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

TREEADS D3.2 Report on Organizational Structural and Sociotechnical factors

Work package	WP3: Organisational, Structural, and Sociotechnical Factors for DRYADS Ecosystem Building and modular approach
Task	3.1: Ecological and environmental Models of Wildfires 3.2: TREEADS Governance and parametric Insurance Models and Guidelines 3.3: Building Strong Networks and Liaisons empowering behavioural change of citizens, local authorities, businesses and schools, Co-Creation Thinktank and clustering for European wildfire landscape 3.4: Innovation Watch, Cross-Fertilisation, and Foresight Exercises 3.5: Pan-European Fire Management Platforms: Standards and Interoperability
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GLOSSARY OF TERMS

Term	Description
TREEADS Platform	Toolbox of technologies to advance stakeholder capabilities for before, during and after extreme fire events. The toolbox will be available at TREEDS platform.
TREEADS Ecosystem	Sustainable and holistic wildfire management ecosystem.
Wildfire management stakeholder	Actors who affect or are affected by wildfires.

LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Meaning
AAM	Alkali-Activated Materials
AFDL	Automated fire detection and localization
AR	Augmented reality
CBS	Copenhagen Business School
CEN	European Committee for Standardization
CENELEC	European Electrotechnical Committee for Standardization
CNN	Convolutional neural networks
CWPP	Community Wildfire Protection Plans
DTU	Technical University of Denmark
EFFIS	European Forest Fire Information System
EFFO	European Forest Fire Observatory
EUCPM	European Union Civil Protection Mechanism
EUWFN	European Wildland Fire Network
GA	Grant agreement
IAWF	International Association of Wildland Fire
IEC	International Electrotechnical Commission
IoT	Internet of things
ISO	International Organisation of Standardization
KET	Key Emerging Technologies
LBS	Location based system
NWCG	National Wildfire Coordinating Group
NGO	Non-governmental organisation

OPC	Ordinary Portland Cement
PWAs	Post-wildfire Wood Ashes
R&D	Research and development
RDSS	Radio Determination Satellite Service
RNSS	Radio Navigation Satellite Service
STI	Science Technology and Innovation
TRV	Technology Readiness Levels
UAV	Unmanned aerial vehicle
UNISDR	United Nations International Strategy for Disaster Reduction
VIT	Vision transformers
VR	Virtual reality
WA	Wood Ashes
WCG	Wildfire Coordinating Group
WP	Work Package

EXECUTIVE SUMMARY

PRESENTATION

TREEADS is a large-scale EU Green Deal project that brings together a consortium of 46 partners from 13 European countries and Taiwan in the fight against wildfires. The project will increase the effectiveness of enhanced sustainable fire and forest management under changing climate conditions by building upon state-of-the-art high Technological Readiness Level (TRL) products and the latest innovations in fields covering all three stages of fire management: prevention and preparedness, detection and response, restoration, and adaptation - and uniting them under the umbrella of a holistic Fire Management Platform Ecosystem. TREEADS will capitalize on expert knowledge and EU initiatives but also address the need for proactive governance, change of forest management practices, community-based awareness, and preparedness activities, where local communities and bio-economy sectors will play a central role.

Deliverable 3.2 conveys the results of the TREEADS project efforts under Work Package 3 (WP3), covering the work performed in tasks 3.1 3.2, 3.3, 3.4 and 3.5 between months 1 and 13. The main objective under WP3 is to identify and develop the organizational, structural, and sociotechnical factors for TREEADS Ecosystem. The approach is developed in two complementing components. The first aims to identify and validate parameters for the TREEADS Platform, ensuring that its design addresses stakeholders' needs across different phases of wildfire management. The second aims to design and establish the vision, concepts, and process of the TREEADS Ecosystem governance model.

During the period covered by this report, WP3 activities were structured around the following efforts:

- Consultation of all relevant stakeholders to identify the optimal form of wildfire risk governance and their economic and probabilistic insurance models.
- Literature review on Stakeholder engagement in wildfire management.
- Identification and categorization of local stakeholders engaged in the eight pilots of the project, including a preliminary mapping of issues that motivate their engagement.
- Literature review on technology, innovation, and trends in wildfire management. The research supports the development of a framework to understand which technologies are available at each stage of wildfire management according to the stakeholders engaged.
- Literature review on Alkali-Activated Materials (AAMs) manufactured using Wood Ashes (WAs) or Post-wildfire Wood Ashes (PWAs) as precursors or activators and cement-based materials manufactured using WAs or PWAs as partial Ordinary Portland Cement (OPC) replacement
- Identification of relevant existing standards to implement as part of the TREEADS Platform, and leveraging of these results to contribute to ongoing and future pre-normative activities of appropriate standardisation bodies

These products' current status and corresponding results are presented in this live report. For the upcoming months, the activities will focus on finalizing the literature

reviews and conducting the next steps of the stakeholder analysis process, moving from identifying and categorizing stakeholders to mapping the relationships between them and how they will shape the governance and think-tank objectives. These analysis results will set parameters for the local pilot and Pan-European levels of the TREEADS Platform stakeholder engagement process.

MAIN ACTIVITIES IN THE PERIOD

The activities in the period were related to tasks 3.2, 3.3, 3.4 and 3.5.

- Task 3.1 - Ecological and environmental Models of Wildfires
  - K3Y collected data on the ecological and environmental wildfire-related services in various EU member states involved in the TREEADS large-scale piloting activities. The collected data helped to understand the environmental factors that influence the provision of these services and how they interact with technological and other resources. This information was then used to support the activities of professionals and other actors through the development and use of the TREEADS Platform. These findings were also incorporated into Deliverable 3.1 (D3.1), which was successfully submitted. Additionally, the task employs a series of surveys throughout the project's duration to update the action plan based on updated ecological and environmental models. The first survey was successfully created, translated to each pilot country's language, and is being distributed as part of D3.8. The rest of the surveys will be developed in the context of Task 3.1 and will be included and discussed in D3.9 and D3.10.
- Task 3.2 - TREEADS Governance and parametric Insurance Models and Guidelines
  - DTU's activities focus on developing economic and probabilistic insurance models, including the consultation of all relevant stakeholders to identify the optimal form of wildfire risk governance.
- Task 3.3 - Building Strong Networks and Liaisons empowering behavioural change of citizens, local authorities, businesses and schools, Co-Creation, Think-Tank and clustering for European wildfire landscape
  - A literature review on stakeholder involvement in wildfire management served as the starting point for task 3.3. A preliminary analysis of the key findings was conducted and reported in the current report.
  - CBS also created a template in which project partners were asked to provide existing contacts of stakeholders involved in the pilot areas.
  - The team prepared the material for the training workshops based on these two sets of data (literature review and stakeholder list). In September 2022, CBS held eight (8) sessions with the pilots to introduce them to the activities they would have to conduct later with local stakeholders.

  - Following the training sessions with the pilot partners, CBS assisted them with organizing local workshops and even participated in a few, either physically (Greek workshop) or virtually (Spanish, Norwegian, and Austrian).
  - After all of the workshops in the pilot regions were completed, CBS collected the results and conducted a thorough analysis, which is presented in this report.

- Task 3.4 - Innovation Watch, Cross-Fertilisation, and Foresight Exercises
  - CBS also conducted a literature review on wildfire management Technologies, Innovation, and Trends for task 3.4. This report provides an overview of the review.
  - Report on this task also includes updates on the literature review conducted by RINA Consulting (linked third party of STRESS) on the possibility to reuse Alkali-Activated Materials (AAMs) manufactured using Wood Ashes (WAs). The review also includes analysis performed on cement-based materials manufactured using WAs or PWAs as partial Ordinary Portland Cement (OPC) replacement.
- Task 3.5 - Pan-European Fire Management Platforms: Standards and Interoperability
  - K3Y identified relevant existing standards to implement as part of the TREEADS Platform and leveraged these results to contribute to ongoing and future pre-normative activities of appropriate standardisation bodies. The task mapped current and relevant standards and common ontologies for the interoperability of fire management systems across EU member states in use by digital solutions and technologies. Additionally, the task addressed future needs by identifying standardisation gaps, needs, and opportunities within the scope of TREEADS project and formulated recommendations for new work items on simple integration and interoperability approaches. The results of Task 3.5 will be incorporated into D3.8, D3.9 and D3.10.

MAIN RESULTS IN THE PERIOD

The efforts in WP3 conducted between months 1 and 12 resulted in a series of relevant developments. The highlights of the period are:

- Development of a preliminary version of the stakeholder engagement literature review. The research will inform the next steps of the TREEADS Platform development and the strategy of the local-level engagement processes.
- The first stage of stakeholders' analysis includes a preliminary mapping of issues that motivate their engagement. The key points of the current analysis are:
  - The TREEADS Platform engages a diverse profile of stakeholders across different sectors and levels. The diversity indicates the potential of the TREEADS Platform to work as a hub to coordinate actors through frameworks and processes that enable a holistic approach to wildfire prevention and management.

  - The current profile of stakeholders is concentrated on local governments and research institutions/universities indicating the potential of the platform to bridge the gap between research and practice, particularly in the prevention and preparedness phase.
  - The TREEADS Platform needs to expand the number of first response actors directly involved in the development. These actors offer critical inputs for the platform design and can contribute decisively to the success of the solutions designed.
  - The number of actors representing user groups in the pilot areas currently involved is also limited. While their contribution may be limited to targeted consultations during the TREEADS development, they are one of the key stakeholders in the dissemination and use of the platform's solutions.
  - Actors engaged with wildfire management at the local level have a strong demand for solutions. The main concerns are improving prevention & preparedness capacity to minimize the risk of occurrence, and to develop effective response mechanisms in cases where wildfires occur.
  - The diversity of issues identified locally corroborates the understanding of wildfires as complex problems with multiple causes and systemic impacts. This understanding poses a relevant challenge to the TREEADS Platform to prioritize approaches in its development process.
  - Demand for solutions in the restoration & adaptation phases is limited.

- Preliminary version of the Technology, Innovation and Trends literature review. The results of the research will support the TREEADS Platform development by building a framework to understand which technologies are available at each stage of wildfire management according to the potential stakeholders engaged.
- Literature review on Alkali-Activated Materials (AAMs) manufactured using Wood Ashes (WAs) or Post-wildfire Wood Ashes (PWAs) as precursors or activators, and cement-based materials manufactured using WAs or PWAs as partial Ordinary Portland Cement (OPC) replacement.

SECTION 1: INTRODUCTION

OBJECTIVES

The TREEADS project aims to build a holistic Fire Management platform to optimize Socio-technological resources to address Wildfires. The initiative is developed by a consortium of partners coordinating its work across nine work packages, building solutions covering the three phases of Wildfire management: prevention & preparedness, detection & response, and restoration & adaptation.

The main objective under WP3 is to identify and develop the organizational, structural, and sociotechnical factors for TREEADS Ecosystem. The approach is developed in two complementing components. The first aims to identify and validate parameters for the TREEADS Platform, ensuring that its design addresses stakeholders' needs across different phases of wildfire management. These efforts are developed in close collaboration with the project partners and each of the eight pilots and dialogue with context-specific and pan-European policies. The second component aims to design and establish the vision, concepts, and process of the TREEADS Ecosystem governance model.

Both efforts are developed in close collaboration with project partners and wildfire management stakeholders in the European Union and Taiwan. From the bottom up, the research and development effort work with the pilots to identify the main stakeholders of wildfire management – including, but not limited to, individuals, community, first responders, industrial and commercial providers, and policy-makers – and their needs and requirements in a participatory, holistic approach. From the top down, the research effort is focused on refining the TREEADS Ecosystem vision and concepts through an in-depth literature review on the current state-of-the-art of research on the stakeholder engagement, and techniques and technologies available across the three phases of wildfire management.

The knowledge built in these two components will be consolidated in the platform design, ensuring the effectiveness of the effort and the platform's sustainability after the project's end. The results of this ongoing work are consolidated in the live documents. For the first version of the document, the results were presented according to each task's development. From the bottom-up, the current development is focused on the results of the first stakeholder engagement workshops, identifying the profile of the key stakeholders involved in each workshop and the main issues mapped. From the top-down, the live report presents the working versions of two different pieces of literature—the literature on stakeholder engagement and the literature reviews on technologies and innovation in wildfire management. The results of these reviews will feed into the platform design, guidelines, and concepts fostering a shared understanding of its vision.

PURPOSE AND SCOPE

The purpose of this deliverable is to present the activities and the current results of the Work Package 3 (WP3) activities between months 1 and 12 (M1-M12) regarding the following tasks:

- Task 3.1 - Ecological and environmental Models of Wildfires

K3Y activities in the period focused on gathering data on the ecological and environmental wildfire-related services in various EU member states involved in the TREEADS large-scale piloting activities.

- Task 3.2 - TREEADS Governance and parametric Insurance Models and Guidelines

DTU's activities focus on developing economic and probabilistic insurance models, including the consultation of all relevant stakeholders to identify the optimal form of wildfire risk governance.

- Task 3.3 - Building Strong Networks and Liaisons empowering behavioural change of citizens, local authorities, businesses and schools, Co-Creation Thinktank and clustering for European wildfire landscape

Task coordinated by CBS. The report presents the activities and the results of the stakeholder analysis performed with inputs from stakeholder engagement workshops conducted by each of the eight pilots. As a first step in the TREEADS Platform development, the report identifies and analyses the key stakeholders and the pressing issues for each pilot. These tasks report also presents updates on the literature review on stakeholder engagement in the three phases of wildfire management. The overview of the topic presented in this live document will be updated, revised, and prepared for publishing in the coming months.

- Task 3.4 - Innovation Watch, Cross-Fertilisation, and Foresight Exercises

Task coordinated by CBS. The report includes updates on the activities and an overview of the current results of the Literature review on technologies, innovation, and trends in wildfire management. The current analysis identifies how the current technological solutions meet the TREEADS stakeholders' priorities, preventing unnecessary duplications with activities developed by other work packages in the project. The overview of the topic presented in this live document will be updated, revised, and prepared for publishing in the coming months.

This report also includes updates on the literature review conducted by RINA Consulting (linked third party of STRESS) on the possibility to reuse of Alkali-Activated Materials (AAMs) manufactured using Wood Ashes (WAs). Cement-based materials manufactured using WAs or PWAs as partial Ordinary Portland Cement (OPC) replacements are also reviewed.

- Task 3.5 - Pan-European Fire Management Platforms: Standards and Interoperability

Task coordinated by K3Y focus on identifying relevant existing standards to implement as part of the TREEADS Platform and leveraged these results to contribute to ongoing and future pre-normative activities of appropriate standardisation bodies.

RELATION WITH OTHER WPS AND TASKS

This deliverable is related to the following WPs and Tasks, as based on the Grand Agreement (GA):

- WP2 Task 2.2- Europe-wide geographical and socio-economic conditions and contexts in wildfires: results from this deliverable feed into Handbook and methodology produced in task 2.2.
- WP 2Task 2.6: Holistic Management systems and resource re-utilization Requirements: Validation of the TREEADS Platform by stakeholders.
- WP4 T4.1: TREEADS Socio-technological toolset for secure incident-management, decision-making, and communication: The results presented in D3.2 will feed into the activities of T4.1.
- WP8 Tasks 8.1-8.9: TREEADS Pan-European Pilot Campaign. The live document results and its following iterations will support all pilot cases with stakeholder engagement in their activities throughout the project.

STRUCTURE OF THE DELIVERABLE

This report is structured as follows:

Section 1: Introduction: This section provides an introduction to the deliverable, which covers both the organizational. structural and sociotechnical factors including Insurance models, standards, Interoperability and Pan-European Initiatives in Policy and guidelines.

Section 2: “Organizational Structural and Sociotechnical Factors” presents the progress of Task 3.2 under sub-section “TREEADS governance and parametric insurance models and guidelines”; and Task 3. 3, under subsections “Literature review on stakeholder engagement in wildfire management” and “Stakeholder engagement Actions: Stakeholder engagement in the pilot areas”.

Section 3: “Standards, interoperability and pan-European initiatives in policy and guidelines” presents progress related to task 3. 4, under sub sections “Innovation Watch, Cross-Fertilisation, and Foresight Exercises: Literature review on Technologies, Trends, and innovations in wildfire management” and “Innovation Watch, Cross-Fertilisation, and Foresight Exercises: Wood Ashes (WAs) or Post-wildfire Wood Ashes (PWAs)” and tasks 3.1 and 3.5, under sub-section “Review conclusions and implications Pan-European platforms: standards and interoperability”.

Section 4: “Conclusion”, concludes the report presenting the main takeaways and the next steps in WP3.

SECTION 2: ORGANIZATIONAL STRUCTURAL AND SOCIOTECHNICAL FACTORS

TREEADS GOVERNANCE AND PARAMETRIC INSURANCE MODELS AND GUIDELINES

CONTEXT AND OBJECTIVES

In the last few decades, the likelihood and severity of wildfires has increased across Europe. A wildfire event can have significant social, ecological, and economic impacts. Estimating the associated wildfire costs is of paramount importance for good pre and post wildfire management. However, the true costs of such events are still underestimated.

This task involves the consultation of relevant stakeholders, in particular individual, community and first responders representatives, industrial and commercial providers, and policy-makers - to support the identification of optimal forms of wildfire risk governance, in particular with respect to risk transfer solutions like insurance products.

The task leverages the catastrophe risk estimation knowledge within TREEADS to estimate the physical damage and economic losses arising from wildfire activity. Merging novel components derived from the TREEADS fire modelling and innovative observational systems with open data sources, the task aims to develop a state-of-the-art impact and risk modelling procedure compliant with insurance sector standards (i.e., an "insurance assistant module") for assessing the physical damages and economic risks related to forest fires in economic terms for both past (forensic analyses), present (emergencies, prevention) and future (adaptation) climate conditions upon request. This will enable relevant stakeholders to identify and evaluate different risk management approaches including the input of the insurance companies like cost of capital and operational costs. Wildfire insurance solutions and other potential alternative or complementary risk transfer options will be addressed here, as informed by the risk assessment process considering all the above info. This may include identification of best practices for implementing a mechanism for renegotiating the insurance coverage and premiums based on the wildfire readiness level, e.g., TREEADS Fire index factor status. Such renegotiation could be automatic if an appropriate API was provided from the associated insurance company or via a (authorised) human by delivering all the relevant information needed to renegotiate the fees or the coverage plan.

The model interface will be GIS-enabled and fully compliant with the TREEADS forest fire management system and made available to all case studies. Upon analysis of, and engagement with, relevant insurance companies and stakeholders, the results of the risk assessment could inform the definition of appropriate insurance and risk transfer solutions, e.g., well-defined premiums for different levels of wildfire readiness. This could include parametric insurance, which will be hypothesized and prototyped together with stakeholders based on the abovementioned TREEADS impact and risk-modelling

framework. The use of open-source data and tools will increase transparency and also encourage the implementation of wildfire risk mitigation solution.

ACTIVITIES DEVELOPED IN THE PERIOD

The current focus of this task has been on preliminary literature reviews, connecting with the different pilots and based thereon scoping the development of the abovementioned impact and risk modelling procedure.

- The task has so far particularly been linked to the Spanish, Italian and Greek pilots, where it will for example contribute fire/loss modelling to the pilot narratives, which was indicated as a need at the stakeholder meetings. All three pilots exhibit a broad group of stakeholders and has a deep availability of data and compatible technologies that will be synergetic with the implementation of Task 3.2.
- So far, the key sectors / domains identified in the pilots have been natural values / ecosystem services, tourism, buildings, cities, and forestry and to a smaller extent: transport.
- Initial contacts have been made with several insurance sector experts (Gennillard & Co., Munich Re, Forest Re).
- The revised role(s) of the insurance and risk transfer module with respect to the TREEADS ecosystem was elaborated in Deliverable 3.5 together with USAL. Task 3.2 will be in line with other TREEADS technology modules and placed under RESTORATION tools.
- The open source ForeFire model has been tested as means of providing decadal-scale fire spread modelling to complement existing TREEADS activities.

Preliminary findings validated that there is a need for developing a methodology to estimate the costs of wildfires that take in consideration different territories with different land structures. For this purpose, it is first necessary to understand the associated wildfire costs, which will be done through an extended literature review and data collection in the coming period. Here, we need to determine the structure and composition of the database that will allow estimating the surveyed variables and that can provide consistent information in the econometric modelling of socioeconomic and environment costs.

Another point is that there is a need for advancing the spatial-temporal determination of wildfire risk in probabilistic terms, which is also partially addressed in WP4. The integration of this knowledge with socioeconomic and environmental costs estimation can help immensely with a decision support system and help to implement different policies for wildfire management.

Lastly, it was highlighted by the pilots that information provided by the task will be useful as means of creating a more inclusive and collaborative governance, since this information is essential to deal with complex event. It could serve as a base for developing an anticipatory governance that is based on the capacity to integrate uncertainty into decisions. The use of a scenarios analyses can help decision makers and communities to prepare for different futures outcomes. This is also true in terms of risk

governance, where the link between science and society build legitimacy for actions to address wildfire risk (Miller et al., 2022).

Lastly, the design of a wildfire cost model and the spatial-temporal risk probability will allow improvements in the operation of the insurance market, that can set a more accurate risk-based price. The insurance market is seen here as an important economic policy tool, that's it not only for cover the damages but also as instrument to manage risk. However, in addition to the necessary regulations to deal with the inherent market imperfections of the insurance market, disaster insurance markets may have extra challenges, due to the character not always predictable of a natural disaster and the scale of the event. Thus, the information acquired in the model proposed here serves as a basis for designing a more stable insurance market. By communicating this information to homeowners could also help address misperception of risk by signalling the expected benefits of insurance (Wagner, 2022).

NEXT STEPS

For the coming period, task 3.2 will focus on

- Further engagement with, in particular, the Greek, Spanish and Italian Pilots.
- Further literature review and collection of data. In particular, review of cost estimation models, their variables and calculation methods.
- Implementing the first pilot version of a generic wildfire cost model.
- Explorative risk assessments applied to cases, combining wildfire hazard and cost modelling while considering selected preventive measures.

STAKEHOLDER ENGAGEMENT TOWARDS BUILDING STRONG NETWORKS AND LIAISONS EMPOWERING BEHAVIOURAL CHANGE OF CITIZENS, LOCAL AUTHORITIES, BUSINESSES AND SCHOOLS, CO-CREATION THINKTANK AND CLUSTERING FOR EUROPEAN WILDFIRE LANDSCAPE: LITERATURE REVIEW ON STAKEHOLDER ENGAGEMENT IN WILDFIRE MANAGEMENT

BACKGROUND

Large-scale, high-severity wildfires can pose a significant threat to the "social-ecological sustainability" of forest ecosystems worldwide in the future. Wildfire management is a "collective action problem" that requires strong coordination among stakeholders (Charnley et al., 2020). Engaging diverse stakeholders in collaborative processes for integrating environmental information into decision-making is crucial and challenging. Working at and across the boundaries of knowledge types is necessary. This involves navigating complex environments (value systems, social conventions, and mental models) and multiple stakeholder-engagement processes that can promote knowledge exchange and co-creation (Sitas et al., 2016).

To better understand stakeholder involvement, the present review examines the literature on wildfire management and environmental disaster management to identify how scholarly arguments over the significance of multi-stakeholder engagement in wildfire management processes.

Even though many stress the importance of interdisciplinary and multi-stakeholder participation in decision-making to tackle wildfire-related issues, there is a need for more investigation in that field.

This first version will be revised and updated throughout WP3 work. It will also be prepared for publishing in the coming months.

OBJECTIVES

This report's primary objective is to identify the current state of research, collect the necessary knowledge, and provide a first overview of the role of stakeholder engagement in wildfire management. The TREEADS Ecosystem discussions will provide an overview and outlook on future scenarios in which the TREEADS Platform is embedded and contributes solutions to strive for wildfire prevention, response, and restoration. Furthermore, this literature review will serve as a starting point for future investigation and actions towards enhanced and better coordinated participation of diverse groups of stakeholders in the field.

The purpose of the analysis is the tool will help the TREEADS Platform with decision-making and communication with all respective stakeholders.

STRUCTURE OF THE LITERATURE REVIEW

Following this introduction, the second section of this report describes the literature review process carried out by the Copenhagen Business School (CBS) team in 2022. The main findings are presented in the third section.

PROCESS OF LITERATURE REVIEW

CBS conducted a literature review on stakeholder engagement in wildfire management across the globe.

The task began with the gathering of academic articles. Google Scholar was used for the search, and all the searches were conducted in English between December 2021 and February 2022. To obtain a better overview of the results, there were no publication date or geography restrictions in our research. A pool of more than 180 articles was created. Following an initial review of the abstract and conclusion sections, the articles were further clustered themes such as stakeholder engagement, governance, participation, involvement, and wildfire management. At least 50 articles were fully comprehended and analysed for this initial literature overview. The software NVivo was utilized to facilitate the in-depth analysis and identification of the most prevalent factors. CBS will continue the analysis of the topic in the coming months. The word cloud generated from the article's analysis can be seen in Figure 1.

Figure 1: Most frequently words appeared in the initial overview.

STAKEHOLDER ENGAGEMENT IN WILDFIRE MANAGEMENT

Wildfires affect communities all over the world. Increased wildfire events — due to inadequate disaster and forest management— indicate that wildfires can have significant and long-lasting repercussions on the affected communities (Marie & Labossière, 2015; Pearce, 2003; Pereira et al., 2016) emphasizing the significance of a holistic approach to wildfire management.

In a democracy, public perspectives on the most significant environmental and social issues can affect and shape government policy (Palaiologou et al., 2021). To evaluate the response of stakeholders to fire policy, including government measures towards fire prevention, response, and adaptation, it is necessary to understand stakeholders' perspectives regarding the effects of fires on the environmental, social, and economic aspects of protected areas. Stakeholder perceptions and involvement are critical in landscape and wildfire management (Pereira et al., 2016; Robinne et al., 2021).

In the case of wildfire management, there has always been the problem of “many hands." The lack of coordination and communication among the different sectors, actors, and political scales (including the emergency services, the forestry sector, and the overall national crisis management system) can significantly hinder any wildfire management actions (Palaiologou et al., 2021). Additionally, raising public awareness of the risks, difficulties, and solutions to these problems is frequently absent from public conversations (Palaiologou et al., 2021). The need for better education, training, and informational campaigns that highlight success stories while aiming to engage the community in the decision-making process is justified by negative perceptions of some policy changes (such as those involving fire use) (Palaiologou et al., 2021; Shi et al., 2021). Moreover, when a community is excluded from the policy and decision-making processes, it frequently finds itself trapped between contradictory ideas in post-disaster scenarios. For instance, some people want the community to return to its pre-disaster state, while others will pursue alternative planning objectives. Officials have resisted disclosing hazards and threats to their respective communities for too long out of fear that panic would ensue or people would flee. However, successful community programs demonstrate the opposite (Pearce, 2003), and results are frequently improved when local communities are actively involved in the design and execution of fire management strategies (Palaiologou et al., 2021). Community members have a right to participate in making difficult decisions as well as a right to knowledge and understanding of potential hazards. Community members must have access to the information necessary for making informed decisions if they are to have any chance of influencing lawmakers (Pearce, 2003).

Moreover, by seeking to form partnerships, an interdisciplinary approach to crisis management aims to balance conflicting interests while moving towards common goals. Given the importance of establishing and maintaining positive relationships with local communities, disaster managers and community planners must consult with and include members of the public in their preparations (Palsa et al., 2022). In this respect, different studies have shown a necessity for stakeholder readiness and increased social resilience. That can be achieved through improved collaboration, transparent communication, risk consciousness, and knowledge exchange among the relevant stakeholders (from

residents to local authorities and fire management agencies). Locally appropriate solutions to risk limitation can be successful (Cutter et al., 2008; Johansson & Lidskog, 2020; Palaiologou et al., 2021; Robinne et al., 2021).

Collaboration and social learning among participants can be facilitated by developing local programs, such as Community Wildfire Protection Plans (CWPPs). These programs can be vital tools for tackling intricate issues in environmental management. As different types of stakeholders do not always participate actively in decision-making (Pereira et al., 2016), community programs can also help increase the possibility of local stakeholders' engagement in the suggested behaviours by increasing their knowledge of hazards, building consensus on mitigation solutions, and improving their understanding of those strategies (Palsa et al., 2022).

Trust between government officials and community members built through collaborative programs gives locals more control over fire prevention measures, thereby lowering the danger of wildfires. A community's willingness to take part in planning projects can help fulfil those plans (Palsa et al., 2022). Additionally, a growing body of research on adaptive governance points to the positive effects of participatory, transparent, and accountable engagement and collaborative learning processes in fostering more adaptive wildfire preparation (Essen et al., 2021).

Continuous engagement and participant variety in multi-stakeholder settings allow for synthesizing various types of knowledge, which in turn aids stakeholders in dealing with the uncertainty and complexity of the risks posed by wildfires (Palsa et al., 2022; Robinne et al., 2021).

The participation of a wide range of local stakeholder groups is essential to the success of community-based hazard planning, as these groups are the most likely to be affected by hazards and whose support of disaster preparedness is essential to the success of large-scale risk mitigation initiatives (Palsa et al., 2022). Thus, advancing wildfire governance will enable a) collaboration and knowledge transfer among those different groups of stakeholders and b) prevention and preparedness (Robinne et al., 2021). One more critical aspect is that the poor and members of minorities are almost always the most affected in post-disaster scenarios and make up most individuals in need of alternative housing, counselling, and other social assistance. That implies that the underprivileged groups must have access to information regarding mitigation measures and a voice in their development. This is the case in both developed and developing countries. Disaster preparation must include the poor and marginalized (Essen et al., 2021; Pearce, 2003). Some argue that inclusive procedures welcome more diverse viewpoints and can better reflect populations' and organizations' differential adaptability (Palsa et al., 2022). Existing networks should share power and authority with underrepresented groups (such as Latinos, Black, Indigenous, and tribal populations and authorities, or poor and marginalized groups in general) to decrease wildfire risk while increasing resilience, trust, and mutual understanding (Essen et al., 2021; Palsa et al., 2022).

Moreover, incorporating such considerations into a broader portfolio of criteria used to obligate resources to mitigate wildfire risk necessitates an investment in understanding how underserved groups both perceive and are affected by wildfire, beyond structure loss, including impacts on employment or social networks that might facilitate adaptation

and recovery (Essen et al., 2021; Palsa et al., 2022).Given the growing recognition of how indigenous fire practices maintained landscapes and the growing influence of tribal governments and associated organizations on land management, greater participation of tribal government representatives could inspire advances in community resilience (Palsa et al., 2022). Additionally, investing in underrepresented stakeholders in collaborative processes and networks is crucial to ensuring that the entire range of values and power allocations are included when managing wildfires as a complex risk (Essen et al., 2021).

Concluding, many would argue that the change appears inevitable, and the trend is undeniable: stronger and continuous community involvement, fundamental responsibility at all levels, and integrated disaster management planning with community planning (Pearce, 2003) will lead to addressing of severe wildfire events and disastrous impacts on ecosystem services across the globe (Robinne et al., 2021).

The word cloud of the most frequent words and the most frequently appeared types of stakeholders can be seen in Figure 2 and Figure 3, respectively.

Figure 2: Word cloud of the most frequent words in the analysed literature.

Figure 3: Word cloud of the most frequently appeared types of stakeholders in the analysis.

STAKEHOLDER ENGAGEMENT ACTIONS: STAKEHOLDER ENGAGEMENT IN THE PILOT AREAS

OVERVIEW

The pilot leaders conducted the workshops between June and November 2022, with one event conducted in the eight pilot areas. Each pilot received a methodology and the corresponding tools for stakeholder engagement, filling out the information with support from the CBS team.[1]

The specific objectives, content, and dynamics were adapted to the local context following the pilots' objectives and local actors' current level of engagement. Still, all the systematization and reporting were standardized so the project could level information across all the different contexts.

The information provided by the pilot leaders was systematized internally by CBS. The results of the analysis are provided in the results section.

The efforts will follow in the coming months with a social network analysis within each pilot.

OBJECTIVES

The workshops with local stakeholders in the pilot areas aim to support the TREEADS Platform development by establishing guidelines and strategies for delivering wildfire-related services following the wildfire management stakeholders' needs.

They are a fundamental step in the definition of the platform's optimal strategies, with the following objectives:

- Identify stakeholders involved in the pilots according to their sectors and areas of expertise in wildfire management.
- Identify the pressing issues and priority issues according to the stakeholders' profiles and phases of wildfire management.
- Build a framework for the stakeholder analysis processes to be conducted in the following stages of the TREEADS Platform development.
- Develop a preliminary understanding of the specific national and regional contexts of wildfire management for each pilot area, region, and country.
- Contribute to the alignment between the pilot's strategies and the TREEADS Platform mission and goals.

[1] CBS team participated physically in the Greek workshop and remotely in the Austrian Norwegian, and Spanish workshops. Support to the remaining workshops was provided through interactions before and after.

- Support future service design by the TREEADS platform, contributing that services are designed according to the stakeholder profiles and needs.

METHODS

The proposition was to conduct one Stakeholder engagement mapping per pilot. The workshops should have a duration of one day.

The pilot leaders should mobilize the stakeholders formally and informally associated with wildfire management in the pilot areas through the channels available, including email messages and online meetings. The mobilization processes were supported by the stakeholder engagement template provided.

The leaders conducting the workshops were allowed to tailor the events according to the specific context, profile of participants, and modes of participation of each event (physical or online) of each pilot.

While most of the dynamics could be adapted to the online format, the method contemplated the possibility that some participants took part in one of two workshop stages.

WORKSHOP STAGES

Stage 1 – Brainstorm

In the first stage, participants had to identify problems, lacks issues, and potential actions to be addressed by the TREEADS platform and its associated initiatives on the prevention and preparedness, detection and response, and adaptation and restoration phases of wildfire management. The brainstorming tool developed specifically for the task by CBS supported the exercise.

The output of this section is presented as “Issues Identified” in the results section of the report.

Stage 2 – Ranking relevance

Once the main issues were identified, the participants were invited to rank the issues identified by importance. The ranking process should be based on the “Relevance Ranking” template and workshop guidelines according to the high, medium, and low relevance levels.

The output of this section is presented as “Priority Issues” in the results section of the report.

Stage 3 – Engagement

At the third stage of the workshop, participants were invited to assess the level of engagement of the stakeholders. The assessment was performed using a Likert scale (with ranks ranging from one to five) on two different moments in time: the current and desired levels of engagement. All activities were developed by CBS based on the tools and canvases presented by Mastrogiacomo and Osterwalder (2021).

Ideally, the event would be conducted at a venue close to the pilot area to maximize the participation of actors involved in wildfire management in the pilot areas.

After the workshop, the pilot leaders shared with participants a survey to assess potential modes of engagement with the pilots. The survey was not mandatory; only interested pilots shared the form with participants.

MATERIALS

CBS developed a set of materials (see Annexes 1-5, pp 66-78) to support pilot leaders in conducting the workshops. The first set of materials supported Stakeholder Identification and Categorization, while the second focused on prioritizing issues.

MANUALS

- Stakeholder engagement mapping methodology
- Workshop Guidelines
- Activity how-to

TEMPLATES & FORMS

- Stakeholder engagement email template
- Stakeholder engagement survey form
- Meeting attendance and consent template
- Workshop reporting template
- Brainstorm tool (jpeg)
- Relevance assessment tool (jpeg)
- Engagement assessment tool (jpeg)

TRAINING WORKSHOPS

The CBS team directly engaged with the pilot leaders to train them to implement the methodology. The training workshops were conducted on the following dates/times.

- Romania - 2nd of September 2022 (10.45 am-12.15 pm)
- Norway - 6th of September 2022 (09.00 am -10.30 am)
- Greece - 6th of September 2022 (11.00 am-12.30 pm)
- Austria - 7th of September 2022 (09:00 am-10.30 am)
- Germany - 7th of September 2022 (01:00 pm-02.30 am)
- Taiwan - 8th of September 2022 (09.00am-10.30am)
- Spain - 8th of September 2022 (03.00 pm-04.30 pm)
- Italy - 29th of September 2022 (04:00- 05:30 pm)
- Romania - 2nd of September 2022 (10.45 am-12.15 pm)

STAKEHOLDER ANALYSIS METHODOLOGY

The analysis of information from the workshops is structured on two complementing components. Following the identification of stakeholders provided by the pilot leaders, the initial effort intended to differentiate and categorize the stakeholders according to their sector and function concerning the wildfire management phases. The complementing effort analysed information on the priority issues, categorizing them according to their phase and type of issue within each phase of wildfire management.

The following figures present an overview of stakeholders involved in Preparedness and Prevention (Figure 4), Detection and Response (Figure 5), and Restoration and Adaptation (Figure 10).

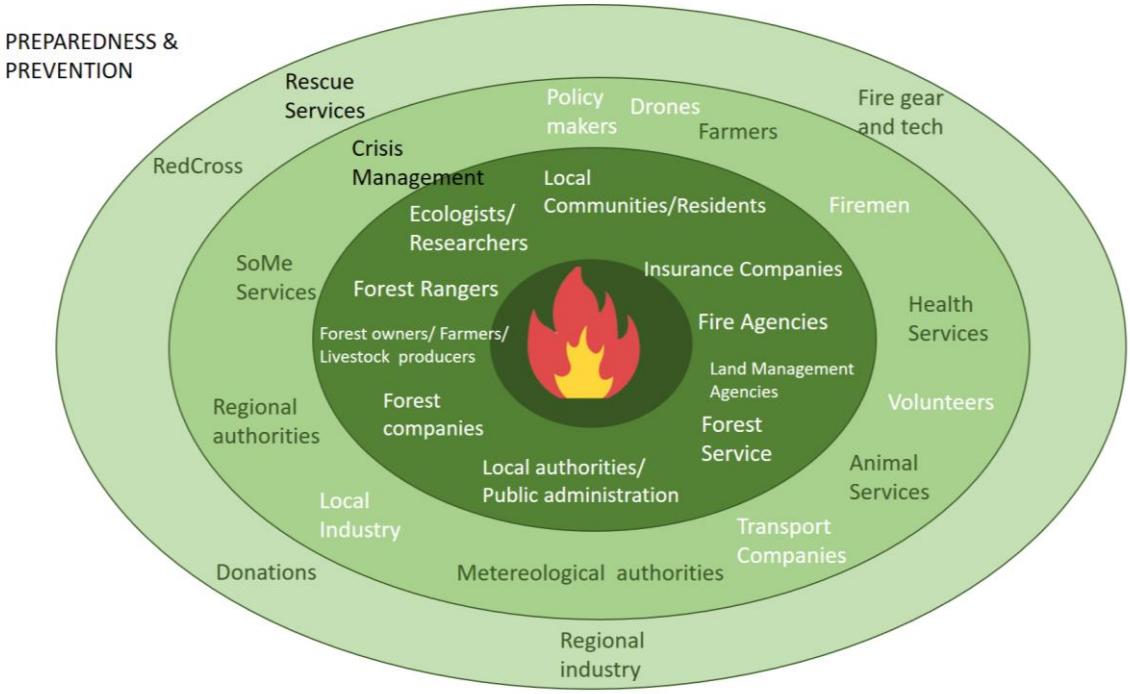

Figure 4: Overview of stakeholder Preparedness & Prevention phase.

The study provides a first insight into the current context of the TREEADS project implementation. It supports the following steps of the WP3 work by establishing the framework for investigating the relationships between stakeholders. Overall, the analysis presented in this live document supports the structuring of the TREEADS Platform on the components addressed by the WP3 effort. At the pilot implementation level, it provides information on the priority types of stakeholders and which issues are more levant for the types of stakeholders engaged. A schematic presentation of the stakeholder analysis stages is presented in Figure 7.

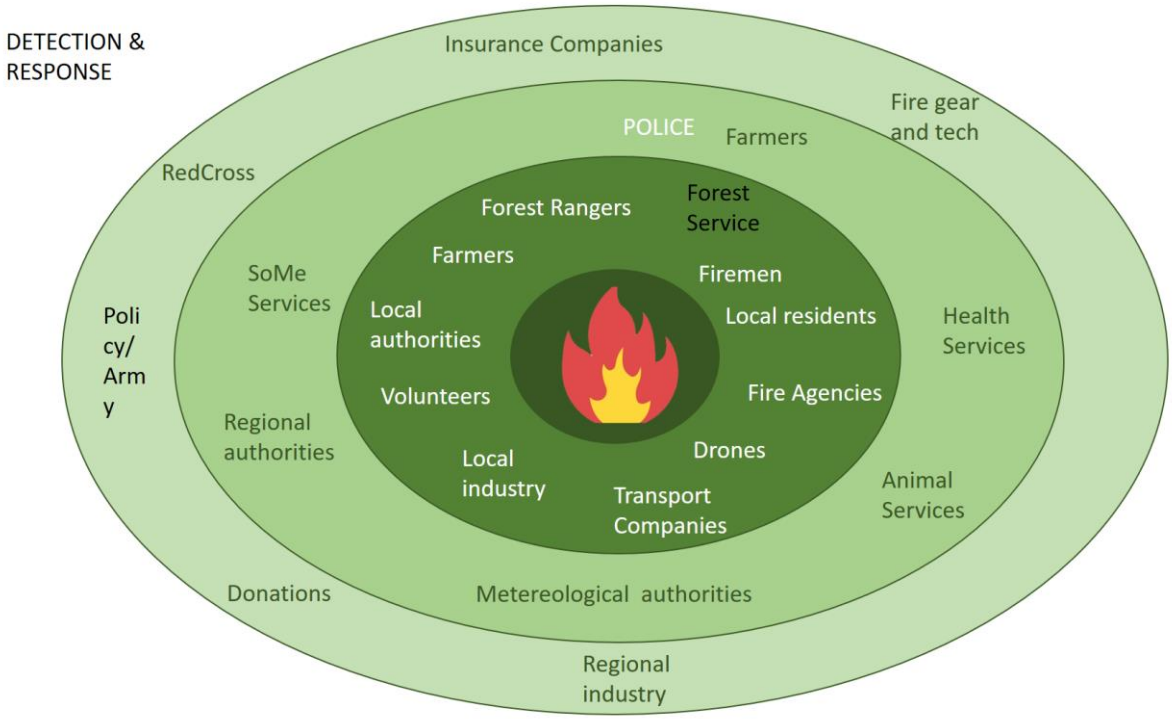

Figure 5: Overview Stakeholders Detection and Response phase.

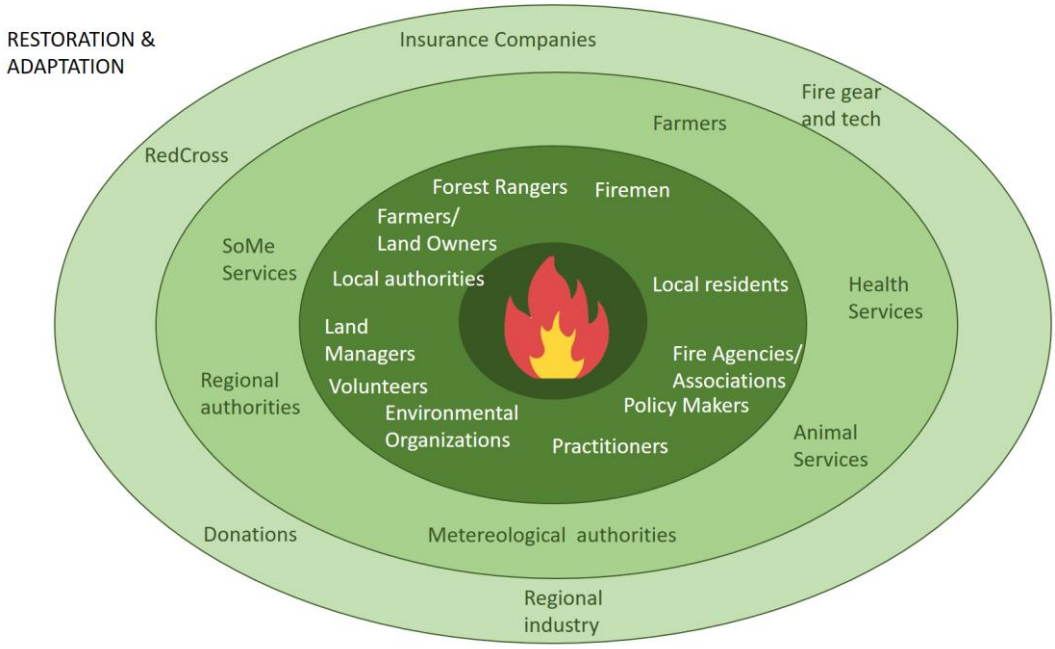

Figure 6: Overview Stakeholders Restoration and Adaptation phase.

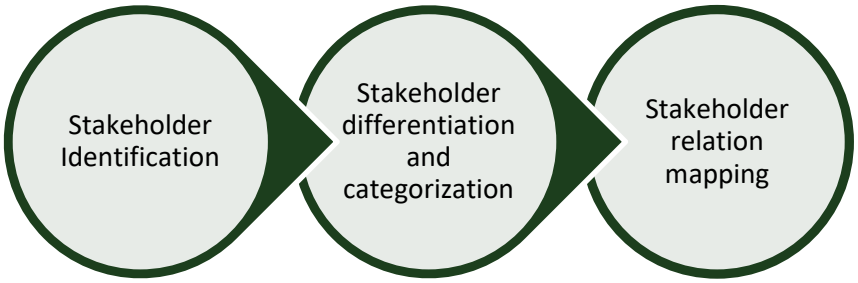

Figure 7: Stakeholder analysis stages[2].

At the platform level, the analysis complements the work of the stakeholder analysis literature review to provide critical inputs for the platform governance design and future implementation strategy. Those components are outlined in this report and will be consolidated in future versions of this live document as the categorization of stakeholders is followed by mapping their relations.

STAKEHOLDER IDENTIFICATION

The pilot leaders identified the stakeholders in the workshop report templates delivered at the end of each workshop. Each pilot leader filled these templates individually, with support from CBS in case of doubts on specific fields. The reports provided a preliminary identification and categorization of the participants according to each pilot context and internal process of each pilot leader. CBS then reviewed the categorization, checking the profile of each participant on multiple sources to standardize information on sectors, levels, and functions regarding wildfire management across the pilots.

123 stakeholder groups participated in the eight pilots, with the number of different groups in each initiative ranging from 4 in Taiwan to 32 in Norway. The average number of participants was 15, and de median was 13.5. We identified relevant heterogeneity in group mapping criteria, with pilots still setting their scope, limiting participants and others who have already set their scope, listing groups they want to engage within the initiative's next steps.

[2] Framework adapted from Reed et al. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of Environmental Management, 90(5), 1933–1949.

STAKEHOLDER DIFFERENTIATION AND CATEGORIZATION

The initial analysis identified the sector of the participants, according to their sector, differentiating actors between Government, Civil Society, and the Private Sector. For the analysis of sectors, research institutions/universities were categorized as government. For the analysis of sectors and levels, the research institutions/universities and companies were sorted out of the analysis, as these actors frequently work across all sectors of society.

The results of the stakeholder categorization process indicate that the current TREEADS initiative is composed of stakeholders of the three sectors, with actors from the public sector/government representing almost 72 out of the 123 participants at the first efforts of pilot implementation. Civil society ranked second with 30 participants, and the private sector in third place with 21 participants listed. Figure 8 presents the stakeholder groups per sector.

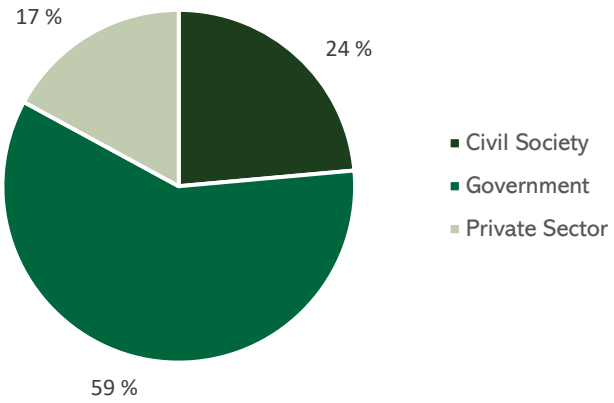

Figure 8: Stakeholder groups per sector.

When decomposed by level and sector (Figure 9), the profile of the stakeholders indicates a predominance of the local level actors in government and civil society (49 out of 123 stakeholders mapped). The concentration is more intense in government than in civil society: 67% of governmental actors are concentrated at the local level, while only 55% of actors in civil society share the same profile. All pilots have stakeholders in government, ranging from 3 to 22 groups. Regarding civil society, the number of actors per pilot ranges from 1 to 9, with the pilot from Taiwan presenting no actors in this group.

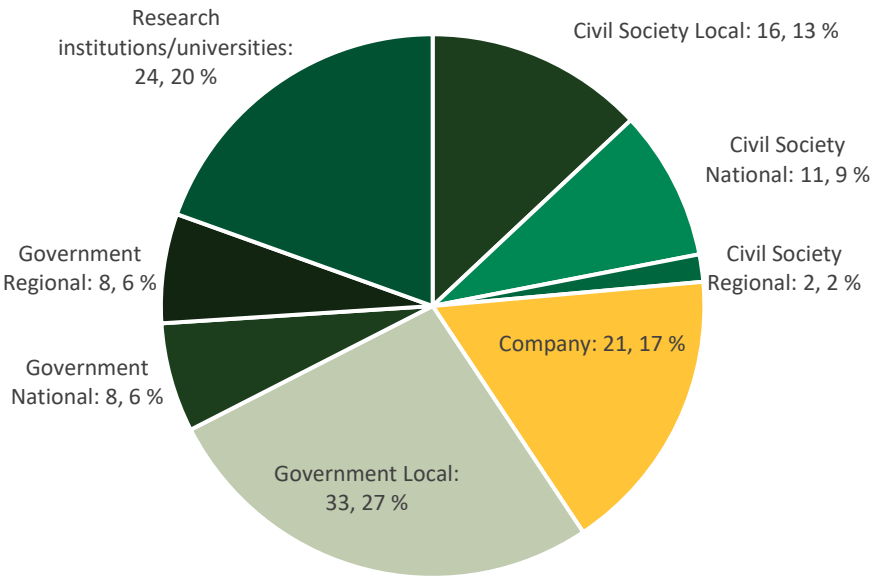

Figure 9: Stakeholder groups per sector and level.

The categorization of the stakeholder groups per wildfire management function (Figure 10) followed a reconstructive approach, with the CBS team using the categories provided by the actors in the consent lists, or by the pilot leaders in the reports, as inputs for an analytical structure that highlights the different roles played by actors within each sector. Actors in civil society, for example, are differentiated between local NGOs, local volunteering organizations, NGOs related to fire safety and regional civil society, and national civil society. Actors in fire and rescue services are present across government and civil society, with the category "Fire and Rescue Services" covering local and regional fire brigades and fire fighter associations. The function categorization supports the subsequential steps in analysing relationships between the stakeholders, as actors performing similar functions tend to relate to wildfire issues with similar interests and levels of engagement.

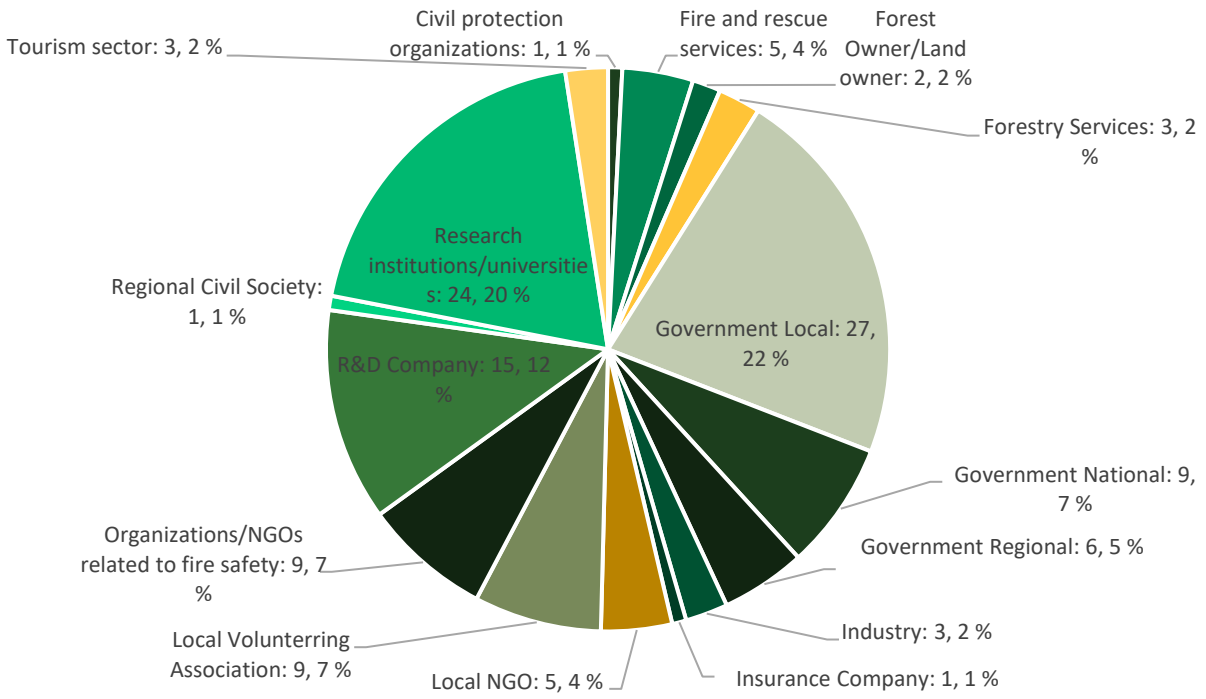

Figure 10: Stakeholder groups per wildfire management function.

The analysis indicates that the current sample of stakeholders is distributed across a profile of 19 different functions, with a relevant concentration of research institutions (24) and local governments (27) representing 41% of the sample. Also relevant is the number of R&D companies participating in the pilots (15). When bundled with the research institutions, the representatives of R&D-related actors' amount to 31% of the sample. The concentration reflects the pilot leaders' profile and provides a Science, Technology, and Innovation (STI) character to the TREEADS Platform and its stakeholder networks. It also indicates potential pathways for each pilot to develop, as the pilot networks should extend their reach and diversify their profiles in time.

Regarding the functions currently performed by the stakeholders, it is also worth noting the presence of actors whose primary function is related to fire safety and wildfire management, such as fire and rescue services (5), NGOs related to fire safety (9), and local volunteering organizations (9). These actors play an essential role not only as potential final users of the TREEADS platform services but also as providers of inputs for the pilot's design. Finally, the functions performed by the different levels of government may differ from one national context to the other.

Two essential points should be noted as limitations of the analysis. First, it is impossible to categorize the stakeholder per wildfire phase. Most of the actors listed in the workshops perform functions across different stages of wildfire management, particularly the ones in the public sector. The second limitation relates to the absence of actors and function categories in the initial analysis. As the lists only register the actors participating in the meetings, some critical functions in wildfire management may be

absent from this initial analysis. The available information does not support the assessment of how comprehensive these preliminary lists are nor does it identify which essential functions might be missing in each pilot. These gaps will be addressed in the subsequential steps of the stakeholder analysis through mapping and social network analysis processes.

A final analysis of the stakeholder groups per function and pilot (Figure 11) demonstrates that the pilots have very different configurations regarding the number and diversity of participants. The main attributes of each pilot are:

- Austria – 18 attendees with ten stakeholder groups represented across the three sectors. Prevalence of regional and National governments (40%) and NGOs related to fire safety (30%). Absence of local governments.
- Germany – 14 attendees total, with eight stakeholder groups from civil society and government. Prevalence of regional and National governments (50%) and civil society across the local, regional, and national levels. Absence of private actors.

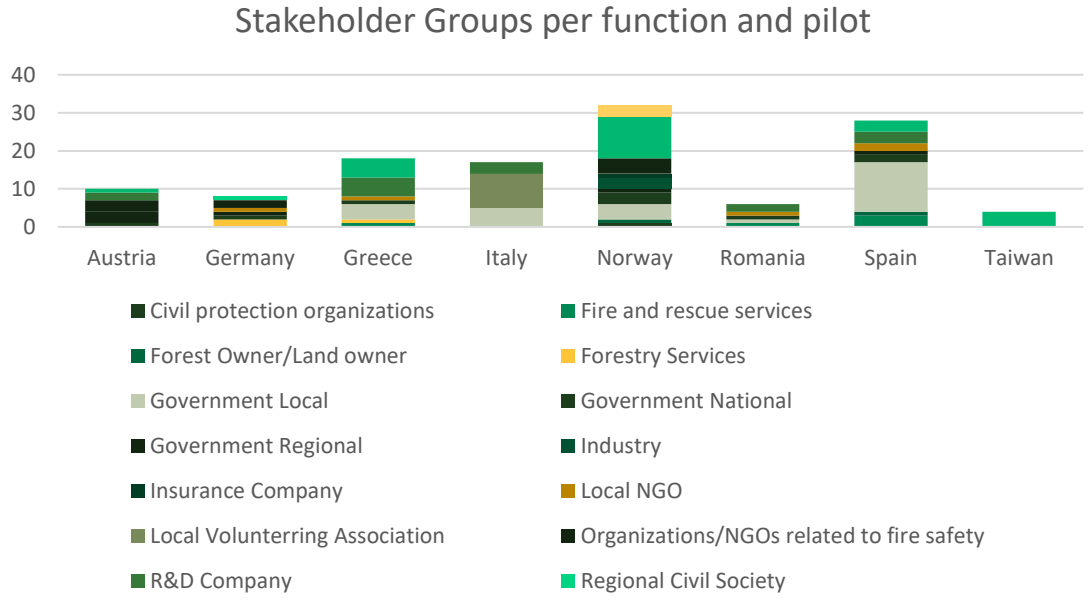

Figure 11: Stakeholder groups per wildfire management function and pilot.

- Greece – 38 attendees with 18 stakeholder groups represented across the three sectors. Prevalence of Local governments (22%), Research Institutions (27&), and R%D Companies (27%). Limited presence of Civil Society representatives, with only one actor from this sector.
- Italy – 22 attendees with 17 stakeholder groups represented across the three sectors. Participants' profile is limited to the categories of Local Government (29%), Local Volunteering Association (53%), and R&D Companies (18%). Some

of the participants listed did not take part in the workshop meeting but will integrate the pilot initiatives.

- Norway – Workshop conducted in hybrid format. 36 attendees total, with 32 stakeholder groups represented across the three sectors. Diverse profile of stakeholder groups represented, with a high prevalence of Research Institutions (34%), Local Governments (12%), and NGOs related to fire safety (12%). The pilot has three actors from the tourism sector.
- Romania – 16 participants total, with six stakeholder groups represented across the three sectors. Diverse profile of participants, including two from the R&D Company category and one each of the Fire and Rescue Services, National Government, Local Government, and Local NGO.
- Spain – 40 attendees with 28 stakeholder groups represented across the three sectors. Stakeholder groups profile concentrated on Local governments (46%), with limited participation of R%D Companies (8%), Research institutions (8%), and Fire and Rescue Services (8%). Some of the participants listed did not take part in the workshop meeting but will integrate the pilot initiatives.
- Taiwan – 10 attendees total with 04 stakeholder groups represented. All (100%) stakeholders are of the Research institutions/universities category.

A more significant number of stakeholders should be engaged in the following steps of the pilots, particularly in the initiatives still designing essential parts of their scope. The subsequential integration between the pilots and solutions associated with the TREEADS Platform should also allow the engagement of stakeholders at the European level. Information regarding these developments will be incorporated into the database, allowing new analysis, and continuously informing the platform strategy.

PRIORITY ISSUES

The stakeholders participating in the workshops were invited to map and rank in importance the issues related to wildfire management. These issues could be related to wildfire management in numerous ways, such as risks posed by socio-ecological configurations of the landscape, infrastructure, and human resources, technological limitations to wildfire management, limitations of frameworks or systems, or limited knowledge regarding restoration and adaptation techniques.

The issue mapping process varied according to the pilot (Figure 12), with 113 issues identified. Some pilots approached issue mapping listing only the priority issues, resulting in only four issues in Germany, Taiwan, Norway, and Romania. Other pilots approached the process more openly, resulting in more significant numbers, such as 53 in Austria, 24 in Italy and 14 in Greece.

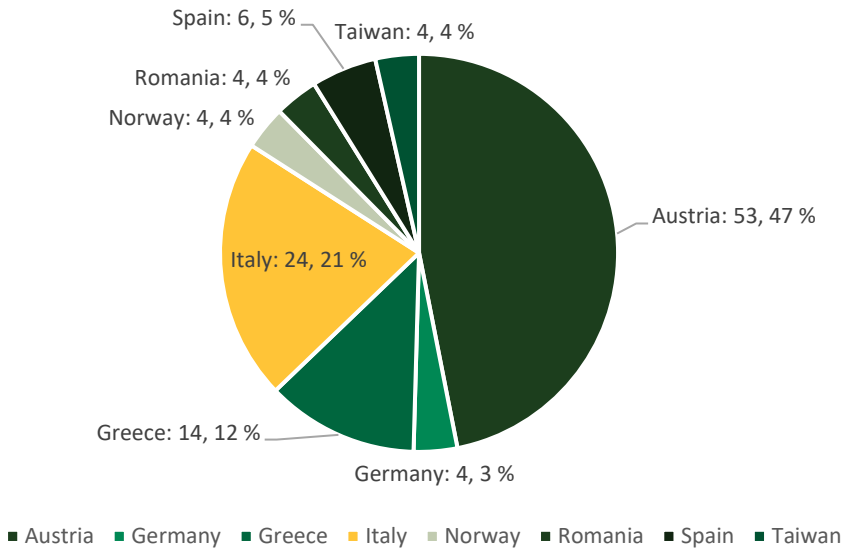

Figure 12: Issues Identified per pilot.

An analysis of issues per phase (Figure 13) indicates that 46% of the issues identified are related to the Detection and Response phase, with a remaining 41% in Prevention and Preparedness and only 12% in the Restoration and Adaptation phases. The concentration of issues in a particular phase may be attributed to the workshop participants' profile, as each stakeholder's wildfire management function can determine the issues that they are more sensitive to. For example, Fire and Rescue Services are prone to identify issues related to response, while local governments may be sensitive to adaptation and restoration. Further analysis is required to identify how the actor's profile and issues are correlated.

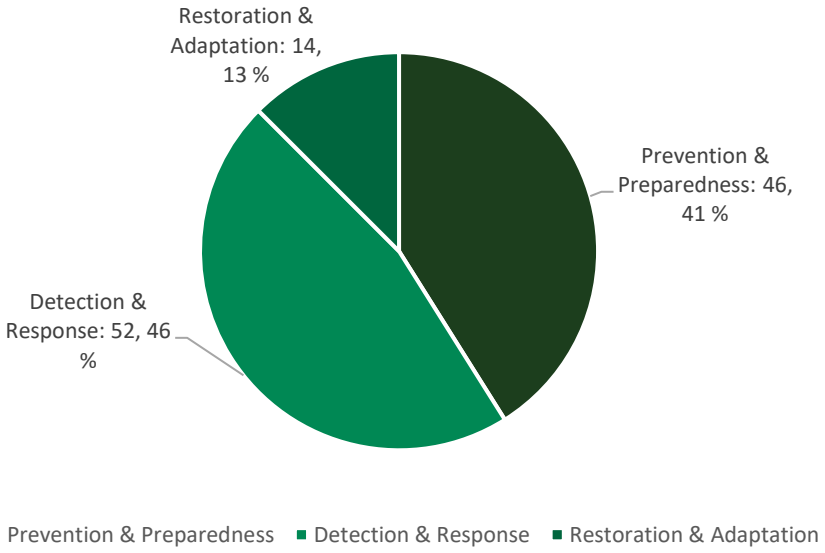

Figure 13: Issues Identified per phase.

Separating the issues by type within each phase highlights the potential priority issues to be addressed by the pilots. Regarding the Prevention and Preparedness phase, the priority issues (Figure 14) are concentrated awareness about wildfire risks (32%) and the adequate management of forests (23%). In the Detection & Response phase, the issues (Figure 15) are concentrated on drone surveillance (38%) and coordination (23%). Finally, the priorities in the Restoration and Adaptation phases (Figure 16) are concentrated on restoration techniques (66%).

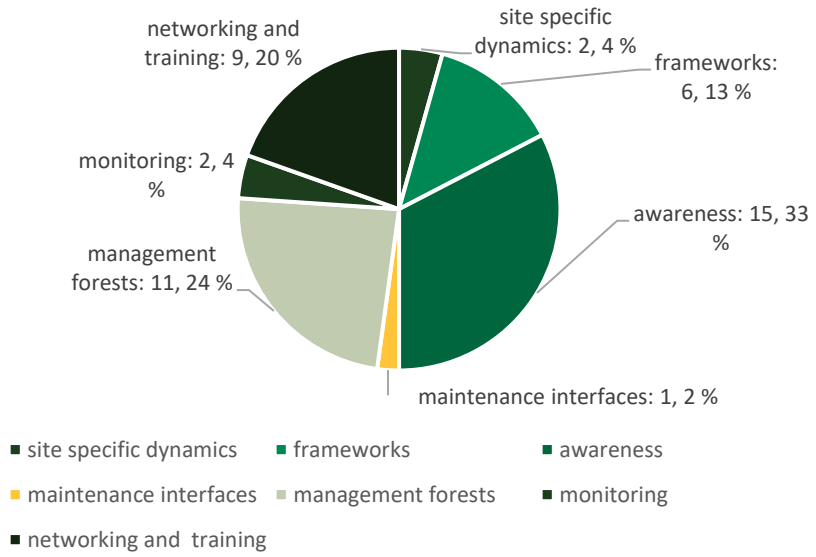

Figure 14: Prevention and Preparedness issues

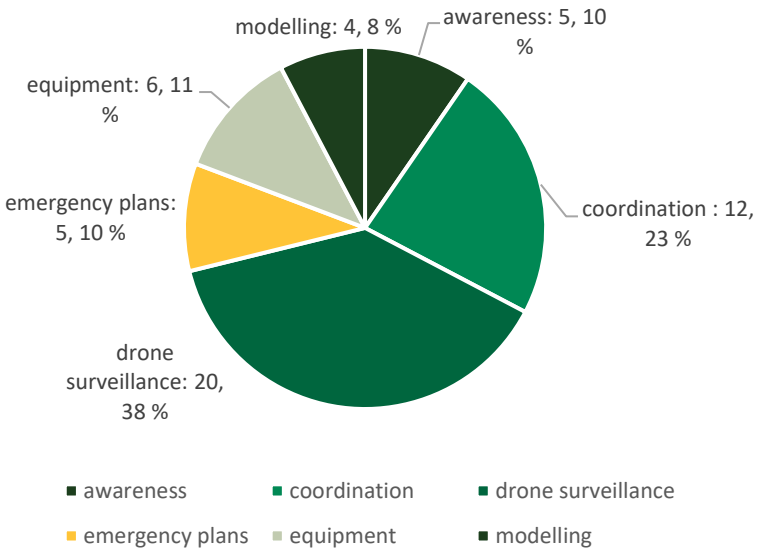

Figure 15: Detection and response issues

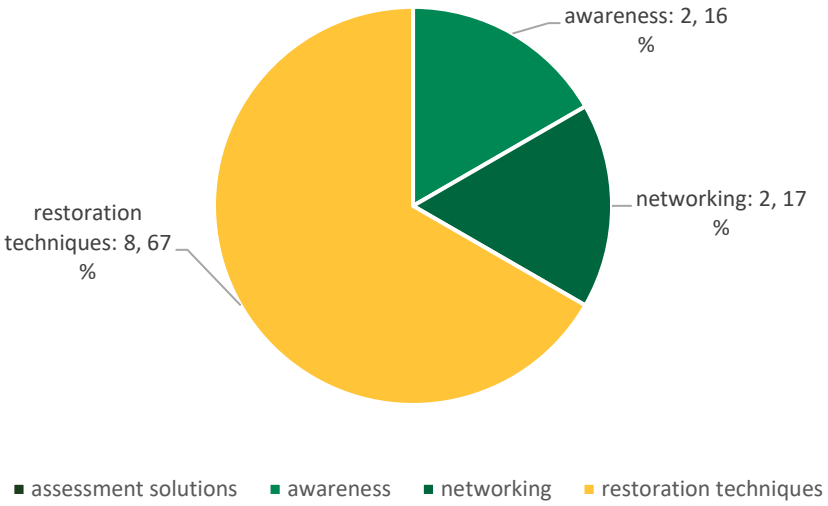

Figure 16: Restoration and Adaptation issues

The individualized analysis per phase also allows the identification of issues across the different phases. The main transversal issues identified in this initial analysis are related to the Awareness and coordination of actors. A final analysis is needed to assess if the pilots address these priority issues. The match between priority issues and the pilots' objectives is critical to ensuring the ongoing engagement of stakeholders.

MAIN RESULTS

- The TREEADS Platform engages a diverse profile of stakeholders across different sectors and levels. The current diversity indicates the potential of the TREEADS platform to work as a hub to coordinate actors through frameworks and processes that enable a holistic approach to wildfire prevention and management.
- The concentration of actors in local governments and Research institutions/universities categories indicates the potential of the platform to bridge the gap between research and practice, particularly in the prevention and preparedness phase.
- There is a need to expand the number of actors directly involved with first response in the TREEADS platform development. These actors should offer critical inputs for the platform design and contribute decisively to implementing solutions.
- The number of actors representing user groups in the pilot areas is also limited. While their contribution can be limited to targeted consultations during the TREEADS development, it is expected that these actors play a more relevant role in the implementation phase.
- Actors engaged with wildfire management at the local level have a strong demand for solutions. The main concerns are improving prevention & preparedness

capacity for minimizing the risk of occurrence and developing an effective response in cases where they occur.

- The diversity of issues identified locally corroborates the understanding of wildfires as complex problems with multiple causes and systemic impacts. This understanding poses a relevant challenge to the TREEADS Platform to prioritize approaches in its development process.
- Demand for solutions in the restoration & adaptation phases is limited.

LEARNINGS

- The pilots differ significantly in their scope and current level of implementation. Some initiatives approach the project intending to test technologies to address specific issues. In contrast, others use exploratory approaches, first assessing the main challenges and then reaching out to technology providers to address them. These differences impact the stakeholders' profile and should be considered when incorporating information from these analyses into the TREEADS Platform strategic planning process.
- The pilots approached the stakeholder mapping process differently. Part of the leaders limited their stakeholder lists to the workshop participants, while other listed actors that will be engaged in the next steps of pilot implementation.
- The TREEADS Platform should expect its stakeholders' profile to evolve as the pilot implementation progresses and new connections between the local-level initiatives and pan-European dynamics are established. Information on how the stakeholder engagement process evolves is also relevant to the analysis.
- There is a strong endogeneity between the stakeholder profiles and the priority issues. Stakeholders tend to list as priorities the issues they are more familiar with or that allow opportunities for their expertise to be accessed.
- The workshops method design incentivized the engagement with local actors. New methodologies should be designed to map and support the engagement of the platform actors with regional and European stakeholders.

INNOVATION WATCH, CROSS-FERTILISATION, AND FORESIGHT EXERCISES: LITERATURE REVIEW ON TECHNOLOGIES, TRENDS, AND INNOVATIONS IN WILDFIRE MANAGEMENT

INTRODUCTION

Wildfire Forests and wildland areas are critical natural assets for human societies and wildlife. Maintaining their balance is crucial for our quality of life and managing the risks posed by climate change. The increasing threat of wildfires to natural areas, infrastructure, and human lives has led to a growing interest in technologies and system that support prevention, risk management, and response. Specifically, the adoption of information and communication technologies (ICT) in firefighting systems increased significantly over the last 40 years across all scalar levels and functions of wildfire management including raising awareness, fire detection, response coordination, decision-making, and restoration.

The proliferation of ICTs in wildfire management is co-evolving with new understandings about holistic wildfire management that advocate for the integration of functions across wildfire response stages, and the development of new risk management and response frameworks. Recent policy work notwithstanding, there is not yet a shared understanding about how ICT should be integrated into wildfire management.

We address this gap through a systematic literature review of 312 articles covering ICT usage in integrated wildfire management between 2015 and 2023, making three contributions to the field. First, we review the current development of wildfire management ICT guided by three European frameworks. Second, we create a typology of ICT technologies in wildfire management, inductively differentiating their modes of deployment in three categories according to their primary functions: sensors, carriers, and processors. Third, we integrate these two analyses into a single framework that identifies the distribution of technology types by wildfire management phase. The result supports a fine-grained identification of the concentrations and gaps in the use of ICTs in the field, indicating opportunities for further research and development, leveraging opportunities, and challenges associated with the concentration of different solutions performing similar functions.

The full version of this revision has been submitted to the journal of environmental management and is currently under review.

OBJECTIVES

The aim of this systematic literature review is to increase understanding about the utilization of ICTs in integrated wildfire management by surveying existing research in line with three recent disaster risk reduction frameworks in Europe. Our study dialogues with literatures of ICT usage in wildfires and integrated wildfire management, contributing to bridge gaps between the two fields.

PROCESS OF LITERATURE REVIEW

CBS conducted a systemic literature review to best capture the current literature across different fields and disciplines related to ICT in wildfire management. We used the following search terms in a Boolean operation: "ICT AND wildfire," "innovation AND prevention AND wildfire AND forest," "innovation AND detection AND wildfire AND forest," and "innovation AND restoration AND wildfire AND forest." Searches were conducted through Google Scholar (April 2023) and Scopus (August 2023) in English and limited to articles and conference papers published in their final form between 2015 and 2023. 312 articles remained after clearing redundant entries.

The Integrated wildfire management frameworks

The integrated wildfire management approach intends to strengthen the resilience of rural landscapes to wildfires. This approach is grounded in the recognition that fires, whether they are cultural practices or occur naturally, have a significant role in maintaining ecosystems. However, they also bring forth potential hazards and risks that can be managed and reduced (Silva et al., 2010). Such an understanding is the foundation of IWMA frameworks aimed at improving fire management with two overarching principles: the management of all phases of the wildfire cycle and the use of local stakeholder capabilities to plan and implement risk management actions that meet local land management objectives (AGIF, 2023).

The IWMA approach resulted in different frameworks promoting reduction in disaster risk. For the purposes of this study, we selected three of the most recent frameworks applicable to recent debates by researchers associated with Horizon 2020 research programs on wildfire management (Couto et al., 2020).

ICT typology

The ICT typology utilized in this study was developed inductively from the article pool gathered for this literature review. We initially conducted a word count in the article pool to identify the most cited types of ICTs in wildfire management. After identifying the most cited, we searched the literature for references of technology types to systematize the information collected. Our typology is guided by Jazebi et al. (2020) that organized

technologies according to their primary function. The typology was intentionally broad to capture hardware-software integrations commonly used in wildfire management:

- Carriers are physical hardware devices used to transport and support various components, materials, or systems. They serve as a means of conveyance or delivery, enabling other types of technology to reach previously inaccessible areas due to height or heat.
- Sensors encompass a wide range of technologies designed to detect and measure physical, chemical, or biological phenomena. These sensors convert detected phenomena into measurable or observable signals, allowing the detection and monitoring of wildfire behavior.
- Processors are software, algorithms, or closely integrated hardware-software systems responsible for executing instructions and performing calculations. In wildfire communication and management, processors are deployed to process data collected from humans, sensors, or databases, playing a crucial role in two phases.

Data Analysis

We performed descriptive analysis is three subsequential steps using three IWMA Frameworks and a typology of ICT types developed for this study as references for keyword queries with N Vivo.

Step one was to analyse of the current focus of ICT development in wildfire management was performed by word queries of the article pool using N vivo and the three IWMA Frameworks as references for keyword query searches. Step two was the analysis of the concentration of technology types followed the initial analysis that supported the creation of the ICT typology by performing NVivo text queries for each of the ICT types, including the aggregate terms (Carriers, Sensors, Processors) and each individual ICT type. Step three was content analysis that integrated the previous results into a query matrix that identified the cases where the ICT keywords were utilized along with the wildfire management phases keywords.

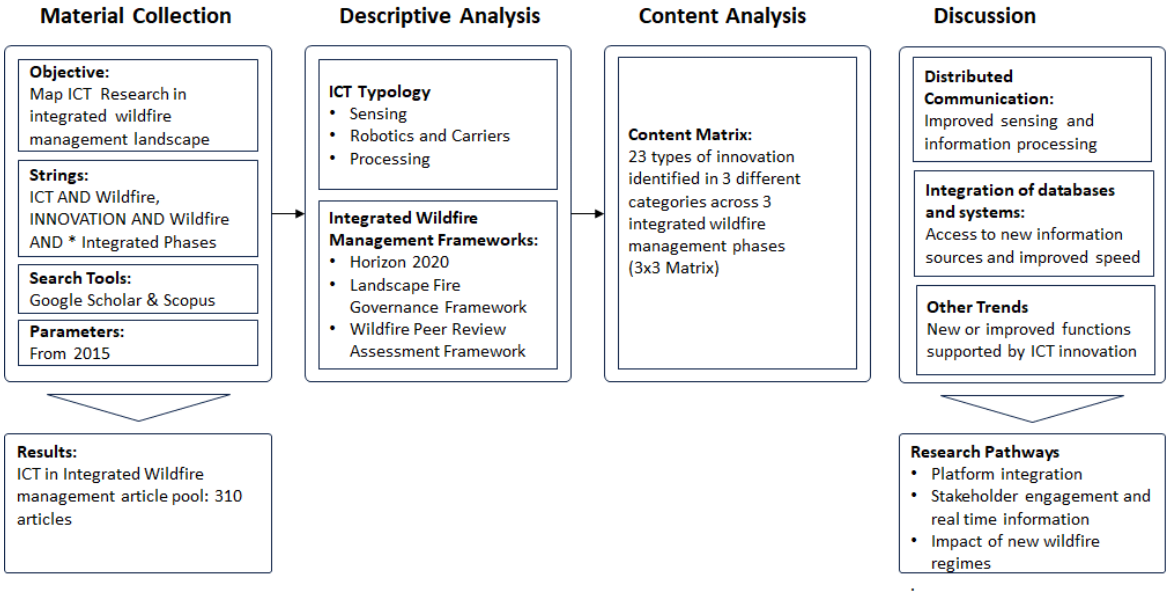

Figure 17: Literature Review Method

TECHNOLOGIES

Carriers

Carriers are physical hardware devices that may be used in different functions of wildfire management, from deploying sensors to the dispersion of flame retardants or seeds for restoration. Their primary added value is improving coverage by enabling reach to previously inaccessible areas due to height or heat, increased speed, and ease of maneuverability.

Robotics and robot motion

Robotics and robot motion are integrated into various wildfire-related technologies, such as unmanned surface vessels, aerospace tasks, and data acquisition systems. Especially in densely populated and dangerous regions, robots and robotic tools are employed to lower the risk of physical danger for fire fighters and increase the results of human-technology interactions. The main challenges associated with their adoption are high-cost, limited sensor and camera capabilities to detect fire, and the lack of guaranteeing specific performances like the speed of response.

Satellite and pseudo-satellites

Satellite-based techniques have been commonly used in various wildfire monitoring activities to deploy sensors from high altitudes and identify fires through thermal infrared cameras and different image processing techniques (Jazebi et al., 2020). They also support components of the global critical infrastructure, such as the Radio

Navigation Satellite Service (RNSS) and Radio Determination Satellite Service (RDSS), that support numerous other wildfire management activities through global positioning information.

Unmanned aerial vehicles (UAVs)

UAVs support rescue and search operations, forest surveying, and firefighting while lowering the risk for individual firefighters and management. They are used in firefighting situations to reach locations risky for firefighters to collect microclimate data such as speed and direction of the fire (Jazebi et al., 2020; Mukherjee et al., 2022). UAVs can be equipped with visual remote sensing, smoke detection, and video and audio coverage to identify high-risk fire areas (An et al., 2021; Bouguettaya et al., 2022). With satellite data, on-ground technologies, and connected deep learning systems, UAVs can detect and report fires in real time. Other recent developments in UAVs usage include a conceptual model for using self-adaptive and autonomous unmanned aerial vehicles (Kilic & Ozkan, 2019). A UAV-IoT system is considered a cost-friendly solution compared to satellite imaging used for fire detection (Bushnaq et al., 2021).

Sensors

Sensors encompass a spectrum of technologies designed to capture diverse data modalities, such as images, temperature, smoke, and light (Dong et al., 2020; Jazebi et al., 2020). They play vital functions in three phases of wildfire management, supporting essential aspects of prevention and, most importantly, detection. Their purpose lies in working remotely, gathering information from managed regions, whether from distance or proximity and relaying these to central coordination hubs.

Accelerated fire detection and localization (AFDL)

Accelerated fire detection and localization (AFDL) are systems of sensors and processors able to determine fire locations by providing the exact localization of fire spots or other relevant objects (such as humans, villages, etc.). Most recent developments in this front include a system to detect fires through variations in color, flame size, contour, and environment. These new AFDL systems can infer at high frames per second (fps) to increase accurate fire and non-fire classification but still face the challenges of other image processing and rule-based fire detection systems that may work well in one environment but need adjustment and recalibration to function in another one (Mukherjee et al., 2022).

Light detection and ranging (LIDAR)

Light detection and ranging (LIDAR) sensors are utilized for distance measurement through the emission of pulses onto targets, enabling active remote sensing. Objects in the environment scatter the signals, with a portion of the energy received by the sensors. By recording the time between transmission and reception, along with positional data,

LIDAR systems generate a detailed point cloud encompassing intensity and elevation measurements. These sensors are commonly integrated into UAVs to construct environmental models, facilitate obstacle avoidance, and navigation aid (Ye et al., 2022).

Radio detection and ranging (RADAR) sensors

Radio detection and ranging (RADAR) sensors detect, track, and position objects through electromagnetic waves. These sensors can collect comprehensive global data, capturing information at various spatial resolutions and across different spectral regions. By systematically observing the Earth's surface, these sensors offer optimal conditions for multitemporal analysis (Chuvieco et al., 2020b; Pandey & Sharma, 2021).

Sensor fusion

Sensor fusions are combinations of multiple types of sensors that can contribute to early fire and smoke detection. These networks are usually installed in remote areas or UAV platforms (Bouguettaya et al., 2022) and improve the early wildfire detection accuracy by combining the information collected through thermal and optical sensors. Thermal imaging is considered one of the most influential early warning methods to recognize spontaneous combustion.

Sensor networks

These sensor networks can be connected to deep learning analysis systems to improve fire detection and reduce maintenance costs. Pal (2021) proposes a fire-detecting and predicting model based on data collected through sensors stored in the cloud, making the information available through smart devices. Kizilkaya et al. (2022) focus on the energy usage of such networks and implemented a lightweight deep learning model to a wireless multimedia sensor network to cut down unnecessary data transmission. The results indicated the potential to save up to 30% of energy, making the process more economically and ecologically efficient.

Processors

Processors refer to software, algorithms, or closely integrated hardware-software systems that process data collected from individual sensors, sensor networks, or databases to speed up response time and produce meaningful insights and actionable information. They are used throughout the wildfire management cycle but play a crucial role in two steps of the process.

Artificial intelligence and hardware

Integration of artificial intelligence and hardware is increasingly used to increase accuracy and efficiency in wildfire management systems through several different means. Jazebi et al. (2020) present algorithms that evaluate historical data of a given area and predict the risk of ignition using information on location, climate, and vegetation. Using

databases and information provided by temperature humidity, current and voltage sensors, satellites, cameras, and GIS information, the systems find correlations between overarching data sets to facilitate a detailed decision-making process and efficient fire detection.

Augmented reality

Augmented reality (AR) refers to the association of carriers and processors to emulate or enrich realities through immersive experiences. Different forms of its application have been used in entertainment and planning for two decades, but their application in wildfire management is recent, with records dating back to less than ten years.

Deep learning

Deep learning refers to using networks to inform decision-making without human intervention. These techniques can be used in AFDL systems to improve fire and no-fire classifications, continuously increasing accuracy, leveraging feature extraction and engineering.

Gamification

Gamification is a tool that support fire safety training evacuation simulation through digital environments that users engage with. These games can be accessed through different support systems, including mobile, computers, or virtual reality support. Somerkoski et al. (2020), designed games using virtual and augmented reality to improve the nature of fire safety training and make learning more efficient.

Image processing

Shimazaki & Green (2014) developed a detection method based on image processing, which helps to identify the perimeter of burned land in real-time. A similar approach, but for fire detection, was developed by Dung and Ro (2018).

Internet of things

The internet of things (IoT) refers to tools that incorporate new functions through connection to the Internet (Perilla et al., 2018). Concerning fire safety systems, Perilla et al. (2018) and Peinl (2020) argue that integrating IoT increases the efficiency and accuracy of systems by integrating firefighting gear with sensors that send relevant signals in real-time. detection by Peinl (2020), and improvements in data transmission by Perilla et al. (2018).

Machine learning

Machine learning is a discipline within artificial intelligence (AI) and computer science that employs algorithms to mimic human learning processes, steadily enhancing its

precision over time. Machine learning in wildfire management is relevant in monitoring complex and fire-prone areas.

Wildfire management Platforms

Wildfire management platforms refer to a broad range of web-based applications offering integrated decision support tools to actors managing wildland fire hazards in territories ranging from subnational to continental scalar levels. Services in these platforms are usually WEB-GIS applications based on integrating numerous sources, including satellite imagery, weather reports, reports from municipal authorities, and reports from fire services, along with data using cutting-edge algorithms and models.

Simulation

Fire and flame movement simulation can be used in various fields, such as safety evacuation of buildings or underground spaces, to coordinate firefighters or stakeholders related to fire situations (Deng et al., 2021; Liang et al., 2019). Fire simulation can also be used to increase awareness about wildfires. Mendes et al. (2011) or to investigate the effect of weather conditions (Huang et al., 2019).

Recent developments in this area are related to improving realistic representations of fire through coarse particle grid simulation performed on a graphic processing unit (Horvath & Geiger, 2009). Nguyen et al., (2002) already proposed a physically based model to simulate smooth and turbulent flames. Moura & Oliveira (2007) developed a model to coordinate and train agents and their tactics to fight wildfires more efficiently. For example, the further development of such models is made by Choi et al. (2010) who use scientific visualization through the real-time volume rendering of various physical quantities in fire dynamics to ensure an immersive simulation that stimulates the intuitive behavior of firefighting agents.

Diez et al. (2016) developed an interactive 3D application to train fire wardens in building safety and fire prevention in a virtual reality surrounding. Simulating modifications to existing fire drills can also increase the efficiency of such. Keegan Vaira et al. (2016) increased the fire turn-out time of firefighters by simulating and testing improved processes and highlighted the value of considering these factors when designing fire stations and fire turn-out times. Other approaches to simulation follow a zero-fidelity approach, which contributes to the coordination and training of firefighters through cost-effective simulations (Toups et al., 2011).

Social media

Recent experimental developments in sensing online networks are geared towards creating algorithms that extract information on human experiences during disaster situations from social media. These crawlers access platforms such as Twitter, Facebook,

and Instagram to access posts and photos as accounts of the prevailing local conditions, feeding into monitoring systems.

Video processing

Mingdi et al. (2021) addressed video processing problems and constructed a data enhancement technique to improve data samples (through deep learning algorithms) and the accuracy of fire localization. This should decrease the rate of false alarms and consequently lead to more efficient fire detection.

Virtual reality

VR offers a safe way of learning fire behavior and can be deployed in the simulation of hazards and training in dangerous situations. These technologies can be associated with gamification in pedagogical and supervised spaces to improve the learning and motivation of users (Somerkoski et al., 2020).

ICTs and Phases in Wildfire management

Following the induction process of identifying the most prevalent ICT types in wildfire management, the final step of descriptive analysis identified the distribution of the technologies according to the phases of wildfire management, complementing the efforts of the previous steps of the descriptive analysis.

The analysis was performed with the three-fold Horizon 2020, breaking down the numbers identified the results of the first step of the descriptive analysis into the number of citations per technology per phase. The resulting matrix identifies the most prevalent technologies per phase and the focus of development of each ICT, with interesting results, such as the concentrated use of artificial intelligence, machine learning and deep learning techniques in the detection phase, the numerous uses of LIDAR technologies in restoration, and the use of Robots and UAVs in the prevention phase.

	Prevention	Detection	Restoration
Carriers	***424***	***311***	***83***
Sensors	***102***	***147***	***107***
Processors	***684***	***883***	***296***

Figure 18: Technologies Types Distribution per WIM Phase

DISCUSSION

The review of state-of-the-art information and communication technologies in wildfire management indicates a notable trend towards distributed communication and interlinked systems across all phases of wildfire management. These advancements

enhance decision-making during fires and support proactive fire prevention and preparedness strategies (Krasuski et al., 2013) by providing more information to actors managing these emergencies, assuming that more information leads to better decision-making and implementation.

These recent developments presented in the previous sections result from two simultaneous developments. On the one hand, developments of carriers' capacity and connectivity solutions allow technologies to be used in previously unreachable areas. Sensors may now be deployed to (or reach) monitored areas, allowing quicker identifications of emerging or reemerging wildfires and timely responses when necessary. On the other hand, the continuous development in the integration between hardware and software allows the creation of models and systems that incorporate new sources of information in prediction and monitoring, increasing response precision. These processing capacities of these new systems allow the incorporation of diverse sources, from historical fire records to satellite information databases, passing from social media and land use data.

To summarize, the main trends can be understood as follows.

Sensing and distributed communication.

The development of wildfire management systems sensing capacities is the result of three complementing incremental trends in ICT usage for wildfire management: improvements in sensing devices, such as new smoke detectors, and cameras associated with thermal sensors; improvements in carrier capacity, with robotics and heavy payload UAVS now able to deploy sensors to previously unreachable areas; and improvements in distributed communication using onboard video processors and satellite connectivity technologies. This is performed by deploying technologies that have been available since the end of the 20th century, but that can only recently be processed with the real-time speed necessary in emergency response situations.

Socioeconomic engagement in prevention, detection, and response

Change in ICT for wildfire management are associated with increases in connectivity and usage of communication technologies by the general public and governance institutions, allowing management to potentially integrate information from natural sciences (such as weather, fuel load, hydrography, etc.) with social information from stakeholders associated with wildfires. This type of social information offers relevant potential to improve fire management on two complementing fronts.

On the one hand, it allows information on socioeconomic processes associated with increased fires to be incorporated into the wildfire risk analysis, such as land use change, tourism flows, and wildland-urban interface. On the other hand, the interconnectedness between systems and users offers new possibilities to engage with stakeholders affected

by fire in real-time, enhancing the capacity of responders to detect occurrences and coordinate response.

Integration of databases and systems

The trend is observed in wildfire management platforms that integrate different data sources to perform critical analysis in prevention and detection and integrate sensors in devices to improve monitoring capacity while firefighting teams are out in the field.

The improvements promoted by these technologies are twofold. They promise to increase the precision of prediction and monitoring systems by increasing access to different information sources and allowing wildfire managers to perform functions of wildfire management in an integrated manner. Among the practical solutions allowed by such integration is the possibility of integrating firefighting and survey activities through incorporating sensors in firefighting gear, integrating sensing systems with other databases to improve precision, and the automated connection between monitoring and warnings to coordinate response. These advancements in precision and coordination are associated with challenges in maintaining communication in extreme situations and limitations in computing capacity that hinder the performance of multiple functions simultaneously, such as flame identification and localization.

CONCLUSION

Our systematic literature review advances the utilization of ICTs in the integrated wildfire management approach by mapping the distribution of ICT research in wildfires according to the state-of-the-art disaster risk reduction frameworks currently debated in Europe.

The analysis demonstrates that technologies perform functions primarily concentrated in functions when fires are happening, with smaller concentration in the pre fire activities and a residual number of solutions applied to post fire activities. Similar results are observed for analysis within the terms of the three IWMA, with some of the phases, such as the governance of wildfires in the WPRA and the pre suppression phase of the LFGF, not covered by ICTs.

The results dialogue with literatures of ICT usage in wildfires and integrated wildfire management, making a relevant contribution to bridge gaps between the two fields. It also develops a reference to study the empirical applications of the Integrated Wildfire Management Approach.

INNOVATION WATCH, CROSS-FERTILISATION, AND FORESIGHT EXERCISES: WOOD ASHES (WAS) OR POST-WILDFIRE WOOD ASHES (PWAS).

INTRODUCTION

Nowadays, Alkali-Activated Materials (AAMs) manufactured using Wood Ashes (WAs) or Post-wildfire Wood Ashes (PWAs) as precursors or activators, and cement-based materials manufactured using WAs or PWAs as partial Ordinary Portland Cement (OPC) replacement are studied by several researchers. The main reason why this subject gained attention is because it could significantly help one of the most critical challenges facing our society: climate change.

The cement industry is responsible for 5-8% of the anthropogenic CO2 emission worldwide (Andrew, 2018; Font et al., 2020). A challenge within a challenge, in the construction industry, is to use AAM (or geopolymers) instead of Ordinary Portland Cement (OPC). AAM can be produced without OPC. According to the literature, the CO2 emission associated with AAM production can be 55 -75 % lower than those obtained for OPC (Font et al., 2020; Shirley & Black, 2011).

Alkali Activated Material (AAM) is a binder system obtained by the reaction of an alkali metal source (solid or dissolved, i.e., activator) with a solid silicate powder (i.e., precursor). AAMs, which chemistry and reaction mechanisms are radically different from traditional binders based on OPC, have a high potential as an alternative binder to OPC because of their excellent mechanical properties, durability, and environmental benefits (lower CO2 emissions). These solutions are highly suitable to withstand harsh environments related to extreme weather conditions. They can overcome the durability problems of traditional concrete when exposed to harsh environments, thus reducing maintenance and retrofitting needs.

WA has a substantial potential for use as a pozzolanic mineral admixture in cement-based materials and as a precursor or activator in AAMs (Siddique, 2012).

OBJECTIVES

The excellent availability of WA in a post-wildfire scenario opens the way for the possibility of reusing the waste of wood (post-wildfire wood ash – PWA) for the production of Alkali-Activated Materials (AAMs) manufactured using Wood Ashes (WAs) or Post-wildfire Wood Ashes (PWAs) as precursors or activators, and cement-based materials manufactured using WAs or PWAs as partial Ordinary Portland Cement (OPC) replacement. Moreover, the utilization of PWA to produce this kind of materials meets the objectives of the TREEADS project, providing a significant contribution in two different phases of the project:

- Prevention and Preparedness Phase: where the use of WA as raw material in the production of AAM allows obtaining a fire-resilient material for buildings and infrastructures (material to be developed in task T4.7).

- Restoration and Adaptation Phase: in a post-wildfire scenario, wood waste could help restore the affected places.

PROCESS OF LITERATURE REVIEW

The academic State of the Art (SoA) of Alkali-Activated Materials (AAMs) manufactured using Wood Ashes (WAs) or Post-wildfire Wood Ashes (PWAs) as precursors or activators and cement-based materials manufactured using WAs or PWAs as partial Ordinary Portland Cement (OPC) replacement has been investigated.

The research keywords are AAM, Alkali Activated Material, wood ash, wood ash cement, and wood ash cement replacement.

The present report is structured with different tables, each of which contains the main features of a paper selected to achieve the document's aim. This structure simplifies reading and helps to focus the attention on highlights. Furthermore, in the last section (Conclusions and implications), the primary quantitative outcomes of both materials are summarized:

- Alkali-Activated Materials (AAMs) manufactured using Wood Ashes (WAs) or Post-wildfire Wood Ashes (PWAs) as precursors or activators.
- Cement-based materials manufactured using WAs or PWAs as partial Ordinary Portland Cement (OPC) replacement.

The quantitative information provides relevant input for the design of the experimental campaign in task T4.7 TREEADS Fire-resilient materials for buildings and infrastructures.

REVIEW CONCLUSIONS AND IMPLICATIONS

The crucial points (non-quantitative) that come out from most of the analysed papers are:

- WA can be used for concrete and alkali-activated material manufacturing.
- The performance of the result materials strongly depends on different aspects (e.g., type of wood).
- The material could be used for both structural and non-structural applications in the function of its particular characteristics.
- The strength of material with WA is slightly lower than that of ordinary materials;
- The strength increases with age.
- The workability of these new materials is lower than the workability of OPC. Thus, more water is needed. On this point, one paper [21] contrasts the others, affirming that the obtained material is more workable than without WA.

The quantitative information achieved by the academic SoA analysis, which will be used as a guideline for the activities in task T4.7 Fire-resilient materials for buildings and infrastructures, are reported in the following tables (Table 1 Quantitative information achieved for eco-friendly materials by the academic SoA analysis, Table 2: Quantitative information: wood ash – physical analysis and Table 3: Quantitative information: wood ash – chemical analysis)

Table 1: Quantitative information achieved for eco-friendly materials by the academic SoA analysis.

Material	Alkali Activated Material	Wood ash as partial cement replacement
Composition (% of WA)	20 – 30 %[a)]	15 – 20 %
Average Compressive strength (28 days)	Up to 45 MPa [a)]	Around 20 MPa
Best curing process	65°C for 7 days	20°C for 28 days
Slump (workability)	-	30 – 40 mm
Liquid/solid ratio	0.35 – 0.5	about 0.5
[a)] depend on mix design and the other components (e.g., BFA, RHA, BFS, etc.)		

Table 2: Quantitative information: wood ash – physical analysis.

Physical properties	Range value
Specific gravity [kg/m^3]	2,25 – 2,60
Mean particle size d50 (μm)	About 10

Table 3: Quantitative information: wood ash – chemical analysis.

Main Component	Range value
SiO_2 [%]	10.00 – 35.00
Al_2O_3	3.00 – 20.00
Fe_2O_3	2.00 – 10.00
NB. The sum of these three components shall be ≥ 70% (ASTM C618). Lower values are linked to the LoI	

PAN-EUROPEAN PLATFORMS: STANDARDS AND INTEROPERABILITY

OBJECTIVES

Task 3.1 of the TREEADS project successfully gathered data on the ecological and environmental wildfire-related services in various EU member states involved in the TREEADS large-scale piloting activities. The collected data helped to understand the environmental factors that influence the provision of these services and how they interact with technological and other resources. This information was then used to support the activities of professionals and other actors through the development and use of the TREEADS Platform. These findings were also incorporated into Deliverable 3.1 (D3.1), which was successfully submitted. Additionally, the task employs a series of surveys throughout the project's duration to update the action plan based on updated ecological and environmental models. The first survey was successfully created, translated to each pilot country's language, and is being distributed as part of D3.8. The rest of the surveys will be developed in the context of Task 3.1 and will be included and discussed in D3.9 and D3.10.

The TREEADS project is dedicated to improving wildfire management through the implementation of cutting-edge technology. As part of this effort, Task 3.5 specifically aimed to identify and analyze existing standards that could be leveraged to further enhance the TREEADS platform. The goal of this task was to ensure that the TREEADS platform would align with established best practices and industry standards in the field of wildfire management.

To achieve this goal, Task 3.5 performed a thorough analysis of relevant existing standards in the field of wildfire management, including standards related to incident management, firefighting equipment and technology, and post-incident evaluations. This analysis will consider a range of international and national standards, including guidelines developed by organizations such as the International Organization for Standardization[3] (ISO), and the National Wildfire Coordinating Group (NWCG)[4].

The results of Task 3.5 will provide a solid foundation for the development and implementation of the TREEADS platform and help ensure that the platform aligns with established best practices and industry standards. This, in turn, will help to improve the effectiveness and efficiency of wildfire management efforts and ultimately reduce the risk and impact of wildfires.

WILDFIRE-RELATED STANDARDISATION LANDSCAPE

The issue of wildfire-related standardization has become increasingly important in recent years, as the frequency and severity of these disasters has grown. This has led to a

[3] International Organisation of Standardisation (ISO)

[4] National Wildfire Coordinating Group (NWCG)

need for a more comprehensive and cohesive approach to managing and responding to wildfires, one that incorporates standardized practices and protocols.

One of the key areas in which standardization is needed is in the field of wildfire risk assessment. Currently, there is a lack of consistency in the methods used to evaluate the potential threat of a wildfire, which can lead to confusion and inefficiencies in the response effort. By establishing a standardized approach to risk assessment, agencies and organizations can better identify and prioritize areas at high risk for wildfire and develop more effective response plans (U.S. FOREST SERVICE, n.d.).

Another important area where standardization is needed is in the development of fire-resistant building codes and standards. With more and more people living in areas at risk for wildfire, it is essential that homes and other structures are built to withstand the high temperatures and intense flames of a wildfire. This can be achieved through the adoption of fire-resistant building codes and standards that ensure that buildings are constructed using materials and methods that can withstand the heat and flames of a wildfire (National Fire Protection Association, n.d.).

In addition to these specific areas, there is a need for standardization in the overall management and response to wildfires. This includes the development of clear and consistent protocols for evacuation, communication, and incident command, as well as the use of standardized equipment and technology for firefighting and other response efforts.

The landscape of wildfire-related standardization is constantly evolving, and there is still much work to be done to ensure that we are effectively managing and responding to these disasters. By addressing key areas such as risk assessment, building codes, and incident management, a more cohesive and effective approach to dealing with wildfires can be build. This will help to protect lives, property, and the environment from the devastating effects of these powerful natural forces.

TECHNICAL COMMITTEES

Technical committees are responsible for the development of standards within specific industries or fields. Within the context of wildfire management, these committees may focus on specific aspects such as firefighting equipment, communication protocols, or data management. They are typically composed of experts and stakeholders from industry, academia, and government.

INTERNATIONAL STANDARDISATION COMMITTEES

International standardization committees, such as ISO and the International Electrotechnical Commission (IEC)[5], are responsible for developing standards that are recognized and used globally. These organizations work with national standardization bodies to ensure that their standards are relevant and applicable in different regions. In the context of wildfire management, international standardization committees may focus

[5] International Electrotechnical Commission (IEC)

on issues such as fire behavior, fire safety, and emergency management. International standardization committees play a critical role in the management of wildfires, as they work to develop and promote consistent standards and protocols for the assessment, prevention, and response to these disasters. These committees bring together experts from around the world to share knowledge and best practices, and to develop standards that can be adopted by countries and organizations globally.

One important international standardization committee for wildfire management is the International Association of Wildland Fire (IAWF)[6]. Established in 1991, the IAWF is a global organization that brings together experts in wildland fire science, management, and policy to advance knowledge and understanding of wildfire. The IAWF works to develop and promote international standards and guidelines for wildfire management, and it serves as a resource for governments, organizations, and individuals involved in wildland fire management.

Another important international standardization committee for wildfire management is the International Organization for Standardization (ISO)[7]. ISO is a global organization that develops and publishes international standards for a wide range of industries, including wildfire management. ISO works to develop and promote standards for risk assessment, incident management, and firefighting equipment and technology, among other areas. These standards help to ensure that organizations and countries have consistent and effective approaches to managing and responding to wildfires.

In addition to these specific committees, there are also several other international organizations and initiatives that are working to promote standardization and best practices in wildfire management. These include the Global Wildland Fire Network[8], the Wildland Fire Leadership Council[9], and the United Nations International Strategy for Disaster Reduction (UNISDR)[10].

In conclusion, international standardization committees play a vital role in the management of wildfires, by promoting consistency and best practices in the assessment, prevention, and response to these disasters. The International Association of Wildland Fire (IAWF) and International Organization for Standardization (ISO) are two examples of the committees that are working to promote international standards and guidelines for wildfire management. With the continued global impact of wildfires, the importance of these committees and their work will continue to grow.

EUROPEAN STANDARDISATION COMMITTEES

[6] International Association of Wildland Fire (IAWF)

[7] Organization for Standardization (ISO)

[8] Global Wildland Fire Network

[9] Wildland Fire Leadership Council

[10] United Nations International Strategy for Disaster Reduction (UNISDR)

European standardization committees, such as the European Committee for Standardization (CEN)[11], and the European Electrotechnical Committee for Standardization (CENELEC)[12], are responsible for developing standards that are recognized and used within the European Union. These organizations work closely with international standardization bodies and national standardization bodies to ensure that their standards are relevant and applicable across Europe. In the context of wildfire management, European standardization committees may focus on issues such as fire detection, fire protection, and risk management.

European standardization committees play a crucial role in the management of wildfires within the continent, as they work to develop and promote consistent standards and protocols for the assessment, prevention, and response to these disasters. These committees bring together experts from different European countries to share knowledge and best practices, and to develop standards that can be adopted by countries and organizations within Europe.

One important European standardization committee for wildfire management is the European Forest Fire Information System (EFFIS)[13]. Established in 2000, EFFIS is a European-wide system that provides information on forest fires and related issues, such as fire danger and fire management. The system is managed by the Joint Research Centre of the European Commission, and it works to provide consistent and reliable information on forest fires and their management across Europe.

Another important European standardization committee for wildfire management is the European Committee for Standardization (CEN). CEN is a European organization that develops and publishes European standards for a wide range of industries, including wildfire management. CEN works to develop and promote standards for risk assessment, incident management, and firefighting equipment and technology, among other areas. These standards help to ensure that organizations and countries within Europe have consistent and effective approaches to managing and responding to wildfires.

In addition to these specific committees, there are also several other European organizations and initiatives that are working to promote standardization and best practices in wildfire management. These include the European Forest Fire Observatory (EFFO), the European Wildland Fire Network (EWFN) and the European Union Civil Protection Mechanism (EUCPM)[14].

In conclusion, European standardization committees play a vital role in the management of wildfires within the continent, by promoting consistency and best practices in the assessment, prevention, and response to these disasters. The European Forest Fire Information System (EFFIS) and the European Committee for Standardization (CEN) are two examples of the committees that are working to promote European standards and

[11] The European Committee for Standardisation (CEN)

[12] European Electrotechnical Committee for Standardization (CENELEC)

[13] European Forest Fire Information System (EFFIS)

[14] European Union Civil Protection Mechanism (EUCPM)

guidelines for wildfire management. With the continued impact of wildfires in Europe, the importance of these committees and their work will continue to grow.

NATIONAL STANDARDISATION COMMITTEES

National standardization committees are responsible for developing standards that are recognized and used within specific countries. These organizations may work closely with international and European standardization bodies to ensure that their standards are aligned with broader guidelines and best practices. In the context of wildfire management, national standardization committees may focus on issues such as firefighting equipment, evacuation protocols, and incident management.

ANALYSIS OF EXISTING STANDARDS

An analysis of existing standards is crucial for understanding the current state of the art in wildfire management and identifying gaps and opportunities for improvement. This analysis should consider both international and national standards and should evaluate their relevance, applicability, and effectiveness in the context of wildfire management.

Wildfire management standards play a critical role in ensuring that organizations and individuals are prepared to effectively prevent and respond to wildfires. These standards provide guidance on everything from risk assessment and incident management to firefighting equipment and technology. In this essay, we will analyse existing wildfire management standards to understand their key components and how they are used in practice.

WILDFIRE-RELATED INTERNATIONAL STANDARDS

One important standard for wildfire management is ISO 18788:2015 (ISO n.d.), which is an international standard that provides guidelines for the management of wildland fires. This standard covers a wide range of topics, including risk assessment, incident management, firefighting equipment and technology, and post-incident evaluations. It also includes specific guidelines for the management of wildfires in different types of vegetation, such as forests, grasslands, and shrublands. This standard is widely used by organizations and agencies around the world and provides a consistent framework for the management of wildfires.

Another important standard for wildfire management is the National Wildfire Coordinating Group (NWCG)[15] standards for wildland fire operations. This set of standards is developed and maintained by the NWAL FIRE CONSORTIUM and is specific to the United States. The NWAL FIRE CONSORTIUM is a consortium of federal and state agencies, including the U.S. Forest Service, the Bureau of Land Management, and the National Park Service, among others. The NWAL FIRE CONSORTIUM standards cover a wide range of topics, including incident management, firefighting equipment and technology, and post-incident evaluations. These standards are used by organizations

[15] National Wildfire Coordinating Group (NWCG)

and agencies within the United States to ensure consistent and effective wildfire management practices.

WILDFIRE-RELATED EUROPEAN STANDARDS

In addition to the ISO 18788:2015 and National Wildfire Coordinating Group (NWCG) standards, there are also several important European standards that contribute to the effective management of wildfires. For example, the European Committee for Standardization (CEN) has developed a series of standards for firefighting equipment, including firefighting hoses, foam equipment, and firefighting pumps. These standards are critical for ensuring that firefighting equipment is reliable and effective and are used by organizations and agencies throughout Europe.

Another relevant European standard is the European Forest Fire Information System Standard (EFFIS). This standard provides a consistent framework for the collection, management, and dissemination of forest fire information. It includes guidelines for the collection and reporting of data on fire location, size, cause, and impacts, as well as guidelines for the management and dissemination of this information. This standard is used by organizations and agencies throughout Europe to ensure consistent and accurate reporting of forest fire information.

WILDFIRE-RELATED NATIONAL STANDARDS

The chapter on wildfire-related national standards provides a detailed overview of the national standards that are currently in place for wildfire management and response in a specific country, including their scope, purpose, and level of adoption and implementation.

STANDARDISATION GUIDELINES AND RECOMMENDATIONS

In addition to these standards, there are also several other guidelines and best practices that are used in wildfire management. For example, the Wildland Fire Lessons Learned Center[16] provides a wide range of information and best practices for wildfire management, including guidelines for risk assessment, incident management, and firefighting equipment and technology. Other organizations, such as the National Wildfire Coordinating Group (NWCG), also provide guidelines and best practices for wildfire management.

In conclusion, existing wildfire management standards are critical to ensuring that organizations and individuals are prepared to effectively prevent and respond to wildfires. The ISO 18788:2015 and National Wildfire Coordinating Group (NWCG) standards are two examples of widely used standards in this field. These standards provide guidance on a wide range of topics and are used by organizations and agencies around the world to ensure consistent and effective wildfire management practices. However, it is important to note that standards and guidelines alone are not enough for

[16] Wildland Fire Lessons Learned Center

effective wildfire management and need to be implemented in conjunction with other strategies, such as proper land use planning, public education, and community engagement.

SECTION 4: CONCLUSION

MAIN RESULTS

The work on WP3 conducted between months 1 and 12 resulted in many relevant developments. The Highlights of the period are:

- Development of a preliminary version of the Stakeholder engagement literature review. The research will inform the next steps of the TREEADS Platform development and the strategy of the local-level engagement processes.
- Concluded the first stage of the analysis of the stakeholders currently engaged in the platform, including a preliminary mapping of issues that motivate their engagement. The key points of the current analysis are:
    - The TREEADS Platform engages a diverse profile of stakeholders across different sectors and levels. The diversity indicates the potential of the TREEADS Platform to work as a hub to coordinate actors through frameworks and processes that enable a holistic approach to wildfire prevention and management.
    - The current profile of stakeholders is concentrated on local governments and research institutions/universities, the platform's potential to bridge the gap between research and practice, particularly in the prevention and preparedness phase.
    - The TREEADS Platform needs to expand the number of first-response actors directly involved in its development. These actors offer critical inputs for the platform design and can contribute decisively to the solutions' success.
    - The number of actors representing user groups in the pilot areas is also limited. While their contribution should be focused on targeted consultations during the TREEADS development, they represent a relevant.
    - Actors engaged with wildfire management at the local level have a strong demand for solutions. The main concerns are improving prevention & preparedness capacity for minimizing the risk of occurrence and developing an effective response in mechanisms where they occur.
    - The diversity of issues identified locally corroborates the understanding of wildfires as complex problems with multiple causes and systemic impacts. This understanding poses a relevant challenge to the TREEADS Platform to prioritize approaches in its development process.
    - Demand for solutions in the restoration & adaptation phases is limited.
    - All the results must be considered in light of the heterogeneity of pilots, as they differ significantly in their scope and current level of implementation. Some initiatives approach the project intending to test technologies to address specific issues. In contrast, others use exploratory approaches, first assessing the main challenges and then reaching out to technology providers to address them. These differences impact the profile of the stakeholders mapped and the priority issues identified and should be taken into account when incorporating information from these analyses into the

TREEADS Platform strategic planning process. The stakeholder mapping process was also approached differently.
    - Similarly, the workshop design incentivized engagement with local actors. New methodologies should be designed to map and support the engagement of the platform actors with regional and European stakeholders.
- Development of a preliminary version of the Technology, Innovation, and Trends literature review. The research results will support the TREEADS Platform development by building a framework to understand which technologies are available at each stage of wildfire management according to the potential stakeholders engaged.
- Literature review on Alkali-Activated Materials (AAMs) manufactured using Wood Ashes (WAs) or Post-wildfire Wood Ashes (PWAs) as precursors or activators and cement-based materials manufactured using WAs or PWAs as partial Ordinary Portland Cement (OPC) replacement.

NEXT STEPS

The following steps of Tasks 3.2, 3.3, and 3.4 (Figure 18) are:

- Finalizing the review of the stakeholder engagement literature review. The analysis results will set parameters for the local pilot and pan-European levels of the TREEADS Platform stakeholder engagement process.
- Performing the next steps of the stakeholder analysis process, moving from identifying and categorizing stakeholders to mapping the relationships between them.
- Finalizing the review on Technology, Innovation, and Trends. The research results will support the TREEADS Platform development by building a framework to understand which technologies are available at each stage of wildfire management according to the potential stakeholders engaged.

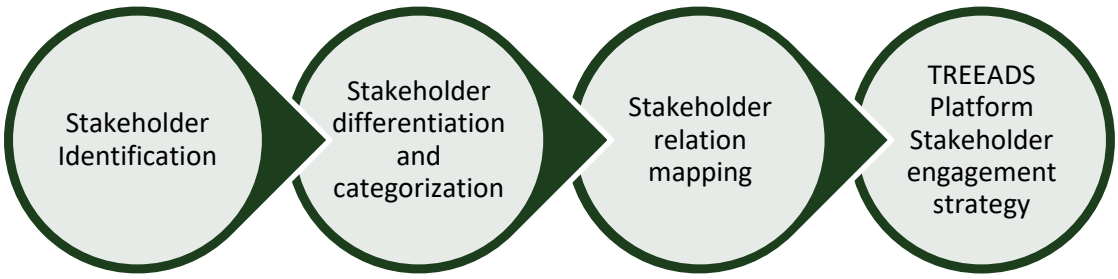

Figure 17: Next Steps.

REFERENCES

An, Z., Zhang, C., Zhang, D., Xing, A., & Jiang, S. (2021, May 20). Research on information transmission system of fire fighting UAV. *ACM International Conference Proceeding Series*. https://doi.org/10.1145/3468691.3468693

Andrew, R. M. (2018). Global CO2 emissions from cement production. *Earth System Science Data*, *10*(1), 195–217. https://doi.org/10.5194/essd-10-195-2018

Bouguettaya, A., Zarzour, H., Taberkit, A. M., & Kechida, A. (2022). A review on early wildfire detection from unmanned aerial vehicles using deep learning-based computer vision algorithms. In *Signal Processing* (Vol. 190). Elsevier B.V. https://doi.org/10.1016/j.sigpro.2021.108309

Burgess, E. R., & Shaw, A. (2016, August 17). Evaluating open collaboration opportunities in the fire service with FireCrowd. *Proceedings of the 12th International Symposium on Open Collaboration, OpenSym 2016*. https://doi.org/10.1145/2957792.2957794

Charnley, S., Kelly, E. C., & Fischer, A. P. (2020). Fostering collective action to reduce wildfire risk across property boundaries in the American West. *Environmental Research Letters*, *15*(2). https://doi.org/10.1088/1748-9326/ab639a

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, *18*(4), 598–606. https://doi.org/10.1016/j.gloenvcha.2008.07.013

Deng, Y., Cheng, W., & Gu, B. (2021). Computer Simulation of Fire Smoke Movement in Large Underground Space Buildings. *ACM International Conference Proceeding Series*, 922–928. https://doi.org/10.1145/3495018.3495305

Dong, W., Ze-Lin, J., & Li-Shun, L. (2020). Design of the building automatic fire alarm and fire -fighting system based on PLC. *ACM International Conference Proceeding Series*, 567–571. https://doi.org/10.1145/3436286.3436504

Essen, M., McCaffrey, S., Abrams, J., & Paveglio, T. (2021). Improving wildfire management outcomes: shifting the paradigm of wildfire from simple to complex risk. In *Journal of Environmental Planning and Management*. Routledge. https://doi.org/10.1080/09640568.2021.2007861

Font, A., Soriano, L., de Moraes Pinheiro, S. M., Tashima, M. M., Monzó, J., Borrachero, M. V., & Payá, J. (2020). Design and properties of 100% waste-based ternary alkali-activated mortars: Blast furnace slag, olive-stone biomass ash and rice husk ash. *Journal of Cleaner Production*, *243*. https://doi.org/10.1016/j.jclepro.2019.118568

Gu, T., Wang, C., & He, G. (2018, December 2). A VR-based, hybrid modeling approach to fire evacuation simulation. *Proceedings - VRCAI 2018: 16th ACM SIGGRAPH International Conference on Virtual-Reality Continuum and Its Applications in Industry*. https://doi.org/10.1145/3284398.3284409

Ha, G., Lee, H., Lee, S., Cha, J., & Kim, S. (2016). A VR serious game for fire evacuation drill with synchronized tele-collaboration among users. *Proceedings of the ACM Symposium on Virtual Reality Software and Technology, VRST*, *02-04-November-2016*, 301–302. https://doi.org/10.1145/2993369.2996306

Hartung, C., Han, R., Seielstad, C., & Holbrook, S. (2006). *FireWxNet: A Multi-Tiered Portable Wireless System for Monitoring Weather Conditions in Wildland Fire Environments **.

Hardey, K., Corapcioglu, E., Mattis, M., Goadrich, M., & Jadud, M. (2012). Exploring and evolving process-oriented control for real and virtual fire fighting robots. *GECCO'12 - Proceedings of the 14th International Conference on Genetic and Evolutionary Computation*, 105–112. https://doi.org/10.1145/2330163.2330179

Hua, B., Zhang, K., Wei, H., Zhang, J., & Xie, L. (2020, July 30). A Multilevel Fire Detection Platform Based on Multi-Source Heterogeneous Information Fusion. *ACM International Conference Proceeding Series*. https://doi.org/10.1145/3415048.3416120

Huang, Y., Gui, J., Zhou, X., Cao, B., Zheng, Y., Ye, K., Ju, X., Ni, Y., & Yang, L. (2019). Modelling the effect of moisture content and wind environment on fire spread on a fuel bed based on large eddy simulation. *ACM International Conference Proceeding Series*, 125–129. https://doi.org/10.1145/3307363.3307395

Jain, P., Coogan, S. C. P., Subramanian, S. G., Crowley, M., Taylor, S., & Flannigan, M. D. (2020). A review of machine learning applications in wildfire science and management. In *Environmental Reviews* (Vol. 28, Issue 4, pp. 478–505). Canadian Science Publishing. https://doi.org/10.1139/er-2020-0019

Jazebi, S., de Leon, F., & Nelson, A. (2020a). Review of Wildfire Management Techniques-Part I: Causes, Prevention, Detection, Suppression, and Data Analytics. In *IEEE Transactions on Power Delivery* (Vol. 35, Issue 1, pp. 430–439). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/TPWRD.2019.2930055

Jazebi, S., de Leon, F., & Nelson, A. (2020b). Review of Wildfire Management Techniques-Part I: Causes, Prevention, Detection, Suppression, and Data Analytics. In *IEEE Transactions on Power Delivery* (Vol. 35, Issue 1, pp. 430–439). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/TPWRD.2019.2930055

Jere, N. R., Scott, M. S., & Taruvinga, A. (2017). An integrated mobile veld fire detection and sharing platform for Southern Africa. *ACM International Conference Proceeding Series*, *Part F130806*. https://doi.org/10.1145/3129416.3129439

Johansson, J., & Lidskog, R. (2020). Constructing and justifying risk and accountability after extreme events: public administration and stakeholders' responses to a wildfire disaster. *Journal of Environmental Policy and Planning*, *22*(3), 353–365. https://doi.org/10.1080/1523908X.2020.1740656

Krasuski, A., Jankowski, A., Skowron, A., & Ślęzak, D. (2013). From sensory data to decision making: A perspective on supporting a fire commander. *Proceedings - 2013 IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent*

Agent Technology - Workshops, WI-IATW 2013, *3*, 229–236. https://doi.org/10.1109/WI-IAT.2013.188

Li, Y., Zhang, S., & Fu, G. (2022). Forest fire modeling and analysis based on K-means clustering algorithm and time series forecasting. *ACM International Conference Proceeding Series*, 310–316. https://doi.org/10.1145/3523286.3524560

Liang, T., Liu, J., & Tao, P. (2019). The implementation of the numerical simulation by utilization of pyrosim on the rectification of the hazard of fires. *ACM International Conference Proceeding Series*, 31–35. https://doi.org/10.1145/3307363.3307397

Luo, T., Wan, W., Gao, Y., Zhao, Y., & Li, Y. (2019). A novel fire rescue system with fog computing. *ACM International Conference Proceeding Series*, 90–96. https://doi.org/10.1145/3361821.3361832

Lv, H., & Chen, X. (2021). Research and Implementation of Forest Fire Smoke Detection Based on ResNet Transfer Learning. *ACM International Conference Proceeding Series*, 630–635. https://doi.org/10.1145/3501409.3501523

Marie, L., & Labossière, M. (2015). *Taking it into Their Own Hands: Innovative Wildfire Mitigation Measures at the Municipal Level*.

Mendes, M., Ângelo, P., Nisi, V., & Correia, N. (2011). Play with fire. *ACM International Conference Proceeding Series*, 1–2. https://doi.org/10.1145/2071423.2071530

Miller, B. A., Yung, L., Wyborn, C., Essen, M., Gray, B., & Williams, D. R. (2022). Re-Envisioning Wildland Fire Governance: Addressing the Transboundary, Uncertain, and Contested Aspects of Wildfire. *Fire*, *5*(2). https://doi.org/10.3390/fire5020049

Moura, D., & Oliveira, E. (2007). Fighting fire with agents - An agent coordination model for simulated firefighting. *Agent Directed Simulation Symposium, ADS 2007 - Proceedings of the 2007 Spring Simulation Multiconference, SpringSim 2007*, *1*, 71–78.

Muhs, J. W., Parvania, M., & Shahidehpour, M. (2020). Wildfire Risk Mitigation: A Paradigm Shift in Power Systems Planning and Operation. *IEEE Open Access Journal of Power and Energy*, *7*, 366–375. https://doi.org/10.1109/OAJPE.2020.3030023

Mukherjee, A., Mondal, J., & Dey, S. (2022). Accelerated Fire Detection and Localization at Edge. *ACM Transactions on Embedded Computing Systems*, *21*(6), 1–27. https://doi.org/10.1145/3510027

Nath, S., Agarwal, S., & Pandey, G. N. (2017). Evaluation of knowledge gaps in mathematical applications of thermal image processing techniques for fire prevention. *ACM Computing Surveys*, *50*(1). https://doi.org/10.1145/3009967

National Fire Protection Association "Building Codes and Wildfire." (n.d.). Retrieved from https://www.nfpa.org/Public-Education/By-topic/Wildfire/Building-codes-and-wildfire

Nilsson, T., Shaw, E., Cobb, S. V. G., Miller, D., Roper, T., Lawson, G., Meng-Ko, H., & Khan, J. (2019, May 2). Multisensory virtual environment for fire evacuation training. *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3290607.3313283

Nugroho, P. S., Latief, Y., & Wibowo, W. (2020). Conceptual Framework for Fire Safety Management Implementation Strategy to Determine Realistic Fire Insurance Premium Costs. *ACM International Conference Proceeding Series*, 247–253. https://doi.org/10.1145/3400934.3400980

Oliveira, S., Rocha, J., & Sá, A. (2021). Wildfire risk modeling. *Current Opinion in Environmental Science and Health*, *23*(4), 1–6. https://doi.org/10.1016/j.coesh.2021.100274

Ooi, S., Tanimoto, T., & Sano, M. (2019). Virtual reality fire disaster training system for improving disaster awareness. *ACM International Conference Proceeding Series*, *Part F148151*, 301–307. https://doi.org/10.1145/3318396.3318431

Palaiologou, P., Kalabokidis, K., Troumbis, A., Day, M. A., Nielsen-Pincus, M., & Ager, A. A. (2021). Socio-ecological perceptions of wildfire management and effects in Greece. *Fire*, *4*(2). https://doi.org/10.3390/fire4020018

Palsa, E., Bauer, M., Evers, C., Hamilton, M., & Nielsen-Pincus, M. (2022). Engagement in local and collaborative wildfire risk mitigation planning across the western U.S.—Evaluating participation and diversity in Community Wildfire Protection Plans. *PLoS ONE*, *17*(2 February). https://doi.org/10.1371/journal.pone.0263757

Pearce, L. (2003). Disaster Management and Community Planning, and Public Participation: How to Achieve Sustainable Hazard Mitigation. In *Natural Hazards* (Vol. 28).

Peinl, P. (2020). A Retrospective on ASPires: An Advanced System for the Prevention and Early Detection of Forest Fires. *Proceedings of the 12th International Conference on Management of Digital EcoSystems, MEDES 2020*, 30–37. https://doi.org/10.1145/3415958.3433039

Pereira, P., Mierauskas, P., & Novara, A. (2016). Stakeholders' Perceptions about Fire Impacts on Lithuanian Protected Areas. *Land Degradation and Development*, *27*(4), 871–883. https://doi.org/10.1002/ldr.2290

Perilla, F. S., Villanueva, G. R., Cacanindin, N. M., & Palaoag, T. D. (2018). Fire safety and alert system using arduino sensors with IoT integration. *ACM International Conference Proceeding Series*, 199–203. https://doi.org/10.1145/3185089.3185121

Ratnasari, A., Fitrianah, D., & Haji, W. H. (2020). BPTrends Redesign Methodology (BPRM) for the Development Disaster Management Prevention Information System. *ACM International Conference Proceeding Series*, 113–117. https://doi.org/10.1145/3379310.3381042

Robinne, F. N., Hallema, D. W., Bladon, K. D., Flannigan, M. D., Boisramé, G., Bréthaut, C. M., Doerr, S. H., di Baldassarre, G., Gallagher, L. A., Hohner, A. K., Khan, S. J., Kinoshita, A. M., Mordecai, R., Nunes, J. P., Nyman, P., Santín, C., Sheridan, G., Stoof, C. R., Thompson, M. P., … Wei, Y. (2021). Scientists' warning on extreme wildfire risks to water supply. *Hydrological Processes*, *35*(5). https://doi.org/10.1002/hyp.14086

Shahid, M., & Hua, K. L. (2021). Fire detection using transformer network. *ICMR 2021 - Proceedings of the 2021 International Conference on Multimedia Retrieval*, 627–630. https://doi.org/10.1145/3460426.3463665

Shi, W., Wang, H., Chen, C., & Kong, Z. (2021). Evolutionary game analysis of decision-making dynamics of local governments and residents during wildfires. *International Journal of Disaster Risk Reduction*, *53*. https://doi.org/10.1016/j.ijdrr.2020.101991

Shirley, R., & Black, L. (2011). Alkali activated solidification/stabilisation of air pollution control residues and co-fired pulverised fuel ash. *Journal of Hazardous Materials*, *194*, 232–242. https://doi.org/10.1016/j.jhazmat.2011.07.100

Siddique, R. (2012). Utilization of wood ash in concrete manufacturing. In *Resources, Conservation and Recycling* (Vol. 67, pp. 27–33). https://doi.org/10.1016/j.resconrec.2012.07.004

Sitas, N., Reyers, B., Cundill, G., Prozesky, H. E., Nel, J. L., & Esler, K. J. (2016). Fostering collaboration for knowledge and action in disaster management in South Africa. In *Current Opinion in Environmental Sustainability* (Vol. 19, pp. 94–102). Elsevier. https://doi.org/10.1016/j.cosust.2015.12.007

Somerkoski, B., Oliva, D., Tarkkanen, K., & Luimula, M. (2020). Digital Learning Environments - Constructing Augmented and Virtual Reality in Fire Safety. *ACM International Conference Proceeding Series*, 103–108. https://doi.org/10.1145/3377571.3377615

Sousa, M. J., Moutinho, A., & Almeida, M. (2020). Wildfire detection using transfer learning on augmented datasets. *Expert Systems with Applications*, *142*. https://doi.org/10.1016/j.eswa.2019.112975

Tedim, F., Leone, V., & Xanthopoulos, G. (2016). A wildfire risk management concept based on a social-ecological approach in the European Union: Fire Smart Territory. *International Journal of Disaster Risk Reduction*, *18*, 138–153. https://doi.org/10.1016/j.ijdrr.2016.06.005

Tedim, F., McCaffrey, S., Leone, V., Delogu, G. M., Castelnou, M., McGee, T. K., & Aranha, J. (2020). What can we do differently about the extreme wildfire problem. In Extreme Wildfire Events and Disasters (pp. 233–263). Elsevier. https://doi.org/10.1016/B978-0-12-815721-3.00013-8

U.S Forest Service "Wildfire Risk Assessment and Planning." (n.d.). Retrieved from https://www.fs.fed.us/science-technology/fire/management/risk-assessment

Vega, J., Rose, S., Eckhardt, C., Tahai, L., Humer, I., & Pietroszek, K. (2017). VR wildfire prevention: Teaching campfire safety in a gamified immersive environment. *Proceedings of the ACM Symposium on Virtual Reality Software and Technology, VRST*, *Part F131944*. https://doi.org/10.1145/3139131.3141218

Vigna, I., Besana, A., Comino, E., & Pezzoli, A. (2021). Application of the socio-ecological system framework to forest fire risk management: A systematic literature review. *Sustainability (Switzerland)*, *13*(4), 1–23. https://doi.org/10.3390/su13042121

Wagner, K.R.H. Designing insurance for climate change. Nat. Clim. Chang. 12, 1070–1072 (2022). https://doi.org/10.1038/s41558-022-01514-2

Wang, Q., Zhang, J., Guo, B., Hao, Z., Zhou, Y., Sun, J., Yu, Z., & Zheng, Y. (2019). CityGuard: Citywide fire risk forecasting using a machine learning approach. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, *3*(4). https://doi.org/10.1145/3369814

Wohl, L., Gorzkowski, R., Fox, N., & Kapadia, M. (2016). KINDLING : A game platform for crowd-sourcing fire evacuation data. *Proceedings - Motion in Games 2016: 9th International Conference on Motion in Games, MIG 2016*, 205. https://doi.org/10.1145/2994258.2994289

Xie, X., Wang, J., Qin, H., & Cheng, X. (2019). The simulation and research of fire spread situation based on osg. *ACM International Conference Proceeding Series*, 156–159. https://doi.org/10.1145/3335656.3335703

Xu, H., Huang, L., Wu, J., Wang, Y., Xu, B., Wang, J., & Wang, D. (2007). *Wireless Fire Monitoring System for Ancient Buildings*.

Yu, A. C., Hernandez, H. L., Kim, A. H., Stapleton, L. M., Brand, R. J., Mellor, E. T., Bauer, C. P., McCurdy, G. D., Wolff, A. J., Chan, D., Criddle, C. S., Acosta, J. D., & Appel, E. A. (2019). Wildfire prevention through prophylactic treatment of high-risk landscapes using viscoelastic retardant fluids. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(42), 20820–20827. https://doi.org/10.1073/pnas.1907855116

Yulei, Y., Jing, T., & Xinyang, S. (2017, August 17). Analysis of the influence of elevation error on Beidou RDSS positioning accuracy. *ACM International Conference Proceeding Series*. https://doi.org/10.1145/3078564.3078584

Zhang, Z. (2021). Constrained Sliding Mode Control for Uncertain Manipulator Systems with Prescribed Performance. *ACM International Conference Proceeding Series*, 1–4. https://doi.org/10.1145/3475851.3475855

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

TREEADS (No, Type) T3.3 Workshop with Pilot Partners & Stakeholders

Type of Meeting	WP3 workshop
Date/Place	**2nd semester 2022**
Authors	**CBS, Isabel Froes , Anna Schmid, Amalia Giannakopoulou**
Status	Final
Due date	24/11/2023
Document date	21/11/2023
Version number	2.0
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CONTENTS

THE WORKSHOP PRACTICALITIES

Preparing for the Workshop

- Set up a date and send out an invitation email (template provided by CBS) – please communicate to the stakeholders that the workshop will take around two hours.
- (Physical meeting) Book room/location, arrange coffee, water, etc.
- Prepare materials (for printing, in case of physical meetings; online files in case of online meeting).
- Decide who will be the main facilitator and the supporting facilitator. The supporting facilitator should be responsible for taking pictures, helping the main facilitator in the activities – making sure the right colour post-its are being used, etc.)
- If a hybrid meeting, please make sure to have at least 3 facilitators two for the physical space and another one for the online part.

Workshop Goals

The goal of the workshop are the following:

- To contribute to the goals of the project with this exercise – setup local governance & agency.
- Identify 6 key issues and questions related to the 3 phases (2 per phase).
- Identify the level of participation of distinct stakeholder interested in engaging with the most pressing issues.
- Set up the plan for stakeholder engagement – next steps.

The Workshop Format

Before the workshop:

- Please make sure everyone signs the document for consenting (sent by CBS) of recording and image material (this is to be uploaded to the repository together with the reporting template).

During the workshop:

- Please remember to record if online and please take pictures of the sessions, including the boards after each activity.

Workshop agenda:

5 min	**People presentation**
5 min	Project presentation – 3 phases of wildfire and purpose of workshop (0)
20 min	Brainstorming on key issues related to the 3 phases of wildfires (local) (remember to take pictures when done)
10 min	Present and discuss/ clarify identified issues
5 min	***break***
20 min	Ranking the identified issues in the Relevant Ranking table (remember to take pictures when done)
10 min	Discuss/ Clarify and select the most relevant ones (2 for each phase)
10 min	In/out activity for participants indicate which and how they would like to engage (from the final selection) (remember to take pictures when done)
5 min	***break***
10 min	Discuss/align activities and expectations
15 min	Lay out the plan for next steps based on in/out activity
5 min	Wrap up

Post workshop:

- Write participants thanking them for their participation and list next steps.
- Fill out template (sent by CBS) with workshop results and plan for next steps within 3 days of holding the workshop.
- Upload images and recordings (if online) to the repository (RISE Sharepoint)

Suggested Tools & Application

In the following you can find the tools to use during your workshops. You can find the online version and further description here on MIRO (please register for free on Miro in case you do not have an account yet – then you will get access to the tools).

- Tool 1: PHASES BRAINSTORM

Instructions

What is it?

Brainstorm on key issues related to the three phases of a wildfire. Think of all related actions, problems, lacks, issues etc. that come to your mind.

How it works

- Write down your thoughts about key issues on a post-it and place it in the respective phase.
- Please make sure to write one issue per post-it.

Description

Preparedness and Prevention: In this phase the aim is to understand and specify functional and nonfunctional requirements in preparedness and prevention of wild fires. Here aspects such as preventing measures, risk assessment, personal emergency evacuation, passive and active fire prevention as well as fire evacuation exercises are in focus. Further, effective fire information and instructions as well as evacuation exercises are considered. The goal is to detail all prevention and preparedness technical requirements to identify objectives to develop a safety culture in wildfire emergency management.

Detection and Response: In this phase the aim of the task is to understand and specify functional and nonfunctional requirements in the detection and response to wildfires. The task aims to understand current detection techniques and response of all stakeholders in accordance to current guidelines and policies considering also current table-top experiences. Focus is also put on automated fire detection systems to then detail the automated wildfire detection and response in all terrains and paradigms.

Restoration and Adaptation: In this phase the aim of the task is to understand specific functional and nonfunctional requirements in the restoration and adaptation after wildfires. Here new techniques to adapt to the threat of wildfire and restore affected areas are examined with the aim to incorporate these techniques in current systems. The goal is to increase the pace and rate of restoration after wildfires.

Brainstorming

Brainstorm on key issues related to the three phases of wildfires.

Preparedness and Prevention	Detection and Response	Restoration and Adaptation

- Tool 2: RANKING RELEVANCE

Instructions

What is it?

Take the identified issues from the previous brainstorming exercise and place them according to relevancy.

How it works

- Take the posits with the identified issues and place them on the relevance ranking canvas.
- The scale goes from low relevance to high relevance and the issues can be placed freely in between.

Description

High relevance: Highly relevant issue which needs to be addressed immediately with special attention. The issue has high influence on national and regional dynamics.

Medium relevance: Relevant issue which needs to be addressed. The issue has influence on national and regional dynamics.

Low relevance: The issue is relevant but not urged. The influence on national and regional dynamics is manageable.

Relevance Ranking

Rank the identified issues according to relevancy.

High Relevance	
Medium Relevance	
Low Relevance	

- Tool 3: IN/OUT ACTIVITY

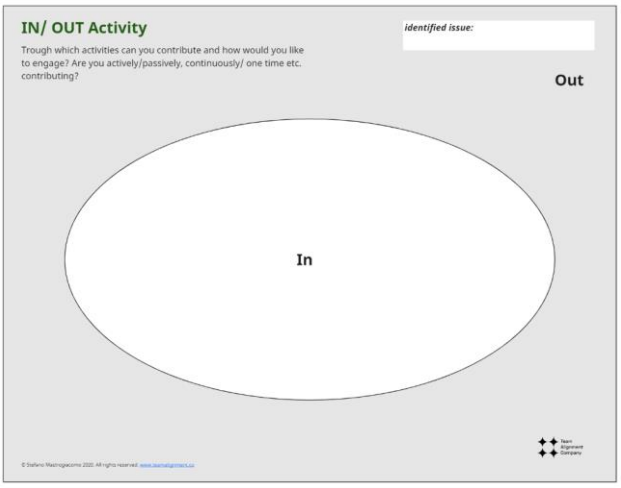
Instructions

What is it?

The IN/ OUT activity functions as overview for potential engagement. The participants are asked to indicate in which identified issues they want and can participate as well as how they would participate.

How it works

- Make sure that all stakeholder understand the identified (6key) issues within the three phases of a wildfire.
- Ask every stakeholder to use a different posit color or write down their name on it.
- Ask all stakeholders to write their activities dows through which they can contribute to the respective issue (in/out).
- Ask the stakeholders to write down how they can contribute to the identified issue and to what extend they are doing it (in/out).



PURPOSE OF THE TRAINING WORKSHOP

The first training workshops will be organized by CBS, DTU and all pilot partners will be invited to participate (per pilot). The workshops will provide us with an overview of:

- Knowledge, level of participation and engagement of local stakeholders in all three phases of wildfires.
- Financing & Insurance aspects.
- The understanding of the role of each stakeholder and how they want to be involved.

The language barrier might arise in some of the pilot cases. Therefore, the pilot partners will be invited to replicate the workshop with the local stakeholders in their own languages.

More specifically the workshop with pilot partners will help clarify:

- The goals and the outcome of the workshop(s),
- The next steps of the workshops with the local stakeholders,
- The co-creation of the Treeads platform governance.

TIMETABLE FOR TRAINING WORKSHOPS

Workshop with Pilot Partners		
Pilot Case	**Day**	**Time**
Romania	2nd of September 2022	10.45am-12.15pm
Norway	6th of September 2022	09.00am -10.30am
Greece	6th of September 2022	11.00am-12.30pm
Austria	7th of September 2022	09:00am-10.30am
Germany	7th of September 2022	01:00pm-02.30am
Taiwan	8 th of September 2022	09.00am-10.30am
Spain	8 th of September 2022	03.00pm-04.30pm
Italy	29th of September 2022	04:00- 05:30 pm

TIMETABLE FOR PILOT'S WORKSHOPS

	Workshops with Stakeholders		
Pilot Case	**Number of Stakeholders invited for workshop**	**Type of meeting (online/physical)**	**Day & Time**
Romania			
Norway			
Greece			
Austria			
Germany			
Taiwan			
Spain			
Italy			

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

TREEADS (No, Type) Workshop Reporting Template

Type of Meeting	WP3 workshop
Date/Place	**2nd semester 2022**
Authors	**CBS, Amalia Giannakopoulou, Anna Schmid, Isabel Froes**
Status	Draft
Due date	24/11/2023
Document date	21/11/2023
Version number	2.0
	TREEADS project has received funding from the European Union's Horizon 2020 research & innovation programme under grant agreement No 101036926. Content reflects only the authors' view and European Commission is not responsible for any use that may be made of the information it contains.

Reporting Template

The table below should be filled out, sent back to CBS, and uploaded to the drive in the folder WP3-T3.3 **folder** reporting templates.

Time	Description
Pilot Case	
Number of attendees	
Which stakeholder groups were represented	
Channel of communication used to reach them	
Which stakeholders were not reached and why	
Please, indicate the 6 more pressing issues identified based on the needs and the phase your pilot case focuses on	
For each stakeholder group, please specify (In and out Activity) • **potential contribution** • **current level of engagement** • **desired level of engagement**	
Identified local challenges	
Ideas to support local communities	
Next Steps: Please indicate a detailed plan with the activities to engage the different stakeholder groups based on their availability and their expertise	
How many participants were interested in being directly involved in the co-creation of the Think Tank	
How many committed to it	

ANNEX 3 – EMAIL INVITATION TEMPLATE

Subject line: xxx

CC: ***who will be in cc?***

Dear xxx,

We are reaching out to you to introduce you to the TREEADS project, which could be of high interest to you. To move towards the project goals and a valuable outcome, the project is engaging relevant stakeholders in the field of wildfire prevention, detection, and control. Therefore, we are very interested in your activities and potential contribution to the project's goals.

About the project:

TREEADS, a large-scale EU Green Deal project, brings together a consortium of 46 partners from 13 European countries and Taiwan, in the fight against wildfires. TREEADS will increase the effectiveness of enhanced sustainable fire and forest management under changing climate conditions, by building upon *state-of-the-art high TRL products and latest innovations in fields covering all three stages of fire management -namely fire prevention and preparedness, detection and response, restoration and adaptation - and uniting them under the umbrella of a holistic Fire Management Platform Ecosystem. TREEADS will capitalise on expert knowledge and EU initiatives, but also address the need for proactive governance, change of forest management practices, community-based awareness and preparedness activities, where local communities and bio-economy sectors will play a central role.*

By adopting a multi-stakeholder, multi-actor approach at its core, the TREEADS solutions will contribute to sustainable development as an inclusive societal process and secure sustainability and resilience of the natural environment, as well as local societies on unique levels. Especially, to contribute to local governance and system changes, the project collaborates with a variety of stakeholders, who can participate and contribute to the project in different ways. To collect insights on a local level, we are reaching out to you to understand your activities and potential contribution to TREEADS. Therefore, we hope you are interested and kindly ask you to go through the attached survey document and state your possible participation in the activities of the project.

Practical information:

- The questionnaire will take you about 5 minutes to fill out and will give us an insight into your participation in the project activities. Please send the document back to us as soon as possible.
- The questionnaire functions as an initial overview and will be followed up by more detailed information.
- Please do not hesitate to contact xxx for further information.
- Find further information about the project here: xxx.

We look forward to hearing back from you and getting part of TREEADS.

Kind regards,

xxx

TREEADS

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

TREEADS (No, Type) Attendance Template

Type of Meeting	WPx meeting, GA meeting, XX phone call…etc.
Date/Place	
Authors	**CBS, Amalia Giannakopoulou, Anna Schmid, Isabel Froes**
Status	Final
Due date	24/11/2023
Document date	21/11/2023
Version number	2.0
	TREEADS project has received funding from the European Union's Horizon 2020 research & innovation programme under grant agreement No 101036926. Content reflects only the authors' view and European Commission is not responsible for any use that may be made of the information it contains.

Participation List

Organisation	Name	DATE	Signature

I understand that a minimum of personal data (email address, date/time, images & video) are recorded by the host server at the premises of the (Name of the TREEADS partner) and protected by the General Data Protection Regulation (GDPR). They cannot be used for purposes other than the one for which they were gathered (to generate an organisation's profile and identify stakeholders' priorities in order to create an efficient communication within the project stakeholders). They are for the exclusive use of their recipient (Name of the TREEADS partner) and TREAADS Consortium and subject to confidentiality. They will be deleted within a maximum period of 5 years after the end of the project.

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

TREEADS (No, Type) T3.3 Workshop with Pilot Partners & Stakeholders

Type of Meeting	WP3 workshop
Date/Place	**2nd semester 2022**
Authors	**CBS, Amalia Giannakopoulou, Anna Schmid, Isabel Froes**
Status	Final
Due date	24/11/2023
Document date	21/11/2023
Version number	2.0
	TREEADS project has received funding from the European Union's Horizon 2020 research & innovation programme under grant agreement No 101036926. Content reflects only the authors' view and European Commission is not responsible for any use that may be made of the information it contains.

TREEADS: Stakeholder mapping

The purpose of this questionnaire is to gather info regarding types of engagement/participation of the different groups of stakeholders

1. What is your affiliation?

2. What type of activities would you like to participate in?

- ☐ **Meetings**
- ☐ Project Events
- ☐ Conferences
- ☐ Think-Tank
- ☐ Other:

3. Would you be willing to participate in the dissemination activities of the project on voluntary basis?

- ☐ **Yes**
- ☐ No
- ☐ Maybe

4. Would you be willing to participate in the dissemination activities on a voluntary basis as…?

- ☐ **Ambassador (help promote the project across networks locally)**
- ☐ Local Contact
- ☐ Other:

5. If interested, please share your name and preferred contact information:

I understand that a minimum of personal data (email address, date/time) are recorded by the host server at the premises of the (Name of the TREEADS partner) and protected by the General Data Protection Regulation (GDPR). They cannot be used for purposes other than the one for which they were gathered (to generate an organisation's profile and identify stakeholders' priorities in order to create an efficient communication within the project stakeholders). They are for the exclusive use of their recipient (Name of the TREEADS partner) and subject to confidentiality. They will be deleted within a maximum period of 5 years after the end of the project.

ANNEX 6 – WORKSHOP REPORTS

INDIVIDUAL WORKSHOP REPORTS

Each pilot conducted one workshop, with eight (8) workshops conducted between October and November 2022. The meetings were conducted in a physical or hybrid format.

NORWAY PILOT

Rise FR conducted the Norway pilot on November 9th. The meeting was conducted in a hybrid format and registered 36 participants from 32 stakeholder groups.

ATTENDEES

- 15 physical (representing 15 organizations)
- 21 digital (representing 17 organizations)

STAKEHOLDER GROUPS REPRESENTED

- Authorities (5)
- Fire and rescue services (4)
- Funding agency (1)
- Industry (2)
- Insurance (1)
- Landowner (1)
- Organizations/NGOs related to fire safety (2)
- Research institutions/universities (11)
- Miscellaneous (3)

CHANNELS OF COMMUNICATION

- Stakeholders were identified by brainstorming among the TREEADS partners connected with the Norwegian pilot, trying to ensure that representatives from different stakeholder groups were included. The project group has had contact with individuals in most of the stakeholders as part of previous projects and therefore had personal relationships with many of the contacted individuals. Before the workshop, five stakeholders were directly involved in addition to the partners: 3 with letters of intent and 2 with initial dialogues on potential collaboration.
- Emails were sent with an invitation to the stakeholder workshop, and reminder emails or phone calls one week later were used to reach the stakeholders.

WHICH STAKEHOLDERS WERE NOT REACHED AND WHY

- Invited, planned to attend but could not come: Authorities (1), Fire and rescue services (0), Funding agency (0), Industry (0), Insurance (0), Landowner (1), Organizations/NGOs related to fire safety (), Research institutions/universities () and Miscellaneous ().

- Invited, did not attend, or respond: Authorities (2), Fire and rescue services (2), Funding agency (), Industry (0), Insurance (0), Landowner (1), Organizations/NGOs related to fire safety (0), Research institutions/universities (4) and Miscellaneous (7).
- One of the groups not reached is the indigenous Sami people. It would have been very favourable to have them involved, as they represent a key stakeholder in certain areas of Norway, particularly their reindeer activity.

PRESSING ISSUES IN RELATION TO THE THREE WILDFIRE PHASES

The challenges ranged as high importance (only) and were clustered based on topic, and four key issues were identified. The critical issues identified in the workshop were:

- For Phase Fire Prevention & Preparedness:
  - Safe Border Zones (WUI)
  - Knowledge of framework factors, legislation, nature, resources
- For phase Detection & Response/ Effort:
  - Human Resources and Knowledge
  - Prediction of fire development and logistics
- For Phase Recovery & Customization:
  - Nobody

SIX MORE PRESSING ISSUES

- See above

POTENTIAL CONTRIBUTION/CURRENT LEVEL OF ENGAGEMENT/DESIRED LEVEL OF ENGAGEMENT

- The current level of engagement is registered by FRN based on letters of intent and collaboration dialogues.
- The desired level of engagement and communication method preferred was specified by the stakeholders in the workshop (see annex) and is registered by FRN.
- For the digital participants, there was insufficient time for each stakeholder to give input on the desired level of engagement and preferred communication method. Still, most of them have already replied to the survey.

LOCAL CHALLENGES

See the annex for all input from participants[17]

IDEAS TO SUPPORT LOCAL COMMUNITIES

Not discussed at the workshop

[17] Information provided in the native language and not incorporated in the final report.

NEXT STEPS

We will email the participants with information on the identified key issues, information on the planned activities in the pilot, information on future stakeholder workshops, and information that we will contact them directly linked to activities and that they are welcome to contact us.

HOW MANY PARTICIPANTS WERE INTERESTED IN BEING DIRECTLY INVOLVED IN THE CO-CREATION OF THE THINK TANK

- Not reported

HOW MANY COMMITTED TO IT

- Not reported

ADDITIONAL INFORMATION

- Not reported

ITALY PILOT

The Italian pilot was conducted by Stress on November 11th. The meeting was conducted in physical format and registered 22 participants from 17 stakeholder groups.

ATTENDEES

- Twenty-two people attended the workshop

STAKEHOLDER GROUPS REPRESENTED

- Local Volunteering associations
- Local Administrations
- Municipal Civil Protection
- Local companies
- Researchers

CHANNELS OF COMMUNICATION

Telephone and Email

WHICH STAKEHOLDERS WERE NOT REACHED, AND WHY

- Regional Civil Protection
- Regional Fire Fighter Corps

Initial contacts were established, but the collaboration request remains open (unanswered).

PRESSING ISSUES IN RELATION TO THE THREE WILDFIRE PHASES

Prevention and Preparedness:

- Behavioural Handbook
- Monitoring
- Constant Drone surveillance of the territory
- Immediate analysis of the causes of fires, patrolling and surveillance, sustainable management of the forests (support the growth of humus layers, topsoil shading, avoid reforestation with resinous essences)
- Analysis of the possible impacts on the sea and marine areas
- Focus on "le Tore and Punta Campanella" protected areas
- Involvement of population
- Need for correct fire propagation modelling
- Regulations on controlled brushwood burning
- Sensor's network, firebreak paths, correct modelling
- Correct maintenance of interfaces, thermal radars, fire hydrant network in the surroundings of forests, and intervention exercises

Detection and Response phase:

- Coordination between authorities for fast intervention
- Territorial emergency plans
- Creation of fast intervention plans
- Early detection of forest fires
- Use of chemical fire extinguishing agents
- Land/sea evacuation plans

Adaptation and Restoration phase:

- Fast restoration actions
- Cooperation of environmental associations
- Seed Bombing
- Creation of a Restoration Map linking flora and fauna
- Faithful restoration of the forest
- Identification of the correct tree species for the re-planting phase
- Comparative assessment of the different restoration solutions supports the autonomous post-event recovery

SIX MORE PRESSING ISSUES

Prevention and Preparedness:

- Need for correct fire propagation modelling
- Focus on "le Tore and Punta Campanella" protected areas

Detection and Response:

- Coordination between authorities for fast intervention
- Territorial emergency plans

Adaptation and Restoration:

- Fast restoration actions
- Seed Bombing

POTENTIAL CONTRIBUTION/CURRENT LEVEL OF ENGAGEMENT/DESIRED LEVEL OF ENGAGEMENT

Local Administrations, Municipal Civil Protection:

- Sorrento Municipality is a Project partner fully committed to the project activity.
- Piano di Sorrento, Meta, and Massa Lubrense Municipalities declared their interest in the project activities but did not participate in the first workshop. They will be invited for future activities.
- Parc Authority and Mountain Community of Monti Lattari declared their interest in the project activities but did not participate in the first workshop. They will be invited for future activities.

Local Volunteering associations

- MAREVIVO ONLUS: provided the Stakeholder Engagement Questionnaire, participated in the Workshop, and expressed their wish to participate in the following activities: Meetings, Project Events, Conferences, and Think-Tank (IN). They are interested in participating in dissemination activities as both Ambassadors and Local Contact.
- Fondazione Sorrento: provided the Stakeholder Engagement Questionnaire, did not participate in the Workshop but expressed their wish to participate in Conferences. They could be interested in participating in dissemination activities as Local Contact
- Fondazione dei Monti Lattari ONLUS: provided the Stakeholder Engagement Questionnaire, did not participate in the Workshop but expressed their wish to participate in Project Events. They could be interested in participating in dissemination activities as Local Contact.
- CNASAS - Campania Regional Service provided the Stakeholder Engagement Questionnaire, participated in the Workshop, and expressed their interest in the activities (IN) even if previously they were not favourable. They expressed their wish in participating to project events. They could be engaged in the simulation in natural environment activities.
- CAI - Italian Alpine Club provided the Stakeholder Engagement Questionnaire, participated in the Workshop, and expressed their interest in the activities (IN). They expressed their wish to participate in Meetings, Project Events, and the Think Tank. They could be engaged in the simulation in natural environment activities.
- ATS – Arte Turismo e Spettacolo participated in the Workshop and expressed their interest in the activities (IN).
- FAI - Italian Environmental Fund participated in the Workshop and expressed interest in the activities (IN).
- WWF – Local section - Terre del Tirreno -participated in the Workshop and expressed their interest in the activities (IN).

Local Companies

- STRESS – is a Project partner fully committed to the project activity.
- TECNOSISTEM – is an Affiliated Entity to STRESS - fully committed to the project activity.
- PENISOLAVERDE SpA – participated in the Workshop and expressed interest in the activities (IN).

LOCAL CHALLENGES

- Need for a coordinated approach in Forest Fire fighting actions.
- Lack of involvement, in the decision-making processes, of local volunteering associations.
- Difficult rescue and support teams' access to the forest areas due to geomorphology and the high density of urban settlements in other areas.

IDEAS TO SUPPORT LOCAL COMMUNITIES

- Increase the participation of non-profit organizations and associations representing local companies (hotel and restaurant owners, agricultural enterprises, or other commercial enterprises).

NEXT STEPS

- Specific meetings will be organized to engage the interested stakeholders in the Italian pilot activities they can support.
- The pilot leader will set up the first matchmaking of stakeholders to specific pilot activities. The overall detailed activity planning will be completed in the next six months concerning the different actions foreseen for the pilot.

HOW MANY PARTICIPANTS WERE INTERESTED IN BEING DIRECTLY INVOLVED IN THE CO-CREATION OF THE THINK TANK

- Five participants showed interest

HOW MANY COMMITTED TO IT

- Only two (2) committed to

ADDITIONAL INFORMATION

- To be confirmed

ROMANIA PILOT

ASFOR conducted the Romania pilot on the 18th of November, 2022. The meeting was conducted in physical format with 16 participants from six stakeholder groups.

ATTENDEES

- 16

STAKEHOLDER GROUPS REPRESENTED

- Firemen ISU
- APMMM
- Ministry of Environment
- ASFOR
- SIMAVI
- SC MITUFBRA WOOD SRL

CHANNELS OF COMMUNICATION

- Email and Telephone

WHICH STAKEHOLDERS WERE NOT REACHED, AND WHY

- None

PRESSING ISSUES IN RELATION TO THE THREE WILDFIRE PHASES

- Permits for flying with drones
- Introducing technology in the military unit
- Signal mixed up at different heights to other transmissions frequencies
- Educating people to take care of the forest

SIX MORE PRESSING ISSUES

- See above Awareness related to causes of fire forests
- Education for children and adults
- Permits regarding the equipment
- Permission to fly with drones
- AR / VR is open for training I the field
- Details in design graphics to reproduce the exact environment and the special cars used in the operational procedures

POTENTIAL CONTRIBUTION/CURRENT LEVEL OF ENGAGEMENT/DESIRED LEVEL OF ENGAGEMENT

- Ministry of Environment – will engage in dissemination and awareness campaigns regarding the fires in the forest
- Firemen ISU will take care of approvals
- Ministry of Environment - Policy maker dissemination of results at policy level dimension.
- Local firefighters (ISU Tulcea) Firefighters - Availability of firefighters and equipment for the pilot exercise
- Rodna Mountains National Park - Forest owner provides access to the natural park where the pilot is located
- SOFTWARE IMAGINATION & VISION SRL (SIMAVI) - Technical partner in Romania pilot in charge of developing AR/VR training and demonstration modules.

- Fundatia pentru SMURD (FptSMURD) - Liaison with local firefighters. Facilitate the participation of local firefighters, together with the logistical organization for the activities.
- APNMM-RA - Dissemination of results and engagements for citizens' awareness.

LOCAL CHALLENGES

- Making BBQ, and people don't know to take care of the fire not to spread
- Lack of signal at a few points on the field
- Training ISU in the field
- Educating children and adults
- Gathering people on different topics – Attractive and interactive debates for all ages

NEXT STEPS

- Communication plan for disseminating valuable information about TREEADS
- Training sessions for firemen
- Fires in forest Education for children and adults

HOW MANY PARTICIPANTS WERE INTERESTED IN BEING DIRECTLY INVOLVED IN THE CO-CREATION OF THE THINK TANK

- Not reported

HOW MANY COMMITTED TO IT

- Not reported

ADDITIONAL INFORMATION

- To be confirmed

SPAIN PILOT

USAL conducted the Spanish pilot on November 2nd. The meeting was conducted in physical format with forty participants from 28 stakeholder groups.

ATTENDEES

- 30

STAKEHOLDER GROUPS REPRESENTED

- Local associations
- Local councils
- Regional government
- Civil Protection and emergency
- Local companies

- Researchers

CHANNELS OF COMMUNICATION

- Email and Telephone

WHICH STAKEHOLDERS WERE NOT REACHED, AND WHY

- All stakeholders were reached

PRESSING ISSUES IN RELATION TO THE THREE WILDFIRE PHASES

- Prevention:
  - Forest management and planning
  - More people working on silvicultural treatments
- Response:
  - Improve communications, coordination, and connectivity
  - Need to act faster
- Restoration:
  - Good damage severity classification
  - Use of a greater variety of plant species

SIX MORE PRESSING ISSUES

- Firefighters working the hole year, doing silvicultural treatments out of the high fire risk period.
- Increased investment in forest management and planning (focus on fire prevention).
- Development and implementation of new fire prevention planning tools.
- Increased coordination and participation of local agents in all fire phases.
- Communication with society about the importance of forest management.
- Application of new paradigms in post-fire restoration.

POTENTIAL CONTRIBUTION/CURRENT LEVEL OF ENGAGEMENT/DESIRED LEVEL OF ENGAGEMENT

- Local associations
  - potential contribution:
    - Support in tasks associated with restoration tests (locations, types of vegetation)
    - Help with dissemination activities
  - Current level of engagement:
    - Declaration of interest in the project
  - Desired level of engagement:

        - Involvement and participation in future actions

- Local councils
    - Potential contribution:
        - Providers of information and permissions for their competition
        - Help with dissemination activities
    - Current level of engagement:
        - Declaration of interest in the project
    - Desired level of engagement:
        - Involvement and participation in future actions
- Regional government
    - Potential contribution:
        - Support in the task associated with the three phases: prevention, response, and restoration
        - Providers of information and permissions for their competition
    - Current level of engagement:
        - Declaration of interest in the project
    - Desired level of engagement:
        - Involvement and participation in future actions
- Civil protection and emergency
    - Potential contribution:
        - Help with coordination and improvement in fire response tasks
    - Current level of engagement:
        - Declaration of interest in the project
    - Desired level of engagement:
        - Involvement and participation in future actions
- Local Companies
    - Potential contribution:
        - Provide specific services not yet considered in the project
    - Current level of engagement:
        - Declaration of interest in the project
    - Desired level of engagement:
        - Involvement and participation in future actions

- Researchers
  - Potential contribution:
    - Provide specific knowledge on fire issues
  - Current level of engagement:
    - Declaration of interest in the project
  - Desired level of engagement:
    - Involvement and participation in future actions

LOCAL CHALLENGES

- Strategic planning at the landscape level of forest management from the point of view of prevention
- Participation of territorial agents in decision-making on forest policies
- Promotion and consolidation of fluid and agile communication and coordination with the regional government responsible for forest management

IDEAS TO SUPPORT LOCAL COMMUNITIES

- None

NEXT STEPS

- Design for each stakeholder a letter of adhesion to the project, establishing the specific terms of their planned participation.
- Send (and get signed) the adhesion letter.
- Hold, if necessary, bilateral meetings to deepen the role and tasks expected in the project.
- Hold 2-3 meetings in 2023 to report on the progress of the project and promote new lines of collaboration.
- Inform periodically via email or telephone of the actions in which the participation of each stakeholder is involved or considered appropriate.

HOW MANY PARTICIPANTS WERE INTERESTED IN BEING DIRECTLY INVOLVED IN THE CO-CREATION OF THE THINK TANK

- All of them

HOW MANY COMMITTED TO IT

- None (one of the following steps is to send them a collaboration and compromise letter)

ADDITIONAL INFORMATION

- Spanish pilot also has information from a survey applied on site.

AUSTRIA PILOT

DCNA conducted the Austrian pilot on November 9th. The meeting was conducted in physical format. It had 18 attendees from 10 stakeholder groups.

ATTENDEES

- BMLV
- OÖLFV
- LWZ Landeswarnzentrale Steiermark
- Land Steiermark
- Johanniter-Unfall-Hilfe Austria:
- FF GPK/IFR
- DCNA:
- Ing. Richard Feischl
- Johanniter Ausbildung und Forschung gem
- BOKU - Universität für Bodenkultur Wien

STAKEHOLDER GROUPS REPRESENTED

- Fire-related services (OÖLFV Oberösterreichischer Landesfeuerwehrverband, Freiwillige Feuerwehr Gumpoldskirchen)
- Authorities (BMLV Bundesheer, Land Steiermark)
- Academic institutions (BOKU Universität für Bodenkultur Wien)
- NGOs (DCNA)
- SME (Ing. Richard Feischl)
- Non-fire related first responder organizations (LWZ Landeswarnzentrale Steiermark, Johanniter -Unfall-Hilfe Austria, JOAFG Johanniter Ausbildung und Forschung gem. GmbH)

CHANNEL OF COMMUNICATION USED TO REACH THEM

- E-mail and telephone

WHICH STAKEHOLDERS WERE NOT REACHED

All these organizations were invited but had no time to join the meeting. The pilot will keep them updated on the progress of the project.

- Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)
- Ministry of Agriculture, Forestry, Regions, and Water Management (BMLRT)
- Interior Ministry (BMI)
- Zentralanstalt für Meteorologie und Geodynamik (ZAMG)
- Wine growers
- Olive tree growers
- Austrian Red Cross
- Representatives of the government of Lower Austria

PRESSING ISSUES IN RELATION TO THE THREE WILDFIRE PHASES

The pilot listed all identified issues within the three phases here.

- Preparedness and Prevention
  - Networking of organizations; lessons learned (inter-)nationally
  - Raising awareness of the population and authorities on forest fires; education about the dangers
- Detection and Response
  - Networking between authorities, emergency organizations, and experts; international cooperation
  - UAV Integration in firefighting tactics
- Restoration and Adaption
  - Safety zone/ buffer zone established at critical infrastructure
  - Climate forest promotion and consideration of resistance to vegetation

SIX MORE PRESSING ISSUES

- Prevention through silviculture, evaluation of possible ignition sources, and early wildfire detection
- Standardization to make the benefits of the measures quantifiable and understandable
- Training of scenarios in VR, AR, and reality, testing new techniques
- Nature and technology viewpoint in wildfire and industry (NATECH)
- Fuels and extinguishing management to determine decision criteria
- Equipment according to requirements, e.g., technical equipment and forest firefighting equipment for local fire departments

POTENTIAL CONTRIBUTION/CURRENT LEVEL OF ENGAGEMENT/DESIRED LEVEL OF ENGAGEMENT

- Universities (BOKU)
  - potential contribution:
    - Research on forest fires, including relevance for practice
    - Providing forest database and spread modelling (waldbrand.at)
    - Wildland-Urban-Interface
    - Prescribes burning, silviculture, and forest restructuring
    - Raising Awareness
  - Current level of engagement:
    - Declaration of interest in the project
  - Desired level of engagement:
    - Involvement and participation in future actions

- Austrian army (BMLV)
  - potential contribution:
    - Drone-assisted reforestation on forest fire area Großmittel Raising
  - Current level of engagement:
    - Declaration of interest in the project
  - Desired level of engagement:
    - Involvement and participation in future actions
- Local governance (Land Steiermark)
  - Potential contribution:
    - Providing Forest Data
    - Raising Awareness
    - The training area of the fire department school Steiermark
    - Infrastructure
  - Current level of engagement:
    - Declaration of interest in the project
  - Desired level of engagement:
    - Involvement and participation in future actions
- Local governance association (OÖLFV)
  - Potential contribution:
    - Consideration of and connection to ÖBFV knowledge management (results, contacts, etc.)
  - Current level of engagement:
    - Declaration of interest in the project
  - Desired level of engagement:
    - Involvement and participation in future actions
- National association and non-profit (Johanniter-Unfall-Hilfe Austria; JOAFG)
  - Potential contribution:
    - Testing possibilities
  - Current level of engagement:
    - Declaration of interest in the project
  - Desired level of engagement:
    - Involvement and participation in future actions

- Firefighters (FF GPK/IFR)
  - Potential contribution:
    - Knowledge transfer
    - Hot-spot detection
    - AR/ VR-Training
  - Current level of engagement:
    - Declaration of interest in the project
  - Desired level of engagement:
    - Involvement and participation in future actions
- Research (DCNA)
  - Potential contribution:
    - Partner in the project
  - Current level of engagement:
    - Partner in the project
  - Desired level of engagement:
    - Partner in the project and involvement and participation in future actions

IDENTIFIED LOCAL CHALLENGES

- Visibility in the public
- Partially insufficient equipment and budget
- Increased networking desired

IDEAS TO SUPPORT LOCAL COMMUNITIES

- Networking of organizations and interdisciplinary cooperation between authorities, emergency organizations, and experts
- Raising awareness among the population
- Incorporate technologies into reconnaissance (e.g., drone) and training (e.g., VR)

NEXT STEPS

- Contacting every stakeholder who has shown interest to concretize the involvement of each stakeholder in the project.
- Setting up a mailing list for exchange with the stakeholders
- Holding meetings, if necessary, for the organization and transfer of knowledge

ADDITIONAL INFORMATION

- For the voting, every participant had two votes per phase. Initially, it was planned one vote, but the participants requested more votes, so the workshop facilitators agreed on two votes per participant per phase.
- Expert advice should be supported in a targeted way to ensure an optimal assessment of the overall situation (e.g., online meteorology vs. local meteorologist).
- National differences must be considered (what works in another country or environment may not be suitable for Austria or certain geographical conditions.
- The voluntary fire department often does not get to know what happens in research. They would be interested to know what is being researched and whether it is in line with what the emergency forces need on-site → improved knowledge transfer.

GERMANY PILOT

BAM conducted the German pilot in an online format in May 2022. Fourteen participants from eight stakeholder groups were present.

ATTENDEES

- Forestry Saxony-Anhalt
- Forestry Brandenburg
- DWD - German weather forecast
- Fire service Cottbus (Brandenburg)
- Community Flechtingen
- Wildfire specialist DFV (German firefighter association)
- Pinfa, Association for eco-friendly flame retardants
- VFDB section 3 (German fire protection association)

STAKEHOLDER GROUPS REPRESENTED

- Federal government organizations: Forestry Saxony-Anhalt and Forestry Brandenburg
- Municipality: Community Flechtingen
- German fire protection association: vfdb section 3
- German weather forecast: DWD
- Fire service Cottbus (Brandenburg)
- German firefighter association: Wildfire specialist DFV
- European association: Pinfa (Association for eco-friendly flame retardants)

CHANNEL OF COMMUNICATION USED TO REACH THEM

- E-mail and telephone

WHICH STAKEHOLDERS WERE NOT REACHED, AND WHY

- Some had not answered the emails and were called after the workshop by phone

PRESSING ISSUES IN RELATION TO THE THREE WILDFIRE PHASES

- Use and interpretation of existing data
- Improve firefighting tactics
- Safety of public and first responders regarding smoke gas inhalation
- Save water/water efficient fire fighting

SIX MORE PRESSING ISSUES

- A better understanding of different vegetation on fire spread mechanisms
- Smoke gas concentrations and components
- Use of different extinguishment agents and deployment
- Investigation of fire spread in the ground
- The efficiency of firewalls
- Eco-friendliness of extinguishment agents

POTENTIAL CONTRIBUTION/CURRENT LEVEL OF ENGAGEMENT/DESIRED LEVEL OF ENGAGEMENT

- Forestry: data and knowledge about the vegetation and typical use of the forest
- Fire service: current firefighting tactics and gear and challenges, experience reports of real fires
- German weather forecast: providing local weather data for pilot areas and conditions when fires occurred
- European association: assessment of extinguishment agents

IDENTIFIED LOCAL CHALLENGES

- Ammunition in the ground

IDEAS TO SUPPORT LOCAL COMMUNITIES

- Refinement of firefighter tactics/ways to make the forest more resilient

NEXT STEPS

- Regular meetings with the whole group and meetings in between for specific topics with only a part of the participants which are related to the topic.
- Meeting with forestry and DWD for vegetation and weather-related research.
- Meeting with fire service, vfdb and DFV for firefighting tactics, protective gear, and guidelines for smoke protection of first responders.

ADDITIONAL INFORMATION

- How many participants were interested in being directly involved in the co-creation of the Think Tank: The pilot still has to announce the idea as the first workshop was held on May 18th, 2022 already. The next workshop is planned for March 2023 and will introduce the Think Tank and ask for a commitment.

GREECE PILOT

The Greek workshop by TUC on the 26th of October 2022 is in physical format. 38 attendees from 18 groups participated.

NUMBER OF ATTENDEES

- Thirty-eight (38) people participated in the workshop.

STAKEHOLDER GROUPS REPRESENTED

- 8BELLS
- ACCELI
- ADRESTIA
- CBS
- Chania Fire Brigade
- Chania Forest Service
- EKAB - National Center for Emergency Chania
- Frontiers Innovations
- MAICh
- Municipality of Chania
- Municipality of Platanias
- NCSRD
- NECCA - Samaria Gorge Managers
- Neos Omalos - Hotel Managers
- NOA
- OAK A.E.
- Terra Petra
- TUC

CHANNEL OF COMMUNICATION USED TO REACH THEM

- Email and Telephone

WHICH STAKEHOLDERS WERE NOT REACHED, AND WHY

None

IDENTIFIED PRESSING ISSUES IN RELATION TO THE THREE WILDFIRE PHASES IN THE PILOT REGION

- Visitors of the Gorge are not always aware of the level of difficulty/dangers of the route - lack of awareness.
- Necessity to expand the online information provision to the visitors via online registration/tickets – already in action.
- So far, there are no automated means of fire detection within the Samaria Gorge
- The necessity to improve the water supply system in the gorge to meet the fire brigade standards (~3 – 4 bar). In the planning phase, integrate a fibre-optic cable

within the water supply system to serve as a communication network infrastructure. Still, it will not be available in the timeframe of TREEADS.
- Improvement/Maintenance of escape routes and maps.
- Necessity of cameras and speakers along the path – The fire brigade should also have access to them.
- System for the recording of visitors along the path. It is better to have an automated one with a more frequent time step.
- Need for cell phone/5G coverage in the gorge.
- Drones could support the fire brigade's efforts. Already in action for the broader region of Chania – Need for more frequent aerial patrols. Potentially - transportation of firefighting equipment/material.
- Hellenic Civil Aviation Authority has prohibited the use of UAVs because of the possible risk of fire ignition in the case of a UAV accident.
- Necessity for:
    - Sensors for fire P&P enhancement.
    - Better communication among the actors of the Samaria Gorge.
    - Firefighting tools could be distributed along the Samaria Gorge path.
    - Fire Weather forecasts – Need for Fire Hazard Prediction Map all year round- (not only for the summer season).

THE 6 MOST PRESSING ISSUES IDENTIFIED BASED ON THE NEEDS AND THE PHASE OF THE PILOT'S FOCUS

- Development of the visitor information application (P&P).
- Upgrade the existing water distribution network in the gorge (D&R).
- Establish reliable communication tools for the actors and the stakeholders (P&P – D&R).
- Limited access to power supply along the route. There are limited sources of electricity within the gorge – powered by PV (P&P).
- Identify the best UAV solution to be used by the actors (P&P – D&R).
- Difficulties in animal evacuation due to their unpredictable movement (D&R).

POTENTIAL CONTRIBUTION/CURRENT LEVEL OF ENGAGEMENT/DESIRED LEVEL OF ENGAGEMENT

- Chania Fire Brigade: With their expert knowledge, they provide critical guidance on which and how each technology should be used to maximize its impact. Level of engagement 5/5.
- Chania Forest Service: As the most senior actor (former manager of the Samaria gorge and forest experts) in the pilot consortium, they contribute with their knowledge and experience on the Samaria gorge forest matters. Level of engagement 5/5.
- EKAB - National Center for Emergency Chania: They are willing to train the Samaria gorge management personnel for first aid targeted to the potential needs in the case of fire. Level of engagement 2/5.

- Municipality of Chania: They support TREEADS activities by facilitating the activities of TREEADS. Level of engagement 1/5.
- Municipality of Platanias: Level of engagement 2/5 to 3/5.
- NECCA - Samaria Gorge Managers: The managers of Samaria Gorge, as the most crucial actor in the Pilot, contribute with their knowledge and the current infrastructure, to get the best outcome of the pilot use of the technologies that will be used in the premises of TREEADS. Level of engagement 5/5.
- Neos Omalos - Hotel Managers: Level of engagement 2/5.
- OAK A.E.: They are the managers of the water resources on Crete (dams and reservoirs) and have expressed their willingness to provide the water resources needed for the fire brigade water system expansion. Level of engagement 2/5 to 4/5.
- Terra Petra – Local guides Level of engagement 4/5.

LOCAL CHALLENGES

- Steep geomorphology, no mobile network available, limited power supply.

IDEAS TO SUPPORT LOCAL COMMUNITIES

- Increase visitor responsibility and let them know of the risks and dangers of the visiting area, Samaria Gorge.

NEXT STEPS

- Meetings are to be held to let the relevant stakeholders and actors of the advancement of TREEADS.
- Communication channels to be developed to provide feedback back and forth between stakeholders, actors, and the technology providers of TREEADS.

HOW MANY PARTICIPANTS WERE INTERESTED IN BEING DIRECTLY INVOLVED IN THE CO-CREATION OF THE THINK TANK

- Eight people so far.
- How many committed to it: Not yet committed.

TAIWAN PILOT

The Taiwanese workshop with local stakeholders was conducted on the 26th of October 2022 physically with 10 participants from four stakeholder groups.

ATTENDEES

Ten (10) people participated in the workshop.

STAKEHOLDER GROUPS REPRESENTED

- NTUST
- NTUT
- NKUST

- TFRI

CHANNELS OF COMMUNICATION

- Not Informed

WHICH STAKEHOLDERS WERE NOT REACHED – WHY NOT

- Forest owner: This meeting focused on developing the advanced technique used for the Pilot case.

IDENTIFYING PRESSING ISSUES IN RELATION TO THE THREE WILDFIRE PHASES IN THE PILOT REGION

- Install the pilot model
- Set up the IOT system
- Determine the smoke and fire spread simulation model
- Weather conditions detecting system

SIX MOST PRESSING ISSUES

- The advanced technique used in this project
- Laboratory testing for concrete
- Connect the sensors for the IOT system
- Determine the pilot case location
- Trial test for weather condition detection system
- Spread smoke and fire simulation model

POTENTIAL CONTRIBUTION/CURRENT LEVEL OF ENGAGEMENT/DESIRED LEVEL OF ENGAGEMENT

- Early warning system; fire-resistant material; ignition point
- Current level: materials investigation
- Desired level: development of IoT network

IDENTIFIED LOCAL CHALLENGES

- Installation of the pilot site due to the long distance and mountain topography.

IDEAS TO SUPPORT LOCAL COMMUNITIES

- Use of LoRa technique

NEXT STEPS

- NTUT: develop the IOT system and connect it with the weather condition sensors detector
- TFRI: determine the pilot location; Spread smoke and fire simulation model
- NKUST and NTUST: Laboratory testing for concrete

HOW MANY ARE INTERESTED IN BEING INVOLVED IN THE THINK TANK

- All of them

HOW MANY COMMITTED TO IT

- All of them
- Comments from participants that evolved during the discussion:

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
ALTRAN	ES	**EfB**	EL	**DdA**	ES
DH	ES	**LAMMC**	LT	**STRESS**	IT
USAL	ES	**OS**	DE	**ACaMIR**	IT
SQD	BE	**VIPO**	NO	**Sorrento**	IT
CARTIF	ES	**WAS**	NO	**PUI**	FR
UdG	ES	**CBS**	DK	**FAFCYLE**	ES
NCSRD	EL	**K3Y**	BG	**BFG**	AT
SIMAVI	RO	**MAGG**	IT	**TUC**	EL
OVGU	DE	**NOA**	EL	**MAICh**	EL
Adrestia	EL	**MEWF**	RO	**DAAC**	EL
CERTH	EL	**ASFOR**	RO	**NTUST**	TW
8BELLS	CY	**SMURD**	RO	**DTU**	DK
ACCELI	CY	**JOAFG**	AT		

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