FIREURISK - DEVELOPING A HOLISTIC, RISK-WISE STRATEGY FOR EUROPEAN WILDFIRE MANAGEMENT

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Executive Summary

Deliverable D6.15, titled "Policy Integration with FirEURisk Roadmap," represents a significant milestone in the FirEURisk project's mission to enhance wildfire management across Europe. This comprehensive document outlines a strategic approach for seamlessly integrating FirEURisk's cutting-edge tools, models, and methodologies generated in the context of the project into operational wildfire management policies at national, regional, and European levels. By bridging the gap between scientific advancements and practical policy implementation, D6.15 aims to support the use of FirEURisk outcomes and contribute to transforming the landscape of wildfire management in Europe.

A key feature of this deliverable is the Open Platform, a central hub that brings together essential elements of contemporary wildfire management. The Open Platform plays a central role in advancing wildfire risk management across Europe. Designed as a comprehensive digital interface, it brings together critical wildfire-related data and expert knowledge into a single, accessible location. With its data integration and visualization tools, the platform enhances users' ability to monitor, assess, and respond to wildfire threats more effectively. By ensuring the wide dissemination of risk information—both within the FirEURisk consortium and to external audiences such as end-users and the public—the platform contributes directly to the project's overarching goal of building a safer, more resilient Europe. As a collaborative environment, the platform fosters knowledge exchange among a broad community of stakeholders—ranging from fire and forest services to civil protection agencies, urban planners, and decision-makers.

This deliverable document

- Highlights FirEURisk outcomes and its effect on wildfire management policy across Europe
- Reviews existing wildfire-related policies and identifies opportunities for harmonizing and aligning policies
- Explores the use of digital decision support systems for fire risk management
- Outline role of Open Platform and Viewer and their integration into other operational systems
- Lists key principles and strategic objectives for successful integration of FirEURisk outcomes into policy frameworks
- Outlines approach for tracking progress, assessing impact, and continuously improving the implementation of FirEURisk outcomes

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List of Acronyms

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List of Acronyms	
API	Application Programming Interface
COG	Cloud Optimised GeoTIFF
CSS	Cascading Style Sheets
DMP	Data Management Plan
DMB	Data Management Board
DTM	Digital Terrain Model
EFFIS	European Forest Fire Information System
EO	Earth Observation
ET	European Territory
EU	European Union
GeoTIFF	Geographic Tagged Image File Format
GIS	Geographic Information System
HTML	HyperText Markup Language
IRI	Integrated Risk Index
NbS	Nature-based Solutions
REST	Representational State Transfer
URL	Uniform Resource Locator
WMS	Web Map Service
WFS	Web Feature Service
VIIRS	Visible Infrared Imaging Radiometer Suite

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1 Roadmap for Policy Integration and Stakeholder Engagement

1.1 Introduction

The primary objective of D6.15 is to facilitate the seamless adoption and integration of FirEURisk's tools and outcomes into wildfire management practices throughout Europe. This ambitious goal is underpinned by several key findings that highlight the critical importance of a multifaceted approach to wildfire management:

1. **Operational Integration**: The integration of FirEURisk's online FirEURisk's digital decision support systems (DSS) into existing operational frameworks is paramount (FirEURisk D4.4; FirEURisk D4.5). The relevant systems and components, which include sophisticated fire risk assessment models and knowledge based on behaviour prediction tools (FirEURisk D2.6; FirEURisk D4.5), are not just add-ons but are central to enhancing the entire spectrum of wildfire management. From prevention strategies to real-time risk management and post-fire recovery planning, these tools offer a level of insight and predictive capability that can significantly improve the effectiveness of wildfire management efforts (**FirEURisk D2.1; FirEURisk D4.4**).
2. **Stakeholder Collaboration**: The success of any new tool or methodology in the field of wildfire management hinges on its acceptance and adoption by those on the front lines. Recognizing this, FirEURisk has placed a strong emphasis on continuous engagement with a diverse range of stakeholders (FirEURisk D4.5; FirEURisk D6.14). This collaborative approach has been instrumental in validating the project's tools and ensuring their applicability across different regions and fire management contexts (FirEURisk D6.14; FirEURisk D4.5). By involving stakeholders from the outset, FirEURisk has focused to tools that are not only scientifically robust but also practical and relevant to real-world scenarios (FirEURisk D4.5).
3. **Policy Harmonization**: One of the most significant potentials of FirEURisk's tools lies in their ability to harmonize wildfire risk management policies across Europe. By providing a common framework and set of tools (FirEURisk D6.14; FirEURisk D4.4), FirEURisk can help ensure consistency in risk assessments, prevention strategies, and response efforts across different countries and regions. This harmonization is crucial for effective cross-border collaboration and resource sharing (FirEURisk D6.14; FirEURisk D4.5), particularly in the face of large-scale wildfire events that do not respect national boundaries.

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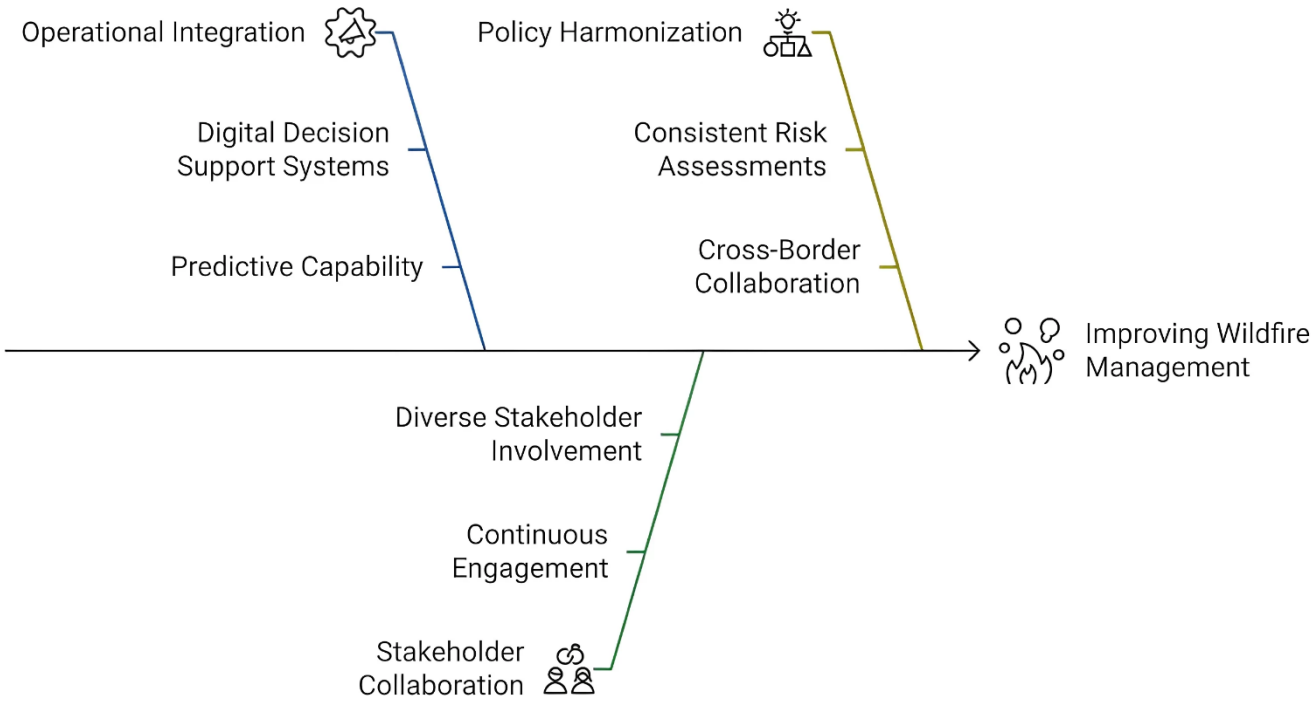


Figure 1 Enhancing Wildfire Management with FirEURisk

The roadmap outlined in D6.15 emphasizes the need for a systemic approach to wildfire risk management (FirEURisk D4.5; FirEURisk D4.4). This approach recognises the intricate connections between disaster risk reduction and climate change adaptation (FirEURisk D2.6; FirEURisk D4.5), acknowledging that wildfires are not isolated events but part of a complex ecological and climatic system. Furthermore, the roadmap stresses the importance of community engagement and adaptive management strategies (FirEURisk D6.14; FirEURisk D4.5), recognising that effective wildfire management requires the involvement and cooperation of local communities (FirEURisk D4.5). Improving wildfire management through data-driven decisions enhances public safety, reduces economic losses, fosters environmental sustainability, and strengthens policy frameworks. Moreover, by promoting collaboration, equity, and training, it can create lasting benefits for society, especially in areas vulnerable to wildfires.

In line with broader European environmental initiatives, the FirEURisk roadmap aligns with key policy frameworks such as the European Green Deal and the EU Biodiversity Strategy for 2030. This ensures that wildfire management strategies are developed in conjunction with larger environmental and climate resilience efforts (FirEURisk D4.5).
The roadmap promotes a dual framework that merges two complementary approaches: Integrated Wildfire Risk Management (IWFRM) and Holistic Landscape Fire Management (HLFM). The detail of this dual approach is elaborated in the following section of this document.

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1.2 Scope and Objectives

Deliverable D6.15, "Policy Integration with FirEURisk Roadmap," represents a crucial component of the FirEURisk project, aiming to bridge the gap between advanced wildfire management research and practical policy implementation across Europe. The scope of this deliverable is comprehensive, encompassing the development of a detailed roadmap for integrating FirEURisk's research outcomes, tools, and strategies into operational wildfire management policies at various governance levels (FirEURisk D6.14; FirEURisk D4.5).

The primary objective of D6.15 is to facilitate the transition from traditional, reactive fire suppression approaches to more holistic, ecosystem-based strategies that align with modern understanding of wildfire dynamics and management (FirEURisk D2.6; FirEURisk D4.4). This shift is encapsulated in the promotion of two complementary frameworks: Integrated Wildfire Risk Management (IWFRM) and Holistic Landscape Fire Management (HLFM). These approaches address both immediate fire suppression needs and long-term landscape resilience, aligning with key EU policies such as the European Green Deal and the EU Strategy on Adaptation to Climate Change (FirEURisk D4.5; FirEURisk D4.4).

To achieve its overarching goal, D6.15 outlines several specific objectives:

- **Operationalise FirEURisk Tools:** A primary focus is on ensuring the practical adoption of the project's outcomes, digital tools for wildfire risk assessment and management (FirEURisk D4.4; FirEURisk D2.6). This requires not only the technical integration and use of such tools but also adopting relevant strategies for their effective use by relevant organizations at local, national, and international levels. The roadmap provides guidance on how to incorporate these tools into existing operational frameworks, ensuring they enhance rather than disrupt current practices (FirEURisk D4.5).
- **Collaborate with Stakeholders:** Recognising that the success of any new system depends on its acceptance by end-users, D6.15 emphasises the importance of stakeholder engagement in the co-production of the roadmap (FirEURisk D4.5; FirEURisk D6.14). This collaborative approach, shaped through a series of online webinars, and workshops, ensures that the final product as closely as possible reflects the real needs and constraints of those working in wildfire management, from local fire services to national policymakers (FirEURisk D4.5; FirEURisk D6.14). The deliverable outlines strategies for ongoing stakeholder involvement, fostering a sense of ownership and commitment to the new tools and approaches (FirEURisk D4.5).
- **Integrate into Existing Systems:** A critical aspect of the roadmap is its focus on aligning FirEURisk outcomes with existing European and national fire management frameworks (FirEURisk D6.14; FirEURisk D4.4). This includes strategies for integrating with established systems such as the European Forest Fire Information System (EFFIS), ensuring that FirEURisk tools complement and enhance existing capabilities rather than creating parallel or competing systems (FirEURisk D4.5).
- **Develop a Dissemination Strategy:** To maximise the impact of FirEURisk's research and tools, D6.15 includes a comprehensive plan for disseminating project outcomes (FirEURisk D4.5; FirEURisk D6.14). This strategy focuses mainly on reaching stakeholders in fire-prone regions across Europe, utilising a variety of channels and formats including the JRC Risk Datahub, to ensure that information is accessible and actionable for different audience types (FirEURisk D4.4).
- **Ensure Scalability and Adaptability:** Recognising the diverse fire risk environments across Europe, the roadmap provides guidance on adapting FirEURisk products to different contexts (FirEURisk D4.5; FirEURisk D2.6). This

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includes considerations for scaling solutions from local to national levels, as well as strategies for adapting tools to regions experiencing changing fire regimes due to climate change (FirEURisk D2.6; FirEURisk D4.4).

D6.15 strives to establish a clear framework for deploying FirEURisk's sophisticated wildfire management strategies throughout Europe. This roadmap acts as a link between scientific findings and practical application, offering decision-makers and field experts the necessary guidance to work on improving wildfire resilience in light of escalating climate-related threats (FirEURisk D4.5; FirEURisk D6.14).

1.3 Relation to Key FirEURisk Deliverables

Deliverable D6.15 does not stand alone but builds upon and synthesizes insights from several other key FirEURisk deliverables. This integration ensures that the policy roadmap is grounded in comprehensive research and practical insights gained throughout the project. The key related deliverables include:

- **D6.14: Integrated Policy and Best Practices Recommendations:** This deliverable provided a foundational analysis of national and European wildfire management policies and best practices. D6.15 builds on this work by translating these insights into actionable policy recommendations. The analysis of existing national regulatory frameworks in D6.14 informs the integration strategies outlined in the D6.15 roadmap, ensuring that the innovative approaches endorsed in FirEURisk align with and enhance current practices rather than conflict with them.
- **D4.4: Conceptual Framework for Integrating Risk-based Fire Management Strategies:** This deliverable established the theoretical foundations for integrating different components of wildfire risk into cohesive management strategies. D6.15 takes this conceptual framework and translates it into practical policy guidance, showing how the theoretical principles can be applied in real-world governance and operational contexts.
- **D4.5: Operational Guidelines for Wildfire Risk Reduction and Management:** While D4.5 focused on proposing an Integrated Wildfire Risk Management System (IWRMS) with detailed guidelines on preparing a tailor-made system for key stakeholders i.e. Policy-makers and managers, D6.15 expands on this by providing a broader policy context for these operational practices. The roadmap in D6.15 shows how these operational guidelines can be supported and facilitated through policy frameworks at various governance levels.

By integrating insights from these deliverables, D6.15 develops a comprehensive roadmap that bridges scientific research, operational practices, and policy frameworks. This synthesis ensures that the policy recommendations are both scientifically and practically feasible and aligned with existing governance structures.

1.4 Relevance to Work Package 6 (WP6)

Deliverable D6.15 is a critical component of Work Package 6 (WP6), which focuses on policy integration, outreach, and networking within the FirEURisk project. The relevance of D6.15 to WP6 is multifaceted:

- **Policy Integration**: At its core, D6.15 provides a clear roadmap for adopting FirEURisk tools and methodologies into existing policy frameworks (FirEURisk D6.14). It addresses the challenge of translating scientific outcomes into actionable policy measures, identifying potential barriers to integration and proposing strategies to

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overcome them. This aligns directly with WP6's goal of ensuring that FirEURisk's research has a tangible impact on wildfire management policies across Europe (FirEURisk D4.5).

- **Outreach and Stakeholder Engagement**: The roadmap emphasises the importance of co-producing policy recommendations with stakeholders. This approach, central to WP6's objectives, ensures that the final recommendations are relevant, practical, and likely to be adopted (FirEURisk D4.5; FirEURisk D6.14). D6.15 includes a structured plan for ongoing engagement and dissemination activities, supporting WP6's aim of effectively communicating project outcomes to a wide range of stakeholders (FirEURisk D4.4).
- **Networking and Collaboration**: D6.15 outlines strategies for building and maintaining networks among various stakeholders in the European wildfire management community (FirEURisk D6.14), including EC policymakers (DG ECHO, DG Research), EU wildfire research ecosystem (Firelogue and Green Deal projects, and the FirEURisk Observatory), as well as national forest and fire management authorities. This networking aspect is crucial for WP6, as it facilitates the sharing of best practices, encourages cross-border collaboration, and supports the continued development and refinement of FirEURisk tools beyond the project's conclusion (FirEURisk D4.5).

By addressing these key areas, D6.15 is vital in achieving WP6's overall objectives of ensuring that FirEURisk's outcomes are effectively communicated, adopted, and integrated into wildfire management practices across Europe. The roadmap serves as a bridge between the project's scientific and technical achievements and their practical application in policy and operational contexts.

1.5 Stakeholders Engagement and Collaboration

The success of the FirEURisk project and the implementation of its roadmap are heavily dependent on effective stakeholder engagement and collaboration. Recognizing this, the project has made concerted efforts to engage a broad spectrum of stakeholders throughout its development process. This diverse group includes national and local authorities, civil protection agencies, research institutions, fire management services, and local communities (FirEURisk D4.5; FirEURisk D6.14). Additionally, the FirEURisk Observatory, comprised of international experts in wildfire research, provided necessary guidance and evaluation regarding the project’s policy orientation and decisions. Each of these stakeholders brings unique perspectives and expertise to the table, enriching the project's outcomes and ensuring their real-world applicability.

This collaborative approach aligns closely with the Landscape Fire Governance Framework (LFGF), a concept that emphasizes the importance of multi-sectoral and multi-level coordination in effective wildfire management (FirEURisk D4.4). By fostering cooperation between governments, businesses, academia, and civil society, FirEURisk aims to create a holistic and integrated approach to wildfire management that can be sustained over the long term.

One of the key aspects of the FirEURisk roadmap is its emphasis on cross-border cooperation. This is particularly crucial in transboundary regions where wildfire risks can have significant socio-economic and ecological impacts that extend beyond national borders (FirEURisk D6.14). By promoting shared tools, data, and strategies, FirEURisk facilitates more effective collaboration between neighbouring countries, enabling coordinated responses to wildfire threats.

The engagement process has involved a variety of activities, including workshops, webinars and seminars to pilots and demonstrations and consultations (FirEURisk D4.5; FirEURisk D6.14). These activities have not only helped to refine and

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validate FirEURisk's tools but have also built a network of engaged stakeholders who are invested in the project's success. This network will be crucial for the long-term adoption and implementation of FirEURisk's recommendations.
Moreover, the project has recognized the significance of engaging local stakeholders in considering Nature-based Solutions (NbS) for wildfire management (FirEURisk D4.4; FirEURisk D4.5). This is particularly relevant in high-risk areas like the Mediterranean, where factors such as rural abandonment have contributed to increased wildfire intensity (FirEURisk D6.14). By promoting to local communities the adoption of such solutions, FirEURisk ensures that management strategies are effective, sustainable, and aligned with local needs and contexts.
Through this comprehensive approach to stakeholder engagement and collaboration, FirEURisk creates a robust foundation for the implementation of its roadmap. The relationships and networks developed throughout this process will be invaluable as the project transitions research results to development, and implementation, ensuring that its tools and strategies could be effectively integrated into wildfire management practices across Europe (FirEURisk D4.5; FirEURisk D6.14).

2 FirEURisk Project Outcomes and Policy Relevance

2.1 Summary of FirEURisk Outcomes

The FirEURisk project has developed a suite of essential outcomes aiming to enhance wildfire management through science-based strategies, innovative tools, and comprehensive policy frameworks. These outcomes aim to significantly improve wildfire prevention, risk management, and operational decision-making across Europe by integrating local knowledge with scientific wildfire management approaches, and international best practices. The core outcomes of FirEURisk can be categorised into three key areas:

- **Wildfire Prevention:** FirEURisk has made significant strides in developing risk-based prevention strategies and land management practices that address the root causes of wildfires (FirEURisk D6.14). This includes the creation of sophisticated predictive models that can identify high-risk areas with unprecedented accuracy (FirEURisk D2.6). These models take into account a wide range of factors, including vegetation types, climate conditions, human activities, and historical fire data (FirEURisk D4.5). By pinpointing areas of high risk, these tools enable authorities to optimise fuel management strategies, such as controlled burns or mechanical thinning, in a more targeted and effective manner (FirEURisk D4.5). Moreover, FirEURisk has developed community engagement frameworks that promote fire-aware behaviour and landscape management practices at the local level (FirEURisk D4.4; FirEURisk D6.14). These frameworks emphasise education and participation, recognizing that community involvement is crucial for successful wildfire prevention. They provide guidelines for creating fire-adapted communities, where residents understand their role in reducing fire risks and are actively involved in prevention efforts (FirEURisk D4.5).
- **Risk Management:** A cornerstone of FirEURisk's outcomes is the creation of integrated wildfire risk models that provide a comprehensive understanding of fire risks under various environmental and socio-economic conditions (FirEURisk D2.6; FirEURisk D4.5). These models go beyond traditional fire danger indices by incorporating a wide range of dynamic variables, including real-time weather data, vegetation moisture

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content, and even socio-economic factors that influence fire ignition and spread (FirEURisk D4.5). Complementing these risk models are advanced fire behaviour prediction tools that enable stakeholders to simulate potential fire scenarios under different conditions (FirEURisk D4.4). These tools use state-of-the-art computational methods to model fire spread, intensity, and smoke dispersion and providing critical information for strategic planning during fire events (FirEURisk D2.6). Together, these risk management tools enable stakeholders to assess wildfire risks with unprecedented detail and accuracy (FirEURisk D4.4; FirEURisk D2.6). This allows for the implementation of more effective mitigation measures, better resource allocation, and improved emergency response planning. The ability to run multiple scenarios also supports adaptive management strategies, allowing authorities to adjust their approaches based on changing conditions and emerging threats (FirEURisk D6.14; FirEURisk D4.5).

- **Digital Decision Support Systems (DSS):** A core aspect of FirEURisk's software adoption strategy (see Section 5.1) is the development of advanced digital platforms for real-time fire risk monitoring and management (FirEURisk D2.6; FirEURisk D4.5). These platforms—including both the Open Platform and the Viewer—integrate data produced using satellite imagery, weather stations, and ground sensors to provide a comprehensive view of fire risks (FirEURisk D4.4). Aligning with the project's broader emphasis on user engagement (Section 5.1) and market potential (Section 5.2), the DSS features user-friendly interfaces designed for a wide range of stakeholders, including fire managers, emergency responders, policymakers, and community leaders (FirEURisk D6.14; FirEURisk D4.5). By presenting complex data through intuitive visualizations, these systems assist users in quickly interpreting the current situation and making evidence-based decisions (FirEURisk D4.4). Beyond their informational functions, these DSS platforms serve as proactive decision-making tools. They incorporate advanced analytics that produce actionable insights and recommendations (FirEURisk D2.6; FirEURisk D4.5).
- As outlined in Section 5.3 on integrating with operational fire risk management systems, these DSS are designed for interoperability with existing frameworks and can scale from local to national levels (FirEURisk D6.14; FirEURisk D4.5). This interoperability not only eases their integration within current operations but also opens the door for potential standardization of wildfire management techniques across various regions and countries (FirEURisk D6.14; FirEURisk D4.5). However, similar to the challenges outlined in Section 5.4 regarding management issues, sustaining and updating these systems over the long term requires strong funding, effective data governance, and commitment from multiple stakeholders. Data maintenance costs, competing established platforms, and inconsistent demand across regions can hinder widespread adoption (Section 5.2). Potential solutions discussed in Section 5.5—such as centralized data governance models, automated validation tools, or outsourced management—could help mitigate these barriers by streamlining workflows and ensuring consistent, high-quality data. Meanwhile, a viable funding model is critical (Section 5.5.1), whether through subscriptions, grants, or public-private partnerships. Ultimately, as noted in Section 5.6, a blended approach that combines technical streamlining, solid governance, and diversified funding avenues is most likely to secure the continued success and impact of FirEURisk's DSS.

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2.2 Frameworks for Operational Exploitation

To bridge the gap between research outcomes and practical implementation, FirEURisk has developed comprehensive frameworks for operationalizing its tools and methodologies. Two key deliverables provide the foundation for this operational exploitation:

- **D4.4: Conceptual Framework for Integrating Risk Assessment, Reduction, and Adaptation:** This deliverable introduces development of a conceptual framework for integrating wildfire risk assessment and adaption in a consistent approach that allows testing the impact of different scenarios. Built on the integration scheme, it combines key variables—such as fire danger, exposure, and vulnerability—into synthetic indices using a dedicated software tool. The outputs are geographically explicit, enabling spatial analysis of policy impacts. The system is scalable and adaptable to various regions and timeframes, making it a practical tool for evaluating and reducing wildfire risks under current and future conditions. Key components of this framework include:
    - A conceptual integration of wildfire risk assessment, mitigation and adaptation is proposed, using the same variables within a consistent and scale-independent framework.
    - The integration scheme incorporates key factors related to fire danger, exposure and vulnerability.
    - The system allows the creation of different scenarios by modifying the risk input variables.
    - Both the input and output layers are geographical datasets; therefore, the consequences of choosing a scenario can be analysed geographically. This feature is particularly important for the use of the system at different spatial scales, as the target scenarios can be adapted to local or regional characteristics.
- **D4.5: Roadmap for an Integrated Wildfire Risk Management Strategy for Europe:** Building on the conceptual framework of D4.4, this deliverable offers concrete guidelines for implementing FirEURisk tools and strategies in real-world contexts. D4.5 focused on proposing an Integrated Wildfire Risk Management System (IWRMS) with detailed guidelines on preparing a tailor-made system for key stakeholders i.e. Policy-makers and managers, D6.15 expands on this by providing a broader policy context for these operational practices. The roadmap in D6.15 shows how these operational guidelines can be supported and facilitated through policy frameworks at various governance levels. Key elements of the IWRMS include:
    - A risk management strategy grounded in robust scientific principles, such as those developed within the project to assess wildfire risk.
    - A framework that organizes and aligns the key principles, objectives, and guidelines for effective risk management.
    - A governance system responsible for implementing the management guidelines, establishing legal frameworks, and overseeing resources, including financial support.

The purpose and implementation of the Integrated Fire Management plan (IWMP) may vary and depend on the country or region. However, the plan and system can be modified and adapted according to the needs of respective stakeholders. The document includes clear and detailed instructions on how this goal can be defined and adopted. Adopting to these common plans may allow countries to have common operating procedures and allow for easy cooperation and collaboration. Together, these plan/system establish the context for FirEURisk's tools and methodologies to be effectively adopted and considered into existing fire management processes, enhancing fire resilience and mitigating the impact of wildfires across Europe.

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2.3 Policy Integration at National and European Levels

FirEURisk recognises that effective wildfire management requires coordinated action at multiple governance levels. The project therefore facilitates policy integration by aligning its outcomes with existing legislative frameworks and enhancing policy-making processes at national and European levels (FirEURisk D6.14; FirEURisk D4.5):

- **National Policy Integration**: At the national level, FirEURisk provides tools and methodologies that can be adapted to fit within existing fire management frameworks while also supporting policy reforms (FirEURisk D6.14). The project's outcomes offer scientific evidence and actionable recommendations that can inform national-level policy decisions (FirEURisk D4.5). Key aspects of national policy integration include:
    - Adapting FirEURisk tools, and findings to national contexts, considering factors such as legal frameworks, institutional structures, and specific wildfire risks (FirEURisk D6.14)
    - Supporting the development of national wildfire strategies that incorporate advanced risk assessment and management approaches (FirEURisk D4.4; FirEURisk D6.14)
    - Providing guidelines for integrating wildfire management with other relevant policy areas such as forestry, agriculture, and urban planning (FirEURisk D4.5)
    - Offering training and capacity-building resources to support the implementation of new tools and strategies at the national level (FirEURisk D6.14)
- **European Policy Integration**: At the European level, FirEURisk contributes to broader EU initiatives and collaborates with European partner institutes to enhance understanding of cross-border wildfire management strategies (FirEURisk D6.14; FirEURisk D4.5). The project's outcomes align with and support key EU policies and strategies. European-level integration efforts include:
    - Contributing to the implementation of the European Green Deal, particularly in areas related to forest protection and climate resilience (FirEURisk D4.4; FirEURisk D6.14)
    - Highlighting need for effective policies, coordinated efforts, and continued investment in technology and research for better wildfire prevention and response (FirEURisk D6.14)
    - Aligning with the EU Strategy on Adaptation to Climate Change by providing tools for assessing and managing climate-related wildfire risks (FirEURisk D4.5; FirEURisk D6.14)
    - Collaborating with European agencies such as the JRC Ispra, the European Environment Agency (EEA) and the European Forest Institute (EFI) to ensure broad dissemination and adoption of FirEURisk tools (FirEURisk D4.5)
- **Harmonization of Wildfire Risk Management Policies**: A key goal of FirEURisk is to collaborate with relevant European wildfire research projects to promote greater consistency and coherence in wildfire risk management approaches across Europe (FirEURisk D6.14). This harmonization seeks to enhance collaboration, knowledge and resource sharing across EU and national borders. Harmonization strategies include:
    - Promoting a common risk assessment framework that can be applied across different countries and regions (FirEURisk D4.4; FirEURisk D6.14)
    - Developing standardized protocols for data sharing and interoperability of management systems (FirEURisk D4.5)
    - Facilitating the exchange of best practices and lessons learned between different countries and regions (FirEURisk D6.14)

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- Supporting the development of common training approaches and certification processes for wildfire management professionals (FirEURisk D6.14)

The project contributes to the creation of more cohesive, evidence-based strategies for wildfire management. These strategies can be implemented towards better and effective policies. This incorporation is essential for tackling the growing challenges posed by the climate change and the rising threats of wildfires across Europe (FirEURisk D6.14; FirEURisk D4.5).

3 Policy Integration Framework

3.1 Review of Policies and Best Practices Across EU Member States

Task 6.4 and Deliverable D6.14 of the FirEURisk project provide a comprehensive review of existing wildfire management policies and best practices across EU Member States. This review forms a crucial foundation for the policy integration framework outlined in D6.15. The analysis reveals that while wildfire risk is a common concern throughout Europe, approaches to managing this risk vary significantly due to differences in fire culture, geography, climate, vegetation, and socio-economic conditions.

Key best practices identified across EU Member States include:

- **Integrated Fire Management Frameworks:** Several countries, notably Portugal and Spain, have adopted comprehensive frameworks that combine prevention, suppression, and recovery strategies. These approaches emphasize the creation of fire-adapted landscapes and communities, utilizing controlled burns and strategic fuel management to reduce fire risks. For instance, Portugal's Integrated Fire Management Program (PMFI) coordinates actions across various sectors and governance levels, from national strategy to local implementation.
- **Community Engagement and Awareness:** Nations such as Greece and France have implemented robust community-based programs that involve local residents in wildfire prevention and response efforts. These initiatives focus on raising awareness about fire risks, promoting fire-safe behaviour, and engaging communities in local fuel management activities. The French initiative "Old Embers, New Flames" (Vieux Feux, Nouvelles Flammes) is an excellent example of how traditional ecological knowledge can be integrated with modern fire management practices.
- **Technological Innovations:** Countries like Italy and Sweden have made significant strides in integrating advanced technologies into their wildfire management strategies. This includes the use of satellite-based fire detection systems, drones for monitoring and early detection, and advanced modelling tools for fire behaviour prediction. Italy's CIMA Research Foundation, for example, has developed cutting-edge systems for real-time fire risk forecasting that are now being adopted across the Mediterranean region.

Despite these positive developments, the review also identified several gaps and challenges that hinder effective wildfire management across the EU:

- **Fragmented Responsibilities:** In many countries, wildfire management duties are dispersed across multiple agencies and government levels. This fragmentation can lead to coordination challenges, inefficiencies in

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resource allocation, and delays in response during emergency situations. For example, in some federal systems, conflicts between national and regional competencies can complicate the implementation of unified strategies.

- **Lack of Long-Term Strategies:** There is often a predominant focus on short-term fire suppression at the expense of long-term prevention and landscape resilience strategies. This short-term focus can lead to increased vulnerability over time, particularly in the face of climate change. Many countries lack comprehensive, long-term strategies that address the root causes of increased fire risks, such as land-use changes, rural abandonment, and climate impacts.
- **Inconsistent Risk Assessment Tools:** The review revealed significant variation in the sophistication and application of risk assessment tools across different EU Member States. While some countries have adopted advanced, data-driven approaches to risk assessment, others still rely on more traditional methods that may not fully capture the complexity of modern wildfire risks. This inconsistency can lead to disparities in preparedness and response capabilities, particularly in cross-border regions.

These findings underscore the need for a more cohesive and integrated approach to wildfire management across the EU. The policy integration framework proposed in D6.15 aims to address these gaps while building on and disseminating the identified best practices. By promoting a more unified approach, FirEURisk seeks to enhance wildfire resilience across Europe while respecting the unique contexts and needs of different regions.

3.2 Role of International Stakeholders

International stakeholders play a crucial role in supporting FirEURisk's policy integration efforts by providing data, expertise, and collaboration platforms. Aligning FirEURisk's tools and methodologies with global best practices is essential for enhancing the effectiveness and credibility of wildfire management approaches across Europe. Key international stakeholders and their contributions include:

- **Organisation for Economic Co-operation and Development (OECD):** The OECD contributes valuable insights into global best practices for disaster risk reduction and environmental policy. Its work on resilience and climate adaptation provides important context for FirEURisk's policy recommendations. Specific contributions include:
    - Providing comparative data on wildfire management approaches across different countries
    - Offering policy analysis and recommendations on integrating climate change considerations into disaster risk management
    - Facilitating knowledge exchange among member countries on innovative approaches to environmental challenges
- **European Forest Fire Information System (EFFIS):** Operating under the European Commission's Joint Research Centre, EFFIS is a crucial partner in FirEURisk's efforts to enhance wildfire management capabilities across Europe. The collaboration between FirEURisk and EFFIS can focuses on:
    - Integrating FirEURisk's advanced risk assessment models with EFFIS's existing monitoring and early warning systems
    - Enhancing EFFIS's capabilities by incorporating more detailed, region-specific assessments developed through FirEURisk

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- Using EFFIS as a platform for disseminating FirEURisk tools and methodologies to a broader audience of European stakeholders
- Collaborating on the development of standardized data formats and protocols to improve interoperability between national and European-level systems

- **European Centre for Medium-Range Weather Forecasts (ECMWF):** ECMWF's advanced weather forecasting and climate modelling capabilities are essential for understanding and predicting wildfire risks. The collaboration between FirEURisk and ECMWF involves:
  - Integrating ECMWF's high-resolution weather forecasts into FirEURisk's risk assessment and fire behavior prediction tools
  - Utilizing ECMWF's seasonal forecasts to support long-term planning and resource allocation for wildfire management
  - Collaborating on research to improve the representation of fire-weather interactions in climate models
- **Copernicus Emergency Management Service (CEMS):** CEMS provides critical support for wildfire risk management through its satellite-based monitoring and mapping services (FirEURisk D1.5).
  FirEURisk's collaboration with CEMS focuses on:
  - Enhancing fire monitoring capabilities by integrating FirEURisk's predictive models with CEMS's satellite observations
  - Improving decision-making processes by combining CEMS's rapid mapping services with FirEURisk's risk assessment tools
  - Supporting post-fire recovery efforts through the integration of burn severity assessments and vegetation recovery monitoring
- **European Environment Agency (EEA):** The EEA is Europe's leading authority on environmental data, knowledge, and policy guidance, making it a pivotal partner for FirEURisk's wildfire management initiatives. Its work strongly aligns with FirEURisk's aim to develop science-based strategies for wildfire risk reduction. Specifically, the partnership between FirEURisk and the EEA focuses on:
  - By utilising the EEA's comprehensive datasets on land use, climate indicators, and biodiversity, FirEURisk can improve its fire risk assessment models to reflect broader environmental factor dynamics.
  - The EEA's focus on incorporating scientific insights into policy processes complements FirEURisk's goal of delivering actionable recommendations for effective wildfire prevention and control.
  - Through its established networks and collaboration platforms, the EEA helps disseminate FirEURisk's tools, methodologies, and findings, promoting coordination across Europe on climate resilience and ecological stewardship.
  - By collaboratively promoting land management systems that help wildfire risk reduction, the EEA and FirEURisk could support the conservation of biodiversity and ecosystem services while mitigating wildfire risk.
- **European Forest Institute (EFI):** The EFI is a prominent international organization devoted to advancing forest research, policy support, and information exchange across Europe. Its mandate aligns closely with FirEURisk's objectives, making it an important stakeholder for collaborative wildfire management initiatives. Specifically, the partnership between FirEURisk and EFI focuses on:

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- By leveraging EFI's comprehensive forest data and expertise, FirEURisk can refine its risk assessment models to consider various forest structures, ecological values, and management practices.
- EFI's policy-oriented work complements FirEURisk's efforts by translating scientific findings into actionable recommendations, aiding decision-makers in harmonizing forest and wildfire policies across Europe.
- Through its wide-ranging network of member organizations and partner institutions and Firelogue's coordination, EFI may act as a channel for disseminating FirEURisk's methodologies, tools, and best practices, fostering a coordinated approach to wildfire risk reduction.
- EFI's emphasis on sustainable forest management and adaptive strategies aligns with FirEURisk's broader goals of mitigating fire risk while preserving forest health, biodiversity, and ecosystem services.

- **United Nations Office for Disaster Risk Reduction (UNDRR):** While not explicitly mentioned in the original text, the UNDRR is a crucial international stakeholder in the context of wildfire management. FirEURisk's alignment with UNDRR's frameworks, particularly the Sendai Framework for Disaster Risk Reduction, ensures that the project's approaches are consistent with global best practices. This collaboration includes:
  - Aligning FirEURisk's risk assessment methodologies with UNDRR's guidelines on disaster risk assessment and management
  - Contributing to UNDRR's knowledge base on wildfire risk reduction strategies
  - Participating in UNDRR-led initiatives to promote integrated approaches to climate change adaptation and disaster risk reduction

By leveraging the expertise, resources, and networks of these international stakeholders, FirEURisk enhances the robustness and relevance of its policy integration efforts. This collaboration ensures that the project's outcomes are aligned with global best practices, facilitates broader dissemination of tools and methodologies, and supports the development of more coordinated and effective wildfire management strategies across Europe.

3.3 Opportunities for Policy Harmonization and Integration

The FirEURisk project presents significant opportunities for harmonizing wildfire risk management policies at regional, national, and EU levels (FirEURisk D6.14; FirEURisk D4.4). This harmonization is essential for ensuring consistent and effective prevention, preparedness, and response strategies throughout Europe. The policy integration framework proposed by FirEURisk aims to enhance coordination while respecting the diverse environmental, social, and institutional contexts across different regions.

Key opportunities for policy harmonization and integration include:

- **Regional-Level Integration:** FirEURisk provides tools and methodologies that can be adapted to the specific needs and characteristics of different European regions (FirEURisk D6.14). This flexibility allows for:
  - Tailoring risk assessment models to account for regional variations in vegetation, climate, and socio-economic factors (FirEURisk D4.5)
  - Developing region-specific decision support systems that integrate local knowledge and practices (FirEURisk D4.4)

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- Facilitating the exchange of best practices between regions facing similar wildfire challenges (FirEURisk D6.14)
- Supporting the development of regional wildfire management strategies that align with broader national and EU-level policies

- **National-Level Integration:** The project promotes the integration of its scientific tools and approaches into national legislative and policy frameworks. This integration can lead to:
  - Strengthening national wildfire management policies by incorporating advanced risk assessment and prediction capabilities
  - Improving resource allocation at the national level through more accurate and timely risk information
  - Aligning national wildfire management strategies with broader climate adaptation and disaster risk reduction policies
  - Enhancing coordination between different national agencies involved in wildfire management
- **EU-Wide Policy Harmonization:** At the European level, FirEURisk contributes to the harmonization of wildfire management policies by:
  - Providing standardized tools and methodologies that can be adopted across member states
  - Supporting the development of common guidelines for wildfire risk assessment and management (FirEURisk D2.1; FirEURisk D2.6; FirEURisk D4.4; FirEURisk D4.5)
  - Contributing to the alignment of wildfire management with key EU policies such as the European Green Deal and the EU Forest Strategy (FirEURisk D6.14; FirEURisk D4.5; FirEURisk D4.4)
- **Cross-Border Cooperation:** FirEURisk's tools and frameworks are designed to foster improved cross-border collaboration in wildfire management. This is achieved through:
  - Developing interoperable systems that allow for seamless data sharing and joint decision-making in border regions
  - Promoting common training standards and joint exercises for fire management personnel from different countries
  - Supporting the development of cross-border wildfire management plans, particularly in high-risk areas
  - Facilitating the sharing of resources and expertise during large-scale wildfire events that affect multiple countries
- **Integration with Climate Change Adaptation Policies:** Recognizing the increasing impact of climate change on wildfire risks, FirEURisk promotes the integration of wildfire management with broader climate adaptation strategies. This includes:
  - Incorporating climate change projections into long-term wildfire risk assessments
  - Aligning wildfire management strategies with national and EU-level climate adaptation plans
  - Promoting nature-based solutions that enhance both climate resilience and wildfire resistance
  - Supporting the development of adaptive management approaches that can respond to changing climate conditions
- **Harmonization of Monitoring and Reporting:** FirEURisk in cooperation with the JRC Ispra and the EFFIS team supports the development of standardized and harmonized monitoring and reporting for wildfire events throughout Europe. This harmonization can lead to:

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- More consistent and comparable data on wildfire occurrences, impacts, and management efforts
- Improved ability to track progress towards wildfire risk reduction goals at national and EU levels
- Enhanced transparency and accountability in wildfire management efforts
- Better-informed policy-making based on comprehensive and standardised data
- Facilitation of cross-country comparisons and identification of best practices

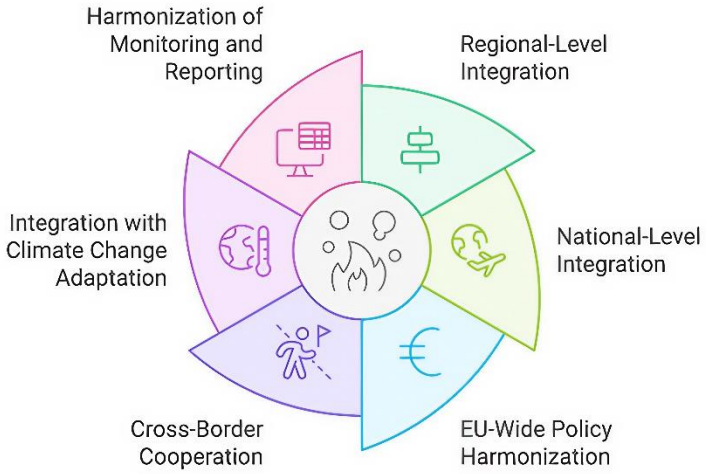


Figure 2 Comprehensive wildfire management strategies

By capitalizing on these opportunities for policy harmonization and integration, FirEURisk aims to create a more cohesive and effective approach to wildfire management across Europe. This integrated approach may enhance the European Union's overall resilience to wildfire risks, improve resource allocation, and support more coordinated responses to large-scale wildfire events.

4 Operational Exploitation Strategy

The operational exploitation strategy outlines how FirEURisk's tools, methodologies, and insights can be effectively implemented in real-world wildfire management contexts. This strategy is crucial for bridging the gap between research outcomes and practical application.

4.1 FireEURisk Methodology for Operational Exploitation

The methodology for operational exploitation of FirEURisk's outcomes involves a structured, iterative approach that ensures the tools and strategies are both effective and sustainable in various operational contexts (FirEURisk D4.5).

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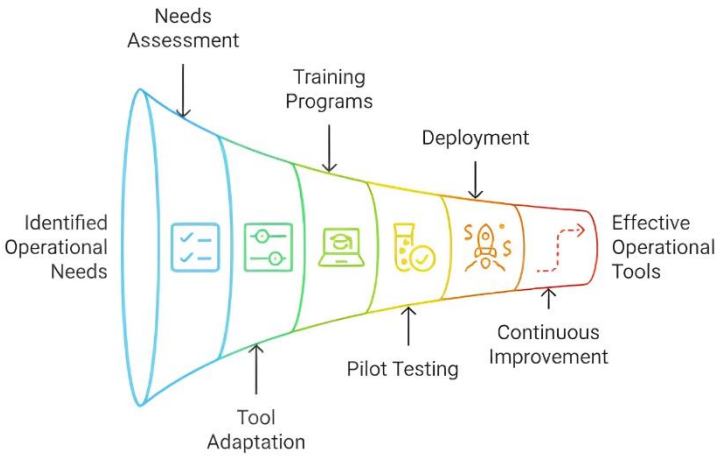


Figure 3 FirEURisk Operational Exploitation Process

The key components of this methodology include:

- **Needs Assessment and Stakeholder Engagement:**
  - Conduct comprehensive surveys and interviews with end-users to identify specific operational needs and challenges
  - Organize workshops and focus groups to gather in-depth insights from diverse stakeholders
  - Establish ongoing feedback mechanisms to ensure continuous alignment with evolving operational requirements
- **Tool Adaptation and Customization:**
  - Tailor FirEURisk tools to fit different operational contexts, considering factors such as local fire regimes, available resources, and existing management practices (FirEURisk D4.8)
  - Develop modular designs that allow for easy integration with existing systems and workflows (FirEURisk D4.4)
  - Create user-friendly interfaces that cater to the technical capabilities of different user groups
- **Training and Capacity Building:**
  - Develop comprehensive training programs for different user groups, from fire managers to policymakers
  - Create e-learning modules and hands-on workshops to facilitate widespread adoption of tools
  - Establish a network of trainers who can provide ongoing support and guidance at local levels
- **Pilot Testing and Validation:**
  - Implement pilot projects in diverse geographical and operational settings to test the effectiveness of FirEURisk tools
  - Collect and analyze data from pilot studies to validate tool performance and identify areas for improvement (FirEURisk D4.8)
  - Engage end-users in the evaluation process to ensure tools meet practical operational needs
- **Deployment and Integration:**

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- Develop detailed implementation plans for integrating FirEURisk tools into existing operational frameworks
- Provide technical support during the initial deployment phase to address any integration challenges
- Establish protocols for data sharing and system interoperability to ensure seamless integration with existing tools and databases

- **Monitoring and Continuous Improvement:**
  - Implement ongoing monitoring systems to track the performance and impact of FirEURisk tools in operational settings
  - Establish regular review cycles to identify areas for improvement and update tools accordingly
  - Foster a community of practice among users to share experiences, challenges, and best practices

This methodology ensures that FirEURisk's outcomes are not only scientifically robust but also practically applicable and sustainable in diverse operational contexts across Europe.

4.2 Role of Key Stakeholders

The successful integration and operational exploitation of FirEURisk tools and methodologies rely heavily on the active involvement and collaboration of various stakeholders. Each stakeholder group plays a unique and crucial role in this process (FirEurisk D2.1; FirEurisk D2.6) as depicted here next:

- **Fire Management Agencies:**
  - Act as primary end-users of FirEURisk tools in operational settings
  - Provide critical feedback on tool functionality and usability
  - Contribute operational expertise to refine and improve tools
  - Integrate FirEURisk tools into existing fire management protocols and procedures
- **Civil Protection Authorities:**
  - Utilize FirEURisk risk assessments for emergency planning and resource coordination
  - Incorporate FirEURisk tools into broader disaster management frameworks
  - Facilitate cross-sector collaboration in wildfire preparedness and response
- **Local Governments:**
  - Integrate FirEURisk risk assessments into local land-use planning and development decisions
  - Lead community engagement efforts to promote fire-safe practices
  - Allocate resources for local implementation of FirEURisk tools and strategies
- **Research Institutions:**
  - Contribute to the ongoing development and refinement of FirEURisk tools
  - Conduct validation studies to ensure scientific robustness of tools
  - Provide training and capacity building support to operational users
  - Bridge the gap between scientific advancements and practical applications
- **Non-Governmental Organizations (NGOs):**
  - Advocate for the adoption of sustainable wildfire management practices
  - Support community-level implementation of FirEURisk strategies

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- Facilitate knowledge exchange between different stakeholder groups
- Contribute to public awareness and education initiatives

- **International Organizations:**
  - Promote the adoption of FirEURisk tools and methodologies across borders
  - Facilitate data sharing and best practice exchange between countries
  - Align FirEURisk outcomes with global frameworks for disaster risk reduction
  - Provide platforms for showcasing FirEURisk successes at international levels
- **Private Sector Partners:**
  - Support the technological integration of FirEURisk tools into existing systems
  - Provide resources and expertise for scaling up tool deployment
  - Develop commercial applications based on FirEURisk methodologies
  - Contribute to innovation in wildfire management technologies



Figure 4 Stakeholder Profiles

By harnessing the distinct capabilities and insights of each stakeholder group, FirEURisk develops tools and methodologies that are technically robust, practically applicable, and potentially widely implemented across various operational settings.

4.3 Case Study: Application in Portugal

The integration of FirEURisk outcomes into Portugal's national wildfire management framework serves as a compelling case study for the effective of the project's results. Portugal, with its Mediterranean climate and extensive forested areas, has faced significant wildfire challenges in recent years, making it an ideal testing ground for FirEURisk's advanced approaches (FirEURisk D6.14; FirEURisk D4.5).

Key aspects of the Portuguese case study include:

- **Improved Understanding of Framework and Guidelines**: A deeper look into frameworks of international, national and regional level has allowed project to get a detailed view of these frame works across several

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countries. This also allowed project to propose an action plan and a road map to define strategies and create framework of their own. The details of these are described in Chapter-2 of deliverable FirEURisk D4.5.

- **Enhanced Prevention Strategies**: FirEURisk tools enabled Portuguese authorities to develop more targeted and effective fire prevention programs (FirEURisk D4.4; FirEURisk D4.5):
    - High-resolution risk maps were used to prioritize fuel management activities in critical areas
    - Community-level risk assessments informed local prevention and preparedness efforts
    - Long-term climate projections were incorporated into strategic planning for landscape-level fire resilience
- **Improved Public Awareness and Engagement**: The integration of FirEURisk methodologies could support more effective public communication and engagement (FirEURisk D6.14; FirEURisk D4.5):
    - User-friendly risk visualization tools were used to enhance public understanding of fire dangers
    - Targeted awareness campaigns were developed based on localized risk assessments
    - Community-based fire prevention initiatives were implemented in high-risk areas, leading to increased local participation in risk reduction efforts
- **Enhanced Cross-border Collaboration**: Portugal's adoption of FirEURisk approach could improve the cooperation with neighboring Spain in managing wildfire risks in border regions (FirEURisk D6.14):
    - Standardized risk assessment methodologies
    - Learning from common interactive sessions involving representatives from different especially countries where FirEURisk pilot sites are located
    - Shared decision support systems improved joint response capabilities during cross-border fire events
- **Policy Adaptation**: The successful implementation of FirEURisk outcomes in Portugal is aligned to several national policy changes (**FirEURisk D6.14; FirEURisk D2.6**):
    - Revision of national wildfire management strategies to incorporate advanced risk assessment methodologies
    - Development of new guidelines for integrating climate change projections into long-term fire management planning
    - Establishment of formal mechanisms for ongoing collaboration between fire management agencies and research institutions
- **Challenges and Lessons Learned**: The Portuguese case study also highlights challenges in implementing FirEURisk tools (FirEURisk D6.14; FirEURisk D4.5):
    - Initial resistance from some stakeholders to adopting new technologies and methodologies
    - Need for extensive training and capacity building to ensure effective use of advanced tools
    - Importance of adapting tools to local contexts and existing operational procedures

This example illustrates the tangible advantages of incorporating FirEURisk outputs and findings into national strategies and operational systems. It highlights how cutting-edge, research-driven methods can substantially improve wildfire management capabilities, resulting in more efficient prevention measures, optimized resource distribution, and enhanced community participation. The insights gained from FirEURisk alignments with Portugal's wildfire management reforms offer valuable guidance for the broader adoption of FirEURisk outcomes throughout Europe.

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4.4 Exploitation of Digital Decision Support Systems

The concept of Decision Support Systems (DSS) is a cornerstone of FirEURisk's operational exploitation strategy. These systems integrate various data sources, models, and analytical tools to provide actionable insights for wildfire management (FirEURisk D6.14; FirEURisk D4.4; FirEURisk D2.6). Alongside the DSS platform (WP4) designed for wildfire risk assessment developed in FirEURisk (WP1), several DSS tools have been employed (WP2 and WP4) for analysing impacts and consequences, as well as for creating innovative strategies related to wildfire risk. The exploitation of the various DSS components developed or considered in FirEURisk across different operational contexts offers numerous benefits:

- **Real-Time Risk Assessment:**
  - DSS provide dynamic, up-to-date assessments of wildfire risks, allowing for rapid adjustments in management strategies
  - Integration of real-time weather data, vegetation conditions, and human activity patterns enables more accurate risk predictions
  - Continuous monitoring and assessment support proactive decision-making in rapidly changing fire situations
- **Fire Behavior Prediction:**
  - Advanced modelling capabilities associated to DSS enable more accurate predictions of fire spread and intensity
  - Simulation tools allow fire managers to explore different scenarios and assess the potential impacts of management decisions
  - Improved predictions support more effective allocation of suppression resources and evacuation planning
- **User-Friendly Interfaces:**
  - Intuitive, graphical interfaces make complex data and analyses accessible to a wide range of users
  - Customizable dashboards allow different stakeholders to focus on the most relevant information for their needs
  - Mobile applications extend the reach of DSS to field operations, supporting real-time decision-making on the ground
- **Integration of Multiple Data Sources:**
  - DSS aggregate data from various sources, including satellite imagery, weather stations, and field reports
  - This integration provides a comprehensive view of the fire situation, supporting more informed decision-making
  - Automated data processing reduces the workload on operators and minimizes the risk of human error
- **Support for Long-Term Planning:**
  - Historical data analysis and trend identification capabilities within DSS support strategic planning for fire prevention and landscape management
  - Scenario modelling tools enable the assessment of long-term risks and the evaluation of different management strategies

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    - Integration of climate change projections allows for adaptive planning to address future fire regime changes
- **Enhanced Collaboration:**
    - Shared platforms facilitate information exchange and coordination between different agencies and jurisdictions
    - Standardized data formats and protocols improve interoperability between national and regional systems
    - Collaborative features support joint decision-making in complex fire management situations
- **Performance Monitoring and Improvement:**
    - Built-in analytics tools allow for ongoing evaluation of DSS performance and impact
    - User feedback mechanisms support continuous improvement of system functionalities
    - Integration of machine learning algorithms enables DSS to adapt and improve over time based on operational experiences

The exploitation of such DSS elements strengthens both prevention and suppression efforts by providing actionable insights, supporting evidence-based decision-making, and facilitating coordination among different stakeholders. As FirEURisk outcomes become more widespread, these systems will play an increasingly crucial role in enhancing Europe's overall wildfire management capabilities.

5 Adoption of the software outputs: Open Platform and the Viewer

5.1 Overview of the approach

In this section, we aim to highlight the project's achievements while addressing the challenges related to encouraging the adoption of its outputs. It explores strategies for maximizing the usability of the Open Platform, research findings, and the Viewer, considering factors such as content management, user engagement, and long-term sustainability. By reflecting on these realities, the document seeks to guide future steps toward ensuring the project's outcomes have a lasting impact.

5.2 Market potentials

The potential markets in FirEURisk software-related outcomes might lie in these alternatives:

1. Niche Insurance Applications

- **Potential**: Insurance companies might value fire risk mapping tools to better assess wildfire risks in high-risk areas. They could use these tools for premium calculation or incentivizing mitigation measures (e.g., vegetation clearance around properties).
- **Challenges**: Insurers often have in-house or contracted risk assessment teams and may not invest heavily in external services unless they demonstrate clear cost-saving benefits.

2. Private Landowners and Timber Companies

- **Potential**: Large landowners and forestry companies might use detailed, updated risk maps and fuel assessments to optimize their fire prevention efforts or to meet sustainability and certification requirements.

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- **Challenges**: Most of these stakeholders rely on public data (e.g., from Copernicus or EFFIS) or have internal resources. Persuading them to pay for a service would require significant differentiation, such as integration with operational workflows or providing real-time insights.

3. Value-Added Layers for Existing Platforms

- **Potential**: Selling or licensing specialized, high-resolution, or updated fuel maps and risk assessments as plugins for existing GIS platforms like ESRI, QGIS, or national systems.
- **Challenges**: The revenue model would depend on ensuring constant updates, which is resource-intensive, and public authorities may not see added value compared to free alternatives.

4. Community and Citizen Science Engagement

- **Potential**: Offer fire risk awareness tools for community engagement, allowing residents to contribute real-time data (e.g., photos of fuel loads or dry conditions). This could complement public prevention strategies.
- **Challenges**: Monetizing community-driven services is difficult. Funding would need to come from public grants, NGOs, or advertising partnerships, none of which provide reliable long-term revenue.

5. Consulting Services

- **Potential**: Instead of focusing on software as a product, pivot to consulting services for governments or organizations looking to implement or enhance their fire risk management strategies using existing data.
- **Challenges**: Consulting is labour-intensive and hard to scale. Moreover, agencies already have long-term contracts with established providers.

6. Targeting High-Risk, Under-Served Regions

- **Potential**: Some regions may lack robust wildfire management systems (e.g., parts of Africa, Asia, or South America). Introducing a basic fire risk mapping tool in collaboration with international aid organizations could be a way in.
- **Challenges**: These markets often have limited budgets and rely on donor-funded initiatives, which are not sustainable for long-term business models.

7. Emergency Preparedness for Corporations

- **Potential**: Corporations with significant infrastructure in fire-prone areas (e.g., utility companies, logistics hubs, or mining operations) might invest in wildfire risk tools to protect assets and ensure continuity.
- **Challenges**: These companies may already rely on private risk assessment firms or internal systems.

Key Constraints and Realities

- **Data Maintenance Costs**: Accurate, up-to-date maps require consistent investment, which is hard to recover unless there's a high-value market.
- **Saturated Market**: Many potential customers (governments, fire brigades) already use existing systems and are hesitant to adopt new, overlapping solutions.
- **Short-Term Demand**: Fire risk solutions are often sought after during crisis peaks (e.g., severe wildfire seasons), making revenue unpredictable.

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5.3 Integrating into operational fire risk management systems

The FirEURisk roadmap aims to provide a structured pathway for integrating project outcomes into operational fire risk management systems. Although direct collaboration with large organizations like OECD, EFFIS, ECMWF, or Copernicus Emergency Services may not be straightforward or immediate, there are potential use cases where alignment with their existing frameworks could be beneficial. For example, FirEURisk's fire risk maps and methodologies could be adapted to complement Copernicus Emergency Services' datasets, particularly in areas where higher-resolution or local-specific data is needed to enhance regional fire preparedness. Similarly, ECMWF's fire danger forecasts could potentially incorporate FirEURisk's risk assessment models to enhance predictions for specific biogeographical zones.
In the longer term, FirEURisk outputs may serve as a reference for policy recommendations or decision-support tools used by international organizations. For instance, OECD's reports on climate resilience and risk management might benefit from insights derived from FirEURisk's comprehensive fire risk analysis and mitigation strategies. While these use cases require careful tailoring to meet the operational needs of these organizations, they provide a conceptual foundation for how the project's outputs could add value in targeted applications.

5.4 Management challenges

There are significant challenges in managing complex, multi-stakeholder projects with ongoing data and content requirements, especially when long-term funding and management structures are uncertain. Below is a concise overview of the major day-to-day operational hurdles FirEURisk faces (Key Challenges), followed by overarching structural or contextual constraints (Realistic Observations) that can affect the project's long-term viability. These points aim to guide future decisions on resource allocation, stakeholder engagement, and system maintenance.

Key Challenges

- **Data Upload and Presentation Standards**
  - Lack of adherence to rules for uploading and presenting data leads to inconsistencies.
  - Different countries have varied preferences, adding to complexity.
  - Without enforcement of standards, the Viewer becomes unreliable.
- **Geoserver and SLD Maintenance**
  - Creating and maintaining data layers, styles (SLDs), and ensuring compatibility with the Viewer require specialized skills and time.
  - Delegating this responsibility is challenging when no funding exists for long-term management.
- **Post-Project Coordination**
  - Coordination of terminology, data cleaning, and ongoing updates becomes orphaned once project funding ends.
  - No organization is incentivized to take on this resource-intensive work without compensation.

Realistic Observations

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- **Post-Project Limbo**: Many research projects face a cliff where useful systems are abandoned because no sustainable management model exists.
- **Voluntary Participation Risks**: Relying on project partners or participants to voluntarily contribute their time post-project is unreliable and unsustainable.
- **Country-Specific Needs**: Customization for different countries adds a layer of complexity that is difficult to justify without funding.
- **Viewer Dependence**: The functionality of the Viewer is tightly linked to the quality of content management, creating a single point of failure.

5.5 Potential Solutions

Below is a list of potential solutions for addressing the challenges discussed earlier, each providing a distinct strategy for mitigating issues related to data management, standardization, and long-term sustainability. These approaches range from establishing centralized governance structures to streamlining system complexity, reflecting a blend of technical and organizational methods aimed at ensuring FirEURisk's ongoing viability.

1. Centralized Data Governance Model

- **Approach**: Establish a single, central entity responsible for ongoing data management, funded by participating countries or an international body.
- **How it Helps**:
  - Ensures consistency in data standards, terminology, and updates.
  - Provides a single point of accountability.
- **Challenges**:
  - Requires upfront commitment from stakeholders to fund or staff this central body.
  - Coordination between countries and partners can still be politically sensitive.

2. Automated Data Validation Tools

- **Approach**: Develop or implement automated tools to validate uploaded data against predefined standards before allowing it into the system.
- **How it Helps**:
  - Reduces manual effort in data cleaning and ensures compliance with rules.
  - Flags errors early, making corrections easier for the data providers.
- **Challenges**:
  - Building robust validation tools requires an upfront investment.
  - Not all data issues can be solved automatically (e.g., terminology discrepancies).

3. Outsourced Data Management Service

- **Approach**: Hire an external provider to handle ongoing data cleaning, SLD creation, and Geoserver maintenance as a managed service.
- **How it Helps**:
  - Offloads the technical burden from the organization or partners.

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- Provides a predictable cost structure if funding is secured.

- **Challenges**:
- Long-term funding must be secured to support the service.
- Loss of control over data management processes.

4. Simplified Data Layers

- **Approach**: Reduce the complexity of the Viewer by limiting the number of layers and standardizing their presentation across all countries.
- **How it Helps**:
- Reduces the maintenance burden for Geoserver.
- Encourages uniformity, avoiding excessive country-specific customizations.
- **Challenges**:
- Requires agreement from all stakeholders to streamline the system.
- Some countries may perceive this as a loss of functionality.

5. Regional Hubs for Decentralized Management

- **Approach**: Divide the responsibilities among regional hubs (e.g., by grouping neighboring countries) to reduce the load on a single organization.
- **How it Helps**:
- Shares the workload, making it manageable for each hub.
- Maintains some level of customization for regional needs.
- **Challenges**:
- Coordination between hubs becomes essential, and inconsistencies may still arise.

6. Open-Source Community Approach

- **Approach**: Transition the system into an open-source community project, relying on voluntary contributions for updates and maintenance.
- **How it Helps**:
- Minimizes direct costs for management.
- Encourages innovation and participation from a broader community.
- **Challenges**:
- Quality and frequency of updates become unpredictable.
- Requires significant effort to foster and sustain an active community.
- Current tool is technically not possible to be open source for many reasons, so the Viewer should be rebuilt from the scratch before this could be possible at all.

5.5.1 Funding and Sustainability Considerations

1. **Subscription Model**:
- Charge organizations or countries a subscription fee for access to the Viewer and data management services.
- Offers predictable revenue but may deter participation if fees are perceived as too high.
2. **Grants and International Funding**:
- Seek ongoing funding from international bodies (e.g., EU, UN) for the public good.
- Provides stability but is competitive and not guaranteed long-term.

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3. **Corporate Partnerships**:
   - Partner with private companies that could benefit from fire risk management data, such as insurers, forestry firms, or infrastructure providers.
   - Creates a potential revenue stream but may require significant adaptation of the system to their needs.
4. **Freemium Model**:
   - Offer basic access for free, with premium features (e.g., high-resolution maps, custom analytics) available for a fee.
   - Encourages widespread adoption but requires careful balancing of free vs. paid features.

5.6 Final Recommendation

The most realistic path forward is a **hybrid approach**:

- Streamline the system to reduce ongoing maintenance needs (e.g., fewer layers, stricter upload rules, automated validation).
- Establish a centralized governance model for coordination, funded by a combination of subscription fees and international grants.
- Explore partnerships with private sector actors who can provide funding or in-kind resources.

Without a clear funding model and streamlined process, the system risks becoming obsolete post-project. Realism dictates focusing on minimizing costs while securing at least partial funding from stakeholders who directly benefit.

6 Stakeholder Engagement and Dissemination

Effective stakeholder engagement and dissemination of project outcomes are critical for the success of FirEURisk and the long-term adoption of its tools and methodologies. This section outlines the strategies for involving stakeholders in the co-production of knowledge and for ensuring widespread dissemination of project results.

6.1 Co-production with Stakeholders

The co-production process involves actively engaging stakeholders throughout the development and implementation of FirEURisk tools and strategies. This approach ensures that the project's outcomes are practically relevant and tailored to the needs of end-users. Key elements of the co-production process include:

- **Identifying Stakeholders:**
  - Conduct stakeholder mapping to identify key players in wildfire management across different sectors and governance levels
  - Ensure representation from diverse groups, including fire management agencies, civil protection authorities, local governments, research institutions, NGOs, and community representatives
  - Establish a stakeholder advisory board to provide ongoing guidance and feedback throughout the project
- **Consultations and Workshops:**

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- Organize regular stakeholder workshops to gather input on tool development and implementation strategies
- Conduct targeted consultations with specific user groups to address unique operational needs and challenges
- Use participatory methods such as focus groups and design thinking sessions to co-create solutions

- **Feedback Integration:**
  - Establish formal mechanisms for incorporating stakeholder feedback into tool development and refinement processes
  - Conduct iterative testing and validation of tools with end-users to ensure usability and relevance
  - Develop a transparent process for prioritizing and addressing stakeholder suggestions and concerns

An example of successful co-production is the collaboration with Rafina-Pikermi Municipality in Greece. This partnership involved:

- Engaging local fire management officials of the Municipality and community leaders in the design of risk assessment tools
- Adapting FirEURisk methodologies to address specific local challenges, such as the wildland-urban interface-related risks
- Integrating local knowledge and practices into the development of community-based fire prevention strategies

This collaborative approach ensured that the tools developed were not only scientifically robust but also practically applicable in the local context, leading to higher adoption rates and more effective implementation.

6.2 International Collaborations and Meetings

FirEURisk actively collaborates with international organizations to align its outcomes with global best practices and to facilitate knowledge exchange across borders (FirEURisk D6.14; FirEURisk D4.4; FirEURisk D4.5; Chuvieco et al., 2023).

FirEURisk has organized various webinars, workshops and interactive discussions for stakeholders, public, research institutes and industries. The beneficiaries and participants also include agencies connected to firefighting and rescue services. Some of these efforts are also outlined in above mentioned deliverables. During the biannual plenary meetings FirEURisk has also collaborated with local and regional fire fighting and rescue services to spread awareness of the project and technical developments made during the project.

In addition, FirEURisk members have also participated in international conferences, workshops and symposiums where they have reported their findings of their respective studies carried out using FirEURisk resources.

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Following is list of some of the collaborations with other international and EU-funded projects.

- FIRELOGUE (HORIZON 2020-Green Deal project): During the course of the project FirEUrisk has closely collaborated with another HORIZON 2020-Green Deal project FIRELOGUE. The project aims of FIRELOGUE is to coordinate with other EU-funded projects, integrate results across projects and facilitate exchange of knowledge through workshops, interactive discussions and collaboration platforms.

  FIRLOGUE organized the **Wildfire Risk Management Project Clustering Event 2023**, which took place on 22nd November 2023 in Brussels. The event was attended by participants from various Green Deal Innovation, HORIZON-2020 and other EU-funded projects. The list includes TREEDS, SILVANUS, FIRE RES, FirEUrisk, DG ECHO projects (AFAN, IPA Flood and Fires, WUITIPS).

  The project members provided updates on the project and held discission on the latest outcomes, challenges faced and various topics of their respective projects. The topics of discussion also included common approaches to Wild Fire Risk Management (WFRM), their impact on EU member states, and the European Commission's future expectations for supporting actions aimed at achieving the 2030 Impact targets.

  Besides this event FirEUrisk has
  - Regularly participated in meetings for the joint activities, by EUC, SCIENSEED, and ADAI.
  - UAH attended the related H2020 FIRELOGUE meeting that took place in Berlin on 17-19 December 2020
  - Liaison between FirEUrisk and FIRELOGUE communication teams to inform of mutual activities and include FirEUrisk in their website
  - Participated in a survey prepared by FIRELOGUE with details about FirEUrisk and its communication and dissemination actions, (Figure 12)
  - FirEUrisk has featured in the Newsletter prepared and released by FIRELOGUE, https://firelogue.eu/blog-post-layout.php?25
  - Participated in the WFRM Clustering event, 5th-6th of April 2022, which brought together 8 European projects (SILVANUS, FIRE-RES, TREEATS, FIRELOGUE, FirEUrisk, SAFERS, FIRElinks, FIRE-IN), Figure 11
  - Under the initiative EU FIRE PROJECTS UNITED, FirEUrisk coordinator ADAI participated in the production of a video, published on the YouTube channel of FIRELOGUE (https://www.youtube.com/watch?v=VivY3NTzuyo&ab_channel=Firelogueeu)
  - Presentation for Joint Dissemination Workshop, 23rd January 2023, by UdL with the title "Developing a holistic, risk-wise strategy for European wildfire management", presenting FirEUrisk in general and outputs from the fuel classification mapping research as part of WP1. In the workshop also participated, FIRELOGUE, SILVANUS, FIRE-RES, TREEATS, SAFERS, FIRElinks, FIRE-IN, Pyrolife, FIRE-ADAPT.
  - Continuous communication and dissemination activities to the project's consortiums, including those organised by the EUP board for FirEUrisk.

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- Collaboration with JRC (Joint Research Center): During the course of the project FirEUrisk has collaborated with JRC in several activities related to analysing large wildfires.

  In year 2023, FirEUrisk published a technical report ***titled Analysis of 2021 critical wildfire events in the Mediterranean region***. The report revied the 2021 wildfire season in Mediterranean region using data from European Forest Fire Information System (EFFIS). Five cases of wildfire were extensively studied and analysed by the FirEUrisk project.

  1. The Fire Event of Castro Marim (Portugal)
  2. The Fire Event of Gonfaron (France)
  3. The Wildfire Event of Montiferru (Sardinia, Italy)
  4. The Varybobi Fire Event, Attica (Greece)
  5. The Limni Fire Event, North Evia (Greece)

  The aspect studied includes pre-fire conditions, fire evolution, impacts to support future wildfire management, impact on communities and need for improvement. The report is part of an ongoing collaboration between FirEUrisk and the JRC.

  Beside the technical report available here, the preliminary results of the analysis of critical fires in Europe during 2021 were presented in a Webinar held on December 2nd, 2021. The webinar titled Major fire events of 2021 in the Mediterranean Basin : lessons learned and new challenges also included an overall perspective of the fires of 2021 in the World and Europe

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Following is a list of possible future collaborations and their outcomes:

- **Collaboration with EFFIS:**
  - Integration of FirEURisk tools with the European Forest Fire Information System (EFFIS) to enhance data accessibility and coordination
  - Joint development of standardized risk assessment methodologies for use across Europe
  - Collaboration on improving early warning systems and fire danger forecasting
- **Partnership with Copernicus Emergency Services:**
  - Utilization of Copernicus satellite data for validation and enhancement of FirEURisk fire detection and monitoring tools
  - Collaboration on developing improved methodologies for assessing post-fire impacts and recovery
  - Integration of FirEURisk risk assessment models with Copernicus emergency mapping services
- **Participation in International Conferences:**
  - Regular presentations of FirEURisk outcomes at major international conferences on wildfire management, disaster risk reduction, and climate adaptation
  - Organization of dedicated FirEURisk sessions and workshops at these events to facilitate knowledge exchange
  - Engagement with global research networks to stay abreast of the latest developments in wildfire science and management
- **Collaboration with Global Initiatives:**
  - Alignment of FirEURisk methodologies with the Sendai Framework for Disaster Risk Reduction
  - Engagement with the Global Wildland Fire Network to share experiences and best practices
  - Participation in OECD working groups on environmental risk management and climate resilience

These international collaborations and meetings serve to validate FirEURisk approaches against global standards, facilitate the exchange of knowledge and best practices, and position the project's outcomes within the broader context of international efforts to enhance wildfire management and climate resilience.

6.3 Dissemination Activities

Guided by Deliverables D6.2 and D6.3, FirEURisk has developed a comprehensive dissemination strategy to ensure that project outcomes reach appropriate audiences and are effectively integrated into management frameworks. Key elements of this dissemination strategy include:

- **Raising Awareness:**
  - Development of a dedicated project website and social media presence to share updates and findings
  - Production of accessible materials such as policy briefs, infographics, and short videos to explain complex concepts to non-technical audiences
  - Organization of public events and webinars to showcase FirEURisk tools and methodologies
  - Engagement with media outlets to disseminate project findings to broader public audiences
- **Training and Capacity Building:**

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- Development of comprehensive training programs for different user groups, from fire managers to policymakers
- Creation of e-learning modules to facilitate widespread access to training materials
- Organization of hands-on workshops and field demonstrations to provide practical experience with FirEURisk tools
- Establishment of a network of trainers who can provide ongoing support and guidance at local levels

- **Creating Sustainable Networks:**
  - Establishment of a FirEURisk Community of Practice to facilitate ongoing knowledge exchange among practitioners
  - Development of an online platform for sharing experiences, challenges, and best practices in implementing FirEURisk tools
  - Creation of regional hubs to support localized dissemination and adaptation of FirEURisk methodologies
  - Facilitation of twinning arrangements between regions to support peer-to-peer learning and knowledge transfer
- **Academic and Scientific Dissemination:**
  - Publication of research findings in high-impact, peer-reviewed journals
  - Presentation of results at scientific conferences and symposia
  - Organization of special issues in relevant academic journals to showcase FirEURisk outcomes
  - Development of open-access repositories for FirEURisk data and tools to support further research and innovation
- **Policy-oriented Dissemination:**
  - Production of policy briefs and white papers tailored to the needs of decision-makers at various governance levels
  - Organization of policy roundtables and briefings to present FirEURisk findings to key policymakers
  - Engagement with parliamentary committees and policy working groups to inform legislative processes
  - Development of case studies demonstrating the impact of FirEURisk tools on policy and practice
- **Multi-lingual Approach:**
  - Translation of key materials into multiple European languages to ensure wider accessibility (D2.6)
  - Provision of interpretation services at major events to facilitate participation from diverse linguistic backgrounds
  - Development of language-specific dissemination strategies tailored to different national contexts
- **Leveraging Partner Networks:**
  - Utilization of consortium partners' existing networks and communication channels to amplify dissemination efforts
  - Collaboration with national and regional fire management associations to reach practitioner communities
  - Engagement with EU-level platforms and networks to disseminate findings to broader European audiences

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These dissemination activities are designed to ensure that FirEURisk outcomes reach and impact a wide range of stakeholders, from local practitioners to European policymakers. By employing a diverse set of dissemination strategies, the project aims to maximize the uptake and long-term sustainability of its tools and methodologies.

7 Roadmap for Policy Integration

The roadmap for policy integration provides a structured approach to incorporating FirEURisk's outcomes into wildfire management policies and practices across Europe. This roadmap is designed to guide the transition from current practices to more integrated, science-based approaches over the short, medium, and long term.

7.1 Key Principles and Strategic Objectives

Successful integration of FirEURisk outcomes into policy frameworks is grounded in several key principles and strategic objectives:

- **Evidence-Based Decision-Making:**
  - Ensure that policy decisions are informed by robust scientific evidence and data-driven insights
  - Promote the use of advanced risk assessment and modelling tools in policy formulation and implementation
  - Establish mechanisms for regular review and update of policies based on new scientific findings
- **Multi-Level Governance:**
  - Foster coordination and coherence across local, regional, national, and EU-level policies
  - Develop flexible policy frameworks that can be adapted to diverse governance structures and institutional contexts
  - Promote vertical and horizontal integration of wildfire management policies across different sectors and jurisdictions
- **Adaptive Frameworks:**
  - Design policies that can evolve in response to changing environmental, social, and technological conditions
  - Incorporate regular review and revision cycles into policy frameworks to ensure ongoing relevance and effectiveness
  - Promote experimentation and learning in policy implementation to identify and scale up successful approaches
- **Stakeholder Involvement:**
  - Ensure ongoing engagement of diverse stakeholders in policy development and implementation processes
  - Establish formal mechanisms for stakeholder consultation and feedback in policy-making
  - Promote co-creation approaches that leverage local knowledge and expertise
- **Sustainable Funding:**

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- Advocate for long-term, stable funding mechanisms to support the adoption and maintenance of FirEURisk tools and strategies
- Promote innovative financing models, such as public-private partnerships and green bonds, to support wildfire management initiatives
- Ensure that funding allocations reflect the true costs of wildfire risks and the benefits of prevention and preparedness

7.2 Roadmap for Exploitation

Figure 5 presents the FirEURisk Exploitation Roadmap, outlining a five-year strategy for implementing and integrating FirEURisk tools across the European Union. This timeline illustrates critical milestones and activities, from securing pilot project commitments since the project started to achieving recognition as best-practice standards beyond the formal end of the R&D project. The roadmap highlights crucial phases, including piloting outcomes, launching demonstrations, implementing training programs, initiating policy integration, and ultimately establishing FirEURisk tools as best-practice standards in EU wildfire management.

Key Milestones and Actions:

- Year 1: Secure commitments from five EU member states to implement FirEURisk pilot projects
- Year 2: Launch pilot projects and establish feedback working groups
- Year 3: Implement comprehensive training programs in adopting regions
- Year 4: Begin formal policy integration processes at national levels
- Year 5: Achieve recognition of FirEURisk tools as best-practice standards in EU wildfire management guidelines



Figure 5 FirEURisk Exploitation Roadmap

As illustrated in Figure 6, the roadmap for exploitation beyond the end of the project outlines a phased approach to integrating FirEURisk outcomes into policy and practice.

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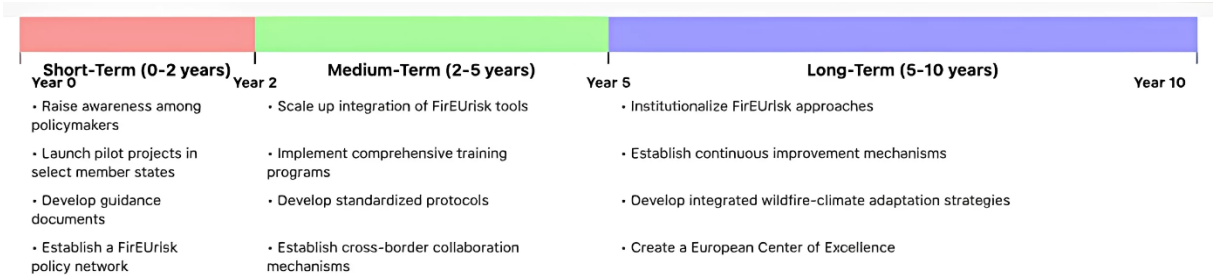


Figure 6 Final FirEURisk 10-Year Exploitation Roadmap Horizontal Timeline

More in particular, the relevant activities may include:

Short-Term (0-2 years):

- Raise awareness among policymakers about FirEURisk tools and their potential impact
- Launch pilot projects in select member states to demonstrate the effectiveness of FirEURisk approaches
- Develop guidance documents for integrating FirEURisk tools into existing policy frameworks
- Establish a FirEURisk policy network to facilitate knowledge exchange and best practice sharing

Medium-Term (2-5 years):

- Scale up integration of FirEURisk tools across regions and countries
- Implement comprehensive training programs for policymakers and practitioners
- Develop standardized protocols for incorporating FirEURisk risk assessments into land-use planning and development decisions
- Establish cross-border collaboration mechanisms based on FirEURisk methodologies

Long-Term (5-10 years):

- Institutionalize FirEURisk approaches within national and EU-level wildfire management policies
- Establish continuous improvement mechanisms to ensure ongoing refinement and adaptation of policies
- Develop integrated wildfire-climate adaptation strategies incorporating FirEURisk tools
- Create a European Center of Excellence for Wildfire Management to sustain and further develop FirEURisk approaches

7.3 Recommendations for Policymakers

To support the successful integration of FirEURisk outcomes, the following recommendations are provided for policymakers at national and international levels (FirEURisk D6.14; FirEURisk D4.5; Chuvieco et al., 2023):

National Level:

- Adopt risk-based frameworks for wildfire management, incorporating FirEURisk tools and methodologies (FirEURisk D6.14; FirEURisk D4.5)
- Integrate wildfire risk assessments into broader land-use planning and development processes (FirEURisk D6.14; FirEURisk D4.4)
- Invest in capacity building and training programs to ensure effective use of FirEURisk tools (FirEURisk D4.5; FirEURisk D6.14)

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- Develop national wildfire strategies that align with FirEURisk approaches and EU-level frameworks (FirEURisk D6.14)
- Establish formal mechanisms for collaboration between fire management agencies, research institutions, and local communities (FirEURisk D6.14; FirEURisk D4.5)

International Level:

- Promote the adoption of standardized risk assessment methodologies based on FirEURisk tools across EU member states (FirEURisk D4.4; FirEURisk D6.14; Chuvieco et al., 2023)
- Facilitate cross-border collaboration in wildfire management, particularly in high-risk regions (FirEURisk D6.14)
- Integrate FirEURisk approaches into EU-level disaster risk reduction and climate adaptation strategies (FirEURisk D6.14; FirEURisk D4.5)
- Support the development of a pan-European wildfire data sharing and analysis platform (FirEURisk D6.14; FirEURisk D4.4)
- Encourage investment in wildfire management technologies and research through EU funding programs (FirEURisk D6.14)

Policymakers can significantly enhance Europe's resilience to wildfires by implementing these recommendations and progressing toward the proposed plan. This strategy will effectively utilize the advanced tools and insights developed through the FirEURisk initiative.

8 Monitoring and Evaluation of Policy Integration

Effective monitoring and evaluation are crucial for successfully integrating FirEURisk tools and methodologies into wildfire management policies and practices. This section outlines the approaches for tracking progress, assessing impact, and continuously improving the implementation of FirEURisk outcomes.

8.1 Key Performance Indicators (KPIs)

A set of Key Performance Indicators (KPIs) has been developed to measure the success of policy integration efforts. These KPIs cover various aspects of implementation and impact:

- **Adoption of Outcomes (including project tools):**
  - Number of countries and regions officially adopting FirEURisk tools & outcomes
  - Percentage of target user groups actively using FirEURisk systems
  - Rate of integration of FirEURisk methodologies into national and regional policies
- **Improvement in Mitigation and Response:**
  - Reduction in average response times to wildfire incidents
  - Increase in accuracy of fire behaviour predictions
  - Decrease in the area affected by wildfires in regions using FirEURisk tools
- **Stakeholder Engagement:**
  - Number of stakeholders participating in FirEURisk training programs
  - Level of stakeholder satisfaction with FirEURisk tools (measured through surveys)
  - Frequency and quality of stakeholder inputs in tool refinement processes

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- **Policy Alignment:**
  - Number of national and regional policies incorporating FirEURisk recommendations
  - Degree of harmonization in wildfire risk assessment methodologies across EU member states
  - Extent of integration of FirEURisk approaches in EU-level disaster management frameworks
- **Cross-Border Collaboration:**
  - Number of cross-border wildfire management initiatives using FirEURisk tools
  - Frequency of data sharing and joint decision-making in border regions
  - Improvement in coordination during cross-border wildfire events
- **Economic Impact:**
  - Reduction in economic losses due to wildfires in regions adopting FirEURisk approaches
  - Cost-effectiveness of prevention and preparedness measures informed by FirEURisk tools
  - Level of investment in wildfire management technologies and practices
- **Environmental and Social Impact:**
  - Changes in ecosystem resilience in areas implementing FirEURisk-based management strategies
  - Improvement in community awareness and preparedness for wildfire risks
  - Reduction in health impacts related to wildfire incidents

8.2 Feedback and Continuous Improvement

To ensure the ongoing relevance and effectiveness of FirEURisk tools and strategies, a robust system for feedback collection and continuous improvement has been established (FirEURisk D6.14; FirEURisk D4.4; FirEURisk D4.5; Chuvieco et al., 2023):

- **Stakeholder Feedback Loops:**
  - Regular user surveys and feedback sessions to gather insights on tool performance and usability
  - Establishment of a dedicated online platform for users to report issues and suggest improvements
  - Annual stakeholder workshops to review progress and identify areas for enhancement
- **Continuous Training:**
  - Development of updated training materials to reflect tool improvements and new functionalities
  - Implementation of refresher courses and advanced training modules for experienced users
  - Creation of a mentorship program to support peer-to-peer learning and knowledge transfer
- **Peer Review:**
  - Regular external audits of FirEURisk methodologies by independent experts
  - Participation in international benchmarking exercises to assess tool performance against global standards
  - Organization of scientific review panels to validate ongoing developments and refinements
- **Data-Driven Improvement:**
  - Implementation of automated performance monitoring systems within FirEURisk tools
  - Regular analysis of operational data to identify trends, challenges, and opportunities for improvement
  - Use of machine learning algorithms to enhance tool accuracy and predictive capabilities over time
- **Adaptive Management Approach:**

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- Establishment of a formal process for reviewing and updating FirEURisk strategies based on implementation experiences
- Regular scenario planning exercises to anticipate future challenges and adapt tools accordingly
- Flexibility in project management to allow for rapid response to emerging needs and opportunities

This comprehensive approach to feedback and continuous improvement ensures that FirEURisk tools and methodologies remain at the forefront of wildfire management practices, continuously evolving to meet the changing needs of stakeholders and adapting to new challenges posed by climate change and evolving fire regimes.

8.3 Role of Technological Innovations

Technological innovations play a pivotal role in enhancing the efficacy of FirEURisk tools and facilitating their integration into operational practices. Key areas of technological advancement to consider in this regard include:

- **Artificial Intelligence and Machine Learning:**
  - Development of advanced predictive models that improve in accuracy over time
  - Implementation of AI-driven decision support systems for real-time fire management
  - Use of machine learning algorithms to identify patterns and trends in historical fire data
- **Satellite Monitoring and Remote Sensing:**
  - Integration of high-resolution satellite imagery for improved fire detection and monitoring
  - Use of advanced remote sensing technologies for real-time vegetation health assessment
  - Development of automated systems for rapid post-fire damage assessment
- **Big Data and Cloud Computing:**
  - Leveraging cloud platforms to enable large-scale data processing and analysis
  - Development of big data analytics tools to extract insights from diverse data sources
  - Implementation of distributed computing solutions to enhance processing speed and capacity
- **Internet of Things (IoT) and Sensor Networks:**
  - Deployment of advanced sensor networks for real-time environmental monitoring
  - Integration of IoT devices for improved early warning and detection systems
  - Use of connected vehicles and drones for enhanced situational awareness during fire events
- **Virtual and Augmented Reality:**
  - Development of VR training simulations for firefighters and incident commanders
  - Use of AR technologies to support on-the-ground decision-making during fire events
  - Creation of immersive visualization tools for public education and awareness
- **5G and Advanced Communications:**
  - Leveraging high-speed, low-latency networks for real-time data transmission from the field
  - Enhancing communication and coordination capabilities during large-scale fire events
  - Improving the reliability and reach of early warning systems in remote areas

By leveraging the technological advancements outlined above—ranging from AI and remote sensing to big data analytics, IoT, VR, and advanced communications—FirEURisk can significantly enhance the utility and impact of its project outcomes. Integrating these innovations will not only refine existing risk assessment and decision-support tools,

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but also foster more effective collaboration, faster data processing, and more responsive on-the-ground interventions, ultimately ensuring the project remains relevant and transformative in the constantly evolving arena of wildfire management.

9 Conclusions and Recommendations

9.1 Summary of Key Findings

The FirEURisk project has developed a comprehensive suite of tools, methodologies, and strategies aimed at enhancing wildfire management across Europe. Key findings from the project include:

- **Advanced Tools:** FirEURisk has produced (WP4) sophisticated models and decision support systems (the Open-platform and the FirEURisk viewer) that enable better anticipation, prevention, and response to wildfire risks. These tools integrate multiple data sources and advanced analytics to provide actionable insights for fire managers and policymakers.
- **Digital Systems:** The project has demonstrated the value of real-time information and data-driven decision-making in wildfire risk management. The FirEURisk's platform has visualization capabilities and it can host data critical for risk assessment, improving situational awareness while WP4 outcomes support effective prevention and wildfire management.
- **Stakeholder Engagement:** The co-production approach adopted by FirEURisk has ensured that project outcomes are practically relevant and tailored to the needs of end-users. This collaborative process has been crucial for the successful adoption and implementation of new tools and strategies.
- **Policy Integration Framework:** FirEURisk has developed a structured roadmap for integrating its outcomes into wildfire management policies at local, national, and European levels. This framework provides a clear path for enhancing policy coherence and effectiveness across different governance levels.
- **Cross-Border Collaboration:** The project has highlighted the importance of and opportunities for improved cross-border cooperation in wildfire management. FirEURisk tools and methodologies provide a common language and framework for joint planning and response efforts.
- **Climate Change Adaptation:** FirEURisk has demonstrated the critical need to integrate climate change projections into long-term wildfire management strategies. The project's tools support adaptive planning approaches that can respond to changing fire regimes and environmental conditions.

9.1 Policy Recommendations

Based on the project's findings and outcomes, the following key policy recommendations are proposed:

- **Adopt Risk-Based Management:** Policymakers should promote the adoption of risk-based wildfire management approaches, utilizing FirEURisk's advanced risk assessment models to inform prevention, preparedness, and response strategies.
- **Institutionalize Decision Support Systems:** There is a need to formally integrate digital decision support systems into wildfire management frameworks at all levels. This includes providing necessary resources for implementation, training, and ongoing maintenance of these systems.

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- **Enhance Governance Structures:** Policies should promote better coordination between different agencies and governance levels involved in wildfire management. This includes establishing clear roles and responsibilities, and creating formal mechanisms for information sharing and joint decision-making.
- **Invest in Training and Capacity Building:** Significant investment in training programs and capacity building initiatives is crucial to ensure effective utilization of advanced wildfire management tools and methodologies.
- **Support Continuous Innovation:** Policies should encourage ongoing research and development in wildfire management technologies and practices. This includes providing funding for innovation projects and creating regulatory environments that facilitate the testing and adoption of new approaches.
- **Align with Climate Strategies:** Wildfire management policies should be closely aligned with broader climate change adaptation and mitigation strategies. This includes incorporating long-term climate projections into risk assessments and management plans.
- **Promote Community Engagement:** Policies should emphasize the importance of community involvement in wildfire prevention and preparedness. This includes supporting community-based initiatives and integrating local knowledge into management strategies.
- **Enhance Data Sharing and Standardization:** There is a need for policies that promote greater standardization and sharing of wildfire-related data across borders and between different agencies. This includes developing common data formats and protocols for information exchange.
- **Integrate Land-Use Planning:** Wildfire risk considerations should be more closely integrated into land-use planning and development policies. This includes using FirEURisk risk assessment tools to inform zoning decisions and building regulations in fire-prone areas.
- **Support Cross-Sectoral Approaches:** Policies should promote more integrated approaches to wildfire management that consider interactions with other sectors such as forestry, agriculture, and urban planning.

By implementing these recommendations, policymakers can significantly enhance Europe's resilience to wildfire risks, leveraging the advanced tools and insights developed through the FirEURisk project to create more effective, sustainable, and adaptive wildfire management strategies.

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