: DREAM.

| 2.3 RAWE contributions and impacts in FAA and the risk management cycle.

In order to further contextualise RAWE's activities, we provide below a summary of the possible entity of contributions and impacts on the decision-making process of this type of activity. This is done by connecting with what has already been described and defined in Table 1 of D2.2 Guidelines of fire analysis competencies and skills (Castellnou et al., 2021): below are the indications provided by the aforementioned table, selected for those that can be concretely reflected in RAWE's activities. This makes it possible to integrate and identify the usefulness of RAWE independently of the existing procedures in each organisation. Selected dynamics from Table 1 where useful impacts can be found through remote activity are described and divided in the three columns, while the final section of each table contains a dedicated commentary on RAWE's activity for each of the 4 phases represented by each table.

Table 1. RAWE contributions and impacts on DM process. section 'Planning measures according to anticipated risks'. Source: Guidelines of fire analysis competencies and skills (modified)

PLANNING MEASURES ACCORDING TO ANTICIPATED RISKS		
The organisation managing the emergency should assess the risk scenario that has to face, based on an anticipated risk, and assess the measures needed to deal with it. When: Phase prior to the risk scenario. Scales: Periodic (daily, weekly, campaign) or punctual (episodic warnings). Local, regional, national or international.		
ORGANIZATION NEEDS	FIRE ANALYSIS CONTRIBUTION	DECISION-MAKING IMPACTS
Not foreseen	Not foreseen	Not foreseen
Comment		
RAWE as understood in this document is not considered to be included at this stage, as it is currently intended as a support activity present during the emergency and to have an impact on decision-making in the active and evolving emergency phase.		

Table 2. RAWE contributions and impacts on DM process, section 'Dispatching and response coordination'. Source: Guidelines of fire analysis competencies and skills (modified).

DISPATCHING AND RESPONSE COORDINATION		
The organisation needs to coordinate the different responses according to active services, with a dispatching of resources sufficient and adjusted to the priorities of the scenario that requires to be faced, and to maintain the capacity to plan and anticipate scenarios to avoid collapse at the emergency coordination level. When: Both in the phase of receiving a warning and coordinating simultaneous active incidents. Scale: Regional, National and European Dispatch – Command & Control Rooms.		
ORGANIZATION NEEDS	FIRE ANALYSIS CONTRIBUTION	DECISION-MAKING IMPACTS
"Resource dispatching" (DM Ground and air routes for fire detection); "Redistribution of resources according to the prioritisation between active services and the evolution of the risk"; "Integration, distribution and assignment of external resources in LVFs complex scenarios".	"Analysis of the scenarios of fire with the available information". "Monitor the temporal and territorial evolution of the risk". "Monitor the active incidents". "Identify scenarios that can lead to collapse and criteria for their resolution".	"Reduction of the simultaneity of ignitions and reduction of vulnerability to fires with extreme behaviour". "Proactivity in the activation of the resources and different manoeuvres and resources ready to be used ('toolbox')". "Proactivity in the management of scenarios with the potential of being LVFs complexes".
Comment		
This phase mostly refers to the initial dynamic of managing reporting or multiple events simultaneously. In this section, it is possible to find how the RAWE activity is adaptable within different organizations by supporting in establishing which events could be more prioritized than others.		

Table 3. RAWE contributions and impacts on DM process, section 'Guide the efforts for the resolution of the incident'. Source: Guidelines of fire analysis competencies and skills (modified).

GUIDE THE EFFORTS FOR THE RESOLUTION OF THE INCIDENT		
The organisation that manages the emergency has to respond to a specific incident or complex of incidents, so it is necessary to organise, decide and act with the resources that have arrived and the information that is available at each moment. This is the on-field response but at the same time monitored from the respective Dispatch-Command & Control room. All command and coordination positions in the organisation must be aware of the incident scenario of resolution and the uncertainty factors that could change it. There are usually 3 scenarios: small fires that can have runs outside of the fire suppression capacity (scenario A), small or medium fires that can become large vegetation fires (scenario B), and the complex of several large vegetation fires (scenario C).		
ORGANIZATION NEEDS	FIRE ANALYSIS CONTRIBUTION	DECISION-MAKING IMPACTS
When "The organization needs to guide efforts towards a shared idea of the incident resolution. establish strategy and prioritised tactical objectives" (scenarios A, B, C). When "The organization has to have a vision and a mission to choose between the achievable objectives and those it will not be able to achieve".	"Analytical/tactical methodology": Identify the driving force of the fire (CPS), its propagation, the key variability and change factors, the 'windows of opportunity' and the estimated potential impact of the fire (What does the fire want to do? What can the fire do?); Choose a scenario of resolution (What do I want to do? What I can do?); Provide vision and mission in the assignments to build safety in an integral/transversal way and avoid the collapse of the device of responders (Incident action plan). "Strategical/evaluative methodology": Establish the diagram of fire potentials and the values of the polygons of each potential (What does the fire want to do?); Assess the 'fire probability of flux' through each polygon (What can the fire do? How can it do it?); Define the different scenarios: desired, accepted and discarded (What I can do?); Provide the vision and mission in the assignments with the aim to build	Efficiency in the management of fires that have the potential to become LVF. Effectiveness in the management of fires that have the potential to become LVF. In the confidence of the emergency system in strategic and tactical decisions in complex scenarios. In the vision of the shared scenario. In the capacity to face changes. In the trust of the organizations to make- decisions, the awareness of its limits and constraints, and the trust to communicate them in a transparent way in front of uncertain scenarios.

	the integral safety of the scenario including the sources of uncertainty and eliminating noise to have a common and certain image of the scenario (Incident action plan). Monitoring the objectives achieved: Determine the information to be monitored in order to be aware of the level of achievement of the objectives, as well as to identify indicators that allow us to detect when the rate of achievement does not match the rate foreseen in the planning and indicates that there is a mismatch between what was foreseen and the reality. Monitoring the indicators of the strategy: Identify the indicators and their change targets to ensure that the planning, response and understanding of the situation of the emergency scenario is consistent and in line with reality, reducing the gap between reality and response. Incorporate internal self-assessment method or delegate supervision to someone external to the emergency environment and conditions. Incident action plan: Create products with the necessary operational information to be included in the Incident Action Plan, to be explained and distributed at incident coordination meetings, and to develop situational awareness and protection measures for the population.	

Comment
This phase mostly refers to the initial dynamic of managing reporting or multiple events simultaneously. In this section, it is possible to find how the RAWE activity is adaptable within different organizations by supporting in establishing which events could be more prioritized than others.

Table 4. RAWE contributions and impacts on DM process, section 'Tactical deployment'. Source: Guidelines of fire analysis competencies and skills (modified).

TACTICAL DEPLOYMENT		
The organisation is at the incident location and has a forward command post deployed there. In this situation, the emergency management team has stablished its incident action plan and must implement it during an operational period. It´s time to order actions, move resources and monitor key indicators to achieve the strategy and tactical objectives defined. In this context it is important to adjust the necessary resources, information and actions. It must be established where, when and how the division supervisors and the units/team leaders of each area will have the specific resources, information, and links with others that will allow them to develop the actions that are commended to each sector. It is necessary to create tactical architecture to see which manoeuvres come before others, what windows of action exist, what priorities are set and what can withstand a breakdown situation or fail. For all this, it is necessary to constantly monitor the achievement of objectives, to observe the gap between analysis and reality, and to constantly reassess the scenario.		
ORGANIZATION NEEDS	FIRE ANALYSIS CONTRIBUTION	DECISION-MAKING IMPACTS
[...]	[...]	[...]
Comment		
As explained in all this document, remote assessment requires information both directly and from those in the field that can be obtained independently. In particular related to the structure of the organization to which RAWE is provided will be indispensable if one of the purposes is to support in establishing manoeuvres and tactics of the resources available on the fire: here we enter a much more detailed realm that is also related to specific information and constraints of resources and scenario present, an area in which the final word is needed to be taken by those on the ground coordinating the event. Therefore, in order to avoid unduly or incorrectly influencing those on the ground, the choice of providing tactical guidance remotely will be left to the ability of the RAWE team based on the information received and updated on the resources deployed in the event, the characteristics of the terrain (WUI, etc.), and the knowledge they have about the organization capacities that is coordinating and operating on the fire at that time.		

3

3. Framework

This chapter reviews the themes that were found to be most recurrent in the approach to RAWE of the various organizations that collaborated on this document by providing information, analysis, and past experience. The following paragraphs have been identified to find activities and tools needed in RAWE and that are essential to provide support for decision-making tasks: capability, position, mission, vision (Castellnou et al., 2021).

This subdivision into main thematic areas therefore makes the information and examples gathered useful both for organizations that have already developed procedures and activities specific to remote support, and for those that will want to do so in the future, to better understand the potential of this type of support and to enable at the European level to come to an extended understanding of the resources needed both to provide and to receive this type of support.

| 3.1 Communication flow and translation to the IC: who sends and who receives.

From different past cases and experts opinions has emerged that it's very important that the flow of communications is well organized and clear for both remote and field personnel. It's necessary the presence of someone who has a fire analysis understanding and who knows how to **translate data and observations coming in remotely, process it, and pass it on in a usable way to decision makers**. Reports from remotely are useful for confirming or refuting the analysis of those in the field, but not for contributing general, purposeless opinions. If all the communication flow is done efficiently and accurately those in the field during the emergency, will thus have to spend less time and energy on analyses useful for decision making while trying to reduce the resulting uncertainties and speed up the analysis process. Remote reporting is not a show of information already known, not a list of charts to be copied and pasted from the most reliable weather sites, but it must be the processing and **analysis of the most useful data and observations gathered and then providing it as information format to someone who can quickly use it in decision making**. Clearly, there is then a need for this information to be confirmed or denied by the one who will be making the decisions or by a dedicated staff present in the field since that is where the decisions are made.

FA is not always present in all European organizations, and in some it still needs to be defined in its competence, role, and training. The risk is to have a gap of correct translation from remote to the field. If RAWE's products do not enter the decision-making process, even if only as an act of awareness, this kind of support is not needed. A further added value of dialoguing with a FA (or other personnel present in the field) also lies in feedback and the ability to then be able to update what was done remotely with data and observations coming directly from the event area. Therefore, two ways (either formal or informal) have been explored until now:

- Products processed and sent via RAWE **only when requested** by personnel involved in decision making in the field, following precise identification of what needs are requested by those in the field.

- Products processed and sent via RAWE **offering it without an initial request** from the personnel involved in field decision making. This happens especially when decision making personnel is already trained to take in and understand this type of information, being able to use it.

In the first case, such dynamics were detected in the interventions (requested and/or offered) by FAST (Malaga 2021, Greece 2021), while in the second case this dynamic is already operational through the service contributed by the NAD-AIR group of ANEPC in Portugal and also in INFOCA in Andalucía.

The RAWE product can be updated according to the fire trend (NAD-AIR, SDIS13), or to the field requests. This is influenced both by the changes that may occur in the area of the event, the type of information requested from the field and the data available to process it (satellite images, forecast models of some weather variables, etc.).

Another issue of high importance is that related to the language (especially during international RAWE) and the technical terminology to be used in the description of the fire scenario analysis. Therefore, capacities will be needed remotely or in the field, for better relating to the IC or other operational personnel involved in the decision-making process. The objective is adapting the language from the analysis carried out through RAWE to explain and pass that type of information as clearly and quickly as possible. The legend used in any graphics or maps in the remotely produced reports also takes on considerable importance.

A good communication flow can contribute to build mutual trust and respect between those in the field and those supporting remotely.

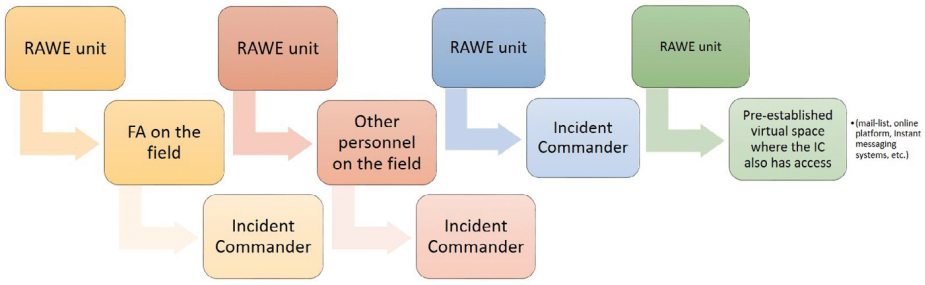


Figure 6. Example of possible types of field-remote communication flows with the figures involved being implemented by different organisations. Each colour represents a different model. Source: DREAM

Main communication needs from the field:

- Translating RAWE analysis to the IC so that it can be integrated into decision-making process.

- Receive clear information (RAWE product) that can be updated in agreement with the RAWE unit, when necessary.

Main communication needs from the field:

- Receive feedbacks from the field on the actual situation to: update information, adapt the format of information to the most useful format in the field (e.g. map, graph, document, or others.).

- Receive timely data and observations detectable only from the field (e.g., local weather dynamics, BEH, etc.).

Figure 7. Fire Analyst of the Technical Unit of Analysis and Prevention of Forest Fires in the regional room in Valencia while preparing products to be sent to the field for local RAWE in Valencia. Source: UT-902 VAERSA.

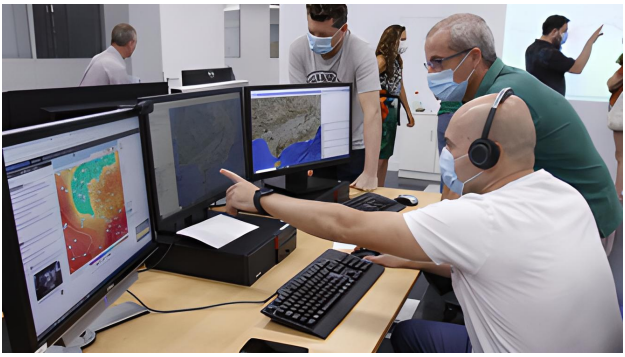


Figure 8. Analysis phase in the INFOCA service operations room. Source: INFOCA Andalucía

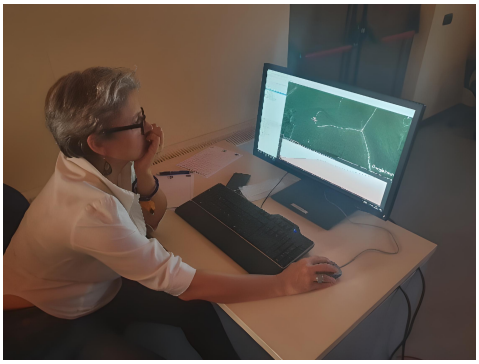


Figure 9. Fire Analysts in the field exchange information with the RAA in the operations room. The field FA then talk to the IC to translate the shared analysis. Vicopisano, 08/14/2021. Source: DREAM

Figure 10. Place and time of analysis of RAWE's Núcleo de Apoio à Decisão - Análise de Incêndios Rurais (NAD-AIR). Source ANEPC GAUF Portugal.

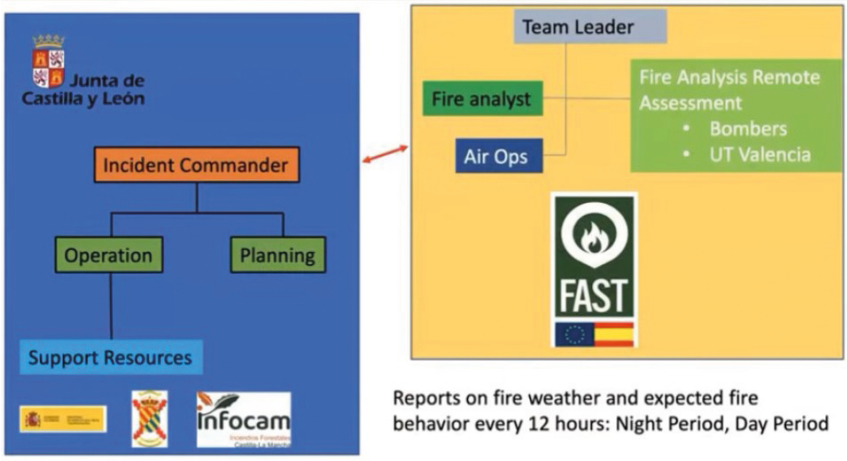


Figure 11. Communication flow and FAST personnel involved in the RAWE support during the Navalacruz 2021 fire. Source: FAST

| 3.2. Basic data and information to be asked and received

To **avoid overly general information** being provided remotely that would only contribute to the uncertainty of those in the field, it's necessary to **identify the most useful data and observations** to receive for analysing and assessing a fire through RAWE. A well-functioning communication flow between field and remote personnel is essential (Chapter 3.1), but also questions requesting information must be carefully formulated. Obviously, this difference in the input of information will also be due to the analysis that will then be procured remotely: whether it will be strategic level or tactical level.

Some of the support is sometimes related to specific requests (possibility of pyrocumulonimbus formation, status of the fire perimeter, etc.). Therefore, data and observations needed to develop a product for submission depends

on the level of detail of the request. Then, the completeness of the responses will also depend on the amount and quality of data and feedback that can be obtained from the field. In the experiences of recent years and from what has emerged in discussions with technicians and fire analysts from Europe and beyond, useful data and observations has been gathered regarding:

- Information desired by those requesting remote support
- Data and observations that should be asked for in order to provide useful remote support

Data and observations to be received certainly also depends on the operational capacity of those in the field, useful information cannot always be procured as desired, and sometimes the remote-field dialogue can take place between very different technical and professional levels.

3.2.1 Information more needed by remote support requestors.

The requests **depend a lot on the degree of experience of the organization and the team on the ground**. Generally, requests can be strategic analysis or up to request support on tactical aspects. Certainly, it is increasing likely that in the near future many requests will come more frequently from organizations that have been forced to change their approach in recent years (longer and more intense fire seasons, etc.). But it already happens that even well-equipped organizations need remote support to receive more detailed analysis on certain aspects that are not easily analysed during an emergency on the ground or just for validation of the strategy.

It is important to emphasize that **when someone asks for support he/she expects to receive help, a reading of the problem that can reduce his uncertainties**, which is achievable not by sending data but by sending information (RAWE products) that have already processed that data and can explain what has already happened, what is happening and what will happen in the wildfire area. Below are the main features of support requests via RAWE:

- Know where the perimeter is, know what the active fronts are, have a snapshot of the current situation. Support is also required to continue to update it quickly
- To know what the evolution will be, what the fire wants to do and what it can do. In particular, the request is aimed at understanding how the various sectors of the fire may move and what other sectors may be affected as the hours go by having support for tactics. How best to use resources to be able to achieve the objectives proposed by the analysis

- Safety aspects of personnel on the fire
- Knowing how quickly the front will reach a given point (often for wildland-urban interface issues or particularly critical points)
- Knowing how changing weather patterns will affect fire behaviour
- Interpreting and translating radiosounding to understand the fallout of such conditions on the fire area and predicting the possibility of pyrocumulus or pyrocumulonimbus forming

3.2.2 Data and observations more needed to provide remote support

The following are some types of useful data and observations that are more frequently requested from remote field operations personnel. This is not a definitive, standard checklist, because the quantity and quality of data to be requested depends on the demand:

- Updated perimeter
- Ignition point
- Active parts of the fire, stabilized parts, controlled parts, and extinguished and reclaimed parts (suppressed)
- Local weather (real time data)
- Fire behaviour (photo and video)
- Smoke column (photo, video and data)
- Fuel models
- WUI localization

Some observations and data related more to the possibility of tactical support instead may be:

- Fire suppression capacities
- Impact of fire operation on the ongoing/active fire

While some of the above are more easily available to those in the field (perimeter, ignition point), for others much depends on the area in which they are searched and how often they are kept up-to-date in the relevant databases (fuel models, WUI). Very useful is to know the positions of the fire fronts and to divide the perimeter into sectors that have different phases (active sector, sector in containment, stabilized sector, sector in control) in order to better estimate evolutions and potentials. Some difficulties are encountered in the case of RAWE to do internationally or between different regions of the same country, when the nomenclature used to describe the status of the perimeter is not the same. Certainly, the fire behaviour evolution and applied manoeuvres result should be monitored in the various sectors of the wildfire.

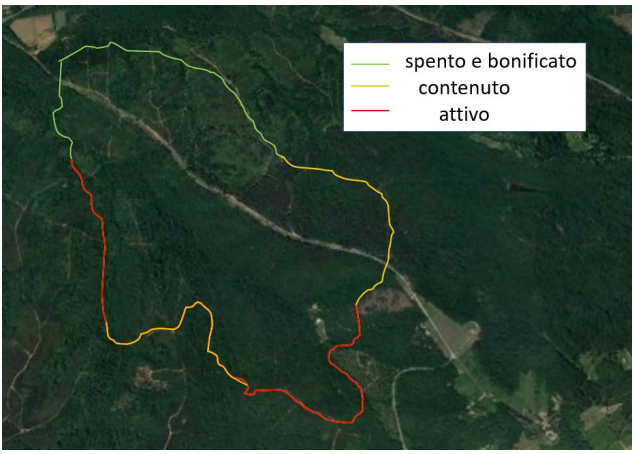


Figure 12. Wildfire divided into sectors with different phases (active, contained, control) sent remotely to the field to be able to better understand future evolution, potential surfaces, and to be able to focus tactical objectives and manoeuvres at strategic points (Grosseto 2021). Source: DREAM

Table 5. List with basic requests that are made remotely to ground staff to provide an initial analysis of an incident (the current and future scenarios) used in Wales. Source: South Wales Fire and Rescue Service.

Data/Observation	Notes
Fuel type	Currently affected and soon to be affected
Topography	Currently involved and soon to be involved
Weather	Current and expected
Fire behaviour	Current and expected
Seasonal weather	How will this affect fire behaviour in different fuels
Locations of prepared/natural fire breaks	To be verified by satellite and/or drone images
Available resources	Tactics employed
Historic fire information	When was the last time the fire occurred and where was it stopped

| 3.3 Tools for remote analysis

The tools that can be used to conduct remote analysis are many. Technology is making more and more different types available for collecting and processing data: websites, software and online platforms. Obviously, the proper use of these also depends on the skills and technical knowledge of those who use them and on the possibility of access to the data. For example, in discussions with various experts, the need emerged to have the possibility of accessing the images and data recorded by all the different satellite constellations around the world during an emergency in which there is a need for RAWE, so as to provide the necessary information to those who are remotely located without having to be limited by access restrictions.

There is a widespread need to be able to know how to use the ever more advanced technology in the best way possible, finding the most appropriate method to contribute appropriately in analysis through RAWE. For this reason, too, there is no proposal here to standardize the tools that can be used in RAWE, but rather useful ideas and examples on the use of analysis capabilities already present in different organizations. This section will not provide an exhaustive list of portals, software, and websites (a small overview of this can already be found in D2.5 Guidelines on the use of tools, science, and best practices for fire analysis), but will illustrate some examples of different types of tools that can be grouped into the following categories:

Table 6. Types of tools and features needed for RAWE activities. Source: DREAM

Tool type	Notes	Required characteristics
Website	Meteorological, spatial, carto-graphic data, etc.	Accessible to the whole team. Access security. Ability to share even large content. Ease and simplicity of use. Shared symbology Interoperability
Software	Processing of collected data, graphic design, etc.	
Real time shared portals	Real-time data/observations and analysis sharing between remote and field personnel	

3.3.1 Websites

The data useful during RAWE and obtainable from websites is of various types, and the accuracy and level of detail also depends on the availability of local information. There will be a different level of detail by consulting large-scale data than when one has availability to consult small-scale data (meteorological data, spatial data, etc.). Whether it is intended to provide a large-scale scenario analysis or whether a more detailed analysis of some particular parameter is required to the RAWE

(mapping of active fronts, expected weather scenario in a sector of the fire, tactical level information, etc.).

Below are some examples of websites with data related to meteorology, hazard indices, and spatial data (small- and large-scale):

- Global Wildfire Information System: https://gwis.jrc.ec.europa.eu/apps/gwis_current_situation/index.html
- Copernicus Emergency Management Service: https://effis.jrc.ec.europa.eu/apps/effis_current_situation/index.html
- Sentinel Hub EO Browser: https://apps.sentinel-hub.com/eo-browser/?zoom=10&lat=41.9&lng=12.5&themeId=DEFAULT-THEME&toTime=2022-05-27T10%3A56%3A01.169Z
- Radiosounding:
  - University of Wyoming: www.weather.uwyo.edu/
  - Tropical Tidbits: www.tropicaltidbits.com
- Standard weather:
  - Wetterzentrale: www.wetterzentrale.de
  - Windguru: www.windguru.cz
  - Meteoblue: www.meteoblue.com
  - Wxcharts: https://wxcharts.com
  - SPOTWX: www.spotwx.com
  - Windy: www.windy.com
  - SIR Tuscany Region: http://sir.toscana.it/consistenza-rete
- Spatial Information
  - Google Maps
  - OpenStreetMap

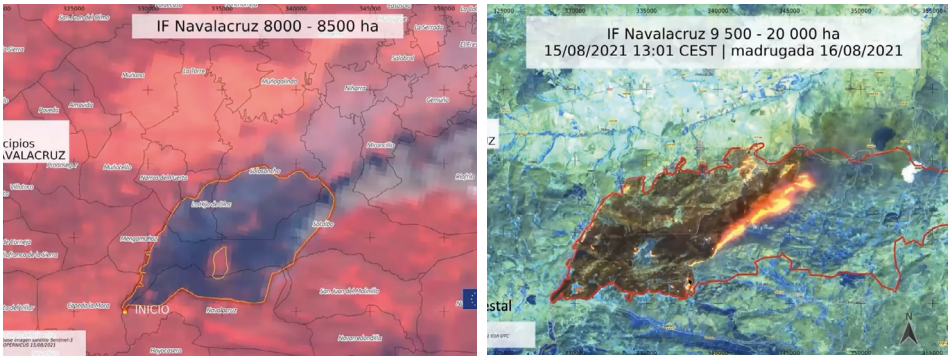


Figure 13. Example of processing done using data obtained from websites (Copernicus) for remote assessment. Source: FAST

3.3.2 Software

Software useful for RAWE can include both the most commonly used ones (open source and not created specifically for the FAA) and those that are dedicated to the processing of propagation simulation that process different types of data (fuels, meteorology, terrain morphology, etc.) and at the same time require a specific degree of knowledge of their use. In both cases, however, it is possible to integrate and adapt these types of tools to the purpose of the required analysis. In this part it has been chosen to not go in depth about simulations software potentialities and limitations, just because it's a wide topic and it's not the objective of this deliverable. Below, there are some software examples. In order to make maps of possible fire spread using the polygon method, GIS software (or Google Earth) and software for setting up presentation documents (e.g., MO Power Point) are needed so that coloured arrows can then be placed on the image according to primary, secondary, and tertiary connections.

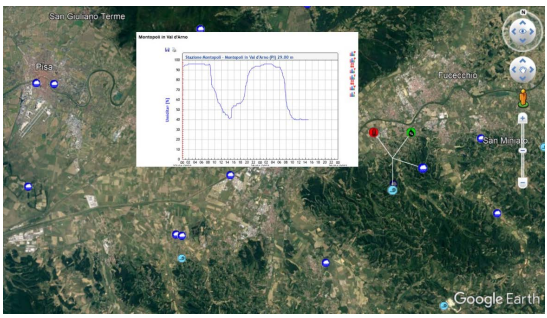


Figure 14. Placement of all Tuscany Region Functional Centre weather stations on Google Earth with the possibility of a direct link to the station so that the weather stations closest to the fire can be monitored. Source: DREAM

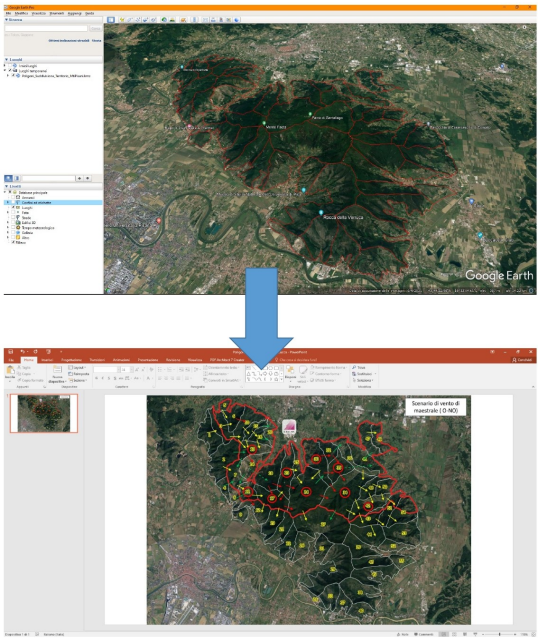


Figure 15. Example of the preparation of a product based on the polygon method: above on Google Earth as a function of fuel types, orography and other variables the polygons are defined, below on Power Point the map is shown, the polygons are numbered and the arrows are placed as function of primary, secondary and tertiary interconnections. Source: DREAM

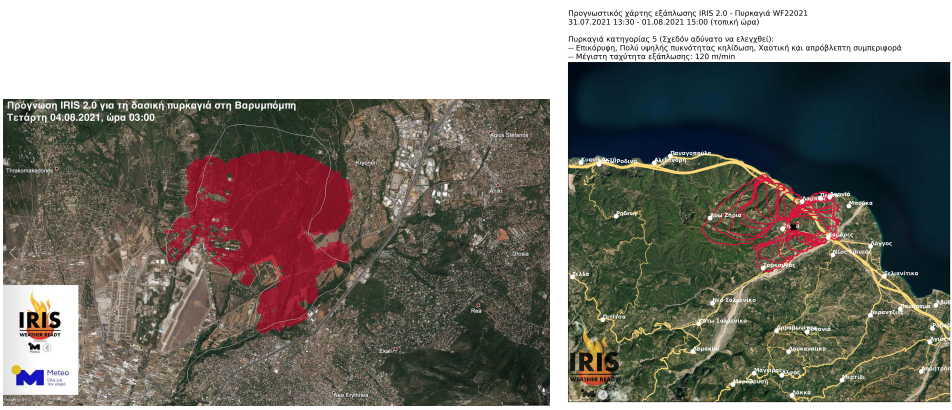


Figure 16. Examples of the use of fire propagation simulation software: on the left IRISvsFIRMS_04Aug2021_0300LT (August 2021), on the right FireSpreadBehaviourGuidance-IRIS2.0 (July 2021). Source: NOA (Greece)

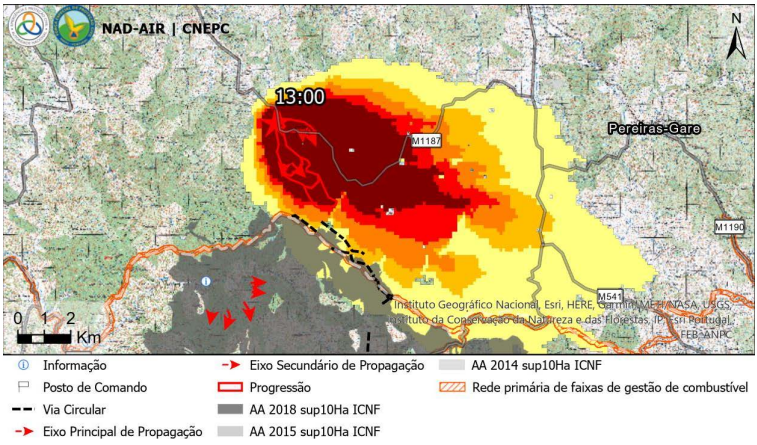


Figure 17. Example of graphical restitution through use of simulation software as information to be added (at the RAA operator's choice) in the INFOP report produced by the RAWE NAD-AIR service. Source: ANEPC GAUF Portugal

3.3.3 Real time shared portals

Some organizations take advantage of specific unique portals for receiving and processing data and observations between field staff and remote staff so as to facilitate the work of the RAA or RAT (FEPC Portugal, FAST, etc.). These are shared portals within the support team where RAWE operators can retrieve up-to-date data and observations regarding the fire area, the location of the fire perimeter, possibly on the fire behaviour with geolocated photos, ongoing operations by observing the location of the teams present, etc. These shared portals between remote crew and team present in the field are advantageous in that those in the field are able to provide immediate feedbacks and updates to those remotely.

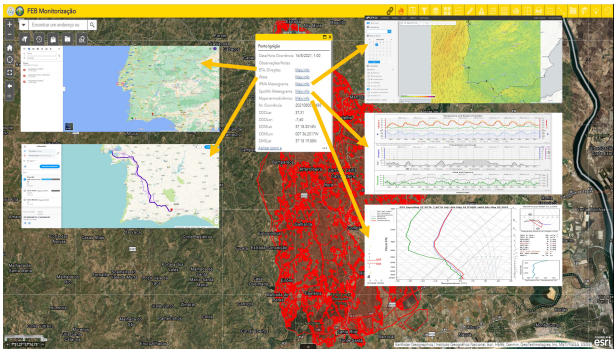


Figure 18. Data that can be extracted once the fire ignition point is established through the portal of the NAD-AIR service of the Portuguese ANEPC. Source: ANEPC GAUF Portugal

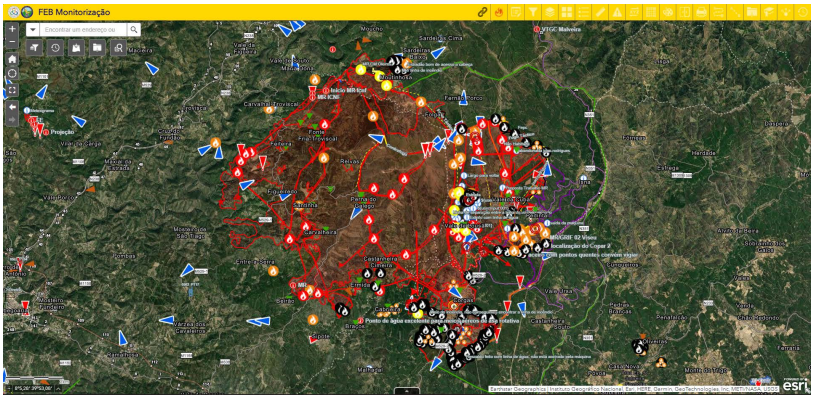


Figure 19. Example of the data that can be obtained during the fire from the portal used by the NAD-AIR service, this is updated both by personnel present in the field and remotely. Source: ANEPC GAUF Portugal

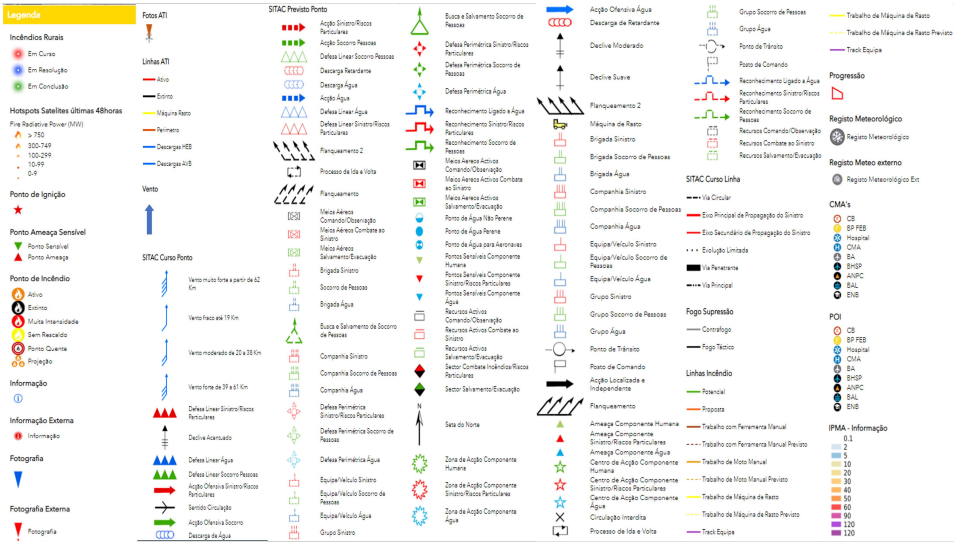


Figure 20. Part of the legend with the different types of information that can be found on the shared portal of the NAD-AIR service Source: ANEPC GAUF Portugal

| 3.4 Remote analysis products

A RAWE "product" is defined as a result of the remotely processed analysis that is then sent to field operator to facilitate and support decision making. A product can then resume the RAWE analysis in various forms: report, graph(s), diagram(s), maps, etc. or only simple phrases for resuming and explaining the predicted scenario(s). The aim of a good remotely realized product, whether it is a detailed report or a brief written and/or graphical restitution of the analysis, is to make those on the ground aware of the evolving situation and the existence of different options that otherwise would not be considered. In the process of making and updating the product, it is important that what is made is then compared with what is happening in the field through an exchange of information between field staff and RAWE staff in order to understand and possibly correct what is being analysed.

It is considered a useful option that the products being sent are adaptable, especially when not everyone can or is trained to interpret them in the same way. Because it's important that those in the field are then able to make proper use of that type of information brought in through RAWE so that their margin of uncertainty during the decision-making process is reduced, without procuring or increasing pressure on them at the choice stage.

Nowadays it exist different opinions as to whether the products of this type of activity should be in the near future standardized or whether they should be kept adaptable to the context to which support is being provided. Beyond that it should be kept in mind that what RAWE's products bring is the development of an analysis which implies the ability to be proactive and to understand how to provide valuable support for field staff in order to help them make decisions (Figure 1). There is therefore first and foremost a need to know how to identify and use an appropriate methodology for providing and/or receiving support through RAWE.

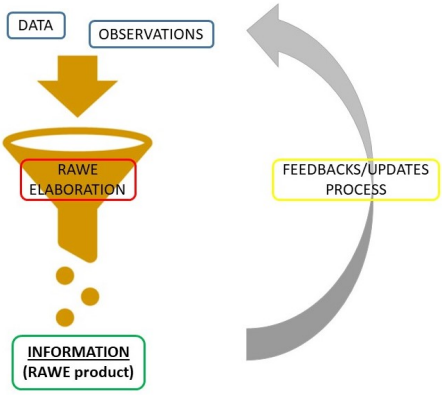


Figure 21. Example diagram of the process of elaborating (and updating) a product using RAWE service. Source: DREAM

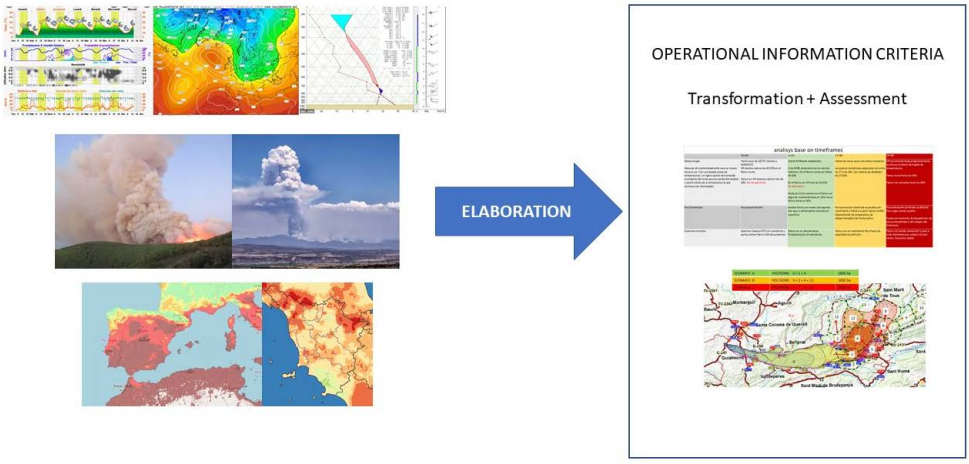


Figure 22. Example of processing and transformation from "data" and "observations" (raw) to a product ("information")". Source: DREAM, CFRS, FAST.

Below are some collected examples of products sent remotely to those in the field made by different organizations. Some have similarities in terms of content, others differ in both the format chosen and the timing with which they are updated (pre-set or on demand or when conditions on the fire area change significantly).

Main objectives of RAWE products usually are:

- To provide information about foreseen fire spread potential (surfaces)
- Weather forecast in the fire area (present and foreseen)
- To highlight opportunities to better fight the fire
- To localize sensitive areas (e.g. human settlements) and critical points (areas from where fire can spread in other areas)
- To localize priorities areas for fighting the fire
- To describe fire behaviour (present and foreseen)
- Others

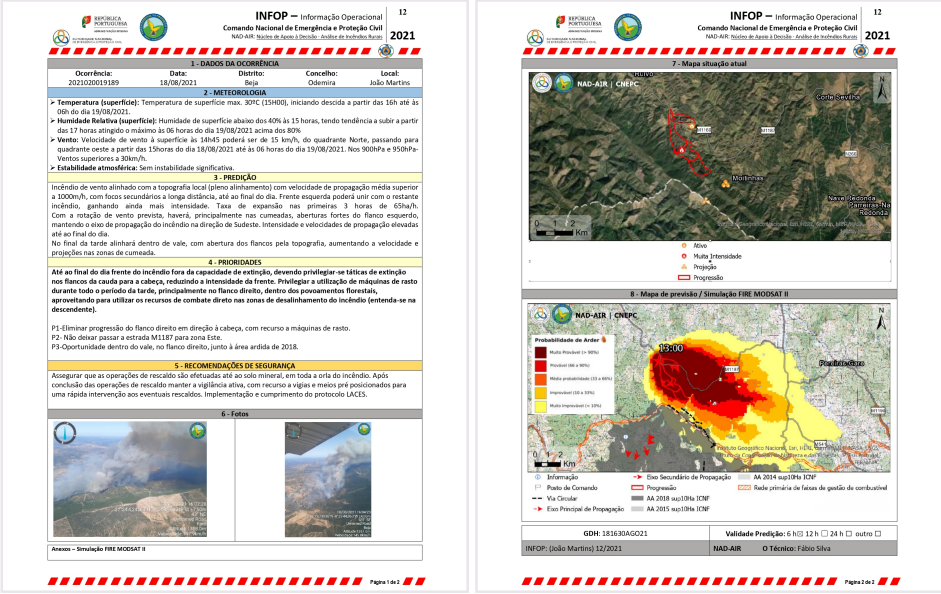


Figure 23. INFOP – Informação Operacional, João Martins fire (Portugal), 2021, 18th of August. Source: ANEPC GAUF Portugal (ANEPC)

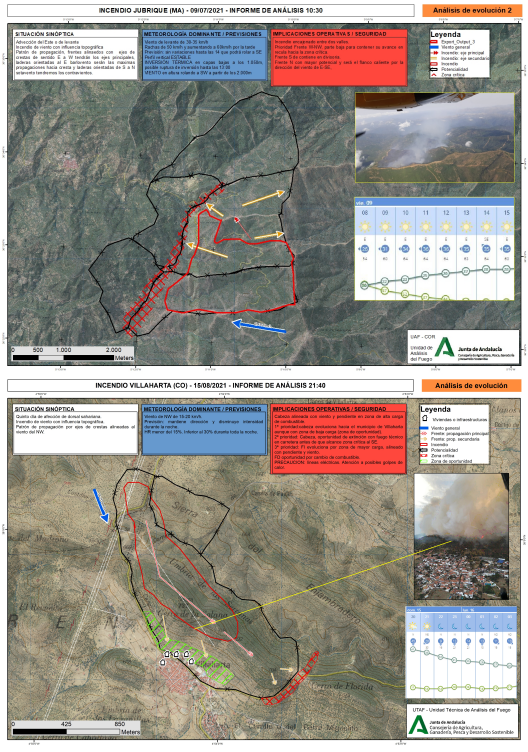


Figure 24. Preliminary fire reports of the Jubrique Fire (Málaga, Spain) on the 9th of July of 2021 and Villaharta fire (Cordoba, Spain) on the 15th of August 2021. Source: AMAYA - INFOCA

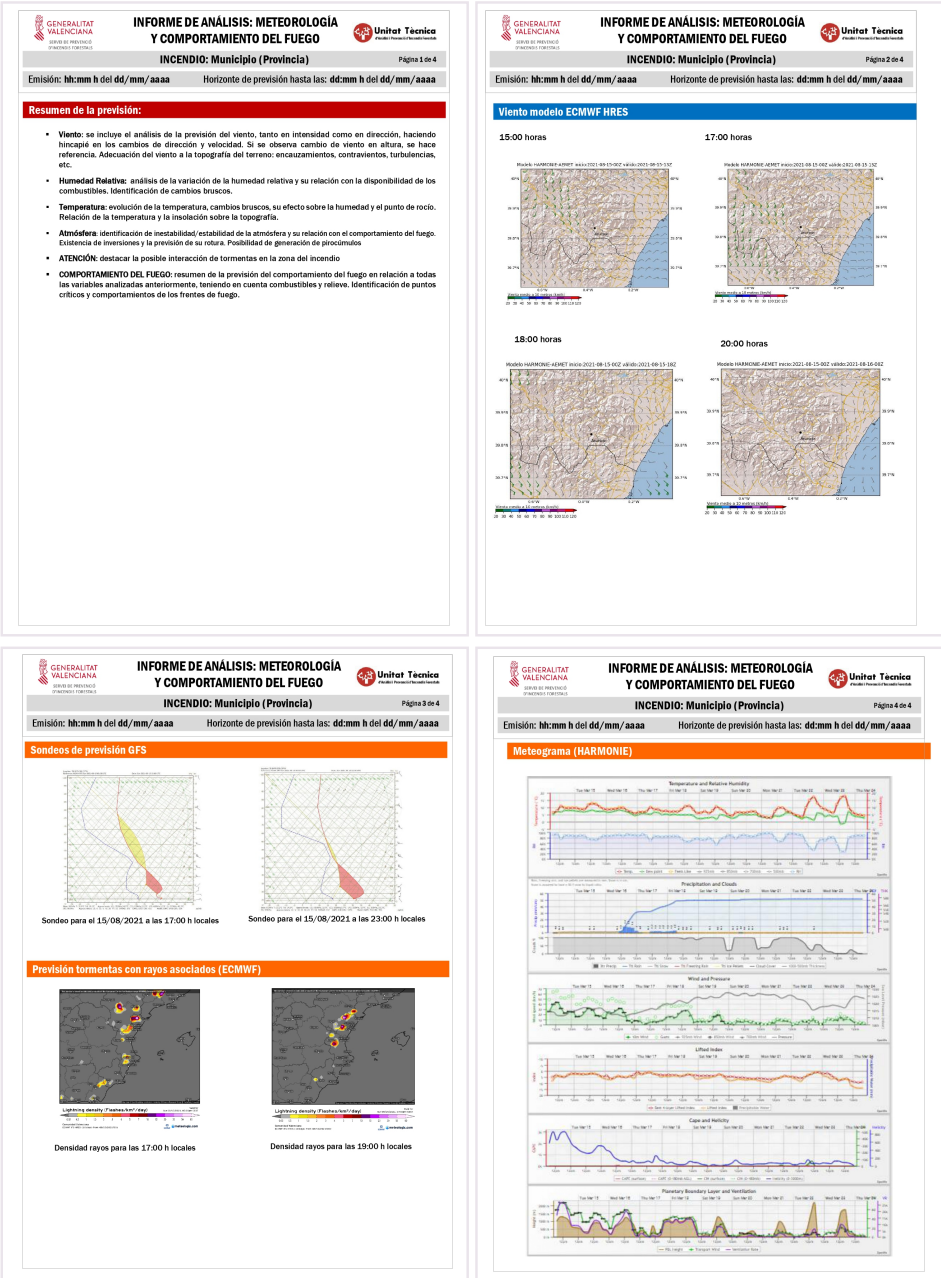


Figure 25. Example of the type of content of a product that can be processed through RAWE by the Unitat Tècnica d'Anàlisi i Prevenció d'Incendis Forestals (Generalitat Valenciana). Source: UT-902 - VAERSA

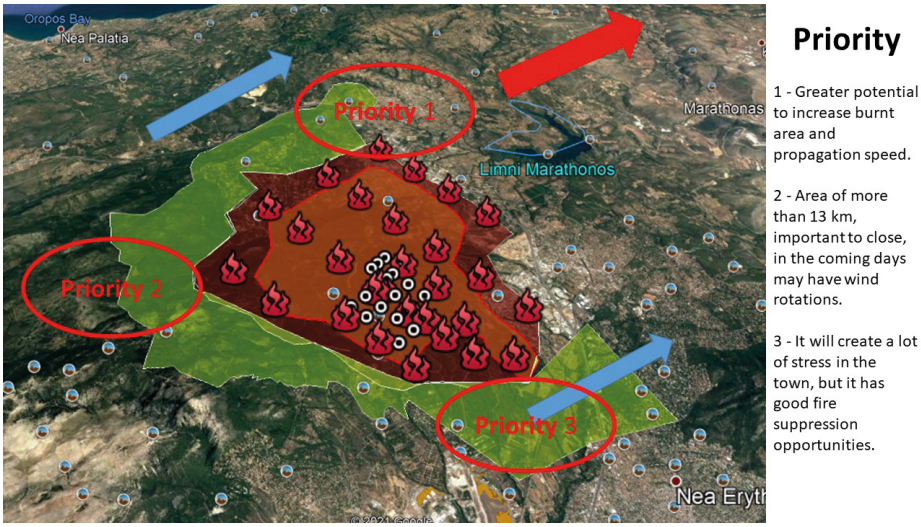


Figure 26. Part of the product made remotely by ANEPC (GAUF, Portugal) and National Observatory of Athens (NOA, Greece) during the Varympompi fire on August 3, 2021. Source: NOA

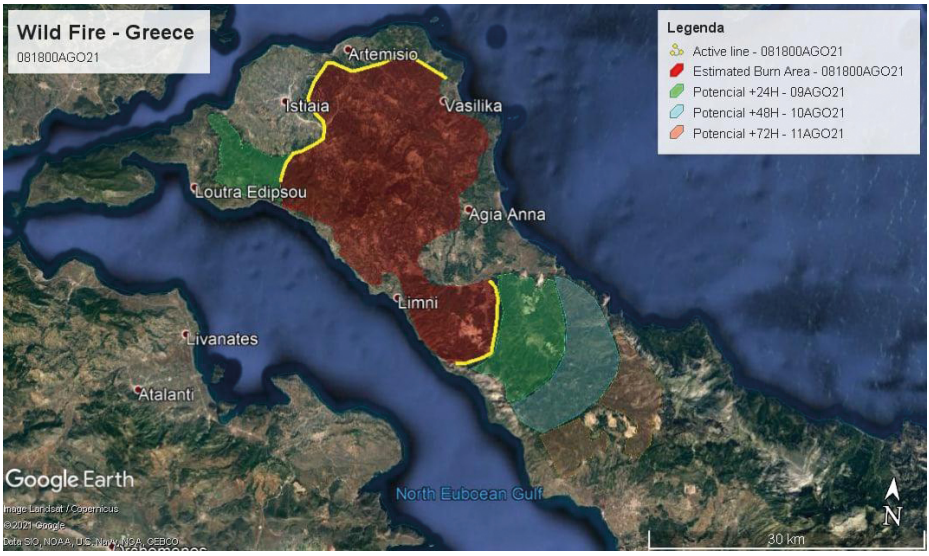


Figure 27. Part of the product made remotely by ANEPC (GAUF, Portugal) and National Observatory of Athens (NOA, Greece) during the Euboea fire on Aug. 8, 2021. Source: NOA

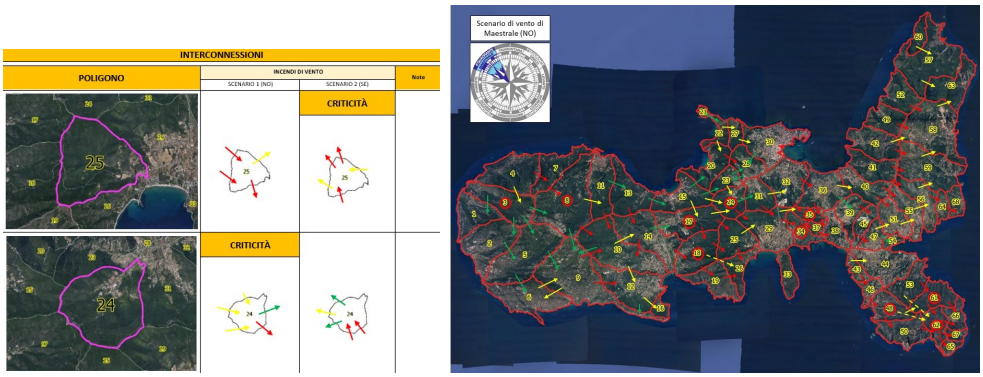


Figure 28. Example of information on which the control room fire analyst in Tuscany can base the processing of his products. Source: DREAM

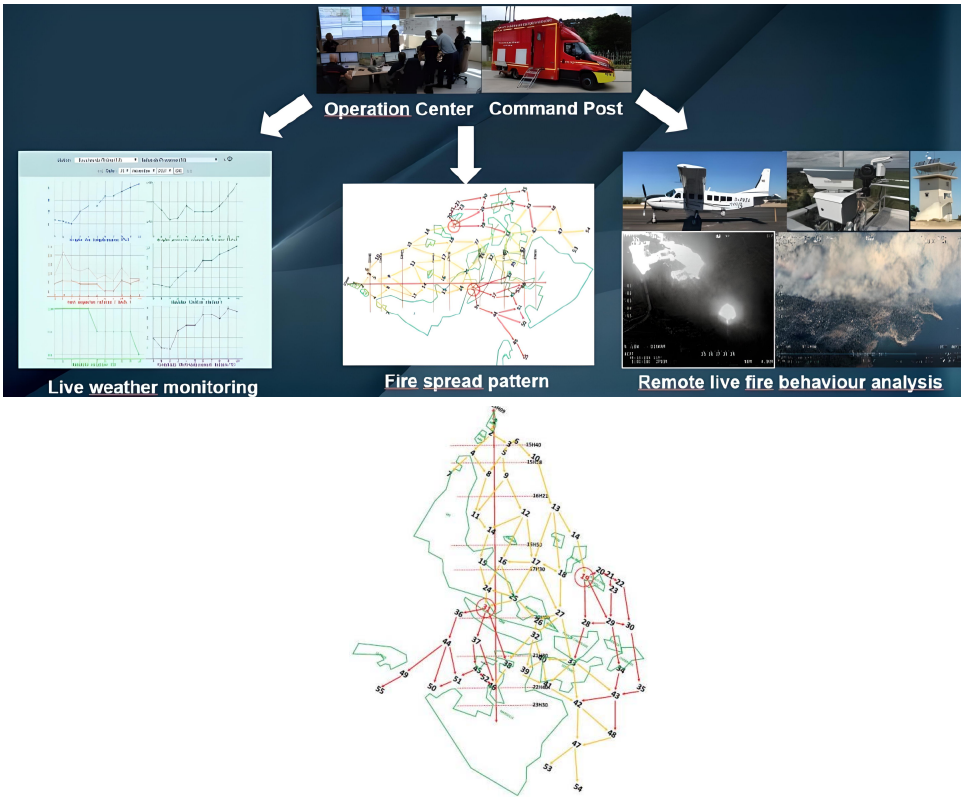
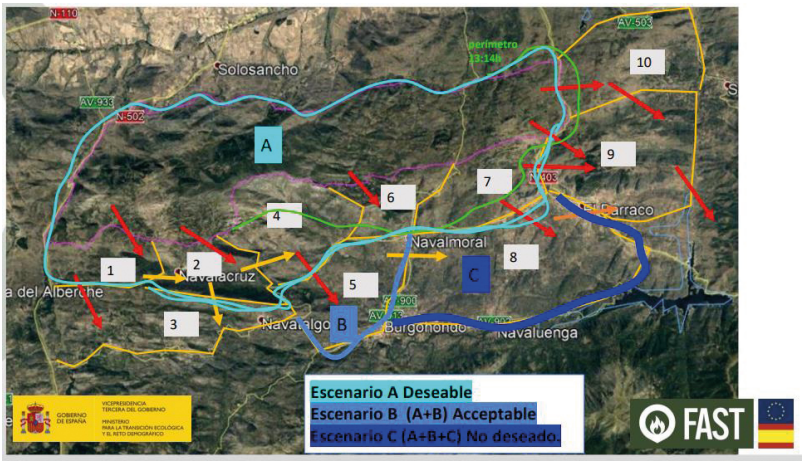
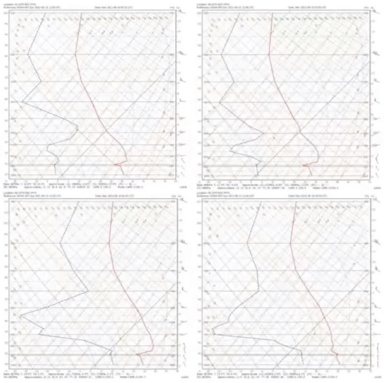


Figure 29. Example of the process and part of the product made remotely by SDIS13, Rognac fire on August 10, 2016. Source: Pompiers Des Bouches Du Rhône 13 (France)



Pyroconvection Potential

Análisis de los perfiles meteorológicos a través de sondeos de predicción. Periodo nocturno del día 15 al 16 de agosto:



Potente inversión térmica en superficie hasta las 10:00 de la mañana aproximadamente. En esta situación de estabilidad nocturna el humo tenderá a estancarse cerca de la superficie. La escasez de ventilación redundará en un comportamiento del fuego más atenuado. Sin embargo, se pueden producir problemas de visibilidad y de exposición a ambientes cargados de humo, u problemas para el trabajo de medios en las primeras horas después del alba. A partir de las 10:00 de la mañana se prevé que empiece a levantarse la inversión nocturna, con lo que la capa de mezcla irá aumentando su grosor con el paso de las horas de la mañana del día 16.

Analysis base on timeframes

	00-06h	6-12h	12-18h	18-00h
Meteorología. RESUMEN: Masa de aire extremadamente seca se mueve hacia el sur. Con una bajada suave de temperaturas i un ligero aporte de humedad providente del norte que se mantendrá estable y será el efecto de la temperatura la que dominara las Humedades	Viento seco de OESTE rolando a NOROESTE. HR alcanza valores de 40-50% en el flanco norte. Flanco sur HR alcanza valores max de 20%. No recuperación.	Viento NORoeste establecido. A las 8:00h alcanzaremos los valores máximos. En El flanco norte con HR de 50-60%. En el flanco sur HR max de 20-25% No favorables. Hasta las 12 los valores en el flanco sur seguirán manteniéndose en 20% i en el flanco norte en 30%.	Viento de norte seco con plena insolación. Las peores condiciones esperadas son entre las 17 y las 18h. Con valores de alrededor de 15-20%.	HR incrementa hasta progresivamente las 00 por el efecto de bajada de temperaturas. Flanco norte hasta los 40% Flanco sur aumenta hasta los 30%.
PyroConveccion	No pyroconveccion.	posible PyroCu en medio día bajando aire seco y alimentando incendio en superficie.	Pyroconveccion profunda es posible con crecimiento a PyroCb a partir de las 14:00h. Dependiendo de temperatura de disparo=longitud de frente activo.	Pyroconvección profunda se dificulta. Pero sigue siendo posible. Puede ser momento de desaparición de pyroconvectividad o del colapso del fenómeno.
Escenario incendio.	Apertura Cabeza ESTE con pendiente y partes activas flanco SUR descendentes	Flanco sur en descendente. Probablemente sin pendiente.	Flanco sur en crecimiento libre fuera de capacidad de extinción.	Flanco sur pierde convección y pasa a estar dominado por colapso y/o por viento. Descenso rápido.

Figure 30. Processed products realized through RAWE for the Navalacruz fire of August 14, 2021. Source: FAST

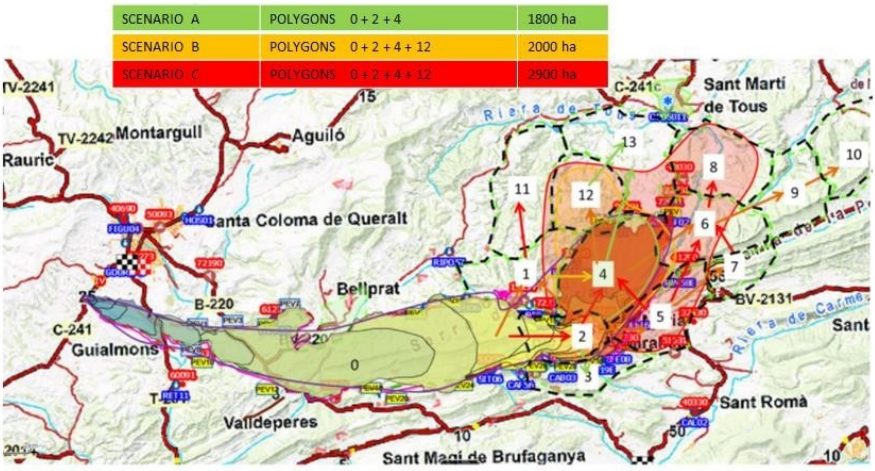


Figure 31. 2021 Santa Coloma de Queralt Fire (Catalonia, Spain) from the 23-27th of July 2021. Identification of a set of possible final strategic scenarios (A, B, C) with probabilities (arrows and numbers in white squares). Source: CFRS

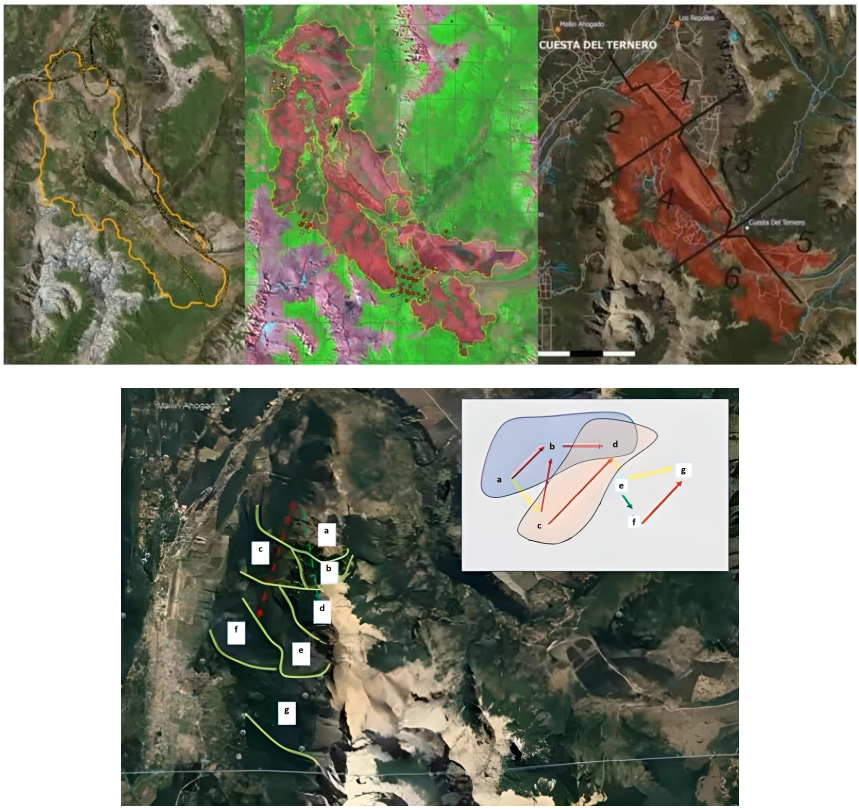


Figure 32. Processed products produced through RAWE for the Cuesta del Ternero - El Boquete Complex Fire and Las Golodrinas - radal Complex Fire (Argentina, March 2021). Source: Mercedes Bachfischer

Figure 33. Process of analysis and processing (and updating) of a RAWE product made for the 2019 Chaco (Bolivia) and Cerrado (Paraguay) wildfires. Source: Wildfire Magazine. 28.5 (p. 31)

| 3.5. Communication channels

The topic of communication channels that can be used is closely related to that of "Communication flow" (see Chapter 3.1). But how the flow of information between remote and fire zone is established will also determine the choice of the most suitable communication channels.

For these reasons, it's useful to point out the advantages and possible criticalities of the different types of communication channels that have emerged where RAWE services are present. The communication channels can be categorized as follows:

Table 7. Main advantages and disadvantages of different channel typology. Source: own elaboration.

Channel Typology	Notes	Advantages	Required characteristics
Instant Messaging Systems	Apps and Web Apps	Ease of access. Low or no costs (for apps and most common data storage systems). Possibility of exchanging content of different formats and sizes. Possibility of sharing with several parties at the same time.	No guarantee of copyright protection of what is shared through the specific portal/website. Costs to be incurred for specific apps or data storage systems. Strong correlation of functionality with the presence of a good degree of internet connection capacity (remotely as well as in the field) to send and receive content. Need for preliminary training in the correct use of the chosen communication channel (for less commonly used communication and sharing systems)
Online data storage systems	E.g.: WeTransfer, Google Drive, Dropbox, etc.		
Ordinary online communication systems	E.g.: email		
Alternative to digital systems	Analogue systems (e.g. radio, telephone, etc.)	(see paragraph text)	(see paragraph text)

Numerous alternatives of more or less common portals, sites and apps can be recognized in the categories listed above. In addition, digital technologies manage to mutate and update their features with much higher frequencies than analogical tools of more traditional use.

Concerning analogical systems alternative to digital ones (such as telephone and radio apparatus mainly), it is obvious the limited capacity of immediate exchange of the contents of different formats in real time. But it's considered necessary to maintain also this type of option during the performance of RAWE activities in case of deficiencies in the functioning of the most common and performing digital systems in particular phases: i.e., in case of no possibility of Internet connection in the wildfire area, malfunction/damage (even temporary) of digital communication tools for un-predictable reasons (hacker attacks, system collapses, etc.).

Below the major needs during RAWE activity that could guide in choosing the most suitable tool for different organizations, considering their own capabilities and procedures:

- Robustness of communication: maintain the ability to be able to communicate with operator present in the field and remotely at any time, including making up for unforeseen shortcomings and using fixed, pre-established channels or channels created specifically for the event

- Sharing of different types of content: using platforms or web apps that allow sending and receiving different formats of remotely produced or field-detected content (photos, videos, geographic information files, documents, etc.)

- Use of a secure and reliable data storage service: do not put shared material in weakly protected portals, ensure traceability even after the fact of what is shared, and (eventually) possibility of guaranteeing copyright to those who share the material and not to the eventual private entity that owns the service

- Be clear about who are the people responsible for the use of the content sharing channel: establish in advance, or at the beginning of RAWE's activity, who are the people who have the right of access to the channels of communication and sharing of content produced by remote and in the field

Nowadays, information is moving faster and faster, and even through social media and other channels share a lot of it, useful or not. But all this also needs to be managed and put into a useful and controlled format, so as not to risk creating pressure on those on the ground. **There is a need to gain control; to gain control it is unthinkable to deny information** but rather to build the way to enable the proper use of information. This is a very timely issue and one that has emerged exponentially, with the increasing facility to access and share more and more types of information.

Figure 34. Tuscany Region fire analyst who updates the perimeter of a fire and sends via Telegram the perimeter in kml format built on OruxMaps to the RAWE Unit present in the control room (2021). Source: DREAM

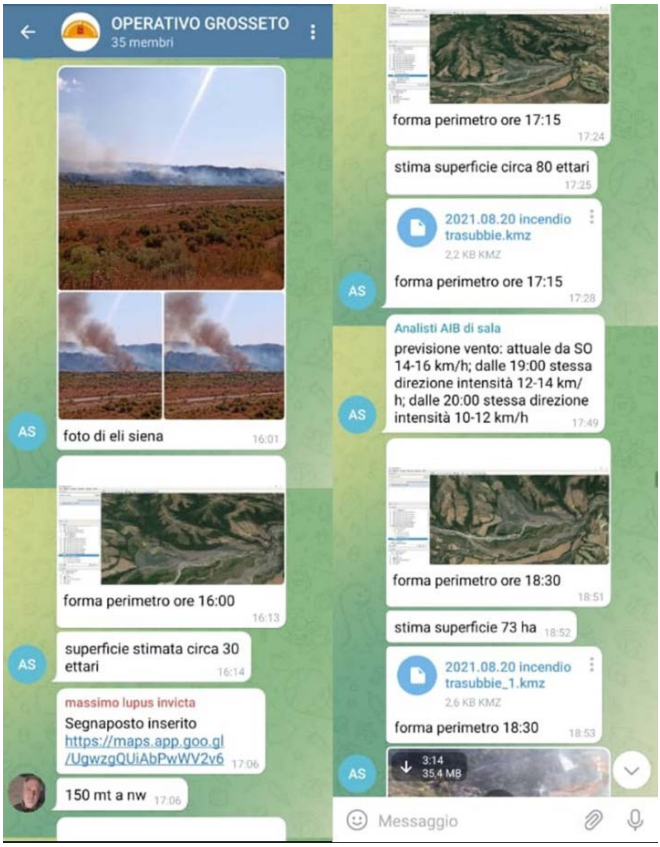


Figure 35. Example of information and product exchanged through a dedicated Telegram channel (Tuscany Region). Source: DREAM

| 3.6. Responsibility

The responsibilities associated with RAWE operators is a sensitive issue, but at the same time it has some fixed points in organizations where remote support service is provided: the responsibilities of RAWE operators (RAAs or RATs) is linked to the responsibility associated to the analysis products and sent into the field that is then used to make decisions. Responsibility considerations are therefore currently discussed with regard to what RAAs or RATs produce with data and observations available to them (and according to their own skills and training levels) and sent to the field. But it remains quite clear that even in the case of a request for support from the field at the tactical level, **the choice of whether or not to apply manoeuvres remains with those in the field.**

This is intended **to mark a difference between product responsibility** and decision responsibility, which will still be specifically assigned within each organization

according to its own procedures and rules of engagement. For this reason, it is necessary to keep content shared between RAWE and the field, as well as to have pre-established and trained roles for this type of activity.

Based on this it may be more clearly defined in each organization where the responsibility for what is produced by the RAWE and sent to the field begins. **It depends on what the legislation is like in each place.** Responsibility of the RAA or RAT may be in providing well-made products, while responsibility for decisions made may be retained by those in the field who are already designated and prepared for that type of role. Accountability should be on the basis of competency: it should be clear when the competency is making decisions or instead just aiding (those who are remote cannot know if safety measures, recommendations, etc., are being followed on site). In fact, RAWE's job is to support and facilitate choices, maintaining trust and reliability among operational team.

4

4. Critical issues and lessons learnt

This section aims to resume some of the most relevant aspects that emerged during the production of this document through the analysis of the different realities in which RAWE has been applied. This covers both the major critical issues and the main lessons learned while conducting this type of support.

Regarding the **critical issues**, it's highlighted:

- **Unshared language**: at the international RAWE level, not speaking the same language can make support activities more complex to not have in the remote team who can properly interact in the language of the personnel present in the field or in the languages most commonly used internationally (e.g., English). Even language understood as terminology, if not pre-established, needs attention and further explanation to properly integrate remote communications with field communications (both locally and internationally)

- **Increasing the sources of information may directly increase the variability of them:** need to pre-establish dedicated channels and roles that "filter" and manage the flow of information from the field or other available sources

- **Response times not always pre-established by procedures:** useful RAWE activity to frame the situation as early as possible for those in the field, so not excessively long times are needed for sending the first product remotely. In the case of international RAWE, the possible time difference between field and remote (time zone) should also be considered

- **Communication flow is not always clear and constant between remote and field:** need for updates, confirmations or refutes of forecasts, signalling of useful local data sources (e.g., websites with local weather stations, land use, etc.) to be reported to those who process products remotely and are not part of the local organization

- **Difficulties in translating analysis into decision making**: proper use of what is produced remotely by field crew is not always guaranteed (same issue often present even when FA is directly in the field), need to increase understanding and level of trust between field and remote personnel, especially when RAWE activity is carried out between different organizations

Some of the most relevant **lessons learnt** include:

- The RAWE does not make decisions: **decisions are only and always made from the field**, especially since remotely it is complex to know the extent and capabilities of resources in the field. In addition, the level of FAA knowledge depends on the organization; not everyone interprets in the same way what the

FAA is and how it can support decision making

- **It is recommended to have a FA on site** (or a fire analysis team): this position is to receive the product, talk to the IC and explain what this analysis describes, helping to reduce uncertainties and gain more awareness to facilitate decision making. The FA on site is in charge of adapting messages to the level of understanding of the receiving person/organization

- It is always **necessary to have feedback** from the ICP to the ones providing RAWE: to understand whether the content of the product is understandable, its format, whether the predictions are correct or not, etc. Otherwise a lot of uncertainty remains remotely while producing official documents. Feedback is best provided by the fire analyst or analysis unit that is on site, in the next few hours as well as in the following days

- It is important to understand **the requirements of those in the field**: the RAWE achieves its maximum efficiency when it answers questions from those requesting support

In the attachments (Annex 1), we propose the article realised for Wildfire Magazine, no. 28.5 (October - December 2019), in which the case of support through RAWE organised and realised during the fires in the Chaco (Bolivia) and Cerrado (Paraguay) in 2019 is illustrated.

| 4.1. Training to perform RAWE activities

When RAWE service is offered, personnel with specific FAA capabilities are called upon to perform this. By this is not to say that only personnel with FA profiles are useful in supporting RAWE, but it is essential that they are involved in the process of building and processing products that are sent to the field. So as a first step it would be useful to have training that harmonizes FAA capabilities at the European level (see D2.2 Guidelines of fire analyst competencies and skills). This will be able to train and also prepare to better receive those in the field who will receive support during RAWE. After that, a shared outline program could also be added and integrated, with the aim of also preparing for remote FAA activity (the RAWE), establishing for example:

- Requirements needed to be part of a RAWE service

- Training course and exercises shared at the European level

- Key points for any operational procedures when support is required for a single event or for simultaneous events

Taking advantage of the experiences that already exists and also the products of the

AFAN project, it is considered possible that in the near future a way will be indicated that can be shared by all European countries to prepare and train a large-scale RAWE service, adaptable to its own context but also integrable with other countries' structures to facilitate real cooperation in case of need.

Examples of exercises used for training RAA capacities in Tuscany Region, Italy (source: DREAM):

- **RAWE for a single wildfire**: with a first wildfire perimeter, meteorological data (present and foreseen), atmospheric conditions (present and foreseen), to make FAA and provide a RAWE product with scenario analysis and prediction for the next 1h -3h -6h for sending it to the field personnel

- **RAWE for simultaneous events**: the objective is to provide priorities for each wildfires for which different data/observations are available (some only coordinates, provisional perimeter, photos and videos and weather analysis). With pre-established timeframes, RAWE personnel must provide priority considerations for each ongoing wildfires for helping control room personnel and field personnel

| 4.2. Profiles overview for RAWE activities

As previously mentioned, there can be various types of technical profiles useful in RAWE activities. This will depend primarily on the level and type of analysis required by the field team. Assisting the work of the remote FA may be, for example, technical experts in: GIS, meteorology, modelling, other experienced operational personnel, operator with good level of the foreign language used in case of international RAWE, etc.

It is not intended to propose an exhaustive list because one must be aware that it remains the risk of linking each role of each aspect of the analysis to be processed to more than one person: in the case of the sudden absence of one of these roles one must therefore avoid that the remote support service collapses and crashes. In addition, it's to consider the responsibility that each role has to take for the RAWE product sent (see Chapter 3.6).

| 4.3. Post-fire analysis

Although the post-fire analysis is detached in timing and dynamics from the RAWE, it has been chosen to place of post-fire report examples selection because **this type of work is considered very useful for increasing knowledge sharing, training and raising awareness of all operational personnel**, fire analysts and non-fire analysts alike. In addition, in order to process these documents, information and data of the same types used during remote support (weather data, spatial, photos, videos,

etc.) are processed and using many of the same tools. This also allows sharing the analysis with multiple figures and with it the possibility to study the dynamics and evolution of the most important parameters of a fire: MET, POS, BEH, PAT, TP, SCA (Castellnou et al., 2021).

It is also noted that with the information collected during RAWE it is then much more immediate to prepare a post-fire analysis report. Below are some examples with links where you can find and consult different types of post-fire reports, others can be seen in the images.

- Unitàt Tecnica 902 - Generalitat Valenciana: https://agroambient.gva.es/es/web/prevencion-de-incendios/actuaciones-post-incendio1

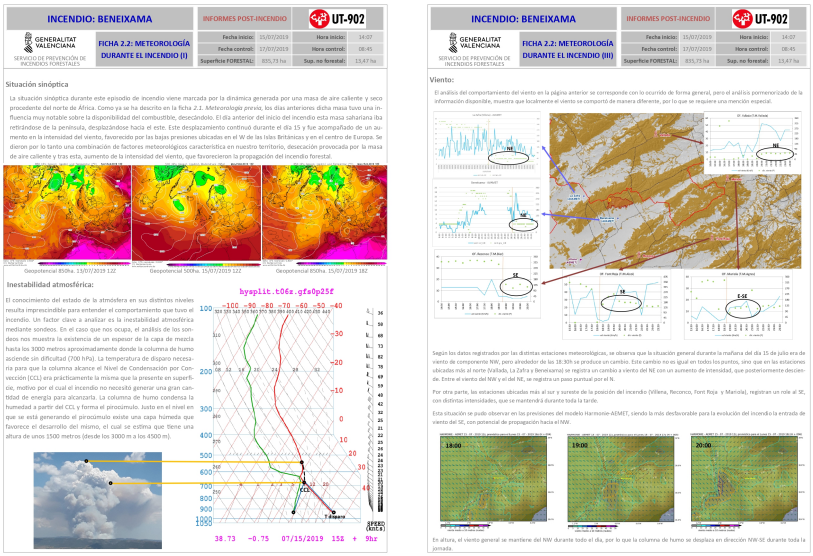
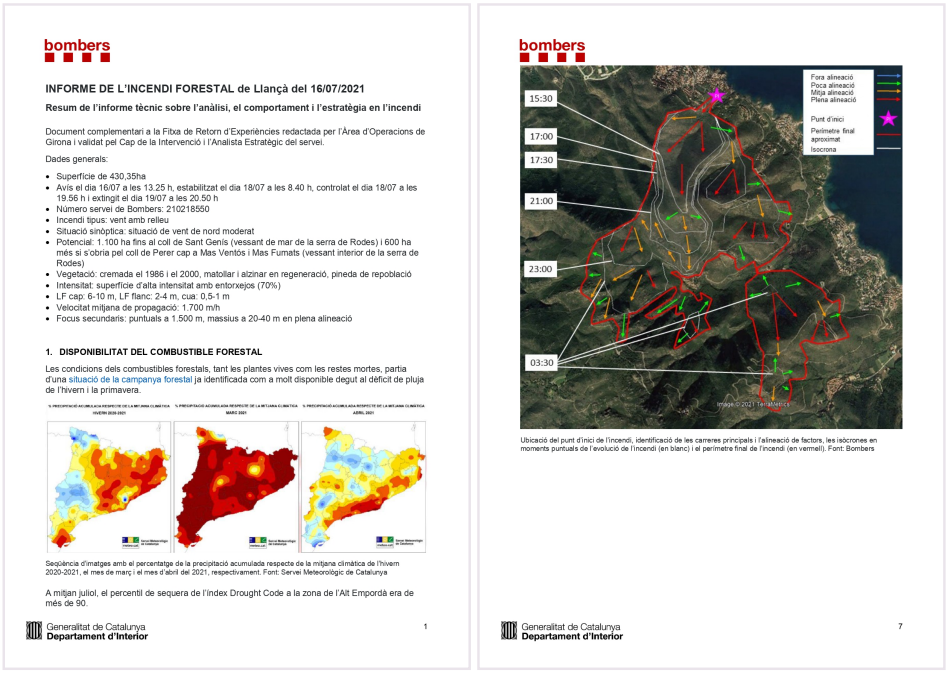


Figure 36. Example of post-fire report related to the Beneixama fire event on 07/15/2019: study of synoptic meteorology, the vertical profile of the troposphere applied to the smoke column, and the change in weather variables during the fire. Source: UT-902

- Bombers - Generalitat de Catalunya:
  - Catalan post-fire reports: http://interior.gencat.cat/ca/arees_dactuacio/bombers/foc-forestal/incendis_forestals/informes-dincendis-forestals/
  - Out of Catalunya post-fire reports: http://interior.gencat.cat/ca/arees_dactuacio/bombers/foc-forestal/incendis_forestals/incendis_de_fora_de_catalunya/



bombers

INFORME DE L'INCENDI FORESTAL de Llançà del 16/07/2021

Resum de l'informe tècnic sobre l'anàlisi, el comportament i l'estratègia en l'incendi

Document complementari a la Fitxa de Retorn d'Experiències redactada per l'Àrea d'Operacions de Girona i validat pel Cap de la Intervenció i l'Analista Estratègic del servei.

Dades generals:

- Superfície de 430,35ha
- Avís el dia 16/07 a les 13.25 h, establiitzat el dia 18/07 a les 8.40 h, controlat el dia 18/07 a les 19.56 h i extingit el dia 19/07 a les 20.50 h
- Número servei de Bombers: 210218550
- Incendi tipus: vent amb relleu
- Situació sinòptica: situació de vent de nord moderat
- Potencial: 1.100 ha fins al coll de Sant Genís (vessant de mar de la serra de Rodes) i 600 ha més si s'obria pel coll de Perer cap a Mas Ventós i Mas Fumats (vessant interior de la serra de Rodes)
- Vegetació: cremada el 1986 i el 2000, matollar i alzinar en regeneració, pineda de repoblació
- Intensitat: superfície d'alta intensitat amb entorxejos (70%)
- LF cap: 6-10 m, LF flanc: 2-4 m, cua: 0,5-1 m
- Velocitat mitjana de propagació: 1.700 m/h
- Focus secundaris: puntuals a 1.500 m, massius a 20-40 m en plena alineació

1. DISPONIBILITAT DEL COMBUSTIBLE FORESTAL

Les condicions dels combustibles forestals, tant les plantes vives com les restes mortes, partia d'una situació de la campanya forestal ja identificada com a molt disponible degut al déficit de pluja de l'hivern i la primavera.

Seqüència d'imatges amb el percentatge de la precipitació acumulada respecte de la mitjana climàtica de l'hivern 2020-2021, el mes de març i el mes d'abril del 2021, respectivament. Font: Servei Meteorològic de Catalunya

A mitjan juliol, el percentil de sequera de l'índex Drought Code a la zona de l'Alt Empordà era de més de 90.

Generalitat de Catalunya
Departament d'Interior

1

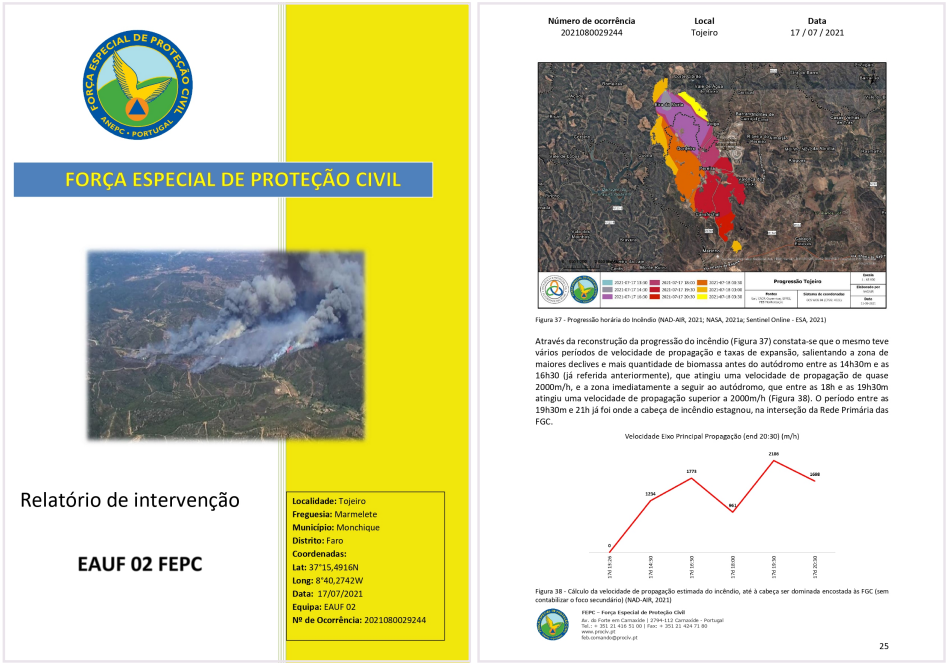
bombers

Ubicació del punt d'inici de l'incendi, identificació de les carreres principals i l'alineació de factors, les isòcrones en moments puntuals de l'evolució de l'incendi (en blanc) i el perímetre final de l'incendi (en vermell). Font: Bombers

Generalitat de Catalunya
Departament d'Interior

7

Figure 37. Part of a post-fire report produced for a wildfire in Catalunya (Llançà, 07/16/2021). Source: CFRS



FORÇA ESPECIAL DE PROTEÇÃO CIVIL

Relatório de intervenção

EAUF 02 FEPC

Localidade: Tojeiro
Freguesia: Marmelete
Município: Monchique
Distrito: Faro
Coordenadas:
Lat: 37°15,4916N
Long: 8°40,2742W
Data: 17/07/2021
Equipa: EAUF 02
Nº de Ocorrência: 2021080029244

Número de ocorrência	Local	Data
2021080029244	Tojeiro	17 / 07 / 2021

Figura 37 - Progressão horária do incêndio (NAD-AIR, 2021; NASA, 2021a; Sentinel Online - ESA, 2021)

Através da reconstrução da progressão do incêndio (Figura 37) constata-se que o mesmo teve vários períodos de velocidade de propagação e taxas de expansão, salientando a zona de maiores declives e mais quantidade de biomassa antes do autódromo entre as 14h30m e as 16h30 (já referida anteriormente), que atingiu uma velocidade de propagação de quase 2000m/h, e a zona imediatamente a seguir ao autódromo, que entre as 18h e as 19h30m atingiu uma velocidade de propagação superior a 2000m/h (Figura 38). O período entre as 19h30m e 21h já foi onde a cabeça de incêndio estagnou, na interseção da Rede Primária das FGC.

Velocidade Eixo Principal Propagação (end 20:30) (m/s)

Figura 38 - Cálculo da velocidade de propagação estimada do incêndio, até à cabeça ser dominada encostada às FGC (sem contabilizar o foco secundário) (NAD-AIR, 2021)

FEPC – Força Especial de Proteção Civil
Av. do Forte em Carnaxide | 2794-112 Carnaxide - Portugal
Tel.: + 351 21 418 51 00 | Fax: + 351 21 424 71 80
www.prociv.pt
feb.comando@prociv.pt

25

Figure 38. Part of a post-fire report made for a wildfire in Portugal (Tojeiro - Monchique, 07/17/2021), note that the RAWE report is also included in the attachments of each post-fire report. Source: AENPC GAUF Portugal

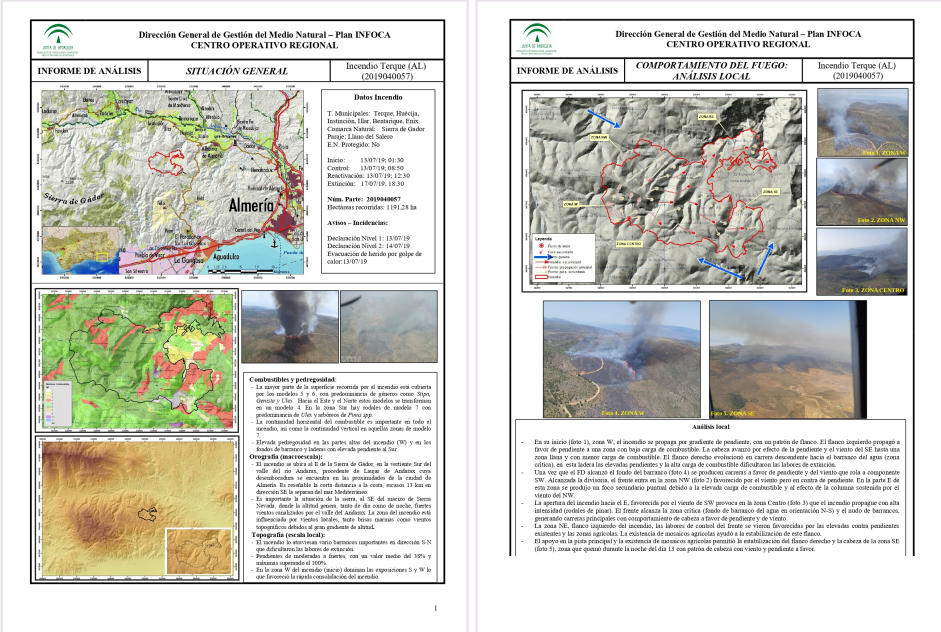


Figure 39. Part of a post-fire report made for a wildfire in Andalucía (Terque, 07/13/2019). Source: INFOCA Andalucía

Instead, for other types of more in-depth reports, prepared especially on very serious occasions (e.g., for fires in which entrapments with deaths or injuries have occurred), the following are some examples.

- Yarnell Hill Fire (USA, 06/30/2013): https://www.documentcloud.org/documents/800042-yarnell-hill-serious-accident-investigation-report.html#document/p9/a123274
- Pedrogao Grande (Portugal, 06/17/2017):
  - https://www.ipma.pt/export/sites/ipma/bin/docs/relatorios/meteorologia/20170630-relatorio-pedrogaogrande-ipma-completo.pdf
  - https://cdn.cmjornal.pt/files/2017-12/2017-12-07_15_54.38_Relat_rio_fogos_Xavier_Viegas_aaa.pdf
- October 2017 fires complex (Portugal, 10/15/2007): https://www.portugal.gov.pt/pt/gc21/comunicacao/documento?i=analise-dos-incendios-florestais-ocorridos-a-15-de-outubro-de-2017

5

5. Conclusions

RAWE activity comes from **wildfire community needs**, and at the same time from **opportunities** provided by modern tools and knowledge. There are **needs** because fire seasons are getting longer and more complex, asking even more for help between different fire services, also through FAA capacities around Europe and not only. RAWE comes also from **opportunities** that means and technologies each year are succeeding in providing more and more efficient and accessible tools even for FAA issues, also succeeding in connecting people faster and with them the knowledge useful to best employ what experience and technical skills can bring to help remotely during emergency situations.

The evolution of recent wildfire events and technological advances have been running rapidly in the past years, but European fire-fighting organizations are not necessarily updating in the same phase. **The use of the powerful tools available is not always effective in supporting action**, even though the knowledge and skills deployed are sometimes of a high level. This leads to a risks of improvising during emergencies. **There is therefore another need: preparation**. To prepare for situations that are more complex than ordinary, at every European latitude, by finding ways to make proper use of what is already available technically and culturally. Reorder then and plan procedures to enable receiving and providing support remotely during an emergency. Know the issues technically and adapt them to different contexts, not by simply "copying," but by sharing, learning, adapting, practicing and integrating. This is because the cultural gap on FAA issues is wide in Europe, making it increasingly necessary for forces to be integrated if what is desired is a large-scale cooperation and mutual learning process.

The main objective and ultimate aim of all the fire analysis community **is to increase the degree of preparation, level of awareness and confidence of decision-making during wildfire emergencies**. This has been one of the cornerstones that has moved the entire AFAN project, laying the foundation for extensive European-wide collaboration and experimentation that will hopefully be well followed. In fact, with the same principle, these guidelines on RAWE were drafted, gathering insights and critical issues, breaking them down into themes and finally providing an overview of the current situation. With the hope of having provided more awareness on this specific support activity. Indeed, it was emphasized from the introduction that what is outlined in this document is not intended to propose standardizations, as the entire AFAN project does not. But rather to provide current and existing **reference points to be understood, digested, and subsequently improved**. Each organization will be able to do so internally, and this will be more useful and quicker if it does so by comparing itself with European organizations that have already invested in this area also because of complex situations already experienced in past years. The whole initiative can hopefully be supported and coordinated at the European level.

In the near future we must expect more and more need for remote support as well, both for the most prepared and the least prepared fire-fighting organizations.

Therefore, if one wants to provide help, or to be able to receive this kind of support, it is essential to drop deep into the knowledge of the FAA and then integrate it into the RAWE. In this document, the chosen subject areas already provide information that can be considered in preparing a RAWE service, so then it is possible to understand how the various aspects need to be addressed. Remotely, one must be able to construct a scenario, thus increasing the awareness of those in the field and the level of credibility of each other and of the organizations themselves. At the same time, those who receive this kind of support must be able to understand it, to trust it, and to confront it. A remote unit provides clear capabilities and ideas about what is happening and what probably will happen in the field: what it proposes can be accepted as well as rejected, but either way in this process, whether of validation or denial, an increase in awareness and analytical capabilities about the present fire-scenario and in the management of it is established.

Safety depends on credibility, and credibility depends on knowing what is happening (in the short term as well as the long term). And remotely, it is possible to provide a clean, clear explanation of what is happening, trying to encourage uncertainty management more than information provision. If a fire service can develop this kind of capability, a way of support through analysis will be ready to be used and integrated.

6

6. References

Castellnou M., Alfaro L., Miralles M., et al.; *Field journal: Bolivia. Learning to fight a new kind of fire.* Wildfire Magazine n. 28.5 (2019).

Castellnou, M.; Miralles, M.; Nebot, E., Estivill, L.; *Guidelines of fire analyst competencies and skills*. AFAN Project (2021).

Costa, P., Larrañaga, A., Castellnou, M., Miralles, M., Kraus, P.D.; *Prevention of Large Wildfires using the Fire Types Concept (2011)*. Fire Paradox Project. Editorial Office GRAF Technical Unit.

Castellnou, M., Prat-Guitart, N., Arilla, E. et al. *Empowering strategic decision-making for wildfire management: avoiding the fear trap and creating a resilient landscape*. Fire Ecology 15, 31 (2019).

San-Miguel-Ayanz, J., Durrant, T., Boca, R., Mianti, P., Libertá, G., Artés-Vivancos, T., Oom, D., Branco, A., de Rigo, D., Ferrari, D., Pfeiffer, H., Grecchi, R., Nuijten, D., Onida, M., Löffler, P.2021. *Forest Fires in Europe, Middle East and North Africa 2020* EUR 30862 EN, Publications Office of the European Union, Luxembourg, 2021, ISN 978-92-76-42351-5, https://doi.org/10.2760/216466, JRC1267665.

San-Miguel-Ayanz, J., Durrant, T., Boca, R., Maianti, P., Libertá, G., Artés-Vivancos, T., Oom, D., Branco, A., de Rigo, D., Ferrari, D., Pfeiffer, H., Grecchi, R., Nuijten, D. 2022. *Advance Report on Forest Fires in Europe, Middle East and North Africa 2021*, EUR 31028 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-49633-5, doi:10.2760/039729, JRC128678.

7

7. Annexes

Castellnou M., Alfaro L., Miralles M., et al.; *Field journal: Bolivia. Learning to fight a new kind of fire*. Wildfire Magazine n. 28.5 (2019).

AFAN