



Proceeding Paper

Integrating Scientific Risk Assessment and Policy Instruments in European Wildfire Risk Management: A Multilevel Comparative Perspective [†]

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Abstract

The increasing frequency, intensity, and spatial extent of wildfires across Europe require a paradigm shift from reactive fire suppression toward integrated wildfire risk management grounded in scientific evidence and adaptive governance. This article examines how scientific risk assessment methodologies and policy instruments can be effectively aligned across European, regional, national, and local governance levels. The study develops a multilevel comparative analytical framework linking technical risk assessment tools with strategic policy objectives for fire-adapted societies. Particular attention is paid to vertical policy coherence (from EU to local level), horizontal coordination among sectors, and the integration of spatial risk modelling into planning, prevention, and climate adaptation strategies. The article contributes to the field of wildfire risk management by proposing a structured multilevel integration model that connects scientific assessment, ecosystem-based management, and adaptive policy instruments, offering practical implications for strengthening resilience in European forest landscapes under accelerating climate change.

Keywords: risk assessment; wildfire risk management; policy instrument; science–policy integration; multilevel governance; fire-adapted Europe; European policy

1. Introduction

Wildfire risk in Europe intensified significantly in recent decades due to the combined effects of climate change, land-use transformations, and increasing socio-ecological pressures on forest ecosystems.

Recent scientific research substantially advanced the methodological capacity for assessing wildfire risk. For example, the study by [1] proposes an approach for wildfire risk assessment and spatial mapping, combining ecological indicators and spatial analysis to identify areas of heightened vulnerability. The policy report [2] argues for the development of a fire-literate and fire-adapted Europe, highlighting the importance of preventive policies, institutional coordination, and improved integration between scientific knowledge and decision-making processes.

Scientific advances in wildfire risk assessment have improved the capacity to identify high-risk areas and support preventive planning. At the same time, European policy debates increasingly emphasize the need to move from reactive fire suppression toward adaptive and preventive governance approaches. However, despite significant



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progress in scientific modelling and policy development, a persistent gap remains between scientific risk assessment and its integration into policy instruments and operational management practices.

The article examines how scientific knowledge can integrate into strategic policy frameworks and operational management practices. The aim is to identify opportunities for strengthening the institutional integration of scientific risk assessment within multi-level governance structures and to contribute to the development of more coherent and preventive wildfire risk management in Europe.

2. Materials and Methods

This study adopts a qualitative multilevel comparative analysis to examine the integration of scientific wildfire risk assessment into policy instruments across European, national, regional, and local governance levels.

The analysis draws on three complementary sources: the scientific risk assessment model [1], the policy framework [2] and selected EU strategic documents, including key EU policies and strategies on wildfire management, forest management, and climate adaptation.

Effective wildfire governance depends on vertical coordination between policy levels as well as horizontal coordination among sectors such as forestry, environmental protection, emergency management, and land-use planning.

To evaluate the science–policy interface, the article applies three analytical criteria:

- Vertical coherence—Alignment between scientific outputs and policy objectives across governance levels;
- Institutional embedding—Incorporation of scientific risk assessment into legal and strategic frameworks;
- Operational applicability—The extent to which scientific knowledge informs practical management measures.

The analytical procedure follows a structured, theory-informed approach:

- Structured document analysis—Policy and scientific documents are systematically reviewed to extract information on integration mechanisms, governance structures, and operational relevance.
- Comparative integration matrix—Data are synthesized across governance levels (EU, national, local) using predefined criteria: vertical coherence, institutional embedding, and operationalization capacity.
- Governance gap identification—The matrix highlights mismatches between scientific knowledge and policy application, revealing areas where institutional or operational integration is limited or absent.

The analytical process focuses on identifying how scientific knowledge is translated into governance mechanisms, strategic planning, and operational management instruments. Comparative assessment is conducted through the three analytical criteria defined above.

These criteria provide a structured basis for assessing the integration of scientific risk assessment within European wildfire governance.

This methodology allows a concise, policy-oriented evaluation of how scientific knowledge translates into practical wildfire risk management across multiple governance scales.

3. Results

The comparative analysis demonstrates that the approaches presented in [1,2] are complementary and together provide a comprehensive perspective on wildfire risk management in Europe. Study [1] concentrates on the development of a scientific methodology

for assessing and mapping wildfire risk in forest ecosystems, whereas report [2] focuses on the policy and governance changes required to enhance societal and institutional resilience to increasingly severe wildfire events.

The methodology proposed in [1] is based on the integration of ecological indicators, spatial information, and vulnerability factors to identify areas with different levels of wildfire susceptibility. By combining advanced digital forest monitoring technologies, remote sensing tools, and extensive databases, the authors developed a unified register of potential fire risk factors comprising 29 indicators grouped into five thematic categories that reflect hazard characteristics, ecosystem vulnerability, and emergency response capacity. The indicators are evaluated and spatially overlaid to produce an integrated wildfire risk assessment at the smallest forest management unit—the subdivision. This approach provides a valuable evidence base for supporting forest planning, prioritizing preventive measures, and improving decision-making at local and regional levels, particularly in areas where biodiversity conservation and wildfire risk reduction objectives overlap.

In contrast, report [2] addresses wildfire management from a broader governance perspective and emphasizes the need to strengthen the resilience of landscapes and communities to future fire regimes. The report connects wildfire management with several major European policy frameworks, including the Common Agricultural Policy, the EU Climate Strategy, the Biodiversity Strategy, the Farm to Fork Strategy, the EU Forest Strategy, and the Nature Restoration Law. It proposes a toolbox: three urgent key messages and eight policy measures to enable better management of fires today and to prepare and adapt society for the fires in the future, aimed at improving preparedness, reducing landscape vulnerability, and promoting more coordinated approaches to wildfire management across sectors and governance levels.

It is emphasized despite the availability of modern scientific tools for assessing the risk of wildfires, their systematic inclusion in policy instruments and governance structures remains uneven.

The comparison of the two studies reveals that scientific advances in wildfire risk assessment are progressing more rapidly than their incorporation into policy and management practice. Although spatial risk assessments can provide detailed information on fire-prone areas and support preventive planning, their practical application remains constrained by limited institutional uptake and insufficient integration into regulatory and planning frameworks. Consequently, valuable scientific information is often underutilized in land-use planning, forest management strategies, and local prevention initiatives.

Overall, the findings indicate that enhancing wildfire resilience in Europe depends on establishing stronger links between scientific knowledge and decision-making processes. The incorporation of spatial risk assessments into strategic planning and forest management policies would improve the capacity of institutions to anticipate, prevent, and adapt to increasing wildfire risks associated with climate change and evolving land-use patterns. Strengthening coordination among governance levels and improving the implementation of science-based management approaches therefore emerge as key prerequisites for more effective and adaptive wildfire governance.

4. Discussion

Wildfire risk management increasingly reflects the principles of risk governance and adaptive environmental management. Contemporary approaches emphasize prevention, resilience, and adaptation rather than relying exclusively on suppression and emergency response. Within this context, scientific knowledge plays a critical role in supporting evidence-based governance.

The methodological approach developed by [1] demonstrates the growing sophistication of wildfire risk assessment tools. The model integrates ecological indicators, vegetation characteristics, topographic factors, and spatial data to identify wildfire-prone forest areas.

The primary governance value of this approach lies in its ability to generate spatially explicit information that supports preventive planning and ecosystem-based management. Risk maps can inform forest management strategies, biodiversity protection measures, and land-use planning decisions. By identifying areas of high vulnerability, the methodology contributes to prioritizing prevention measures and improving preparedness.

At the same time, the analysis reveals limitations associated with technocratic approaches to wildfire governance. Scientific models alone cannot ensure effective management unless they are institutionally integrated into legal frameworks, strategic planning mechanisms, and operational decision-making processes. In many cases, risk assessments remain advisory rather than mandatory tools, limiting their practical influence on governance outcomes.

5. Conclusions

This study demonstrates that effective wildfire risk governance in Europe depends on integrating scientific risk assessment with multilevel policy instruments.

It contributes to the risk governance by providing a structured framework for evaluating science–policy integration, highlighting governance gaps, and offering actionable recommendations. For European policy, it underscores the need to embed scientific risk assessment into binding strategies and operational practices, ensuring that wildfire risk management is proactive, coordinated, and resilient in the face of environmental challenges.

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Abbreviations

The following abbreviations are used in this manuscript:

EASAC	European Academies Science Advisory Council
EU	European Union

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