A Holistic Fire Management Ecosystem for Prevention, Detection and Restoration of Environmental Disasters

TREEADS D.2.9 Holistic Management systems and resource re-utilisation report V1

Work package	WP2: Understanding the Lifecycle of Wildfires
Task	Task 2.6: Holistic Management systems and resource re-utilisation Requirements
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GLOSSARY OF TERMS

Term	Description
Actor	In IT an Actor is an abstract or concrete entity, that initiates actions or communicates with a computer system to achieve specific tasks or goals. An actor can be a person, another system or external component.
Constraint	Represents any condition, restriction or assertion that limit the intended behaviour of a system.
HRR_X.asc	the value of thermal power released [kW] (or Heat Released Rate - HRR)
Functional need	It is a precursor of a functional requirements. A functional need does not necessarily translate into an IT feature, it could relate to organizational aspects or human actions.
Functional requirements	A Functional Requirement is a description of a service that the software must offer.
Non-functional requirements	A non-functional requirement defines the quality attribute of a software system to ensure the usability and effectiveness of the entire software system.
Provider	A provider is a company, organization, or entity that offers IT-related services to clients, businesses, or individuals, thus them enabling to access and utilize technology solutions without the need for in-house expertise or infrastructure.
Scenario	A description of the intended use of the system, represents the TO-BE situation. As such, it and focuses only on the activities to be performed through the Holistic Platform.
Stakeholder	A stakeholder is any person, group, or entity with a direct or indirect interest, involvement, or influence in a project, organization, or initiative, and whose interests can be positively or negatively affected by its outcomes.

LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Meaning
AAM	Alkali Activated Slag
A&R	Adaptation and Restoration
AR	Augmented Reality
DEM	Digital Elevation Model
DoA	Description of Action
DR	Detection and Response
DSS	Decision Support System
FN	Functional Need Combined with the country code of the pilot (XX) and a number (nn) provides an identifier for the functional need e.g. FN-IT01 first Functional need of the Italian pilot.
FR	Functional Requirement Combined with an integer provides an identifier for the functional requirement
GIS	Geographic Information system
GPS	Global Positioning System
HASP	High Altitude Sounding Projectile
HRR	Heat Release Rate
IoT	Internet of Things
IT	Information technologies
KPI	Key Performance Indicator
LFB	Local Fire Brigade
LoRa	Long Range
NFR	Non-Functional Requirement Combined with an integer provides an identifier for the non-functional requirement

OPC	Ordinary Portland Cement
PLCS	Product Life Cycle Support
PP	Prevention and Preparedness
PWA	Post-wildfires Wood Ashes
RPAS	Remotely Piloted Aircraft System
UAV	Unmanned Arial Vehicle
VR	Virtual Reality
WP	Work Package

EXECUTIVE SUMMARY

This deliverable has the goal to harmonize the requirements elicited and documented in previous deliverables of this work package, with the needs expressed by the pilots to formalize user-centred requirements for the TREEADS holistic Platform.

From a methodological point of view, it has been necessary to put in place supportive measures (templates and workshops) to help the pilots describing their scenarios in a common way that could be easily used to identify the requirements for the platform. Besides providing a common ground for the next steps, these measures will support the categorization and generalization process allowing the identification of commonalties thus ensuring that the final requirements are tailored to the expressed needs and that the features that will be implemented will lead to the optimal usage of technical resources.

The enhanced pilot scenarios have been further analysed, refined, and mapped against TREEADS technological offering to identify the needed technologies and, most importantly, the technical challenges and constraints, the required performances and any other aspect that could hamper the intended behaviour of a system. From the textual analysis of the pilot scenarios, it has been possible to identify high-level functionalities and then abstract them in terms of desired platform features. Finally, these intermediate technical and user centred features have been expressed as functional and non-functional requirement of the platform.

For the next versions of this deliverable, the task will synchronise and align with "WP3 Organisational, Structural, and Sociotechnical Factors for TREEADS Ecosystem Building and Modular Approach" to ensure that the requirements are duly included in the architecture definition and will provide solid ground for the implementation of the holistic platform in "WP7 TREEADS Holistic Fire Management System and Incremental approach of all Phases".

INTRODUCTION

BACKGROUND

TREEADS aims to deliver a holistic Fire Management platform that integrates, optimizes, and reuses available Socio-technological Resources to provide a better response in the different phases of the fire management: prevention and preparedness (PP), Detection and response (DR) and Adaptation and Restoration (A&R) and to improve the overall quality of total Wildfire Lifecycle interaction.

WP2 focuses on the socio-economic aspects and current practices used in Fire management system, to determine existing gaps and barriers that could prevent the adoption of the holistic approach in all three phases of wildfires. To this respect, on top of the analysis of current situation in member states, WP2 derives the high-level requirements for the three phases (T2.3, T2.4 and T2.5 respectively). In Task 2.6 these high-level requirements are then refined and harmonized, together with the requirements derived from the input received form the different pilots, to derive the requirements for the holistic platform. Another aspect this task focuses on is the optimal reutilization of technical resources in every phase of the wildfire management.

PURPOSE AND SCOPE

This deliverable is a live document that will be released in three versions. This first version summarizes the work done in the task and harmonizes the outcomes and findings with the results from previous tasks in WP2. **The deliverable has the goal to derive both functional (user) and non-functional (system) requirements**, which will set the stage for the architecture definition (WP3) and for the integration of the different tools in the common platform (WP7).

The main objectives of this deliverables are

- To present and document the methodological approach that has guided the work done in the task,
- To analyse the received pilots' user stories and constraints,
- To harmonize the received input in a common view of user and system requirements that will support the definition of the common architecture (in WP3) and the implementation of the holistic platform (in WP7) supporting all phases of wildfire management.

To be noted that, although the proposed approach directly engages the pilots and is based on pilots' needs, the focus of the deliverable is on the architecture and the ultimate goal is to derive user and system requirements for the implementation of the holistic platform.

<u>This optimal reutilization of technical resources</u> is at the foundation of the holistic platform, as such it drives the methodological approach aiming to distil the requirements through aggregation and categorization of the needs expressed by the pilots.

It has to be specified that, the information received from the pilot for this first iteration, was often incomplete. This depended *in primis* on the fact that the pilot activities (WP8) had not started yet, but also on the different background and knowledge of IT methodologies. This situation is a common occurrence during the process of designing a software system, but it does not hamper the process, as the information received from the user needs to be elaborated and translated into requirements. Moreover, the adopted iterative approach, allows to refine the results at any iteration.

METHODOLOGICAL APPROACH

The development of TREEADS Holistic Platform is based on an agile methodology. This deliverable documents the requirements elicitation process that is the first step of the software development process.

The cornerstones of requirements elicitation process are:

- Employ elements of Agile methodologies to engage stakeholders early and often.
- Use user stories and personas to capture functional and non-functional requirements.
- Conduct regular meetings to gather feedback and refine requirements iteratively.

One of the key aspects is *the agile approach* that favours an active communication among the parties to increase, on one hand, the efficiency of the overall development process that can start even with partial requirements, on the other hand, it allows a gradual involvement of pilot partners . the other key aspect is iteration, which is essential to complete, refine and correct the information at any iteration. An important consequence of the iterative approach is that the material received from the user should be kept as it was provided in order to document the process and to be sure not to miss any relevant information.

Premises

We need first to highlight some initial considerations concerning the project scope and the type of pilots, since these aspects determine the methodological approach used in this task.

- TREEADS aims to deliver a comprehensive system where different technologies and tools can be used for the three phases of fire ensuring optimal re-utilization of technical resources. Thus, the platform needs to be **i) open** to make use of technologies and tools locally available, ii**) elastic** to provide multiple points of access allowing the composition of workflows that might be partially executed off line; **iii) agnostic** as it needs to satisfy the needs of the different pilots which have quite different goals and focus on different phases of the fire management cycle.
- Several of the needs expressed by the pilots are related to organizational aspects that cannot be executed through the platform.
- The different perspective between pilot partners and technical partners represents a knowledge and language barrier that needs to be overcome in order to ensure the coherence and relevance of the requirements that will be elicited.

To take these aspects into account and overcome the related barriers, it has been necessary to adopt a bottom-up user tailored approach and exploit every opportunity to gain useful information related to the pilot.

The logical steps of our methodological approach are

1. Engage the pilot partners to collect useful information and to evaluate the results

2. Analyse the pilot scenarios and map the needs against TREEADS technologies
3. Elicit the requirements **for the platform**
    a. Derive non-functional requirements (from technology to be used, challenges and constraints, required performances etc.)
    b. Derive functional requirements (from user needs expressed by each pilot).

It is important to notice that the focus of this deliverable is to elicit the requirements for the implementation of TREEADS Holistic Platform. In this perspective, the user needs are important, but only limited to the ways pilots intend to use the platform.

ANALYSE THE PILOTS SCENARIOS

This activity started with the analysis of WP2 questionnaires (TUC), to gain a better understanding of the overall goal of the pilot, and the main desired features. However, the questionnaires did not have enough information concerning **the operational aspects** to be translated into IT features and delivered through TREEADS platform .

Due to this reason, a template (ANNEX 1) to describe user stories has been prepared and illustrated during the technical meeting in Berlin. During the same meeting for each pilot a reference person has been appointed to guarantee a more efficient communication. The template was then distributed to the pilots' reference person. Each pilot has been requested to fill in the template **i)** describing the operational scenarios as a **sequence of tasks**; **ii)** for each task specify the **envisaged TREEADS technologies** to be used; **iii)** for each task, with the support of the technology owner, specify the needed **input** and the expected **output** and eventual **constraints** related to the usage or to the environment; **iv)** For each phase of the fire management identify **relevant KPIs** to be used to assess the impact.

The scope of this template was to obtain initial information to start the requirements elicitation process to define the features the holistic platform should provide. The filled templated are reported in section User stories.

During the general meeting in Trondheim the initial drafts of the pilot stories have been assessed and discussed, additional hints and explanations have been provided with the aim to improve the quality of the pilot stories and to have measurable KPIs for each scenario.

It has to be noted that the current stage of user stories included in this document, provides just a rough view of the pilot's scenario, since the pure operational aspects are mixed with more general needs or *desiderata*. This also affects the quality of the proposed KPIs, which, in most cases, lack the measurability characteristic, but nonetheless identify the metric to be used and will be better specified and fine-tuned in the next version of this deliverable.

The information included in the user stories has been used to identify the TREEADS technologies each pilot considers relevant, which is a preliminary and necessary step to start defining the needed system requirements. The mapping between the pilots and TREEADS technologies is reported in Table 17.

REQUIREMENTS

Definition: Requirements are clearly articulated statements of what a system must be able to do in order to satisfy stakeholder needs.

Requirements are a simply a formalized way to describe the reality of an IT system, they come directly from the expectations and needs of the interested stakeholders, meaning the entity(ies) that will be the main beneficiary/user of the system. Business requirements, which corresponds to the overall vision of the system, are further detailed as shown in the "Requirements Hierarchy" (**Figure 1**) in two clear categories: Functional requirements (or user requirements) describe the required behaviour and functions of the system that the user needs/wants. Requirements, which are not related to functional aspect of software, are Non-functional requirements. They describe specific criteria that can be used to judge the operation of a system e.g., performance, security, availability.

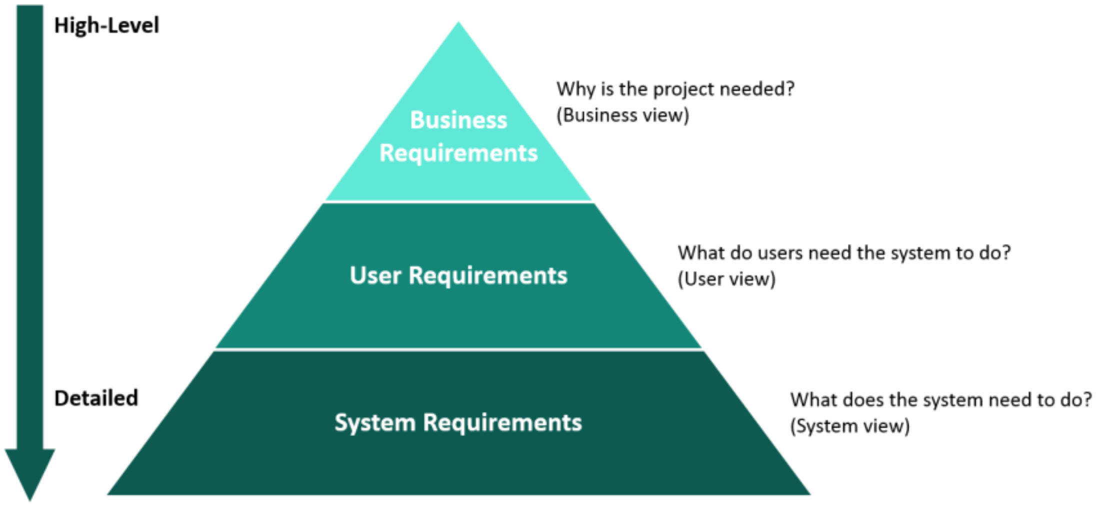

Figure 1: Requirements hierarchy (source "CRVS Digitisation Guidebook"[1])

In the scope of this deliverable, the "business view" is that of the central platform that needs to satisfy different "customers" with different needs.

Therefore, is not to detail the functions requested by a specific user, but rather to generalize the user needs in a "platform perspective".

In order to derive Non-functional requirements for the platform the following information needs to be analysed and elaborated:

- The description of the pilot stories – textual analysis to identify the constraints and required performance.
- The mapping between pilot and technologies, to get a better understanding of the technologies that needs to be integrated.
- The phase-specific user requirements detailed in D2.3, D2.5 and D2.7. These provide fine grained requirements that needed to be generalized for the scope of this deliverable.

[1] http://www.crvs-dgb.org/en/activities/analysis-and-design/8-define-system-requirements/

The input considered to elicit the Functional requirements was limited to

- The description of the pilot stories – textual analysis to identify the required behaviours
- The phase-specific user requirements detailed in D2.3, D2.5 and D2.7.

The result of this process is presented in **Table 18** (Non-functional requirements) and **Table 19** (Functional requirements).

USER STORIES

The user stories specify what the pilots are expected to do from an operational perspective. The exercise to detail the user stories serves (at least) two main purposes. Firstly, it allows to focus on the different aspects, needs and barriers differentiating between those related to IT, which can be transformed into functionalities or characteristics of the platform, and those related to materials, soil, biodiversity etc., which will be implemented in the project, but cannot be integrated into the platform. Secondly, it allows to bridge the different skills and backgrounds using a common simplified language that will improve the efficiency of the process.

The approach has been presented to the consortium during the technical meeting held in Berlin (4-6 May 2022). After the meeting, the template (ANNEX 1) has been circulated among the pilots' partners. The partners were asked to fill in the template focusing on the operational steps in each scenario. Between May and June, a set of workshops and dedicated calls have been held with the goal to support the partners filling the template for the three phases of the fire management. The preliminary results have been assessed during the General Meeting in Trondheim (20-22 June 2022) to evaluate to information provided and specify further clarifications.

The filled templates, which are the concrete results of the workshops, represent one of the preliminary inputs for the requirements elicitation process. As specified in the methodological approach, this is an iterative process that allows on one hand to progressively refine the requirements as the pilots become more mature and clarify their operational objectives, on the other hand it allows to start working on the implementation of the platform, avoiding bottlenecks and delays.

The pilots are a part of WP8, which started in M7, and the input provided by the different pilots and included in this document cannot be considered exhaustive. The information collected lacks important details and clarity, only providing an overview of the desired functionalities to be executed in the pilot. This is a common aspect of the requirements elicitation process, even more in the case of TREEADS, where the data collection happened when the pilots had not started yet. The main criticalities affecting the collected data can be summarised as: difficulty in isolating the features to be performed through the holistic platform, difficulty in identifying KPIs that could be monitored through the platform, difficulty in discerning between stakeholder, actor and project partners.

Although not complete, the information collected was good enough to initiate the process and to identify the needed improvements to be included in Version 2 of this deliverable (M23).

Therefore, the user stories reported in the following chapters will be subjected to iterative refinements and revisions that will be consolidated in future versions of this deliverable.

NORWAY

Pilot overview

The Norwegian pilot focuses on the prevention and preparedness for the wildland fire. The pilot will participate in field exercises on forest fires carried out each year by local firefighters, Norwegian Fire School (NBSK), and Norwegian Directorate for Civil Protection (DSB).

During these field exercises the team will test different technologies and materials and will collect measurements that will be used as the inputs to test the passive fire protection technologies. Furthermore, the pilot plans to produce guidelines regarding necessary safety zones around critical infrastructures.

Additionally, the pilot has the objective to develop a stand-alone app to support the logistics during fire operations.

Platform perspective

The foreseen pilot activities will be conducted off line. At this stage, it appears that the pilot will need the Platform only to provide wider access to the guidelines.

Prevention and Preparedness

Actors:

- Norwegian Fire Academy (NFA)
- Local Fire Brigade (to be confirmed) (LFB)
- Norwegian Directorate of Civil protection (DSB)
- The Norwegian Meteorological Institute (MET)
- The Norwegian Fire Protection Association (NBF)

Table 1: Norwegian pilot - user stories

Operational scenario: Prevention and Preparedness						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Classification of forest and heather land fires. Forest	• LFB • NFA • DSB	• GBD/LAMMC, but no drones. Just soil samples.	Thermocouples Heat Flux Gauges,	Temperature Heat Flux, Wind Speed,	Provide guidelines regarding necessary safety zones around

	and heather land fire exercises with measurements.	• MET	• (OS) will try their fire – fighting extinguishing foam. • (8BELLS) will implement their AR Helmet.	Bi-directional Probes, IR Cameras, Video Cameras. Additional input from local fire brigade, later.	Fire Propagation Video, Soil Samples, Extinguishment performance of foam AR Helmet performance.	critical infrastructure and WUI areas based on Norwegian conditions.
2	Evaluation of current test standards and methods.	FRN	• Woodify materials • VIPO materials	Data from previous forest fires. Data from current test methods and standards. Data from classification done in task 1.	Relevant KPI's used for testing in task 3. Development of the most appropriate test method. Proposed amendments to current fire testing methods.	
3	Evaluation of Fire Resilient Materials with lab testing. Input from measurements done in fire exercises.	• DSB	• (VIPO) supply materials for characterization (PP) modify existing materials (PP) supply passive fire protection solutions to be tested (PP) develop new solutions according to requirements. • (Woodify) Produce fire impregnated wood of various wood-based materials. Conduct fire tests of wood-based materials of different wood species with and without fire impregnation, with and without surface coating for the intended use in buildings and infrastructure exposed to wildland fires.	Output from Task 2.	Performance of the PFP materials will be evaluated after exposed to the fire tests (structural integrity, thermal penetration depth, etc.).	

4	Re-evaluation of the tested PFP with input from the lab tests. Certification of end user products.	• DSB	• Woodify, developed materials • Vipo, developed materials • CBS, guidelines development	Output from Task 3.	• Guidelines regarding building technical requirements for wooden houses and cottages in areas with a high risk of forest fires. • Re-evaluate the PFP and modify it for wildland fire applications. • Draft proposal for amendments to test standards.	Euroclass, SP Fire 105 and EN 167555 EXT DRF.
5	Create standard solution for improved rescue logistics	• LFB • DSB • FRN	• (Jotne) Create standard solution for improved rescue logistics and sensor integration and to create the data management solution for the common operational picture.	Output from task 1 Inventory of equipment from fire brigade Should be integrated with existing solutions such as COBRA for unit location, etc.	Provide a solution for logistics to aid the first responders during exercise/ emergency Map with units, Firemen and related sensors, Fire Trucks, Helicopters, UAVs, Support personnel (food, fuel, replacements etc)	The solution shall be in line with the needs of the fire brigade;
5b	Develop a repository for Norwegian Wildland fires.	• DSB • NBF • NFA •	(Jotne) Standards based repository for sensor integration, ISO10303 AP239[2] PLCS	Output from Task 1	A repository built on the open standard ISO 10303 AP239 that will archive relevant sensor data uploaded via gateways and rest services.	Develop a repository for Norwegian Wildland fires.

[2] https://www.iso.org/standard/38310.html

Table 2: Norwegian pilot - KPIs

KPIs Prevention and Preparedness	Current value	Desired value	Remarks
Classification of Norwegian heather land fire	0	1	Both classifications contain measurements of: - Temperatures - Heat flux - Wind speed Fire propagation
Classification of Norwegian forest fire	0	1	
Repository for Norwegian Wildland fires. Containing data from classification.	0	1	Repository based on the open standard ISO 10303 for improved data interoperability. The repository can through rest services archive sensor data sent through gateways. Update frequency/ solution to be decided.
Number of fire tests developed in lab, based on the classification.	0	3	Small (1). Medium (1). SBI testing. Large scale (1).
Guidelines regarding building technical requirements for wooden houses and cottages, developed.	0	1	Number unknown.
Standards how CAF`s can be used for forest fires.	0	1	To be further defined in august.
AR helmet implemented in firefighter training.	>	Min 4	To be further confirmed in august.
Data regarding different soil samples.	0	1	To be further defined in august.
Improving the logistics for first responders in remote areas and for long term operation.	Separate system for logistics, walky-talky.	To have a common operational picture that provides relevant information in a holistic system	To be further defined in august.
Control of any extreme and potentially harmful wildfire in less than 24 hours	>24h	<24h	
Reduction in building losses and infrastructure	0 %	50 %	

Additional KPIs related to fire resistant material and fire retardants wood products will be developed including fire resistance relevant parameters. during the second stage of the pilot.

ITALY

Pilot overview

The Italian pilot focus on all three phases of fire management, with broader goals. In the prevention preparedness, the main objective is to use the result of fire simulations to optimize the design of the cable-car layout in a way that will minimize the impact of eventual fires on the cable-car infrastructure and on civilians. The simulations will be used on an ongoing feasibility study promoted by ACAMIR (the Regional Transportation Agency), to define the best solutions for the cable-car that, once realised, will be integrated in the regional rail transport system(Circumvesuviana Railway) to connect remote areas in the Sorrento peninsula. In the Detection Response phase the focus is on the evaluation of innovative mitigation measures and safety systems, this action will be performed off-line, outside the holistic platform. In the Restoration Adaptation the focus is on testing Nature-based and fire-resilient solutions to identify areas of applicability to be included in guidelines. Also this activity is performed off-line, outside the holistic platform.

Platform perspective

Only few of the foreseen pilot activities will be conducted through the holistic platform. Moreover, the guidelines concerning the fire-resilient materials should be made available through the platform.

Actors:

- ACaMiR
- Sorrento Municipality
- Regional Civil Protection

<u>Prevention and Preparedness</u>

Table 3: Italian pilot - user stories

Operational scenario: Prevention and Preparedness						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Simulation of forest fires in the Sorrento Peninsula	Sorrento	- Forest fire spread simulation (USAL), - Wind field model (USAL),	**Forest fire spread simulation** **1. height.asc: Topography**: Digital Elevation Model (DEM)	- **HRR_X.asc:** the value of thermal power released [kW] (or Heat	The activity is performed trough the TREEADS platform and it aims to

			- Atmospheric pollutants dispersion model (USAL),	**2. fuel.asc:** File that stores the type of fuel that exists within the area selected for the simulation. (BEHAVE fuel class) **3. param_fuel.asc:** this file contains characterization parameters for each type of fuel in fuel.asc: moisture content, flame temperature, flame length, fuel load per area, pyrolysis temperature, etc. **4. fcc.asc**: The amount of fuel at each point in the simulation area. It varies from 0 (no fuel) to 1 (maximum fuel load) + Weather conditions from **Wind field model** **5. area_type.asc :** the type of surface according to its behaviour to the wind. **6. rugosities.asc**: roughness length of each land use - based on the Davenport criteria.	Released Rate - HRR) - **Temperature field** - **CO and Soot Yield**	integrate the results in the Design simulations for mass transport infrastructure
2	Optimization of cable car layout	ACaMIR Sorrento	- Infrastructures fire emergency management strategy (Tecnosistem),	- **Topography**: Digital Elevation Model (DEM) - **Heat Release Rate Curve** – HRR Curve, - **CO** and **Soot** yield	Optimized Cable car layout	The activity is performed **offline** using the results from the previous analysis.
3 Analysis of possible Interactions between wildfire and infrastructure – Activity performed off-line and based on the results of the Simulation of forest fires in the Sorrento Peninsula						
3.1	Analysis of temperature field on structural parts and main systems of cable car	TECNOSISTEM, ACaMIR	- Infrastructures fire emergency management strategy (Tecnosistem),	- Optimized **Cable car layout** - **Heat Release Rate Curve** – HRR Curve - **Temperature** field	Analysis and layout of the main results in terms of risk factors and predicted effects	Analysis on the probability of the system malfunctioning or service interruption

3.2	Analysis of smoke and toxic species diffusion on cable car	TECNOSISTEM, ACaMIR	- Infrastructures fire emergency management strategy (Tecnosistem),	- Optimized Cable car layout - HRR Curve - CO and Soot yield		Focus on areas with traveling passengers, waiting areas and escape routes
4	Validation of eco-sustainable construction materials/components with improved fire performances	RINA-C, UniNa, NTUST (replication with different ashes	- Nature-based and fire-resilient solution for prevention and restoration	- Physical, Mechanical and fire resistance characteristics of samples and components (provided by UNINA) - (replication with different ashes NTUST)	Operative suggestions for the mix-design of AAMs integrating PWAs as precursor or activator and cement-based materials integrating PWAs as partial replacement of OPC	The activity is performed in laboratory offline. The expected results could be provided through the platform as Guidelines
5	Preventive risk analysis for wildfires in protected forest areas and Risk Transfer solutions	Sorrento, STRESS, DTU, CBS	Insurance Model and Risk Transfer Solutions - Cost-Benefit analysis on possible preventive actions	- Socio economic georeferenced data	Risk mapping and Safety measures guidelines Risk transfer solutions	The activity is performed offline and the results are published trough the TREEADS platform

Detection Response

Operational scenario: Detection and Response						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Analysis of passenger evacuation, evaluation of livability parameters during fire emergency. Evaluation of innovative mitigation measures and safety systems.	Sorrento, STRESS, CBS, DTU	- Infrastructures fire emergency management strategy	- Optimized Cable car layout - HRR Curve - Temperature field - CO and Soot yield - Risk factors and predicted effects from previous analyses	Active and/or passive mitigation measures and resulting emergency procedures	The activity is performed offline and the results are published trough the TREEADS platform

Adaptation and Restoration

Operational scenario: Adaptation and Restoration						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Fire detection and Response simulation in real environment	RINA-C STRESS ACAMIR	Resilient, event-driven, context-aware fire detection and decision support for response processes (FI) - VR TRAINING (SIMAVI)	- TBD	Operative suggestions and Guidelines to be proposed to local actors (Sorrento Municipality, Campania Region Civil Protection, VVFF- Regional Fire Fighters Service in Campania)	The activity is performed offline and the results are published trough the TREEADS platform
2	Mapping of possible areas of application of Nature-based and fire-resilient solution for restoration	RINA-C, STRESS, ACAMIR	Nature-based and fire-resilient solution for prevention and restoration	- Geographic data on infrastructures and past fires	Operative suggestions and Guidelines to be proposed to local actors (Sorrento Municipality, Campania Region Civil Protection, VVFF- Regional Fire Fighters Service in Campania)	The activity is performed offline and the results are published trough the TREEADS platform
3	Analysis of possible economic restoration solutions after forest fires	Sorrento, STRESS, DTU, CBS	Insurance Model and Risk Transfer Solutions (DTU)	Geographic data Socio economic georeferenced data	Operative suggestions for Risk Transfer Solutions	The activity is performed offline and the results are published trough the TREEADS platform

Table 4: Italian pilot - KPIs

KPIs Prevention and Preparedness	Current value	Desired value	Remarks
Definition of the Heat Release Rate (HRR) Curve for mass transport design in wildfire case or external, undefined external source	0	1	HRR curve definition in non-confined areas, where the main heat load is not the rolling stock itself, is a very challenging task in the design of safety systems and procedures for mass transport infrastructure.
Definition of an integrated, innovative approach to fire analysis in external area for critical infrastructure emergency management strategy in case of possible wildfires	0	1	Integration of fire and evacuation analysis in the design flow of mass transport infrastructure, especially for safety system sizing and management, emergency plan and procedures, currently suffer of a lack of study and experience, due to difficulties in ignition source definition, fire spread and smoke diffusion and weathering influence.
Fire resistance improvement on conventional concrete based on Ordinary Portland Cement (OPC)	na	≥ 10%	-
Cost reduction related to damages from forest wildfires	na	< 10%	-
KPIs for the Adaptation Restoration	Na	Na	Will be defined within the pilot activities.

ROMANIA

Pilot overview

The Romanian pilot focuses on Prevention and Preparedness as well as on Detection response. The area of interest is the Măcinului Mountains National Park. It is a protected area in the south-eastern part of Romania, the destination of an intense tourist flow, and therefore subject to a greater risk of fire due to human negligence. In the Prevention Preparedness the pilot aims to improve the surveillance through the use of different technologies and procedures. Additionally, the pilot plan to use AR/VR technologies to train local fire fighters and make them more responsive in case of a fire. In the Detection Response the pilot plans to set up continuous monitoring operations that will improve the time and efficacy of the response phase.

Platform perspective

At this stage, it appear that most of the envisaged activities can be executed through the platform. It has to be clarified how the AR/VR training will be conducted in order to evaluate the possible integration in the platform.

Actors:

- Asociatia Forestierilor din Romania (ASFOR)
- Fundatia pentru SMURD (FptSMURD)
- Local firefighters (ISU Bistrita)
- Forest owner (FO)

Prevention and Preparedness

Table 5: Romanian pilot - user stories

Operational scenario: Prevention and Preparedness						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Mounting temperature, humidity and counting sensors	ASFOR/ FptSMURD/ FO	Forrest black box	Identification of placement locations	Temperature Humidity Count	Natural park, limited intervention to natural landscape
2	Deployment of forward outpost with access to electricity	ASFOR/ FO	Forrest black box (8bells)	NA	NA	Identification of most appropriate location for connectivity and drone hosting
3	Ensuring uninterrupted connectivity of IoT devices to the internet	ASFOR/ FO	5G Portable Communication System (8bells)	Framework for IoT communication	Real-time data availability	
4	Drone placement and cover area identification	ASFOR/ FptSMURD	- UAV Deployable Air Command and Control - SAIA: Low altitude UAV Mission drones	Specific locations	Aerial imagery	
5	Monitoring procedures		- Fire Prevention System - Earth Observation - Territorial assessment - Social media collection and analysis	Monitoring framework	Data streams fed continuously to response system	
6	response system to neutralise early-stage threats		- Machine Learning for Fire Risk Analysis and Fire Spread	Data streams	Semi-autonomous monitoring system	

			- Artificial Intelligence for mission planning & swarm coordination - Context-aware decision support - Predictive decision support			
7	Firefighter AR/VR training	ISU Bistrita	- AR helmet - VR Training	Actual landscape layout Fire exercise scenarios	Trained firefighters	

Detection and Response

Operational scenario: Detection and Response						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Analysis of opening-up of territory for purposes of deployment of fire trucks in case of fire	FO/ISU Bistrita	- Earth Observation - Territorial assessment	Fire location	Territorial assessment	
2	Mapping of suitable water sources	ASFOR/ISU Bistrita	- Earth Observation - Territorial assessment	Fire location	Territorial assessment	
3	Ensuring continuous monitoring activities and uninterrupted flow of data/communication	ASFOR/	- UAV Deployable Air Command and Control - SAIA: Low altitude UAV Mission drones - 5G Portable Communication System - Forrest black box	Forward outpost and communication system	Decision support system	
4	Information (image, text, and coordinates of fire site) transfer to Operational Command Centre of Fire and Rescue Service	ISU Bistrita	All of the above	Communication system	Decision support system	

Table 6: Romanian pilot- KPIs

KPIs Prevention and Preparedness	Current value	Desired value	Remarks
Number of sensors installed	0	10	
Forward outpost installed	0	1	
Monitoring drone placement	0	2	
Deployment of response system	0	1	
Firefighters trained with AR/VR	0	Min 6	
KPIs Detection and Response	**Current value**	**Desired value**	**Remarks**
Drone deployment	1	3	
Min 4G communication bandwidth	0	1	
Decisions support system for pre-arrival assessment of fire	0	1	

SPAIN

Pilot overview

The Spanish pilot focuses on all three phases. In the Prevention and Preparedness the pilot will use different TREEADS technologies to evaluate the territory characteristics, the fire risks – considering different factors – to prepare a defence plan (i.e., Postfire management and restoration plan) to be adopted in case the of a fire. This defence plan will be assessed during field exercises to collect relevant data and measure KPIs.

In the Detection and Response phase, the plan is to start a controlled fire in a field exercise, to test the adequacy of specific technologies and to collect metrics to assess the corresponding KPIs.

In the Restoration and Adaptation phase the pilot will use different monitoring tools (e.g., sensors, aerial means, thematic maps and satellite data) to define protocols for environmental assessment. Such protocols will constitute the conceptual basis of a Decision Support System for an Adaptive postfire management, which will contribute to the Postfire management and restoration plan(Prevention and Preparedness phase).

Platform perspective
At this stage, most of the envisaged activities can be executed through the platform. However, since the pilot relies heavily on field exercises, it will be necessary to understand which activities will be included in the management of the pilot area, and carefully model the pilot ecosystem accordingly.

Actors:

- Managers of Public Use Forests/Junta de Castilla y León. Territorial Environment Service. Natural environment
- Responsible of environmental planning and restoration/ Junta de Castilla y León. Territorial Environment Service. Medio Natural
- Managers of Public Use Forests / Junta de Castilla y León. Territorial Environment Service. Wildfires
- Responsible of forest fire fighting/ Junta de Castilla y León. Territorial Environment Service. Wildfires
- Responsible of risk and action/ Junta de Castilla y León. Territory Secretary. Civil protection
- Emergency Military unit/UME
- Municipalities associations/ First responders and volunteers
- Provincial government/ Provincial government of Ávila
- Federation of Forest landowners Associations of Castilla y León/FAFCYLE
- Private landowners/Private owners
- Responsible of risk and action/ Junta de Castilla y León. Territory Secretary. Civil protection
- Institution in charge of natural disasters monitoring
- NOA. National Observatory of Athens, Greece.
- Municipalities/ Municipalities affected by the pilot
- Provincial government of Ávila

Prevention and preparedness

Table 7: Spanish pilot - user stories

Operational scenario: Prevention and Preparedness						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Define fire defense plan for	Managers of Public Use Forests, Responsible of risk	Fire Prevention System (USAL)	Sensor's data. Real time of fuel, atmosphere, and	- Defence plan	

	an inter-urban forestry space	and action, Municipalities associations, FAFCYLE, Private landowners,	Fire risk prediction system (NOA)	ground by a web information system DEM, land cover maps, satellite imagery, meteorological data, cartographic maps, IoT data.	- Vegetation state and fuel model in the urban-forest interface - Risk information maps	
2		- Managers of Public Use Forests, Responsible of risk and action, FAFCYLE, Private landowners	Earth Observation based toolkit for Fire Exposure and Risk assessment (CARTIF)	Sensor's data	Analytics to identify metrics and KPIs related to existing territorial vulnerabilities and threats (baseline and projections)	
3		- Managers of Public Use Forests, Responsible of risk and action, FAFCYLE, Private landowners	Territorial assessment tool to evaluate climate related risks and vulnerabilities (CARTIF)	Sensor's data Copernicus	- Analytics to identify metrics and KPIs related to existing territorial vulnerabilities and threats (baseline and projections). - A visualization tool, GIS and web mapping based, to aggregate and show the information collected and calculated at different scales (from local to region)	
4		-	High Altitude Airship Prototype (Zeppelin – CAPGEMINI (ALTRAN))	Flying instructions + Operational instructions	Sensors' data, satellite imagery	
5		-	SAIA: Low altitude UAV - Mission drones (ACCELI)	Flying instructions + Operational instructions	Sensors' data, aerial imagery	
6		- Managers of Public Use Forests, Responsible of risk and action,	Earth Observation based toolkit for Fire Exposure and Risk assessment (CARTIF)	Copernicus Sensor's data	Web-based GIS platform that offers services related to forest fire exposure, early warning and risk estimation.	

		FAFCYLE, Private landowners				
7		- Managers of Public Use Forests, Responsible of risk and action, FAFCYLE, Private landowners	Territorial assessment tool to evaluate climate related risks and vulnerabilities (CARTIF)	Sensor's data Copernicus	- Analytics to identify metrics and KPIs related to existing territorial vulnerabilities and threats (baseline and projections). - A visualization tool, GIS and web mapping based, to aggregate and show the information collected and calculated at different scales (from local to region)	
	Applying Fire defense plan exercise (plant biomass reduction)	Managers of Public Use Forests, Responsible of risk and action, Municipalities associations, FAFCYLE, Private landowners, - Pilot Leaders	Fire Defense Plan	Simulation to derive KPIs	KPI's measurements Planning for plant biomass reduction Best practices	

Detection and Response

Operational scenario: Detection and Response						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Fire alarm, launches a detection and localization exercise (controlled stubble burning)	Responsible of forest firefighting,	Hotspot detection (USAL)	Sensor's data. DEM, land cover maps, satellite imagery, meteorological data, cartographic maps, IoT data.	3D models that will support detection and response tasks	

2		Managers of Public Use Forests, Responsible of risk and action, Municipalities associations	Visual Object Recognition on embedded systems (CERTH)	Sensors' data		
3	Fire and smoke simulations (subtask)	Managers of Public Use Forests, Responsible of risk and 4action, Municipalities associations	Forest fire spread simulation (USAL)	Fuel models, DEMs, weather data	Fire and smoke maps through time	
4			High Altitude Airship Prototype (Zeppelin – ECOSAT-CAPGEMINI(ALTRAN))	Flying instructions + Operational instructions	Sensors' data, satellite imagery	
5			SAIA: Low altitude UAV - Mission drones (ACCELI)	waypoints and camera configuration parameters (roll, pitch, yaw), points of interest	images, flight controller parameters – GPS etc)	
6		,	Medium Altitude UAV – Heavy Payloads (DRONE HOPPER)	Flying instructions + Operational instructions	Sensors' data, aerial imagery	
7	Forest and Fire analysis on the fly (subtask)	Responsible of forest firefighting, Municipalities associations, FAFCYLE, Private Owners	Accurate Forest Mapping (USAL) Analysis of Fire Behavior and Spread for the Development of Safety Measures	Drones, HASP imagery	Real-time cartographic products	
8	Fire attack Real time information support applied to response exercise	Responsible of forest firefighting, Pilot Leaders		- Fire Detection and localization - Real Time information	KPI's measurements	

Restoration and Adaptation

Operational scenario: Restoration and Adaptation

#	Task name	Stakeholder	Use of TREEADS technologies	Information Input	Output	Constraints/ remarks/ other to be considered
1	Define protocols for environmental assessment	Managers of Public Use Forests, Responsible of planning and regeneration, Municipalities associations, FAFCYLE, Private Owners, Pilot Leaders	Assessment and biodiversity protocols (UdG and collaborating partners for DSS?) Post-fire burnt area mapping (NOA)	- piloted aircraft system thermal imaging (RPAS) - ground-level sensors and fieldwork, - satellite data - thematic maps	- Protocol for the use of remote sensing with drones for an immediate postfire environmental assessment of burned areas (BA). - Collection of data about fire severity and environmental vulnerability in BA, both at soil and vegetation levels - Mapping of fire refuges for biodiversity in BA - Accessible methodology to obtain fauna indicators for monitoring biodiversity in fire-prone and recently burned areas. - Spatial use, movement and spatial behavior of animals in recently burned areas thanks to their thermal signatures.	
2			High Altitude Airship Prototype (Zeppelin)	Flying instructions + Operational instructions	Sensors' data	
3			SAIA: Low altitude UAV - Mission drones CERBERUS: high-thrust UAV (ACCELI)	waypoints and camera configuration parameters (roll, pitch, yaw), points of interest	Sensors' data	

4			Medium Altitude UAV – Heavy Payloads (DH) for firefighting	Flying instructions + Operational instructions	Sensors' data	
5		Responsible of planning and regeneration, Municipalities associations, FAFCYLE, Private Owners	Artificial Intelligence for mission planning & swarm coordination (CERTH)	Fused and raw real-time data	- Path Planning for Postfire Management and Restoration	
6	Conceptual development of a Decision Support System for an Adaptive postfire management	Managers of Public Use Forests, Responsible of planning and regeneration, Municipalities associations, FAFCYLE, Private Owners, Pilot Leaders		Postfire management and restoration plan (Task 1)	KPI's measurements Maybe: Architecture of the postfire DSS	

Table 8: Spanish pilot - KPIs

KPIs Prevention and Preparedness	Current value	Desired value	Remarks
Improvement in operation times (time)	Control Exercise without using TREEADS	Improve Control exercise results using TREEADS	Hypothesis: improvement in the time needed to manage/execute when acting based on planning and following processes in an orderly manner.
Savings in the use of physical resources (economic cost estimation based on predefined standards)	Control Exercise without using TREEADS	Improve Control exercise results using TREEADS	With TREEADS we will use more precise machinery to the concrete operation and dimension of the area to work in. Known machinery and resources availability, information concerning natural accidents, resources, etc. Evaluation exercise without and with information

ECO indicator (Fuel and energy cost estimation based on physical resources consumption information)	Control Exercise without using TREEADS	Improve Control exercise results using TREEADS	Fuel savings, energy saving Must be lower than control estimation (without TREEADS)
Improved target arrival times (time)	Control Exercise without using TREEADS	Improve Control exercise results using TREEADS	Control: Without plan Exercise: With plan (shortest available path, aerial localization support)
KPIs Detection and Response	**Current value**	**Desired value**	**Remarks**
Improvement in operation times (time)	Control Exercise without using TREEADS	Improve Control exercise results using TREEADS	Hypothesis: improvement in the time needed to manage when acting based on planning and following processes in an orderly manner.
Savings in the use of physical resources (economic cost estimation based on predefined standards)	Control Exercise without using TREEADS	Improve Control exercise results using TREEADS	With TREEADS we will use more precise machinery to the concrete fire type and dimension, will know machinery and resources availability, information concerning natural accidents, resources, etc Evaluation exercise without and with information
ECO indicator (Fuel and energy cost estimation based on resources consumption information)	Control Exercise without using TREEADS	Improve Control exercise results using TREEADS	Fuel savings, energy saving Must be lower than control estimation (without TREEADS)
Improved target arrival times (time)	Control Exercise without using TREEADS	Improve Control exercise results using TREEADS	Control: Without plan Exercise: With plan (shortest available path, aerial localization support)
KPIs Adaptation and restoration	**Current value**	**Desired value**	**Remarks**
Improvement in recovery times (percentage of biomass recovery/time)	Historical reports about restoration area previous works	Improve historical information using TREEADS	In the medium term, the biomass of live vegetation in the burned areas will be measured and compared with the biomass values prior to the fire to estimate the rate of recovery of the vegetation
Evaluation of soil vulnerability to erosion. (Hours of data collection and processing/ha)	Historical reports about restoration area previous works	Improve historical information using TREEADS	

Position and movements of the fauna in the burned areas. (Hours of data collection and processing/ha)	Historical reports about restoration area previous works	Improve historical information using TREEADS	
Determine biodiversity refuges. (Hours of data collection and processing/ha)	Historical reports about restoration area previous works	Improve historical information using TREEADS	

AUSTRIA

Pilot overview

The Austrian focuses on all three phases.

In Prevention and Preparedness it focuses on educational and economic aspects. VR will be used to train firefighters in suburban forest fires as a large-scale scenario. Further activities will be aimed at the general public with the aim of increasing awareness of fire risk and fire prevention, but also of promoting the adoption of appropriate behaviours in the event of fire. Additionally, the pilot will estimate the damages related to forest fires: through the use of Insurance model & risk transfer solutions it will relate the economic damage with the characteristic of the territory and the fire. Finally, it will use TREEADS technologies to continuously monitor the forest.

In Detection response phase the idea is to have a secure environment where to test different technologies (in controlled fires) and assess their usability and adequacy.

In Restoration Adaptation the pilot will test the territory assessment of burned areas and will use drone to spread seeds in the areas to be restored.

Platform perspective

At this stage, the envisaged activities for detection can be executed through the platform. However, since the pilot main focus is to provide a testing environment - a sort of playground where to experiment state of the art technologies with a pragmatic approach and an open mind – it will be necessary to model the pilot ecosystem in a way that it can allow for easy adaptation and modification based on experimental outcomes, and to adopt an iterative development approach to quickly incorporate feedback and refine implementations.

Actors:

- EXCON (Exercise Control) Team (Leader, Taskobserver, TechSupport, OperationSupport, StaffSupport, SommSupport)
- Security Officer

- Fire brigade
- OSOCC (On-Site Operation Coordination Center)
- Armed Forces (Police and/or Military Support forces)
- Cooperation partners (University of Natural Resources and Life Sciences)
- Rescue organisations
- Civil protection organisations
- Insurance companies
- Forest owners

Prevention and Preparedness

Table 9: Austrian pilot - user stories

Operational scenario: Prevention and Preparedness						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	VR training to practice suburban forest fires as a large-scale scenario	JOAFG, fire fighters,	VR Training Ground by JOAFG, Forest Fire Spread Simulator (USAL)	Input needed: terrain, infrastructure and vegetation, hydrant plans, access and exit routes. It is important that we have a conversation with the developer regarding the requirements for the model(s) Forest Fire Spread Simulator (input to be defined by USAL)	VR training sessions for forest fire scenarios	The input of the forest fire scenarios is optional but would improve the training sessions.
2	Developing awareness concepts for forest fire prevention	JOAFG, firefighters, communities all over the country (specifically those	no technologies used	Background information on forest fires	Information campaign on the prevention of forest fires, information campaign among rescue organisations	

		with higher risks of forest fires)				
3	Development of concepts for dealing with mobility-impaired persons during large-scale evacuations	JOAFG, firefighters, retirement homes, communities all over the country	no technologies used	evacuation concepts with special focus on handling of people with mobility limitations	Information campaign among rescue organisations (fire fighters, ambulances, hospitals, retirement homes	
4	promoting first aid for burns for laymen + the responsibility of civil society to jointly cope with large-scale emergencies and disasters	JOAFG (and other rescue organisations) DCNA, Civil protection, communities	no technologies used	Medical information from experts in the field of first aid for burns	Information campaign among rescue organisations and firefighter organisations	
5	Estimations of damages related to forest fires	DTU, DCNA, insurance companies, forest owners	Insurance model & risk transfer solutions	To be defined by DTU	Estimation of damage in € for a defined area under certain scenarios	
6	Monitoring of forest status	8BELLS, firefighters, research organisations	Forest Black Box	To be defined by 8BELLS	Continuous monitoring of the forest	

Detection and Response

Operational scenario: Detection and Response						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Use TREEADS technologies to survey fire scenes and	FF GK, IFR, firefighter organisations, Communities,	Hotspot detection, UAVs for surveillance, Forest Black Box	Geographical information, requirements of firefighters tbd	Map of fire front, identification of fire spots	

	identify the flame front					
2	Share live video streams using 5G technology during wildfire firefighting to improve the operational management and the security of firefighters	FF GK, IFR, firefighter organisations, rescue organisations	UAVs for inspection, AR helmet, 5G instant messaging	Tbd by 8BELLS	Live video stream (from UAVs or AR helmets), geolocation of single firefighters in the field with the possibility of instant communication with head of operations	
3	Estimation of fire development	FF GK, IFR, firefighter organisations, DCNA, research institutions (for integration in other platforms)	Forest fire spread model, Wind field model, Air pollution model	Tbd by USAL	Forecast of development of the fire for the next 24h to optimize fire extinguishing and evacuation measures	

Restoration and Adaptation

Operational scenario: Restoration and adaptation						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Automated protocol with assessment of burned areas	UdG, forest owners, communities, regional government, insurance companies	DSS restoration module	Earth observation data, pool of restoration measures	Incident protocol with proposed restoration measures	
2	Seeding by using drones	GBD, LAMMC, ACCELI, forest owners, communities, ecologists	Drones for agriculture	Data on vegetation, maps, topography	The seeding is done by the drones according to a pre-defined action plan in accordance with the typical vegetation in the area	

Table 10: Austrian pilot - KPIs

KPIs Prevention and Preparedness	Current value	Desired value	Remarks
Training of Commanders	25	50	Only in Lower Austria
Training of field fire fighters	200	600	Only in Lower Austria
Training of integrated missions	5	820	
Training for evacuation of people with limited mobility	0,5 p.a.	2 p.a.	
Promotion of First Aid and Forest Fire Prevention	n/a	1	Development of guideline and reach of 500+ people in direct contact
Reduce number of forest fires due to increased awareness	159 p.a.	< 150 p.a.	
Establishment of a guideline for the estimation of possible damages of forest fires	n/a	1	Development of guideline and distribution among insurance companies and forest owners
KPIs Detection and Response	**Current value**	**Desired value**	**Remarks**
Fast situation awareness picture	120min	30min	
Data transfer rate for live streams including video stream and communication with firefighter to increase their security	2 mbps	10 mbps	
Near real time update of forest fire situation	1 p.h.	4 p.h.	
Estimation of fire development	Done based on experience	Experience & model data	
KPIs Adaptation and Restoration	**Current value**	**Desired value**	**Remarks**
Automated incident handbook generated	0		Automated report from TREEADS Data to guide the lessons learned and the restoration measures. Maybe not all steps mentioned in the description of the technology (DSS restoration module) will be applied
Time needed for seeding of new trees	n/a (h/ha)	(h/ha)	Currently done manually with support of horses, the metric is not available for the as-is scenario Done by drones in the To-be scenario Additional information on the current process needs to be collected

GERMANY

Pilot overview

The German pilot focuses on all three phases. In Prevention and Preparedness the overarching goal is to increase the knowledge of fires (ignition, propagation, toxicity) and compile Health Guidelines and Warning plans for evacuations regarding smoke gases and smoke gas toxicity. This will be achieved through small and large scale field exercises.

In Detection response the focus will be to test the efficacy and environmental impact of foam / fire retardants.

While in Restoration and Adaptation the pilot will evaluate the impact of foam / fire retardants on tree seedlings to be used in the restoration phase.

Platform perspective

Although the pilot plans to use several of TREEADS technologies, at this stage, it appears that most of the envisaged activities will be executed outside the holistic platform.

Actors:

- Forestry Office Manager
- Flechtingen municipality and fire brigade
- Fire service Cottbus / Potsdam
- German weather forecast service
- Wildfire representant DFV (German fire service association)
- Managing Director Pyrobubble manufacturer
- School and Technical Facility for Fire and Disaster Protection of the State of Brandenburg
- Institute of fire department of lower saxony
- German fire protection Association

Prevention and Preparedness

Table 11: German pilot - user stories

Operational scenario: Prevention and Preparedness						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Understanding Ignition Characteristics and Fire-Spread	Fire-Brigades Forest Managers	Propagation Prediction / Fire Prevention System by **USAL**	Small-Scale Burning Experiments	Numerical calculations with input data of experiments using CFD Identification of typical combustion processes	
2	Large-Scale fire tests	Fire Brigades Forest Managers	Test of AR-Helmet, Forest Blackbox by **8BELLS** **ACCELI-Drones / DRONE-Hopper** Test installation of SCC in burned field sample **GBD**	Wind, Weather, local Vegetation properties, Moisture, tree heights,	Parameters for numerical simulations (Temperature, Validation of simulations	
3	Simulation of wildfire spread	Fire Brigades Forest Managers	Digital Twin of the forest Windfield-Model of **USAL**	Geometry data, physico-chemical material properties of typical vegetation, ambient conditions (ambient temperature, ambient air conditions, pressure, relative humidity), combustion reaction equations, mass burning rates, windfields Data of medium and large-scale experiments	temperatures, heat release rates, mass fractions of smoke gas species, soot fraction, velocities, pressure, flame heights, flame thickness, Fractional Effective Dose for the evaluation of smoke gas toxicity	

4	Health Guidelines and Warning plans for evacuations regarding smoke gases and smoke gas toxicity	German fire protection association Fire brigades		Concentrations of different smoke components [ppm, Vol.-%]	Smoke Characteristics (also to be contributed to **USAL)** Standards for firefighters and municipalities	

Detection and Response

Operational scenario: Detection and Response						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
Prerequisite: Development and testing of new firefighting techniques, specifically AR Helmet by 8BELLS and OS Foam						
1	Assessing Environmental Impact of foam / fire retardants		Environmental Assessment by **EFB** Use of Ash for research by **NTUST**	TBD	TBD	

Restoration and Adaptation

Operational scenario: Restoration and Adaptation						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
	Evaluation of fire extinguishing foam effect on tree seedlings		**OS FOAM** Seeds and Laboratory from **LAMMC**	tree seedling growth (morphological parameters) and health (biochemical parameters – secondary metabolism Before <-> After	Evaluation of fire extinguishing foam effect on tree seedlings	

Table 12: German pilot - KPIs

KPIs Prevention and Preparedness	Current value	Desired value	Remarks
Limits for tenability conditions for First Responders	Not available	FED <= 1	
Limits for tenability conditions for population	National Standard DIN 18009-2 Fire Safety Engineering (Evacuation Guidance for Buildings)	National Standard for smoke toxicities	
Evacuation Guidance for WUI	Not available	Warning plans for evacuations regarding smoke gases and smoke gas toxicity	
Reduction in fire extinguishing time due to better prediction of fire and smoke propagation	Not available for German Vegetation	Development of an advanced CFD-modelling approach	
Decrease in the number of forest fires and their severity, trough better understanding of ground fire propagation	Not available for German Vegetation fires and ground fires	All measurable variables in the large-scale experiment, e.g. temperatures, propagation velocities, flame thickness, flame height, gases, etc., help to better assess and reduce the severity of forest fires	
KPIs Detection and Response	**Current value**	**Desired value**	**Remarks**
Reduction in the number of victims trough scenario prediction and response optimization	Not available	Limits for tenability conditions, National Response plans	
Reduction of environmental impact by using innovative fire extinguishing agents as well as strategies that optimize their use.	Not available	Fewer loss in Biomass due to faster extinguishment	
Life Safety Values	Not available	Quantification (FED)	
Permitted use of CAF`s in Vegetation Optimizing extinguishment tactics	none	Standards for use of CAF`s in Wildfires	
KPIs Adaptation and Restoration	**Current value**	**Desired value**	**Remarks**
Standards how CAF`s can be used for forest fires	none	Determined Environmental Impact	

GREECE

Pilot overview
The Greek pilot focuses on Prevention and Preparedness as well as on Detection response. The area of interest is the Samaria Gorge on the island of Crete. It is a protected area visited by an intense tourist flow due to its scenic beauty and rich biodiversity. The gorge, however, has challenging orography, which, in the event of a fire, poses an enormous threat to both natural resources and human lives.
In the Prevention and Preparedness the pilot specifically focuses on this aspect with education al and training activities (for visitors and staff respectively) to increase the awareness about fire hazards and evacuation procedures. Additionally, the pilot will model the evacuation plan taking into account different parameters (season, temperature, weather conditions etc.). This activity will lead to the formalization of different evacuation plans concerning different situations.
In the Detection Response the pilot plans to set up continuous monitoring operations that will improve the time and efficacy of the response phase.
Platform perspective
At this stage, it appear that most of the envisaged activities can be executed through the platform.

Actors:

- Directorate of Forest of Chania Prefecture
- Fire Service Department
- Civil Protection – Ministry of Climate Change and Civil Protection
- Samaria National Park Management Agency

<u>Prevention and preparedness</u>

Table 13: Greek pilot - user stories

Operational scenario: Prevention and Preparedness						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Visitor information about evacuation processes	- Samaria National Park Management Agency Directorate of Forest of Chania Prefecture	-Via phone application (could be developed by Greek Pilot partners)	Number of visitors that have accepted terms of entering area	Number of visitors for evacuation purposes	Visitors want a quick entrance to the Samaria Gorge

2	Evaluation of fire risk	- Samaria National Park Management Agency - Directorate of Forest of Chania Prefecture - Fire Service Department - Civil Protection – Ministry of Climate Change and Civil Protection	- Fire Prevention System - Earth Observation based toolkit for Fire Exposure and Risk assessment - Territorial assessment tool to evaluate climate related risks and vulnerabilities - Accurate Forest Mapping Infrastructures fire emergency management strategy	Information input from meteorological stations and multiple ground sensors	Risk indicator and use case specific modeling to assess preparedness level	Stiff geomorphology and dense vegetation can make the modelling difficult and time-consuming
3	Data collection and Communication	- Samaria National Park Management Agency - Directorate of Forest of Chania Prefecture - Fire Service Department	- Forest Black Box - 5G Portable Communication System - SAIA: Low altitude UAV - Mission drones	-	Providing ground point data stream to the modelling systems as well as dynamic information at operational level	Stiff geomorphology and dense vegetation can make the communication of information difficult
4	Stakeholder Training	- Samaria National Park Management Agency - Fire Service Department	VR Training	Digested Information related to Samaria Gorge specifications and historic events	Training for the better preparedness and knowledge of the different risks	
5	Evacuation Simulation and Modelling	- Samaria National Park Management Agency - Directorate of Forest of Chania Prefecture - Fire Service Department - Civil Protection - Ministry of Climate	Multi-Mission Platform for Crowd and Livestock Management & Evacuation	Provide information about different parameters needed for the evaluation of the evacuation models	Different evacuation plans, regarding different scenarios	The number of parameters/information to be included, along with the great length of the area (also considering an open system with many interfaces), can make the modelling difficult and time-consuming

		Change and Civil Protection				

Detection and Response

Operational scenario: Detection and Response						
#	Task name	Stakeholder	Use of TREEADS technologies	Information Input	Output	Constraints/ remarks/ other to be considered
1	Detection of fire	- Samaria National Park Management Agency Fire Service Department	- Hotspot detection Visual Object Recognition on embedded systems	Data from ground sensors and UAVs (i.e. Forest Black Box, UAVs)	Visualization of real time operational information	Stiff geomorphology and dense vegetation can make the communication of information difficult
2	Wildfire Dynamic Modelling	- Samaria National Park Management Agency - Fire Service Department - Civil Protection	- Forest fire spread simulation - Wind field model Analysis of Fire Behaviour and Spread for the Development of Safety Measures	Data fusion from historical data, combined with real time gathered data	Visualization of real time operational information	Stiff geomorphology and dense vegetation can make the modelling difficult
3	Utilization Fire Service Equipment	- Samaria National Park Management Agency - Fire Service Department	- AR helmet 5G Communication System	Data from ground sensors and UAVs (i.e. Forest Black Box, UAVs)	Visualization of real time operational information	Stiff geomorphology and dense vegetation can make the communication of information difficult
4	Operational Communications	- Samaria National Park Management Agency - Fire Service Department - Directorate of Forest of Chania Prefecture	- Forest Black Box - Data Fusion Mechanism X/BELLO instant messaging	-	Providing ground point data stream to the modelling systems as well as dynamic information at operational level, instant messaging to help evacuation	Stiff geomorphology and dense vegetation can make the communication of information difficult

5	UAV fleet deployment	- Samaria National Park Management Agency - Fire Service Department - Directorate of Forest of Chania Prefecture	- UAV Deployable Air Command and Control - SAIA: Low altitude UAV - Mission drones - AI for mission planning & swarm coordination	Spatial information of fire event	Real time information, monitoring, and coverage of the fire event, Quick firefighting response	Difficulties of coverage due the length of the gorge, Difficulties of UAV deployment due to wind turbulence, heat, and smoke Maintenance could be difficult due to accessibility issues

Table 14: Greek pilot - KPIs

KPIs Prevention and Preparedness	Current value	Desired value	Remarks
% of visitors informed about Evacuation process	-	100%	
% of visitors accepted T&C	-	100%	
Preparedness level indicator	-	(range to be defined)	
Data coverage percentage	20%	100%	
Number of Stakeholder and/or Actors trained	-	100% (acceptable minimum should be defined too)	

TAIWAN

Pilot overview

The Taiwanese pilot focuses on Prevention and Preparedness as well as on Detection response. In prevention the focus is the study of materials, in particular the use of recycled wood ashes to strengthen construction materials (e.g., concrete materials and alkali-activated materials) improving their durability and fire-resistance. The activity concerns essentially to execute laboratory tests to evaluate different properties to the varying of the amount of recycled wood ashes.

In Detection and Response the pilot will use data coming from sensors deployed in the field to predict potential hazards in areas of interest.

Platform perspective

At this stage, it appear the foreseen activities will not be executed through the holistic platfrm.

Actors:

- Lead & Material Research / National Taiwan University of Science and Technology (NTUST)
- Forestry Authority / Forestry Bureau (FB)
- Forestry Research / Taiwan Forestry Research Institute (TFRI)
- Forestry Industry / Jang Chang Liang Co. Ltd. (JCL)
- Construction Industry / Chien Chung Construction Co. Ltd. (CCC)
- Material Research / National Kaohsiung University of Science and Technology (NKUST)
- Information Technology / National Taipei University of Technology (NTUT)

<u>Prevention and preparedness</u>

Table 15: Taiwan pilot - user stories

Operational scenario: Prevention and Preparedness						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1		NTUST NKUST JCL CCC	Hydration reaction	Percentage of recycled wood ashes	1. Compressive strength 2. Thermal-induced damage 3. Microstructure	1. Collection of wood ashes after forest fire incidents (quantity, artificial) 2. Plant types (quality)
2		NTUST NKUST JCL CCC	Alkali-activated technology	Percentage of recycled wood ashes	1. Compressive Strength 2. Thermal-induced damage 3. Microstructure	1. Collection of wood ashes after forest fire incidents (quantity, artificial) 2. Plant types (quality)

Detection and Response

Operational scenario: Detection and Response						
#	**Task name**	**Stakeholder**	**Use of TREEADS technologies**	**Information Input**	**Output**	**Constraints/ remarks/ other to be considered**
1	Prediction for Potential Hazard Areas	NTUST NTUT FB TFRI	IoT LoRa (Long Range)	Temperature, Humidity, Moisture Content of fuel	Calibration of existing prediction model	1. Shield 2. Battery life for sensors

Table 16: Taiwan pilot - KPIs

KPIs Prevention and Preparedness	Current value	Desired value	Remarks
Recycling rate of post-wildfire wood ashes	0%	30%	1. Post-wildfire ashes are not used for building and construction materials. 2. Save the space for the landfill disposal. 3. Developing alkali-activated material to improve strength and durability
Retained strength rate of thermal-induced damage	30% Reduction in strength	0% Reduction in strength	1. Conventional concrete for building construction typically has thermal-induced damage when temperature rises to 500 °C. 2. Development of AAM materials with resistance to fire and thermal-induced damage.
KPIs Detection and Response	Current value	Desired value	Remarks
Coverage rate of the monitoring stations using IoT system with low-power supply in the country. Existing 40 stations are all set up in the regions with low altitude.	0%	5%	When the monitoring station with IoT system can be established, the stations can be setup in the remote mountainous areas with low power supply. The existing prediction model for potential wildfire hazard areas can be calibrated and the early alarm system will be more accurate.

Table 17 provides a summarized view of the technologies envisaged in each pilot. From the table (and the user stories) it appears that some pilots, specifically Norway and Taiwan, focus on material science, they do not foreseen the use of IT features, in particular Taiwan considers using materials developed by local research organizations. Other pilots (i.e. Italy) foresee a hybrid situation where some It features are required as input for an off-line decision process that is implemented using legacy systems.

Table 17: Summary table mapping TREEADS technologies vs pilots

TREEADS technology	Owner	IT	Norway	Italy	Romania	Spain	Austria	Germany	Greece	Taiwan
Fire Prevention System	USAL	X			X	X		X	X	
Earth Observation based toolkit for Fire Exposure and Risk assessment	Cartif	X			X	X			X	
Territorial assessment tool to evaluate climate related risks and vulnerabilities	Cartif	X			X	X			X	
Machine Learning for Fire Risk Analysis and Fire Spread	OVGU/BAM	X			X					
Passive fire protection for key infrastructures and residential buildings	Trelleborg/ VIPO/FRN		X							
Fire-resistant wooden construction materials for increased fire-safety in areas of wildland-Urban Interface (WUI) fire risk.	Woodify /FRN		X							
Insurance Model and Risk Transfer Solutions				X			X			
Hotspot detection	USAL	X				X	X		X	
Visual Object Recognition on embedded systems	CERTH	X				X			X	
Forest fire spread simulation	USAL	X		X		X	X			
Wind field model	USAL	X		X			X	X	X	
Atmospheric pollutants dispersion model	USAL	X		X			X			
Analysis of Fire Behavior and Spread for the Development of Safety Measures	OVGU/BAM	X		X		X				
Infrastructures fire emergency management strategy	STRESS LTP: Tecnosistem			X						
AR helmet	8bells	X	X		X		X	X	X	
5G Portable Communication System	8bells	X			X				X	
X/BELLO instant messaging	8bells	X					X		X	

Reforestation/ Drones for Agriculture - using SCC for aerial mass releases	GBD/ACCELI/ LAMMC									
Restoration of ecological balance - using Bioclip release principles	GBD		X							
Preparation of bio-material for post-fire bioremediation and re-vegetation trails	LAMMC		X					X		
DSS restoration module	UdG						X			
Interoperability Environment for Rescue and Logistics Processes using ISO standards	JOTNE	X	X							
UAV Deployable Air Command and Control	Altran				X		X	X	X	
SAIA: Low altitude UAV - Mission drones	Acceli	X			X	X			X	
Medium Altitude UAV – Heavy Payloads	Windhopper	X				X				
High Altitude Airship Prototype (Zepelin)	Altran	X				X				
Artificial Intelligence for mission planning & swarm coordination	CERTH	X			X	X				
VR Training	Simavi	X		X	X		X		X	
Context-aware decision support	FI	X			X					
Predictive decision support	FI	X			X					
Accurate Forest Mapping	USAL	X				X			X	
Social media collection and analysis	CERTH	X			X					
Forrest black box	8bells	X			X		X	X	X	

FUNCTIONAL NEEDS

NORWAY

The Norwegian user story focuses exclusively on the Prevention and Preparedness phase, in particular:

FN-NO1 - Classification of forest and heather land fires with the idea to test different approaches and practices in order to possibility to conduct forest fire exercises to collect data.

FN-NO2 - Development or modification of innovative materials to be tested under different conditions (different types of wood, with or without impregnation or coating) to assess the possibility to use them in buildings and infrastructure exposed to wildland fires.

FN-NO3 Create standard solution for improved rescue logistics to support fire brigades in the field.

FN-NO4 Develop a repository for Norwegian Wildland fires.

FN-NO1 and FN-NO2 refer to studies in material science therefore not IT related, while FN-NO3 and FN-NO4 although representing important needs are not directly related to the scope of this deliverable.

ITALY

The Italian pilot is a hybrid one that aims to use the knowledge generated by the project for the planning of a cable way in the Sorrento area. The pilot plans to use simulation features to determine of risk factors and predicted effects of possible fire propagation situations to determine the optimal route for the new cable way.

FN-IT01 simulation of forest fires taking into account: Forest fire spread simulation, Wind field model and Atmospheric pollutants dispersion model. The resulting model will be used for the cable way planning conducted offline.

FN-IT02 Preventive risk analysis for wildfires in protected forest areas aiming to analyse fire behaviour and spread for the development of safety measures.

Additionally, the pilot expressed the following functional needs:

FN-IT03 Risk Transfer solutions

FN-IT04 Fire detection and Response simulation in real environment

FN-IT05 Mapping of possible areas of application of Nature-based and fire-resilient solution for restoration

FN-IT06 Analysis of possible economic restoration solutions after forest fires.

But these require further details not provided yet.

ROMANIA

The Romanian pilot’s focus is limited to the Prevention and Preparedness and Detection and Response phases.

Some of the expressed functional needs correspond to activities related to the set-up of the underlying infrastructure (deploying sensors, ensuring connectivity, gathering and mapping geospatial information etc.), as such they are not relevant in this section.

FN-RO01 Monitoring procedures that make use of different tools such as Fire Prevention System, Earth Observation, Territorial assessment, and Social media data collection and analysis to produce digested data to feed the response system.

FN-RO02 Response system a semi-autonomous system that uses different tools such as - Machine Learning for Fire Risk Analysis and Fire Spread, Artificial Intelligence for mission planning & swarm coordination, Context-aware decision support, and Predictive decision support to neutralize early-stage threats.

FN-RO03 Firefighter AR/VR training.

FN-RO04 Decision support system to monitor data coming from different sources to promptly detect threats.

SPAIN

FN-SP01 Define fire defense plan for an inter-urban forestry space based on different types of data (e.g. maps, satellite imagery, meteorological data, cartographic maps, IoT data) and simulation tools (eg., Fire Prevention System, Fire risk prediction system, Territorial assessment tool to evaluate climate related risks and vulnerabilities etc.,

FN-SP02 Fire alarm with detection and localization of the fire front, uses sensors' data, available historical or real time data, and tools like Visual Object Recognition on embedded systems and Hotspot detection.

FN-SP03 Forest and Fire analysis on the fly real time monitor of the forest based on data coming from sensors, drones.

FN-SP04 Fire attack Real time information support fire detection and localization, provision of real time information.

FN-SP05 Define protocols for environmental assessment Protocol for the use of remote sensing with drones for an immediate postfire environmental assessment of burned areas.

AUSTRIA

FN-AU01 VR training to practice suburban forest fires as a large-scale exercise**.**

FN-AU02 Estimations of damages related to forest fires Use of Insurance model & risk transfer solutions to estimate the damage for a defined area under specific conditions.

FN-AU03 Monitoring of forest status to detect potential threats.

FN-AU04 identify the flame front using technologies such as Hotspot detection, UAVs for surveillance, Forest Black Box.

FN-AU05 Share live video streams to improve the operational management and the security of firefighters.

FN-AU06 Estimation of fire development through the use of Forest fire spread model, Wind field model, Air pollution model to forecast the development of the fire front and to optimize fire extinguishing and evacuation measures.

GERMANY

The German pilot aims to conduct a series of test of different techniques to verify the efficacy and the environmental impact of new materials (e.g. fire extinguishing foam).

FN-GE01 Simulation of wildfire spread using geodata and information concerning the environment (vegetation, temperature, humidity…).

FN-GE02 Health Guidelines and Warning plans for evacuations regarding smoke gases and smoke gas toxicity.

FN-GE03 Environmental Impact of foam / fire retardants.

GREECE

FN-GR01 Mobile App to count and monitor visitors, send alert in case of fire and locate visitors for emergency situations – not in TREEADS scope (DoA).

FN-GR02 Evaluation of fire risk based on meteorological stations and multiple ground sensors.

FN-GR03 VR training

FN-GR04 Evacuation Simulation and Modelling to investigate different evacuation plans, corresponding different situations.

FN-GR05 Detection of fire – prompt detection of fire spots vis sensors deployed on the ground and data coming from surveilling UAVs.

FN-GR06 Wildfire Dynamic Modeling to analyze fire behavior and spread with the aim to develop of Safety Measures.

TAIWAN

FN-TW01 Prediction for Potential Hazard Areas using IoT and LoRa data to calibrate existing prediction model**.**

REQUIREMENTS

The elaboration and harmonization of the different sources (i.e., user stories, technology mapping and phase specific requirements) allowed the elicitation of this initial list of non-functional and functional requirements related to the holistic platform. These requirements will be enriched and refined in the next versions of this deliverable.

Table 18: Non-functional requirements for the platform

Req. ID	Requirement Description	Priority
NFR-01	The platform should ensure the optimal reuse of technical resources.	High
NFR-02	The platform should be able to use and combine tools/technologies locally available	High
NFR-03	The platform should provide multiple points of access allowing the composition of workflows that might be partially executed off line.	Medium
NFR-04	The platform should be able to use data coming from different sources	High
NFR-05	The platform should use standard data bases to store relevant data	High
NFR-06	The platform should be able to manage different data formats (geo spatial data, video, sound, text, etc.)	High
NFR-07	The platform should provide near real-time info (10 min-1hr) for rapid intervention	High
NFR-08	The platform should render information from different sensors with high and medium spatial resolution.	High
NFR-09	The platform should use open/international standards for data management	High
NFR-10	The platform should ensure data interoperability	High
NFR-11	The platform should ensure the capacity to manage continuous flows of data.	High
NFR-12	The platform should be capable of managing high volumes of data	High
NFR-13	The platform should be accessible from different interfaces (mobile/web)	Medium
NFR-14	The platform must be compliant with current Privacy regulations (GDPR)	High

Table 19: Functional requirement for the platform

Req. ID	Requirement Description	Priority
FR-01	The platform should allow the definition of user specific workflows that combines methods, services and tools from different providers	High
FR-02	The platform should ensure that each user has access only to the information and features that are relevant for his / her case.	High
FR-03	The platform should provide the possibility to visualize different data formats in the most appropriate way (embedded viewer)	High
FR-04	The platform should allow the smooth integration of different assets (truck, sensors, equipment, people)	High
FR-05	The platform should provide user tailored visualization dashboards.	High
FR-06	The platform should be capable to monitor sensors deployed in the forest according to user defined parameters.	High
FR-07	The platform should allow the execution of simulations based on user defined parameters and using different combination of assets.	High
FR-08	The platform should allow the execution of optimizations based on user defined parameters and using different combination of assets.	High
FR-09	The platform should provide access to Training material	High
FR-10	The platform should be capable to store the results of test fires as well as real fires	High

FR-11	The platform should be able to connect with external systems (mobile apps, legacy systems, open data sources etc.)	High

CONCLUSIONS AND IMPLICATIONS

This deliverable documents the work done in task 2.6 to derive an initial list of requirements that will guide the implementation of the TREEADS holistic platform. The document describes the used methodological approach, the received input (i.e. user stories from pilots), and the process to derive the functional and non-functional requirements.

This document is intended as a live document. Thus, the content presented, especially concerning the user stories, cannot be considered exhaustive or final. The next version of this deliverable will be enhanced with refined information and data from WP8. Moreover, on-going synergies with WP3 will allow aligning the requirements with the architectural vision in WP3.

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2. Capgemini Engineering, 2022, TREEADS D2.5 Detection and Response Understanding and Technical Requirements Report V1
3. Elena Puigdemasa Martí, Marina Palmero Iniesta and Pere Pons (Universitat de Girona), 2022, TREEADS D2.7 Restoration and Adaptation Understanding and Technical Requirements Report.

ANNEX 1: USER SCENARIOS TEMPLATE

Template provided to pilots for the description of user stories.

Pilot case Title:
Actors: Please indicate the roles/ actors/ other stakeholders that **participate** in the operations

- ….

Operational scenario: Prevention and Preparedness						
#	Task name	Stakeholder	Use of TREEADS technologies (please list)	Information input	Output	Constraints/ remarks/ other to be considered

Prevention and Preparedness KPIs

KPIs	**Current value**	**Desired value**	**Remarks**

operational scenario: Detection and Response						
#	Task name	Stakeholder	Use of TREEADS technologies (please list)	Information input	Output	Constraints/ remarks/ other to be considered

Detection and Response KPIs

KPIs	Current value	Desired value	Remarks

Operational scenario: Adaptation and Restoration						
#	Task name	Stakeholder	Use of TREEADS technologies (please list)	Information input	Output	Constraints/ remarks/ other to be considered

Adaptation and Restoration KPIs

KPIs	Current value	Desired value	Remarks

Pilot Environment **where will they try to use it? What other system they should interact with?**	
Challenges/barriers/ things to consider when they try to use it, what can get in their way (e.g., signal unavailable)?	

ANNEX 2: LIST OF TREEADS TECHNOLOGIES

Technology	Owner	Description
Prevention preparedness		
Risk analysis tool - Forestry management regarding Fire Prevention System (FPS) through Monitorization in real time of fuel, atmosphere and ground by a web information system In particular, data from Copernicus Land Monitoring Service will be combined with other observations such as hyperspectral and LiDAR sensors, as well as historical wildfires data (causes, spreading, damages, timeline), allowing to improve the decision-making process. Historical fires will be exploited as labels in deep learning models to forecast fire hazard using as input satellite, meteorological and biomass data.		
Fire Prevention System	USAL	The main role of this module is to improve forestry management regarding forest fire prevention through the use of decision-making supporting tools which integrate heterogeneous, precise and up-to date geospatial information at different spatial and temporal scales. Particularly, the University of Salamanca will apply computer vision and artificial intelligence techniques (ML/DL) for advancing descriptive and predictive models of forest and fire propagation, respectively. To do this is proposed the implementation, maintenance and exploitation of a fire prevention system (FPS) through the monitorization in real time of fuel, atmosphere and ground by a web information system. The idea under this FPS is to provide a better estimation and description of topography, vegetation, fuel models and meteorological information, among others. This FPS constitutes an important challenge due to the need to achieve the integration of multiscale and multimodal information in smart models of the forest which integrate point clouds, fuel models, ground, vegetation models, etc. In particular, data from Copernicus Land Monitoring Service will be combined with other observations such as hyperspectral and LiDAR sensors, as well as historical wildfires data (causes, spreading, damges, timeline), allowing to improve the decision-making process.
Earth Observation based toolkit for Fire Exposure and Risk assessment	Cartif	Using copernicus services and their time series provided, a web-based GIS platform that offers services related to forest fire exposure and risk estimation will be released. The platform and services are based on forecasting technics. The foreseen services to be implemented are the following: 1. Periodically (e.g. daily) estimate the fire risk based on the vegetation conditions (vegetation fuel types, vegetation moisture conditions), terrain conditions, weather conditions of the targeted territory. The information gathered in existing municipal prevention plans will be assessed during the specification of the risk. 2. Service that estimates the exposure of a certain village and/or assets to forest fire, by estimating if a fire starting at a certain point in the surroundings of the village or assets(s) of interest is expected to affect and the time that the suppression resources would have available to protect or evacuate these before the fire reaches them. 3. A service to provide an early warning on potential natural disasters, based on the monitoring of the vegetation cover and other features from the imagery available on EO Browser. The diversity of imagery sources would provide different levels of warnings: from drought alerts on wide or regional areas to the detection of new construction or activities on protected areas.

Territorial assessment tool to evaluate climate related risks and vulnerabilities	Cartif	This Climate Service will be based on Copernicus services. The main objective is to identify the baseline of main vulnerabilities and threats in a specific territory to estimate the associate risk. This service is compound by: • Analytics to identify metrics and KPIs related to existing territorial vulnerabilities and threats (baseline and projections). These analytics are based on computer vision technics (AI) applied to sentinel and Copernicus imaginary to extract knowledge. • A visualization tool, GIS and web mapping based, to aggregate and show the information collected and calculated at different scales (from local to region)
Machine Learning for Fire Risk Analysis and Fire Spread	OVGU BAM	Development of situation aware machine learning methods to predict fire ignition and spread based on historical data and information such as weather conditions, land use and vegetation. A detailed risk analysis should provide appropriate safety measures.
Fire-resilient materials for buildings and infrastructures		
Passive fire protection for key infrastructures and residential buildings	Trelleborg VIPO FRN	Passive Fire Protection (PFP) products protect steel and concrete structures from exceeding critical temperature limits. PFP material can also protect equipment from vibrations, collisions, explosions, and even earthquakes. Our particular interest is to investigate which areas the PFP material/products can be used. In this project we would utilize fire-retardant material that normally are used for protecting structures from Hydrocarbon and Jet fires, to protect structures from Wildland fires. During the project we will work to study the need, opportunity and develop new application of fire-retardant materials that have been used in the offshore environment for more than 30 years.
Fire-resistant wooden construction materials for increased fire-safety in areas of wildland-Urban Interface (WUI) fire risk.	Woodify FRN	Development of wooden construction products that after a fully controlled vacuum/pressure fire retardant impregnation process can withstand simulated WUI fires. Small to full-scale tests will be performed, to identify important parameters like critical thicknesses, fire retardant amount and concentrations needed and for how long such a product can withstand the high thermal loads of a WUI fire.
TREEADS Governance and parametric Insurance Models and Guidelines		
Insurance Model and Risk Transfer Solutions	DTU	Estimation of the physical damage and economic losses arising from wildfire. Upon analysis of the relevant insurance environment and market, the results of this model will inform the definition of appropriate risk transfer solutions.
TREEADS Enhanced Reality, UX Design, Training, including virtual reality simulators for air fleet and ground resources		
VR Training	Simavi	TREEADS Scenario-Based Training platform will build upon Interactive Virtual Scenarios (VS) or simulations (i.e. Scenario-Based Learning; SBL) which are recognized by many teaching and learning communities as effective tools for developing reasoning, and for safe training in workplace competency. The TREEADS Virtual Reality (VR) platform will be used as an online activity modelling

		system that allows users to build interactive 'game-informed' educational activities, such as virtual Flora environment, Wildfire incident simulations, serious games, mazes and Triage processes. Depending on what decisions TREEADS partners make or paths they navigate through the case, the consequences will be different. A well-designed case is considered as challenging and intriguing, with real decisions similar to real-life cases. The TREEADS VR training platform will leverage SIMAVI's existing infrastructure, while the TREEADS serious game environment will be a web application that run on most modern web browsers. In order to create and edit cases, the TREEADS will need to get access to a server running the Scenario-Based Training (SBT). The SBT's platform openness and flexibility will be very useful for creating a variety of different activity designs, going way beyond isolated virtual victim cases. Some examples include: (i) group work cases, (ii) hybrid simulations with standardized example, (iii) bookending high fidelity simulations, (iv) video mashups, (v) resource trade-off scenarios, (vi) multi-case Triage, (vii) mini-cases as mobile exemplars; (viii) script concordance testing; and (ix) bidirectional integration with podcasts and webinars
Detection Response		
Fire Detection		
Hotspot detection	USAL	Computer vision and artificial vision capabilities to the cameras located in fixed or mobile, allowing to detect hotspots in real-time or to provide dimensional analysis capabilities from single images or videos of the fire. Videos in 360º captured by surveillance cameras integrating 5G technology allow the creation of 3D models that will support detection and response tasks through a dimensional analysis of the scene or objects, being an ideal tool for decision making.
Visual Object Recognition on embedded systems	CERTH	all required information will be acquired from various visual related sensors as images and/or footages to exploit the processing capabilities of powerful embedded devices for incorporating cognitive capacities and more specific, object recognition objectives. The objects will be relevant to TREEADS domains and will be specified during the duration of the developments. Deep learning architectures will be utilized for the design and the implementation process which will be adapted properly to consider limited computational resources nonetheless; ensuring high precision results in real operational scenarios. Embedded devices cannot provide the same computational performance neither the size of memory of the desktop alternative systems. So, the main challenge involves the design of an efficient model with minimum cost on computational resources by modifying and enhancing existing architectures such as MobileNet, YOLO versions etc. Additionally, the training procedure will be focused on specific objects that requires to be recognised within the scope of the TREEADS objectives and using public dataset also for an initial evaluation. The embedded processing device will be intricately connected to the visual source and will instantly collect and process the visual data by the deep learning model for the object detection task. Finally, research will also focus on the combination of both shallow and deep representation of visual features in order to extract an accurate and low computational cost recognition outcome.
Fire and smoke propagation forecasting		
Forest fire spread simulation	USAL	Near real-time simulation of wildfire with a physical wildfire spread model based on principles of energy and mass conservation. The model also takes into account the heat lost by natural convection, the effect of the flame tilt by wind or slope over the heat transfer and the influence of fuel moisture content and fuel type. It provides the burned area, the position and depth of the fire front and it is ready to incorporate updated meteorological data during the simulation process, as well as the effect of firefighters works. During the evolution of a forest fire, simulation can be used as a tool to support the complex process of decision-making, as well as to make an ex-post analysis. Combination of experimental and numerical investigation will be used to understand the

		fire behavior of vegetation, especially for fires moving in the ground. Experiments of specimens of forest and grassland ground specimens with a variation of parameters is the basis for detailed modelling of the mechanisms. Small and mediums scale experiments are the basis to develop a numerical model capable of predicting the fire propagation. The large-scale experiments will be used to validate the numerical models.
Wind field model	USAL	Numerical simulation of the wind for the computational simulation of the spread of forest fires with the development of machine learning (PINN) models. These models also incorporate knowledge about vegetations and environmental conditions. Furthermore, the extension of the machine learning methods to predict fire spread in the ground and the incorporation of experimental data will lead to obtain more accurate predictions. Comparison of TREEADS models to traditional physical models will evaluate their aptness for real-time predictions.
Atmospheric pollutants dispersion model	USAL	Forecasting simulation of fire smoke cloud dispersion Precision and computational cost are improved by parallel computing techniques, keeping computation time below real time of simulation.
Analysis of Fire Behavior and Spread for the Development of Safety Measures	OVGU BAM	In this model, combination of experimental and numerical investigation will be used to understand the fire behavior of vegetation, especially for fires moving in the ground. Experiments of specimens of forest and grassland ground specimens with a variation of parameters is the basis for detailed modelling of the mechanisms. Small and mediums scale experiments are the basis to develop a numerical model capable of predicting the fire propagation. The large-scale experiments will be used to validate the numerical models.
Fire emergency management		
Infrastructures fire emergency management strategy	STRESS LTP: Tecnosistem	Fire emergency systems in railway tunnels or underground stations are generally designed with the support of thermo-fluid dynamic simulations capable of highlighting the evolution of smoke diffusion, temperatures, toxic species and livability, so as to optimize the sizing, the management strategy of these systems and the emergency procedures. This design process generally requires as input a typical fire curve of the rolling stock (Heat Release Rate Curve - HRR Curve), often estimated by the manufacturer, not depending on the operating conditions. This approach is unsatisfactory when the fire ignition, or the source of smoke diffusion, can be external, as in this case, where the cable car layout develops in a very dense wooded area. The proposed approach is based on the integration of data from fire modelling services (developed in the project) to provide inputs for the fire load distribution, the fire propagation and smoke diffusion, the characteristics of different materials and ignition temperature. Furthermore, the design process will be integrated by simulation tools of pedestrian movement and evacuation, with single agent passenger behaviour modeling, so as to verify the effect of innovative systems and procedures on a wide range of non-standard emergency scenarios.
TREEADS Personal monitoring and protective equipment for emergency responders		
AR helmet	8bells	The system will overlay data such as locations of individual firefighters for better coordination in situations of low visibility, real-time temperature readings via embedded helmet sensors, real-time command visualization from the centre of operations, a map view of the area with the location of each firefighter and fire fighting vehicle overlayed etc. The system will allow multi-modal interaction with sensors. For example, the user will be able to add, remove, move real/virtual objects and manipulate them multi-modally, either using speech commands or via augmented gesture control receiving natural tactile feedback provided in the mid-air using ultrasonic technologies. In addition to that, using such an AR system will allow the field operators to identify dangerous

		locations and optimize the course of action in order to combat the wildfire effectively. The system would also permit an easy recording of data on the spot, such recordings could be used to make simulations and to train firefighters in wildfire fighting. Finally, the 5G capabilities of the helmet will allow visual feedback from the decision support system situated at the center of operations in real time.
5G Portable Communication System	8bells	The design and implementation of a 5G Portable Communication System (PCS) will be based on an integrated, light-weight, ruggedized physical platform capable of being shipped to the disaster area. The aim is to deploy the necessary wireless network infrastructure and establish the telecommunication ecosystem between UxVs, and Firefighters at 5G (next-generation) performance level. PCS will push innovation towards incorporating all network equipment components into an all-inclusive portable station capable to support the communication needs of Firefighters completely autonomously (i.e., without the need for connecting to external network infrastructures), at any location and environmental condition. PCS will also enable Multi-access Edge Computing (MEC) with network slicing moving all resource-demanded computations from the mobile devices of Firefighters to the portable station, so as, the Firefighters' devices will never become overloaded but keep their resources free and ready to react rapidly to any kind of AR/MR mission-critical projections and/or voice/video communications.
X/BELLO instant messaging	8bells	X / BELLO is a VoIP and instant messaging (IM) application that supports voice chat, real-time video calling, and multimedia sending over the Internet. It will also support secure integration of innovative multimedia applications with smart devices and sensors, AR devices, smartwatches and flexible displays.
ICT tools for detection and response		
Data Format Fusion Mechanism	8bells	In order to be protected, First Responders (FRs) in emergency environments carry toolkits based on wearables, communication and location components, sensors and accessories that offer augmented reality functions. The fusion of all available information among FRs and the public safety agencies is a necessity for developing an advanced C3 (Command, Control & Coordination) that with mobile applications, improve coordination and collaboration among all response units. Data Format Fusion Mechanism is a middleware platform that produces a JSON file with coherent and harmonized data. The process gathers input from different sensor technologies and through an API. It performs data storage, parsing, homogeneity and harmonisation in order to produce consistent, accurate, homogenous data. The produced data are secured and GDPR compliant and are available through an application API to the different interfaces
Accurate Forest Mapping	USAL	Image Spectrometry and LiDAR Forest Scanning will be used for accurate forest mapping, which provides info about plant and tree species and their physical characteristics (e.g. fuel, height, biomass). Also, will be used for the creation of a digital twin of the forest and its interaction along with the three main phases of a fire (pre-fire, active fire and post-fire). High-quality 3D models of plants and trees can offer new possibilities to analyse the complex interactions of fire, plants and trees
Social media collection and analysis	CERTH	Collection and analysis of crowd-sourced information, i.e. social media posts that are published by citizens and refer to fire incidents. Social media data can also be fused with other sources of information, e.g. Earth Observation data, in order to better assess an event's severity level
Forrest black box	8bells	A system that consists of a multitude of low-cost IoT platforms consisting of sensors strategically spread in the forest which will be able to monitor nearby flammable gas and smoke emissions (such as LPG), local temperature and humidity, capture images and sounds and detect movement. Taking into account the limited telecommunication coverage of such remote areas, the IoT platforms will form a communication grid based on the LoRa protocol and transmit the collected data to a centralized storage and processing device called Forest Black Box (FBB). Part of the FBB functionality will be to overlay the collected information on

		a 2D representation of the area, thus allowing the firefighters to know the exact location of the measured events. During the wildfire, the firefighters reaching the FBB will be able to download the collected information, adjust and therefore optimize their course of action. Some indicative examples include: The efficient control of fire, such as building trenches in locations of Ground fires, request for aerial support and use of fire-retardant chemicals in case of crown fire escalation, prioritization of resources for rescuing operations in case of hikers in the area (according to their location), etc.
Restoration and Adaptation		
Pre-fire status model of any forest for accurate Post-Fire Restoration		TREEADS will utilise pre-fire data stemming from a variety of data sources in order to improve First Order Fire Effects Model (FOFEM) software, and compared their performance to locally-parameterized models based on five different forms. Also TREEADS will enhance current post-fire tree mortality models for assisting forest land managers to predict fire effects, estimate delayed mortality and develop. site-specific. management prescriptions taking into account environmental, socio economic and biodiversity indicators
Agroforestry for Restoration		Agroforestry techniques for ecological restoration by using methods from agroforestry including rotational grazing of livestock and recycling forest waste into biochar. It is well known that healthy forest ecosystems produce and conserve soil, stabilise stream flows and water runoff, and host a huge array of wildlife. TREEADS will enable though the animal evacuation plan in the pre-forest phase the grazing of livestock that will churn up the soil, spread manure and seeds. The returned animals will be able to re-enter the fire area after they are feed with specific Internet of things feeders able to restore the soil back to a fertile state
Reforestation/ Drones for Agriculture - using SCC for aerial mass releases	GBD, ACCELI, LAMMC	An innovative capsule with top efficiency that is capable of making the transition from drone to the soil in order to ensure the growth of the seedling. The capsule must contain a space for fertilizers and be manufactured with special material composition to provide the seedling with the right nutrients. Furthermore, the decomposition process of the SCC must be precisely adjusted to support the natural growth of the tree roots. For this reason, we work closely with providers that can customize the biopolymers to these needs. Furthermore, the geometry and functioning of the capsule must be in accordance with the requirements of the drone system. The technical developments of the SCC will be always made in coordination with those responsible for the drone system in order to achieve the overall solution as efficiently and innovative as possible.
Restoration of ecological balance - using Bioclip release principles	GBD	The main role of bioclip is to provide a release device that ensures the success of the restoration of the ecological balance. with a keen on beneficial insects who protect the seedlings from plant predators. The device enables to reinsert the lost populations of insects and other microorganisms in the fields and provides a safe housing against any external threat such as heavy rains or direct sun insulation. As no natural protection will exist at the burned area, it is the perfect container to introduce vulnerable insects that will help the vegetation establishment.
Preparation of bio-material for post-fire bioremediation and re-vegetation trails	LAMMC	Development of bio-material units (e.g., seed-balls) that include plant propagation material (seeds), microbial inoculants, soil and nutrients.
DSS restoration module	UdG	1. Development of a protocol for the use of remote sensing with drones for an immediate postfire environmental assessment of burned areas (BA). 2. Collection of data about fire severity and environmental vulnerability in BA, both at soil and vegetation levels , combining ground-level sensors, fieldwork, satellite data and remote sensing from step 1.

		3. Mapping of fire refuges for biodiversity in BA using remote sensing after fire 4. Extraction of maps for early postfire management with recommended interventions. 5. Adaptation of the corresponding management model. Main sources of information in the mid-term will be soil properties, vegetation regeneration, animal biodiversity, socioeconomic variables. 6. Consisting in the development and suitable explanation of accessible methodology to sample fauna indicators for the monitoring of biodiversity in fire-prone and recently burned areas. 7. Consisting in the use of remotely piloted aircraft system thermal imaging (RPAS) to sample mammals. Thermal signatures of animals in recently burnt areas will be used to get information about their spatial use, movement and spatial behaviour.
Interoperability Environment for Rescue and Logistics Processes using ISO standards	JOTNE	Processes using ISO standards (JOTNE). This module will open up existing systems by adopting information models based on open, international and public available standards like ISO 10303 that have been proven successful in Aeronautics, Space and Defense industries. This module will deliver: • A coherent & consistent approach to the logistics process; • Effective & efficient systems engineering processes; • Software interoperability through the use of open, neutral standards; • Modelling & simulation supporting the overall rescue process. It is envisioned that fire brigades will be able to reuse their existing logistics footprint to do detailed analyses of availability of equipment's trucks, aircrafts, and people to sustain long-term operations. Further, the module will allow cross region/border collaborations of this data including access to sensor data
Space and aerial means – relevant to all phases		
UAV Deployable Air Command and Control	Altran	The Command and Control System represents the main interface for the end users, allowing the definition and planning of field operations, as well as monitoring and managing these operations. The CCS Communication Manager, associated to a distributed communication infrastructure, allows secure, robust communication with UAVs and other aerial means, deployed on the field, used both for control and monitoring purposes, as well as allowing the live collection of raw and pre-processed data from all platforms. TREEADS will use Telemetry systems to collect system information, such as operational status, location, orientation, battery level and service history. It will also provide usage analytics to develop best practices, optimise agents' usage and incident analytics.
SAIA: Low altitude UAV - Mission drones	Acceli	SAITA is a next generation drone, able to lift up to 15 kg of payload, provided by ACCELI. Due to its optimized design, it has an extended flight time of up to 30 minutes, which is a substantial advantage when compared to conventional models currently available in the market, and a high precision localization of 1cm using GPS-RTK2. In addition, SAITA will provide a separate onboard computer with a GPU, running the latest version of ROS (Melodic). This configuration is ideal for running complex Artificial Intelligence algorithms, which makes SAITU the ideal drone for complex tasks such as event detection, object detection/counting and collision avoidance. The flight controller of SAITU is based on the open-source ArduPilot and is wrapped around ROS standard software, being fully integrated with the DDS standard, immediately addressing the needs of thousands of applications that require real-time data exchange, in sectors like precision farming, aerospace and defense, autonomous vehicles, smart grid management, transportation systems, among many others. SAITU also provides out-of-the-box full integration of ROS with multispectral cameras, and high-resolution cameras.

Medium Altitude UAV – Heavy Payloads	Wildhopper	Current aerial means used on firefighting have several drawbacks. Hydroplanes are quite expensive and have operational limitations to release the water, losing precision and therefore efficiency. Helicopters carry less water and their downwash negatively affect the fire. Consequently, they need to release from higher altitude above the ground. Also, their operation involves high risk for the pilots and are not allowed to operate at night in most countries. WILDHOPPER platform offers a distinctive tool to firefighter directors. With a 600-liter capacity water tank, it can release the water in a very precise and efficient way using its patented water nebulization system. It can also enable night operations and avoid the pilots to take risks. The capability to create firewalls in a fast, dynamic, low-cots solution is deemed as a game changer in managing big fires
High Altitude Airship Prototype (Zeppelin)	Altran	The airship under development by Altran together with the proper payload is suitable to be part of an integrated Fire Management Strategy in different missions and scenarios for the 3 fire management phases, with these potential applications (some of them are out of the scope of TREEADS. See "Ambition" and "Implementation" for more detail.):High resolution multispectral aerial imagery of wide areas for fire danger forecast and surveillance, by monitoring moisture content of the biomass, for example. • Satellite communication link for coordination with Copernicus EFFIS • Using infrared cameras for fast fire detection with higher spatial resolution than that from space instruments. • High resolution video cameras and a communication hub for better firefighting coordination (high bandwidth and low latency communication link with UAVs and ground assets). • Long lasting monitoring of wide areas for better evaluation of post-fire restoration and nature-based solutions • Support for monitoring of restoring biodiversity and geospatial analysis. High data rate communications such as (i) Microwave backhaul to communicate with a ground station, (ii)VSAT link for communications via satellite, (iii) 4G/5G to access commercial ground networks
Artificial Intelligence for mission planning & swarm coordination	CERTH	Will exploit fused and raw real-time data towards producing usable knowledge and cognition that will be leveraged in order to establish a fully autonomous action controller for all the surveying assets (eg. UAVs, Airships, cameras on site etc.). Based on the embedded machine learning algorithm, this module will be able to periodically re calibrate a certain set of parameters outlining the navigation control strategy adopted at each given instance. The aforementioned have as an ultimate goal to provide an increased situational awareness to the corresponding authorities, assist to fully utilizing the assets available and remove human error from making decisions under pressure and any possible delays. Summarily, we see that such contributions may benefit all the aspects of the TREEADS via three well defined tools: • Path Planning for Fire Prevention and Damage Estimation/Restoration: • Resource Management System for Optimal Situational Awareness During the Fire • Decision Support System for Optimal Guidance of the Fire Suppression Units

TREEADS

A Holistic Fire Management Ecosystem for Prevention, Detection and Restoration of Environmental Disasters

The Members of the TREEADS Consortium:

Short Name	Country	Short Name	Country	Short Name	Country
FRN	NO	**INNOV**	CY	**DCNA**	AT
Jotne	NO	**FI**	EL	**IFR**	AT
BAM	DE	**GBD**	BE	**FF GPK**	AT
CAPGEMINI	ES	**EFB**	EL	**DdA**	ES
LAMMC	LT	**STRESS**	IT	**ACaMIR**	IT
USAL	ES	**OS**	DE	**Sorrento**	IT
SQD	BE	**VIPO**	NO	**PUI**	FR
CARTIF	ES	**WAS**	NO	**FAFCYLE**	ES
UdG	ES	**CBS**	DK	**BFG**	AT
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SIMAVI	RO	**MAGG**	IT	**MAICh**	EL
OVGU	DE	**NOA**	EL	**NTUST**	TW
ADRESTIA	EL	**MEWF**	RO	**DTU**	DK
CERTH	EL	**ASFOR**	RO	**DH**	ES
8BELLS	CY	**SMURD**	RO	**DAAC**	EL
ACCELI	CY	**JOAFG**	AT		

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