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Framing Coherence Across EU Policies Towards Integrated Wildfire Risk Management and Nature-Based Solutions

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Abstract: Wildfire risk has been exacerbated across Europe by climate change favoring more damaging and severe wildfire events. This evolving wildfire risk context interacts with a broad landscape of EU policies including those on nature conservation, forestry, bioeconomy or climate and energy, all of which may increase or reduce fire hazard and the level of exposure and vulnerability of the values at risk. Coherently addressed, policies may support wildfire disaster risk management synergistically while reducing potential dysfunctions. This research conducts a content analysis of EU policies and initiatives under the European Green Deal with respect to integrated wildfire risk management and related nature-based solutions. The results show that a consistent EU policy framework to address wildfire risk reduction in a synergic way exists, with no major conflicts in the policy design. Nevertheless, better guidance on fire-smart land management practices and the conceptualization of wildfire-related nature-based solutions may enhance a more coherent policy implementation. Additional suggestions around the legal status of wildfire protection and 'whole of government' governance frameworks are discussed. Notably, within the laws, policies and initiatives analyzed, the beneficial side of fire addressed by integrated fire management is either missing or not explicitly mentioned, although it is considered in policy-related supporting guidelines.

Keywords: governance; policy synergies and coordination; fire-smart land management; EU policy landscape

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1. Introduction

The evolving wildfire risk context favoring more damaging and extreme events, both in traditional and unprecedented EU territories, is posing new challenges in terms of wildfire disaster risk management (DRM) [1–10]. As climate change exacerbates the risk of wildfire disasters, there is an increasing need to align disaster risk reduction (DRR) efforts with both international and EU agendas [11–14]. This includes enhancing wildfire prevention and preparedness together with response and recovery capacities while integrating wildfire risk management (WFRM) across all relevant sectors to ensure policy coherence [15–21].

Integrated risk management is based on a proper understanding of the drivers of hazard, exposure and vulnerability, as well as how these factors interact to either increase

or decrease risk along the causality chain [22–24]. Like in an accumulative process, a higher hazard has the potential to increase the impact on the values at risk, thus more mitigation and adaptation efforts related to exposure and subsequent vulnerabilities are needed. Likewise, gaps in prevention and preparedness can create constraints in response efforts and increase recovery needs. Therefore, an integrated WFRM must have a holistic governance coherently addressing sectoral policies that directly or indirectly influence the process of risk creation and reduction. Moreover, integrated fire management (IFM) encompasses the dual goals of reducing damaging wildfires while recognizing the ecological benefits of fire and its role as a tool for land and risk management [25,26]. Within integrated risk management, measures across the entire DRM cycle (i.e., prevention, preparedness, response and recovery) are efficiently coordinated while considering social, economic, environmental, legal and cultural aspects, as well as the participation of all relevant stakeholders [12]. Nevertheless, the inherently cross-sectoral and multi-disciplinary nature of integrated risk management, combined with the lack of a standardized definition for WFRM, may undermine its effective incorporation into policy frameworks [14].

In terms of policy action, the causality chain mentioned above is particularly relevant for wildfires since fire hazard in terms of spread and intensity is highly influenced by fuel distribution [27–32]. This enables us to modify the level of hazard at the beginning of the chain by means of fuel management. Therefore, unlike other natural disturbances with the highest fatalities and affected populations such as extreme temperature events, floods, earthquakes or storms [33] where the intensity of the phenomena cannot be altered, the ability to substantially influence wildfire hazard offers a valuable opportunity within wildfire DRR policy design. Policies enabling fire-smart forestry practices [32,34] and agroforestry practices that enhance fuel discontinuity through mosaic landscapes [35,36] may allow us to achieve fire-smart territories [37] aimed at reducing risk through economic valorization and sustainable development while providing safety and fire-resilient landscapes [38]. Therefore, addressing biomass management in sufficient surface may reduce the risk of high-intensity wildfires in a cost-effective manner [39,40], counteracting the growing trend of population exposure to high-to-extreme fire danger levels and wildfire smoke in the EU [41,42], which is being exacerbated by anthropogenic climate change [43,44]. In this context, nature-based solutions (NbSs) have been positioned as a pillar for mitigation and adaptation within DRR policies [45,46] and coherent DRR planning [47]. When applied to wildfire risk reduction, NbSs can offer multiple co-benefits including strengthening forest resilience, enhancing carbon stocks, promoting bioeconomy and biodiversity conservation [48–50]. However, NbSs may pose some challenges in terms of risk reduction if they lead to stand-level fuel models of higher risk or expand wooded landscapes without considering wildfire risk-counteracting measures [51].

Beyond the hazard factor, policies can influence wildfire exposure and vulnerability. For instance, promoting dispersed settlements near or within wooded areas, which is a precursor of many wildfire fatalities, can increase risk [52,53]. Building codes and regulations [54,55], insurance policies [56,57] and pre-planned emergency management protocols [58] may reduce vulnerability to socially acceptable residual risk (the disaster risk that remains in an unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained (https://undrr.org/terminology, accessed on 19 July 2024)) thresholds. Thus, wildfire likelihood and impacts are shaped by actions and inactions related to hazard, exposure and vulnerability, reflecting both current and past policy, planning and governance decisions. Accordingly, policies should be tailored to the local socio-ecological context and consider potential trade-offs in wildfire risk. This requires structuring the complexity of integrated landscape management to ensure that the multifaceted approach of WFRM is fully embedded [37,59–61].

Over the past few decades, the growing concern over climate-related risks has prompted the EU to develop a wide array of policies and initiatives around climate mitigation and adaptation. Key mitigation efforts, such as the European Climate Law [62] and the Renew-

able Energy Directive [63] aim to facilitate the transition to a climate-neutral economy and a reduction in greenhouse gas emissions. In parallel, the EU Adaptation Strategy focuses on reducing the risk of adverse impacts of climate change on people, nature and infrastructures. To address climate-related risks, the Union Civil Protection Mechanisms (UCPMs) [64] and related initiatives, such as the European Disaster Resilience Goals (DRGs) [13], focus on enhancing the resilience and adaptive capacity of both society and ecosystems to disturbances [65–67]. Complementing these efforts, the European Green Deal (EGD) [68] encompasses policies and initiatives that simultaneously address climate and biodiversity ambitions by means, for instance, of forest ecosystem restoration under the new EU Forest Strategy [69], the EU Biodiversity Strategy [70] and the Nature Restoration Law [71], or by promoting nature-based carbon farming within the Common Agricultural Policy (CAP) [72]. The promotion of the EU Bioeconomy Strategy [73] also targets a green transition. As the threat of wildfires intensifies, recent publications have highlighted potential trade-offs that may arise. These include issues related to the expansion of wooded landscapes through tree planting [51], the management of protected areas [74], the accumulation of dead wood for biodiversity [75] and fire ignitions from wind turbines [76]. Suppression-centered strategies, which can exacerbate the severity of remaining wildfires [30,77], or urban and infrastructure developments that increase the risk of wildland–urban interface fires [78] are among other potential policy trade-offs. Moreover, emerging extreme wildfire events (EWEs) present new challenges in the policy arena, particularly regarding fatalities, human health [79] and urban adaptation to climate risks [80].

Policy coherence refers to reducing conflicts and promoting synergies between and within different policy areas, with the aim of achieving shared outcomes aligned with jointly agreed policy objectives [81]. Policy coherence principles can promote holistic governance frameworks for addressing complex issues like climate agendas, mitigating fragmentated government actions [82–84]. The level of coherence may be assessed across the policy objectives, instruments and implementation practices, and policy outcomes and impacts at both horizontal (across policy domains) and vertical levels (e.g., across EU, member state and subnational levels) [81]. The OECD establishes eight principles of policy coherence for sustainable development, including the level of political commitment, strategic long-term vision, policy integration, whole-of-government coordination, subnational and stakeholder engagement and the policy impacts and evaluation [85]. The EU Adaptation Strategy [86] establishes three subsequent principles of climate-risk management policy coherence (i.e., avoid creating new exposure, reduce existing risk and manage residual risk) that should be addressed in all policies. In the same vein, coherence in integrated WFRM should focus on minimizing unwanted trade-offs and unintended consequences along the risk chain while enhancing synergies that reduce hazards, exposure and vulnerabilities in a coordinated manner across the DRM cycle.

In the context of integrated WFRM, which englobes numerous policies, the field of policy interactions becomes vast and complex, yet a dedicated EU directive for wildfires like the one for floods [87] does not exist. Furthermore, a systematic analysis of the conflicts and synergies across sectoral policies that may influence wildfire risk is lacking. The objective of this research is to analyze the policy coherence of core EU policies, strategies, initiatives and tools in relation to the principles and implementation of integrated WFRM and NbSs. Ultimately, this research seeks to identify, discuss and suggest policy design aspects that enhance synergies and mitigate potential dysfunctions across the policy landscape related to wildfire DRR, thereby proposing suggestions for more coherent wildfire risk governance.

2. Methods

The research involved a structured review of the content of a set of laws, policies and related initiatives related to wildfire risk and the implementation of NbSs at the EU scale. The review aims to evaluate the coherence of existing European policies and tools with integrated WFRM and related NbSs, considering potential dysfunctions and synergies between policies.

In selecting relevant laws and policies, key EU strategic and policy domains related to wildfires and climate risk, as stated in various reports, were considered [11,15,17,20]. The final list of laws and policies was shaped by the authors' expertise, complemented by insights from external experts in the fields of societal dimensions, civil protection, environment, insurance and infrastructure, gathered through workshops and webinars organized by the Firelogue and FIRE-RES projects (https://fire-res.eu, accessed on 15 July 2024 https://firelogue.eu/, accessed on 15 July 2024). This list of laws and policies includes relevant EU laws, such as regulations and directives, as well as relevant EC communications and other policy statements. New legislative and policy proposals, including proposed regulations, were also considered. However, since the focus is on sectoral policies, funding initiatives were not included in the content analysis, although they were consulted when relevant to support the discussion on policy implementation. The term 'policies' is used throughout this paper to refer to those laws, policies and related initiatives as listed in Table 1.

Table 1. European laws (L), policies (P) and initiatives (I) analyzed, and respective relevance for WFRM. Strategies, regulations, initiatives.

Cluster	Law, Policy and Initiatives	WFRM Relation
EU General Framework	The EU Green Deal, EGD (EC, 2019) (P) Taxonomy Regulation (DG FISMA, 2020) (L) General Union Environment Action Program to 2030, 8th EAP (DG ENV, 2022) (P)	EU policy roadmap; Environmental sustainability criteria for economic activities; Sustainable development
Forest, Agriculture and Bioeconomy	New EU Forest Strategy for 2030 (DG AGRI, 2021) (P) The 3 Billion Tree Planting Pledge for 2030 (DG AGRI, 2021) (P) Proposal Forest Monitoring Law (DG ENV, 2023) (L) Proposal on the Production and Marketing of Forest Reproductive Material (DG SANTE, 2023) (L)	Forest policy framework; Forest protection function; Increase in wooded landscapes; Forest health and monitoring; Tree breeding and climate change adaptation of forests
	Common Agricultural Policy 2023-2027, CAP (DG AGRI, 2021) (P) Farm to Fork Strategy (DG SANTE, 2020) (P)	Mosaic landscape shaping and promotion of rural economy and communities
	EU Bioeconomy Strategy (DG REA, 2018) (P)	Forest- and agriculture-based products' value chain
	Communication on sustainable use of natural resources (EC, 2023) (I)	Natural resource management
Nature and Biodiversity	'Nature Directives': Habitats Directive (DG ENV, 1992_2013); Birds Directive (DG ENV, 2009_2019) (P) EU Green Infrastructure Strategy (DG ENV, 2013) (P) EU Biodiversity Strategy 2030 (DG ENV, 2020) (P) Nature Restoration Law (DG ENV, 2024) (L)	Fuel management and nature conservation; Prescribing fire for biodiversity; Forest protection function; Restoring fire-adapted ecosystems to natural fire regimes
Climate and Energy	European Climate Law (DG CLIMA, 2021) (L) Land Use, Land Use Change, and Forestry (LULUCF) Regulation (DG CLIMA, 2018_2023) (L) National Energy and Climate Plans 2021-2030, NECP (DG ENER, 2023) (I) Provisional Agreement on the Carbon Removals and Carbon Farming (CRCF) Regulation (DG CLIMA, 2022_2024) (L)	Wildfires and prescribed fire emissions; Use of bioenergy and wood; District heating; Carbon storing in wood products and related forestry practices
	New EU Strategy on Adaptation to Climate Change (DG CLIMA, 2013_2021) (P) EC Technical guidance on climate proofing of infrastructure (EC, 2021) (P) Communication managing climate risks—protecting people and prosperity (CLIMA, 2024) (I)	Key steps for managing climate risks; EU investment in infrastructures; Climate risk integration in Eurocodes

Table 1. *Cont.*

Cluster	Law, Policy and Initiatives	WFRM Relation
Climate and Energy	Renewable Energy Directive (DG ENER, 2023) (L) EU Wind Power Action Plan (DG ENER, 2023) (P)	Impact of infrastructure on WFRM; Use of bioenergy
Air Quality and Health	Zero Pollution Action Plan (ZP vision) (DG ENV, 2021) (P) Directive on the Reduction of National Emissions of Certain Atmospheric Pollutants, NEC Directive (DG ENV, 2016) (L) Proposal for a Revision of the Ambient Air Quality Directives (DG ENV, 2022) (L)	Wildfire and prescribed fire smoke/Bioenergy use
	Global Health Strategy (DG INTPA, 2022) (P)	Wildfire impact on health
Civil Protection and Disaster Risk Management	EU Civil Protection Mechanism Regulation, UCPM (DG ECHO, 2013_2023) (P) rescEU (DG ECHO, 2017) (P) Wildfire Prevention Action Plan (DG ECHO, 2022) (P) European Disaster Resilience Goals (DG ECHO, 2023) (P) Wildfire Peer Review Assessment Framework (DG ECHO, 2023) (I)	Civil protection deployment; Collective response; WFRM; DRR agendas applied to wildfires; Integrated WFRM assessment framework
	Critical Entities Resilience (CER) Directive (DGHOME, 2022) (L)	Wildfire impact and risk of ignition
	Communication preventing and managing disaster risk in Europe (DG ECHO, 2024) (I)	Progress on UCPM Article 6 Risk Mang.
Environmental Assessment and Liability	Strategic Environmental Assessment (SEA) Directive (DG ENV, 2001) (L) Environmental Impact Assessment (EIA) Directive (DG ENV, 2014) (L)	Environmental assessment of WFRM in projects (EIA), plans and programs (SEA)
	Environmental Liability Directive, ELD (DG ENV, 2004_2019) (L) Environmental Crime Directive (DG ENV, 2024) (L)	Liability for fire ignition and WFRM decision-making all throughout DRM

Finally, 40 sectoral policies and initiatives were included in the review (Table 1), organized into seven main clusters: EU general framework (3 items); forestry, agriculture and bioeconomy (8 items); nature and biodiversity (5 items); climate and energy (9 items); air quality and health (4 items); civil protection and disaster risk management (7 items); and environmental assessment and liability (4 items). Table 1 presents these documents and explains their relevance for WFRM. The General Directorate (DG) responsible for such policies and/or initiatives and the formulation year/last amendment date are indicated as well.

A summative content analysis [88] was conducted for each policy document, focusing on wildfire DRM and related NbSs. The summative approach involved both manifest and latent content analysis. In the manifest content analysis, specific words in the text were quantified to understand their contextual use, involving a quantitative phase where word frequencies were counted. The analysis then progressed to qualitative latent content analysis, where the focus shifted to interpreting the underlying meanings of the words or content, considering not only the term usage across selected documents but also delving into the deeper implications and significance of these terms within their specific contexts.

The quantitative analysis was conducted on six selected terms (see Table 2): 'Wildfire' or closely related terms (including, e.g., forest fires) to determine the presence of the concept in the text; 'Integrated fire management', exact term or similar (e.g., integrated WFRM), to see if this integrated dimension was explicitly mentioned; 'Extreme wildfire events', exact term, to assess whether the term EWE used in recent policy reports and the scientific literature has percolated into policy documents; 'Wildfire disaster', exact term or similar (e.g., forest fire disaster), to understand if wildfires are recognized not only as a natural disturbance but also as emerging disasters; 'Nature-based solutions', to evaluate the inclusion of this tool in policies; and 'Policy coherence', exact term or similar, to identify

if coherence related to other policies was targeted. Mentions of these terms that appeared only in footnotes were excluded from the analysis.

Table 2. Selected terms counted (in bold) and complementary keywords used for the content analysis per topic.

Topic	Terms Counted and Complementary Keywords
WFRM	**(forest/landscape) (wild)(land)fire(storms)**; **extreme wildfire event**; **integrated (landscape) (wild)fire (risk) management**
Wildfire resilience	(wildfire/forest/landscape/climate) resilience/nt; fire ecology; fire regime; (climate) mitigation, adaptation/ive; climate/risk scenario
Nature-based solutions	**nature-based solutions**; ecosystem-based; ecosystem/forest protection; forest protection/ive function; forest/ecosystem/nature conservation; forest/ecosystem/nature restoration; closer-to-nature; (forest/ecosystem) biodiverse/ity
DRR	**(forest/wild)fire disaster**; natural risk; forest/climate(-related) risk; natural/climate hazard; natural disasters; (integrated) risk (management); disaster risk (reduction/mitigation); civil/citizens/infrastructures protection; public safety; insurance
Policy coherence	**policy/ies coherence/coherence (of)(across) policies**; coordination; consistency; governance; regulation

Subsequently, a qualitative content analysis was conducted. To this end, a first scan was performed of each text, extracting paragraphs where the above-mentioned selected terms appeared. Additionally, other keywords were added to contextualize the use of selected terms and related concepts: for instance, if landscape resilience to wildfires was considered alongside the text. Moreover, this allowed us to identify content not directly linked to wildfires but nonetheless relevant, such as policy targets and provisions related to reinforcing resilience to climate-related risks or the implementation of NbSs for climate adaptation that may also be extended to WFRM. The related text from the policies with the selected terms and additional keywords was grouped in five topics: 'WFRM', including EWE and related IFM terms; 'Wildfire resilience', to determine if wildfire-resilient landscapes, fire ecology or fire regime issues were considered; 'NbS', including protection function, nature conservation issues and similar ecosystem-based or closer-to-nature approaches; 'DRR', including DRM beyond wildfires and related civil protection and insurance aspects; and 'policy coherence', including similar terms such as coordination, synergies and consistencies between policies and governance frameworks (see the list of all the words used in Table 2).

An automated search of the selected terms and additional keywords was conducted for each policy document available on the EC and related official webpages, using the word search function in a PDF reader. For each policy, a template was created that included a basic description and complementary information sourced from the corresponding EC website. The paragraphs containing the selected terms and keywords were extracted and organized on the template by topic, indicating the section to which the text belonged and the page number. As mentioned, only the main terms were counted. However, keyword extraction was used to better contextualize the presence or absence of the exact term in the text. The extracted text was then used for the content analysis, reviewing the full text when needed to avoid the risk of a narrow focus on textual data and a potential oversight of broader meanings.

The combination of both quantitative and qualitative searches for terms and related keywords served as the foundation for the discussion and consequent formulation of policy design, considering both the analysis of individual policies and their cross-links with other policies regarding integrated WFRM and NbSs for wildfire risk reduction (Figure 1). Within the discussion, synergistic or counteracting measures related to enhancing coherence were highlighted.

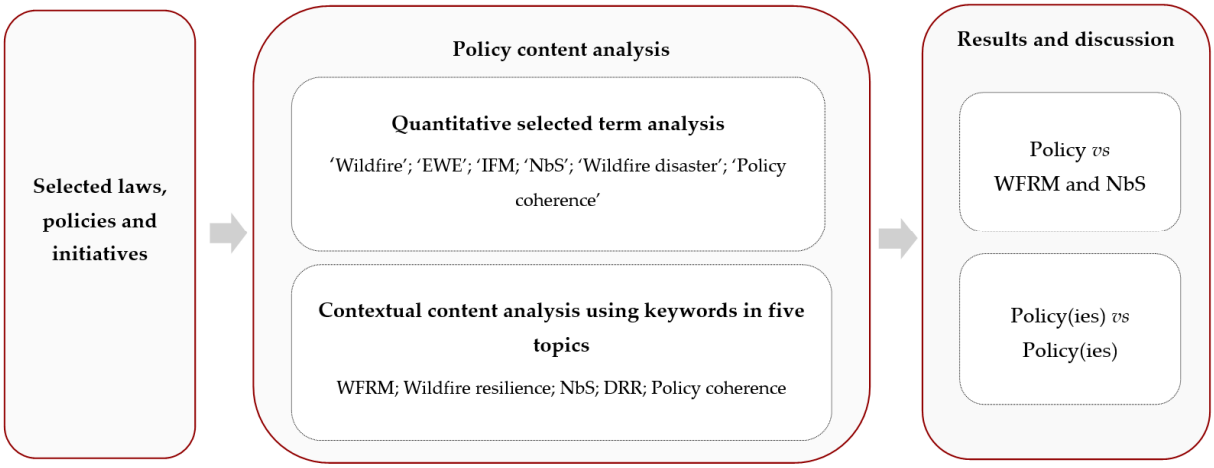

Figure 1. Sequence of the content analysis.

3. Results

The counting analysis (Table 3, Figure 2) showed that all selected or homologous terms are mentioned in the analyzed policies, although frequencies and distribution are very diverse. Wildfire or a homologous term has 847 mentions, 138 in law and policy texts (i.e., not considering the communications or Wildfire Peer Review Assessment Framework). However, IFM or a homologous term appears 7 times, with a unique mention within 1 policy text. Extreme wildfire event has 4 mentions, 2 in a policy text. Wildfire disaster appears 53 times, 9 in a law or policy text. NbS appears 62 times in law and policy texts plus 7 times in additional initiatives, while policy coherence has 97 mentions, 74 times in a law or policy text. Among the clusters and within law or policy texts, wildfire-related terms are present in all of them, mainly in DRM (57 mentions), forestry (45), climate (19) and biodiversity (8). IFM appears only in the Forest Strategy. Similarly, EWE, a term with 2 mentions in DRM policy and laws and 1 additional mention in a climate communication, is poorly represented. Wildfire disaster is present in forestry laws and policy texts (4 times), DRM (3) and biodiversity (2). The NbS term is present in all clusters except in environmental assessment and liability, being the most frequent in climate (26 mentions) and biodiversity (20), followed by bioeconomy and EU general framework (5) ones. Within forestry policy and laws, NbS has only 3 mentions in the 3 Billion Tree Pledge [89], plus 5 in bioeconomy and 1 in agriculture in the same cluster. Similarly, DRM cluster law and policy texts only consider NbSs 1 time. Policy coherence is a term present in all clusters, mainly in forestry, agriculture and bioeconomy (20 times), nature and biodiversity (15), climate (13), DRM (10) and air quality and health (7), with 5 in the EU general framework and environmental assessment and liability/crime.

Table 3. Selected term frequencies in each cluster within law and policy (P&L) and additional initiatives (communication and policy tools (I)).

Cluster	Text	Wildfire	IFM	EWE	Wildfire Disaster	NbS	Policy Coherence
EU General Framework	P&L	2	0	0	0	5	5
Forestry, Agriculture and Bioeconomy	P&L	47	1	0	4	9	20
	I	10	0	0	0	2	0
Nature and Biodiversity	P&L	8	0	0	2	20	15
Climate and Energy	P&L	21	0	0	0	26	12
	I	12	0	1	3	4	1

Table 3. *Cont.*

Cluster	Text	Wildfire	IFM	EWE	Wildfire Disaster	NbS	Policy Coherence
Air Quality and Health	P&L	2	0	0	0	1	7
Civil Protection and DRM	P&L	57	0	2	3	1	10
	I	687	6	1	41	1	22
Environ. Assessment and Liability	P&L	1	0	0	0	0	5

		WF	IFM	EWE	WF Disaster	NbS	Policy coher.
EU General Framework	European Green Deal	1	0	0	0	2	0
	Taxonomy Regulation	0	0	0	0	0	1
	Environment Action Programme to 2030	1	0	0	0	3	4
	Sub-total	*2*	*0*	*0*	*0*	*5*	*5*
Forestry, Agriculture and Bioeconomy	Forest Strategy for 2030	11	1	0	0	0	2
	3 Billion Tree Planting Pledge	7	0	0	1	3	0
	Forest Monitoring Law proposal	20	0	0	0	0	4
	Regulation on Forest Reproductive Material proposal	7	0	0	3	0	2
	Common Agricultural Policy 2023-2027	1	0	0	0	0	1
	Farm to Fork Strategy	0	0	0	0	1	2
	Bioeconomy Strategy	1	0	0	0	5	9
	Com. on sustainable use of natural resources	10	0	0	0	2	0
	Sub-total	*57*	*1*	*0*	*4*	*11*	*20*
Nature and Biodiversity	The Habitats Directive	0	0	0	0	0	7
	Birds Directive	0	0	0	0	0	1
	Green Infrastructure Strategy	1	0	0	1	1	3
	Biodiversity Strategy for 2030	3	0	0	0	11	1
	Nature Restoration Law	4	0	0	1	8	3
	Sub-total	*8*	*0*	*0*	*2*	*20*	*15*
Climate and Energy	European Climate Law	2	0	0	0	2	4
	Land Use, Land Use Change, and Forestry Regulation	0	0	0	0	0	0
	National Energy and Climate Plans	0	0	0	0	2	1
	Carbon Removals and Carbon Farming Regulation	0	0	0	0	1	2
	Climate Adaptation Strategy	3	0	0	0	21	5
	Technical guidance on climate proofing of infrastructure	14	0	0	0	2	1
	Com. managing climate risks-prot. people and prosperity	12	0	1	3	2	0
	Renewable Energy Directive	2	0	0	0	0	0
	Wind Power Action Plan	0	0	0	0	0	0
	Sub-total	*33*	*0*	*0*	*0*	*30*	*13*
Air Quality and Health	Zero Pollution Action Plan	0	0	0	0	1	0
	Red. Nat. Emiss. of Certain Atmospheric Pollutants Directive	1	0	0	0	0	3
	Ambient Air Quality Directive proposal	1	0	0	0	0	3
	Global Health Strategy	0	0	0	0	0	1
	Sub-total	*2*	*0*	*0*	*0*	*1*	*7*
Civil Protection and Disaster Risk Management	Union Civil Protection Mechanism	1	0	0	0	0	1
	RescEU	21	0	2	2	0	1
	Wildfire Prevention Action Plan	30	0	0	1	0	0
	European Disaster Resilience Goals	5	0	0	0	1	3
	Wildfire Peer Review Assessment Framework	665	6	1	38	1	17
	Critical Entities Resilience (CER) Directive	0	0	0	0	0	5
	Com. preventing and managing disaster risk	22	0	0	3	0	5
	Sub-total	*744*	*0*	*3*	*44*	*2*	*32*
Environmental Assessment and Liability	Strategic Environmental Assessment Directive	0	0	0	0	0	1
	Environmental Impact Assessment Directive	0	0	0	0	0	1
	Environmental Liability Directive	0	0	0	0	0	0
	Environmental Crime Directive	1	0	0	0	0	3
	Sub-total	*1*	*0*	*0*	*0*	*0*	*5*
	TOTAL	*847*	*1*	*3*	*50*	*69*	*97*

Nº ref: 30, 20, 10, 0

WF: Wildfire-related words including (forest/landscape) (wild)(land)fire(s)(storms).

IFM: Integrated fire management, exact term or similar such as integrated (landscape) (wild)fire (risk) management.

EWE: Extreme wildfire events, exact term or similar, using the term extreme and referring to a wildfire event (e.g., the prevention of a (wild)fire event of extreme magnitude).
WF Disaster: Wildfire disaster, including (forest/wild)fire disaster (risk).
NbS: Nature-based solutions, only includes the exact term.
Policy Coher.: Policy/ies coherence(s)/Coherence (of)(across) policies, exact term or similar using the term coherence

Figure 2. Frequency of selected terms in the law, policy and initiative texts.

The two European policy roadmaps include the wildfire term (1 time each) and the NbS term, 1 time in the European Green Deal (EGD) and 3 times in the General Union Environment Action Program to 2030 (8th EAP) [90]. Policy coherence is mentioned 4 times in the 8th EAP and once in the Taxonomy Regulation [91]. The rest of the terms are not present. In the UEGD, together with floods, wildfire is the only natural hazard named.

In forestry, agriculture and bioeconomy, all selected terms are mentioned except EWE. In forestry policies, wildfire is present in all of them, mostly in the Forest Monitoring Law [92] (FML, 20 times) and Forest Strategy (11) followed by the 3 Billion Tree Planting Pledge and Forest Reproductive Material (FRP) Regulation [93] (7 each). Forest Strategy is the unique policy text including the IFM concept, naming integrated landscape fire management 1 time. Wildfire disaster has a unique mention in the 3 Billion Pledge (1 time), which also is the unique text considering NbSs (3). Policy coherence is present in the FML (4 times) and the Forest Strategy and FRP Regulation (2 times each). The Common Agricultural Policy (CAP) mentions wildfire and policy coherence once, while Farm to Fork [94] considers NbSs 1 time and policy coherence 2 times. The Bioeconomy Strategy [73] includes wildfire with a unique mention, while NbS and policy coherence are mentioned 5 and 9 times, respectively. Additionally, the communication on sustainable use of natural resources [95] uses wildfire (10 times) and NbS (2).

Within the nature and biodiversity cluster, the wildfire term is present in the Nature Restoration Law (NRL, 4 times), Biodiversity Strategy (3) and once in the Green Infrastructure (GI) Strategy [96]. Wildfire disaster is named in the GI Strategy and NRL 1 time. NbS has 20 mentions across the Biodiversity Strategy (11), NRL (8) and GI Strategy (1). Policy coherence is present in all policies, mainly in the Habitat Directive [97] (HD, 7 times), GI Strategy and NRL (3 times each), while the Biodiversity Strategy and Bird Directive [98] have a unique mention.

In the texts of the Climate Law, Adaptation Strategy and technical guidance on climate proofing for infrastructures [99], wildfire (2, 3, and 14 times, respectively), NbS (2, 21, and 2 times) and policy coherence (4, 5, and 1 times) are the terms mentioned. The Renewal Energy Directive only considers wildfire (2 times), while the Wind Power Action Plan [100] does not mention any term. However, in the communication on the National Energy and Climate Plans [101], NbS (2 times) and policy coherence (1) are present. The communication on managing climate risks [102] considers the wildfire (12 times), EWE (1), wildfire disaster (3) and NbS (2) terms, while policy coherence is not mentioned. This is the cluster with the highest frequency of the NbS term, with the Adaptation Strategy being the text with the most mentions.

The civil protection and DRM cluster is the one with the most mentions of the wildfire term. Wildfire appears in all law and policy texts, mostly in the Wildfire Prevention Action Plan [103] (30 times) and rescEU [104] (21), although is absent in the Critical Entities Resilience (CER) Directive [105]. EWE is mentioned in rescEU, which also includes wildfire disaster, 2 times each. NbS has only 1 mention in the European Disaster Resilience Goals (DRGs). On the contrary, policy coherence appears in most law and policy texts, mainly in the CER Directive (5 times) and the DRGs (3). The Union Civil Protection Mechanism (UCPM) text has a unique mention of wildfire and the policy coherence term. IFM is not mentioned in any law and policy text. However, when considering related initiatives, all of them are mentioned. The Wildfire Peer Review Assessment Framework [17] (WF-PRAF) notably includes 6 mentions of IFM, one of EWE and NbS, 38 wildfire disaster and 17 of policy coherence, plus NbS 1 time. The communication on managing disaster risk [14] includes wildfire (twenty-two times), wildfire disaster (3) and policy coherence (5).

Air quality and health and environmental assessment and liability are the clusters with fewer mentions. In air quality policies, wildfire is mentioned once in the Reduction of National Emissions of Certain Atmospheric Pollutants [106] (NEC) and in the Air Quality Directive [107], while NbS only appears once in the Zero Pollution Action Plan [108]. Policy coherence is included in the NEC Directive (3) and Air Quality Directive (1). The Global Health Strategy [109] does not mention wildfires and only policy coherence is included

once. The environmental assessment directives [110,111] only consider policy coherence once each, while the Liability Directive [112] does not include any of the terms. The Environmental Crime Directive [113] mentions wildfire (1 time) and policy coherence (3).

Accordingly, and when considering only law and policy texts, the wildfire term is mainly present in forest policies (45 times), in DRM texts the Wildfire Prevention Action Plan (30) and rescEU (21), and within the technical guidance on climate proofing (14). IFM is almost entirely absent like the EWE term, while wildfire disaster is rarely used, even in forestry (4 times) and DRM (3) law and policy texts. The NbS term is mostly used in the Adaptation Strategy (21) and Biodiversity Strategy (11) and to less extent in the NRL (eight) and Bioeconomy Strategy (five). However, it is almost absent in forestry policies, only considered in the 3 Billion Tree Pledge (3 times), while in DRM texts it has a unique mention in the DRGs. The EGD and 8th EAP consider the NbS term 2 and 3 times. Policy coherence is mainly used in the texts of the Bioeconomy Strategy (9 times), HD (7) and the Adaptation Strategy and CER (5 each).

In terms of qualitative content analysis, on the topic of 'WFRM', forest fires or wildfires are the most used terms, often mentioned alongside other natural hazards such as floods, extreme weather events, droughts or storms. Although EWE is poorly mentioned, the shift to more hazardous fire regimes (Forest Strategy) and emerging weather and climate-related risks are frequently mentioned, including disruptive ones. All policies address wildfires as a risk or threat and the beneficial aspects of 'good fire' are not considered in law and policy texts. The only reference to beneficial fires is found in the WF-PRAF. However, the role of fire in ecosystems is considered in different EC policy-related voluntary guidelines [49,114–118]. Still, from the IFM perspective, some documents acknowledge the risk causality chain by explicitly stating that prevention efforts can reduce the need for response (e.g., rescEU and FML). In many texts, multi-risk scenarios and corresponding cascading effects, such as those between droughts, heatwaves or bark beetle outbreaks and wildfires, are considered (Forest Strategy). Specifically, the terms wildfire resilience or resilient landscapes to wildfire are not mentioned in any text, although many references to forest and landscape resilience to weather and climate-related risks or disasters could be extended to wildfires where applicable. Beyond resilient environments, some documents address the resilience of the economic sector, businesses and infrastructures (e.g., the Adaptation Strategy and CER Directive) or capabilities such as the need to face uncertainty and disruptive events that could challenge civil protection operations or business continuity (DRGs). The broader concept of societal resilience is also mentioned (e.g., in the EGD and 8th EAP).

In the 'NbS' topic, the exact term NbS is considered in many texts as a biodiversity-friendly and cost-efficient approach to address climate risk impacts and enhance resilience, while also providing multiple benefits such as supporting local economies (GI Strategy) and increasing resource efficiency (Bioeconomy Strategy). In different texts, NbSs are presented as a prominent tool for investments in climate adaptation and DRR (the Adaptation Strategy, EGD, 8th EAP, Biodiversity Strategy or NRL). The WF-PRAF is the only document that lists specific NbS practices for WFRM. Forest protection function as an ecosystem service to mitigate the impact of disasters is mentioned in both the EU Forest Strategy and the GI Strategy. Within the 'DRR' topic, when natural disturbances are addressed in the texts they are mostly equated with disasters. The climate change impact on an escalating disaster risk (including wildfires) is highlighted in several documents, along with the challenges posed by uncertain risk scenarios. The economic impact of disasters is also discussed (e.g., in the Adaptation Strategy and WF-PRAF), as well as their cross-border dimensions (DRGs). Insurance is named in three documents, in the Adaptation Strategy with regard to promoting insurance in DRR, in the communication on managing climate risk about the protection gap and within the CAP document around agricultural insurance promotion in national strategic plans.

On the topic of 'Policy coherence', when the term is explicitly mentioned, it often encompasses both horizontal and vertical dimensions. Even when the term is not used, the

need for coordination to exploit synergies across all policy areas is emphasized, as in the EGD. Sectoral policy integration within an 'all policies' governance framework is explicitly mentioned for sustainable development (8th EAP), climate action (Adaptation Strategy), air quality (Zero Pollution Plan), health (Global Health Strategy) and DRM (UCPM) policies. According to the texts, coherence can be promoted through financial incentives (Taxonomy Regulation), technical frameworks (CER Directive, FML), regulations (Forest Strategy), cross-border cooperation (rescEU, HD, Air Quality Directive) or efficient monitoring and evaluation (8th EAP, NRL, UCPM). Most policies indicate the need for holistic governance frameworks that involve stakeholders and authorities at different levels.

4. Discussion

The counting analysis showed a consistent distribution of wildfire frequencies on those more related policy clusters such as forestry and DRM. However, in terms of integrated WFRM and related NbSs, significant gaps have been highlighted. Notably, in all the law and policy texts wildfire is addressed as a threat, without reference to the role of fire in the ecosystems or the beneficial use of fire as a tool for fuel and land management. The positive side of fire must be found in policy-related guidelines within WFRM [119,120], forestry [117,118] and the Natura 2000 and biodiversity [114–116,121] policy domains. A better integration of both sides of beneficial fires and damaging wildfires into policy texts should serve to better address integrated WFRM, expanding fire ecology fundamentals at the root of wildfire NbSs aimed at emulating natural fire regimes [122–124] to improve forest health while reducing wildfire DRR. In this regard, among all the law and policy texts analyzed, IFM appears a unique time in the Forest Strategy naming integrated landscape fire management, but without any concertation about the concept. Although integrated risk management is considered in DRM policies, integrated WFRM is only present in the Wildfire Peer Review Assessment Framework (WF-PRAF) text. These few mentions contrast with the relevance that the term has in the above-mentioned guidelines, the scientific literature and WFRM governance recommendations [3,9,11,15,16,20,25,31]. The emerging risk of wildfires is indicated in much literature [1,3,7,11]. However, the analysis shows that the EWE term is still not percolating in the policy texts, nor into the forestry, biodiversity or DRM domains. The rescEU is the only policy text using EWE. Other references are found in related initiatives such as the communication on managing climate risk and the WF-PRAF. Wildfire disaster has been counted in forestry, biodiversity and DRM law and policy texts between two and four times, while it is used much more in policy-related initiatives, mainly in the WF-PRAF with thirty-eight mentions.

In the same vein, there is an apparent contradiction between the importance that climate policies give to NbSs for DRR and the poor presence of the term in DRM policies, with only one mention in the DRGs and WF-PRAF. Similarly, the term is absent in the Forest Strategy and almost lacking in the Green Infrastructure (GI) Strategy with a unique mention, although many forest management practices may fit into the NbS definition or equivalent ecosystem-based approaches for risk reduction. The Forest Strategy uses the ecosystem-based management (EbM) term (in light of climate change and biodiversity loss) and closer-to-nature forestry practices. The protection function of well-managed forests as an ecosystem service to cope with the impact of disasters is slightly mentioned, without a dedicated section. However, the contribution of integrated landscape fire management to protecting forests against wildfire is indicated among other positive spillover effects. In a similar way, the GI Strategy mentions the forest protection function as a GI solution. The WF-PRAF is the unique text that specifically mentions NbSs for WFRM such as traditional grazing, forestry practices and crop mosaics. To this aim, a better definition and the mainstreaming of NbSs for WFRM into forestry and DRM policies could enhance the visibility of the contribution of fire-smart forest management to wildfire protection and civil protection targets. Moreover, it could facilitate synergies with biodiversity conservation and ecosystem restoration policies, which make the most extensive use of NbS terms after

climate policies and integrate the fire ecology dimension in the above-mentioned guidelines for forest and wilderness area management [114–116].

Certainly, the wildfire term is absent in the text of some relevant policies concerning integrated WFRM such as the Land Use, Land Use Change, and Forestry [125] (LULUCF) and Carbon Removals and Carbon Farming (CRCF) Regulations [126] and the Global Health Strategy or in the Critical Entities Resilience (CER) and environmental assessment directives. However, despite the lack of direct mentions, this does not mean the terms are not considered within the provisions of the policy. As seen before, wildfire issues may be addressed in complementary guidelines, such as the LULUCF handbook [127] or the guidance on integrating climate change into environmental assessment [128]. Sometimes the guidelines are referenced directly in the law or policy texts, although they mostly accompany the legal text on the dedicated EC website. On the other hand, the term may be absent in the policy text but included in subsequent material, such as in different eligible activities within the Taxonomy Regulation naming wildfire prevention and firefighting. Similarly, the Rural Development Program (RDP) includes wildfire prevention and the recovery of burnt areas in eligible measures. Moreover, as seen in the Adaptation Strategy, wildfires are often categorized under climate risks along with other disturbances, with climate risk being the most used term. Similarly, terms like natural or climate disasters may include wildfire in the context of the text. Likewise, close substitutes such as policy coordination, consistencies and synergies under inclusive governance frameworks are frequently considered in some policies, such as the Forest Strategy and Adaptation Strategy, aligning with policy coherence targets. Finally, the counting does not reflect the relevance of the term for the text. For instance, although being mentioned only two times, the Forest Strategy dedicates an entire chapter to policy coherence like in the WF-PRAF. On the contrary, mentions may refer to a concrete aspect, like the coherence in the implementation of Natura 2000 in the Habitats Directive (HD) text. Therefore, the counting of selected terms indicates the general presence and relative relevance of the term in the policy text, and further analysis of additional guidelines and material may serve to explore how the topics are developed within the policy.

Alongside the analysis, no major conflicts between policies were found, in consonance with the coherent approach principle within the Better Regulation Framework [129] aimed at ensuring consistencies across policy objectives. Common goals and visions, such as the frequently mentioned EU climate and biodiversity ambitions, are typically present across all the analyzed policies. However, some areas for improvement to better address integrated WFRM and related NbSs across the policy landscape were identified (Table 4).

In the following sections, it will be discussed how the target-related measures can contribute to coherently addressing and moving forward towards integrated WFRM and related NbSs for DRR across the EU policy landscape.

Table 4. Measures to support synergic deployment of integrated WFRM and related NbSs into policies.

Suggested Inputs	Measures	Related Policies and Tools
Enhancing the wildfire protection function of land management	Guidance on Fire-Smart Forest and Landscape Management (FSFLM) for forestry activities	Forest Strategy, 3 Billion Tree Pledge, FRM Regulation
	Definition of technical, legal and funding framework for Wildfire Protection Function (WFPF)	Forest Strategy, CAP, Better Regulation Framework, Taxonomy Regulation, UCPM, State Aid
	Integrated planning tools for Forest and CAP strategic plans and DRM—integrates WFPF into spatial green infrastructure	Forest Strategy, CAP, UCPM, GI Strategy
	Monitoring and accountability of WFPF ecosystem services	FML, INCA, SEEA, Environmental Economic Accounts Regulation
	Voluntary schemes and labeling of WFPF and related products in regional and circular and bioeconomy	Forest Strategy, Bioeconomy Strategy, CEAP, CCRI Guidance, Sustainability Labelling Framework, Green Public Procurement, CRCF Regulation, Energy Performance of Buildings Directive

Table 4. *Cont.*

Suggested Inputs	Measures	Related Policies and Tools
Reinforcing fire ecology in biodiversity and ecosystem restoration	Guidance on FSFLM for biodiversity conservation and nature restoration	Forest Strategy, 'Nature Directives', Biodiversity Strategy, NRL, GI Strategy, European Business for Biodiversity
	Reestablishment of less fire-prone adapted forest structures in natural fire regimes	
	Introduces FSFLM biodiversity to Natura 2000 and Nature Restoration Plans	
	Protocols for solving biodiversity and safety trade-offs and establishing integrated planning tools for biodiversity and DRM	Same as above plus UCPM
Wildfire-proofing landscapes	Accountability for avoided GHG emissions	Climate Law, LULUCF, CRCF Regulation, CEAP, Adaptation Strategy, NECP, Forest Strategy, Environmental Economic Accounts Regulation
	Guidance on FSFLM for critical and urban infrastructures. Definition of wildfire-proofing standards	Adaptation Strategy, Technical guidance on climate proofing, CER Directive, DRGs, Renewable Energy Directive, Wind Power Action Plan, Environmental Liability and Crime Directive, Eurocodes
	Guidance and protocols on Fire-Smart Urban Planning and DRM	Adaptation Strategy, Eurocodes, UCPM, DRGs, GI Strategy, CCRI
	Reinforcing insurance schemes	Adaptation Strategy, DRGs, CAP
Embedding fire-smart benefits into the 'one-health' approach	Integrate WF smoke monitoring and early warnings (vulnerable groups) into health system	Air Quality Directive, NEC Directive, Global Health Strategy, FML-EFFIS, Zero Pollution Outlook
	Expand WFPF into 'One Health' approach	Adaptation Strategy, Global Health Strategy, EGD, DRGs
Reinforcing civil protection capabilities	Guidance on FSFLM for civil protection planning and strategies	Wildfire Prevention Action Plan, UCPM, Forest Strategy
	Operationalize common prevention EU standards based on NbS WFPF	Wildfire Prevention Action Plan, UCPM, Forest Strategy
	Multi-stakeholders Risk Assessment and Planning (RA&P) for risk awareness and DRM	Wildfire Prevention Action Plan, UCPM, Forest governance framework, WF-PRAF, 8th EAP
	Legal, technical and funding mechanism for co-responsibility between WFPF ecosystem service providers and beneficiaries	
	Accelerate learning process of growing WF risk within knowledge sharing platforms and tools	Union Civil Protection Knowledge Network, DRMKC, rescEU, Wildfire Prevention Action Plan, UCPM
	Legal and technical robustness for RA&P and emergency decision-making	UCPM, Forest governance framework, Environmental Liability and Crime Directive
Anticipating environmental and liability conflicts	Integrate pre-WF RA&P information sharing protocols and guidance into sectoral policies and project and plan design	EIA and SEA Directives, UCPM, Forest Strategy, 'Nature Directives', Biodiversity Strategy, Renewable Energy Directive, Wind Power Action Plan
	Guidance on WF liability for private operators	Environmental Liability and Crime Directive, CER Directive, Renewable Energy Directive, Wind Power Action Plan, Better Regulation Framework
Moving towards an 'all policies' fire-smart governance framework	Guidance on FSFLM for policy design and implementation	Forest Strategy, UCPM, Wildfire Prevention Action Plan, Better Regulation Framework
	Sustainable funding for wildfire DRR	EGD, Taxonomy Regulation, Directive on Budgetary Framework, State Aids
	Establish cross-EC DGs' shared risk ownership structures under 'all-of-government' approach	UCPM, DRGs, Forest and biodiversity governance frameworks, EGD

4.1. Enhancing the Wildfire Protection Function of Land Management

The Forest Strategy and subsequent policy initiatives provide a consistent policy framework to effectively deploy integrated WFRM and related NbSs, considering both horizontal (more than 43 sectorial policies are mentioned throughout the text) and vertical policy coherence (e.g., by means of national Strategic Forest Plans). Nevertheless, the text could benefit from a clearer definition of the forest protection function against climate risks and more specifically around wildfire protection. In this context, the latest version of the Common International Classification of Ecosystem Services (CICES) has included a 'Fire Protection' ecosystem service class alongside flood control and storm protection [130]. This class covers situations where specific ecological structures, such as grassland corridors or wetland areas, prevent or mitigate the risk of fire spread between forest stands and includes examples like firebreaks maintained through extensive grazing. This classification could

be extended to restore less fire-prone forest structures by means of fire-smart forest management [34] and related NbSs. Enabling a robust technical and legal status for protective forests against wildfires, wildfire protection could be inserted into a green infrastructure (GI) solution. A Forest Monitoring Framework could serve to provide information on wildfire protection ecosystem services to official statistical standards of ecosystem accounting (System of Environmental Economic Accounting, SEEA) [131], giving better visibility to the social, health and security/resilience benefits of GI solutions. In terms of funding, integrating 'wildfire control' into Integrated Natural Capital Accounting (INCA), similar to the approach used for 'flood control' [132], could enhance financial support for WFRM within national environmental protection expenditures from the Environmental Economic Accounts Regulation [133].

Along the same lines, the protection function against wildfires from mosaic landscapes [36,134,135] could be enhanced by the Common Agricultural Policy 2023–2027 in combination with fire-smart forest patch management. Such protection could benefit the food system itself, like the wildfire smoke impact on the wine economy [136] or the increasingly threatened long-term supply of primary materials and ecosystems [137]. Fire-smart forestry practices could also generate additional co-benefits like more water [123,137,138], addressing drought agendas simultaneously. In line with the Farm to Fork Strategy, wildfire protection could be certified under the proposed Sustainability Labelling Framework on the climate, environmental and social aspects of products, promoting them within the lacking urban circular bioeconomy strategies (Bioeconomy Strategy). To this regard, the Circular Economy Action Plan (CEAP) [139] could better address wildfire risk and benefits and promote forest and mosaic GI in Circular Cities and Regions Initiatives (CCRIs) or the new Circular Economy Act to come.

By means of fire-smart voluntary guidance and certifications, the bioeconomy could operate not only within safe ecological limits [140] but also in a fire-smart manner. This aligns, for instance, with the biomass cascading principle (the cascading principle was already enshrined in the EU Forest Strategy 2014–2020; under this principle, wood is used in the following order of priorities: (1) wood-based products, (2) extending their service life, (3) re-use, (4) recycling, (5) bioenergy and (6) disposal) derogation for pre-commercial thinning and forest management in high-risk wildfire areas (article 3, Renewable Energy Directive) or the consideration of wildfire prevention activities as an exception to the ban on the open field burning of forest residues as envisaged by the Directive on Reducing National Emissions of Certain Atmospheric Pollutants. In terms of funding, the additional cost of wildfire risk reduction in forestry practices should be accounted for, for instance in measure 8 (forest and wildfire prevention) and measure 15 (payments for forest climate commitments) of the Rural Development Programme (RDP) or complementary eco-schemes. However, in the period 2014–2022 (https://agriculture.ec.europa.eu/common-agricultural-policy/financing-cap/cap-funds_en, accessed on 10 August 2024) only 4.6% and 0.3% of the budget was dedicated to these measures. On the contrary, extensive grazing in wooded lands for wildfire prevention [141–143] should be better supported in the CAP beyond voluntary eco-schemes. Therefore, further options should be explored [144] to integrate spendings on wildfire protection, like within climate-related services in complementary forestry State Aid guidelines [145] or alongside the criteria and monitoring of the Taxonomy Regulation to promote NbSs within Green Public Procurement [146]. Protection against wildfires across forestry, agriculture and the related circular and bioeconomy could emerge as a strategic policy target, enhancing an EU-level GI as a standard component of spatial planning and development in synergy with DRM policies [147,148].

4.2. Reinforcing Fire Ecology in Biodiversity and Ecosystem Restoration

As stated in closer-to-nature, biodiversity-friendly [117,118] and Natura 2000 network guidance [114–116], fire plays a role in ecosystems, some of which are fire-dependent. Examples of the reintroduction of fire as a natural disturbance in Boreal forests for biodiversity conservation like those implemented in LIFE Taiga are included. Sustainable

forest management restoring fire-adapted forest structures and ecosystems could align with the Biodiversity Strategy and especially the Nature Restoration Law, which target ecosystems with the greatest potential to prevent natural disasters, addressing climate adaptation alongside DRR within the National Restoration Plans. The use of fire for biodiversity conservation [121] but also the habitat's transformation, benefiting certain bird species [149], beyond 'destruction' narratives shows the fire ecology dimension of WFRM. The LIFE MONTSERRAT and LIFE PINASSA projects in Natura 2000 are examples of the potential of reestablishing fire-adapted forest stands to prevent damaging wildfires by means of prescribed burns and extensive grazing, simultaneously addressing biodiversity and DRR targets [150]. In this regard, restoring ecologically appropriate fire regimes or 'let it burn' approaches [122], particularly regarding the public safety concerns as noted in the closer-to-nature guidelines [118], remains a significant policy challenge. To this end, promoting fire-smart guidance for ecosystem-based approaches for adaptation and DRR (Eco-DRR) under the principles of the Convention on Biological Diversity (CBD) [151] could support NbSs for wildfire protection in nature and biodiversity policy domains. They could be promoted in the European Business for Biodiversity movement, aimed at incentivizing NbSs and removing barriers to their implementation. Filling gaps in science-based evidence on natural fire regimes and related forest stands in EU landscapes, compared to other territories [152–154], should help to disseminate IFM approaches across forestry and environmental sectors.

In terms of WFRM, both sides, the wildfire impact on Natura 2000 sites [155] and the risk of wildfire spread across protected areas, must be addressed. Wilderness guidelines, for instance, identify trade-offs related to non-intervention management in National Parks and wildfire risk, particularly in proximity to settlements [116]. To this regard, the Nature (Habitats and Birds) Directives, particularly in article 6 of the HD, include public safety in the reasons of overriding public interest to contrast habitat conservation (p. 8). Similarly, the EC criteria and guidance for protected area designation [156] includes wildfire prevention among the limited activities permitted in strictly protected areas. Within the NRL, wildfire risk is required to be considered when implementing restoration measures according to Commission guidelines [18], which allows us to balance potential trade-offs with the indicators that member states are required to improve (e.g., deadwood, uneven-aged forest structures and forest connectivity). For instance, deadwood management as part of sanitary logging could be included to address extreme events [75]. Other measures like the cessation of harvesting may be balanced by active fire-smart forest management to encourage self-regulatory functions and resilience. Reestablishing extensive grazing is another measure proposed in the Annexes of the NRL. Moreover, wildfires are recognized as a large-scale force majeure which may justify the non-fulfillment of certain obligations. In the same vein, biodiversity-friendly re- and afforestation guidelines [117] for the 3 Billion Tree Planting Pledge consider the ecosystem service of protecting settlements from wildfires, which should avoid conflicts with WUI wildfires. Within tree selection, evolving climate conditions must be considered as stated in the Forest Reproductive Material Regulation. From the DRM policy side, within the horizontal principles of the European Disaster Resilient Goals are environmental sustainability, the use of NbSs and minimizing the environmental impact of civil protection operations.

4.3. Wildfire-Proofing Landscapes

The WFRM approach may synergistically support EU climate mitigation and adaptation targets. In terms of climate mitigation, wildfires are a key factor reducing carbon sinks [157] which may turn the LULUCF sector into a net emitter. Fire-smart forestry practices hence may contribute to the 'triple role' of forests (i.e., carbon sinks, storage and substitution). For instance, the avoidance of wildfire greenhouse gas (GHG) emissions may become determinant when it is accounted for in LULUCF, unless in the case of extreme events. Controlled burns or managed 'let it burn' wildfires must always be included, although a significant portion of the burned biomass is converted into pyrogenic carbon,

which can be stored for centuries or millennia and is considered a mechanism for long-term carbon sequestration [4]. Long-lasting harvested wood products (HWPs) may enhance carbon sinks while bioenergy use may cause a negative impact on the carbon cycle [158,159]. Monitoring the benefits of WFRM policies in emissions and removals projections such as in the Carbon Budget Model of the Canadian Forest Sector [127] could help to document mitigation implications and analyze cost–benefit effects. The monitoring could be included in the eligible forestry and agroforestry activities [160] of the Carbon Removals and Carbon Farming Certification (CRCF) in line with the stated priorities in the proposal such as long-term forest structure, the stability of carbon pools, co-benefits with biodiversity and ecosystem health and DRR. Fire-smart land management could support climate-friendly business models for carbon sequestration and storage, avoiding emissions while reducing the risk of carbon reversal. In line with forest bioeconomy and the New European Bauhaus (https://new-european-bauhaus.europa.eu/index_en, accessed on 7 August 2024), the CRCF Regulation could support the use of HWPs in construction, in synergy with the Energy Performance of Buildings Directive [161] and the declaration of buildings' carbon storage capacity in the Energy Performance Certificate.

In terms of climate adaptation, fire-smart territories could form part of the climate-resilient landscapes envisaged in the communication on managing climate risks, since they support the 'triple dividend' of adaptation (i.e., avoiding future losses, generating economic benefits by reducing risks while increasing productivity and innovations, and considering social, environmental and cultural benefits). Fire-smart forestry practices could compensate for the aforementioned gap in NbS deployment for enhancing carbon sinks and resilience in the National Energy and Climate Plans (NECPs) [157]. By means of European standard Eurocodes (https://eurocodes.jrc.ec.europa.eu/, accessed on 7 August 2024), fire-smart regulations on infrastructure design could be extended to the wildland–urban interface and urban settlements, embedding the spatial GI for wildfire protection beyond perimeter strips with limited effectiveness. Similarly, wildfire NbSs could be promoted within the technical guidance on climate proofing of infrastructure at the core of the project design. For example, the deployment of renewal energy infrastructures in wooded landscapes should consider their exposure to fire impacts as well as their risk of ignition and hence the source of wildfire risk [76,162]. Likewise, wildfire NbSs could be extended to the Critical Entities Resilience (CER) Directive and related national strategies and governance frameworks, engaging entity managers in wildfire risk reduction. A similar approach could be implemented to limit the risk of wildfire impacts on mobility infrastructure [42]. However, demonstrating the benefits of prevented wildfires in terms of avoided losses and recovery costs remains a challenge [163] that may hinder political support, budget allocation and related policy readiness in the medium–long-term timeline for achieving wildfire-resilient landscapes. Moreover, the level of protection should be properly balanced in case of EWEs [138,164], ensuring all needed measures, from prevention to recovery, while giving robustness to climate risk spatial planning and related political challenges, such as planned reallocations [157]. In this regard, the communication on managing disaster risk highlights the lack of insurance availability in high-risk areas, as is already occurring in wildfire-prone regions [165]. To this aim, by means of Climate Resilience Dialogues [166], the Adaptation Strategy seeks to enhance natural disaster insurance penetration to narrow the predominant climate protection gap [167]. Along the same lines, increased support for agricultural insurance in the CAP could better enhance the resilience of the food system and mosaic landscape maintenance globally, which at the same time is providing protection.

4.4. Embedding Fire-Smart Benefits into the 'One-Health' Approach

Beyond the benefits for healthy ecosystems, fire-smart landscapes may also reduce the growing public health risk from wildfires [11] as stated in the Adaptation Strategy, which calls for a stronger capacity to address them under the 'One Health' approach. Along the same lines, the EGD, 8th EAP and the Global Health Strategy consider air pollutants a global health risk. The Spanish Strategic Health and Environment Plan [168],

for instance, has added wildfire smoke in the latest version. The European Climate and Health Observatory (https://climate-adapt.eea.europa.eu/en/observatory, accessed on 7 August 2024) launched by the Adaptation Strategy is already showing data on direct wildfire fatalities. However, air quality and pollution policies give limited attention to wildfire smoke. The Zero Pollution Action Plan only mentions pollution from biomass used for heating although workers' health risks from environmental factors could be extended to firefighters' exposure to smoke. Wildfire emissions are classified as 'contributions from natural sources' (like volcanic eruptions) in the Air Quality Directive. In line with the directives, which pay specific attention to vulnerable groups, wildfire smoke monitoring could be inserted into public information protocols on air quality and into Short-term Action Plans, including cross-border cooperation. In terms of WFRM, according to these action plans, activities that increase emissions and exceed alert thresholds may be suspended, which could affect prescribed burns. However, potential limitations have to be balanced carefully since prescribed fire can also reduce more harmful wildfire emissions [169,170] or mitigate wildfire smoke-related traffic accidents [171], among other benefits.

4.5. Reinforcing Civil Protection Capabilities

Integrated DRM is at the core of the Union Civil Protection Mechanism (UCPM) and related policies, connecting the benefits of better prevention to fewer response and recovery efforts. In this regard, the communication on managing climate risk indicates the relevance of security provision as part of the social contract with citizens. To this aim, the spatial functionality of wildfire protection GI within DRR strategy could align with preserving the capacity of civil protection, health systems and businesses to manage emerging disruptive high-impact low-probability (HILP) events like unprecedented or extreme wildfires, as is stated as a need in the European Disaster Resilience Goals (DRGs). To this regard, in coherence with the limitation of suppression-centered strategies as noted in the communication on sustainable use of natural resources, the Wildfire Prevention Action Plan aims to strengthen prevention by improving forest and landscape management and capacities, knowledge and financing. The envisaged good practice guide on wildfire prevention could mainstream fire-smart land management into civil protection policies. Along the same lines, the comprehensive vision of integrated WFRM developed in the Wildfire Peer Review Assessment Framework (WF-PRAF) serves to spread the systemic wildfire DRM across national and regional civil protection authorities. Within the WF-PRAF, the named NbSs (i.e., traditional grazing, forestry and crop mosaics) are encouraged. The envisaged forest fire agenda reflected in the EU report Sparking fire-smart policies [20] offers guidance on balancing EU efforts within the entire DRM cycle. The Union Civil Protection Knowledge Network provides an excellent platform to exchange lessons learned across the evolving landscape risk context addressing all DRM phases (e.g., disseminating the role of extensive grazing for wildfire prevention (https://civil-protection-knowledge-network.europa.eu/stories/value-grazing-wildfire-prevention-tool, accessed on 26 July 2024)). In line with the rescEU initiative reinforcing collective response, common standards and understanding could be extended to prevention frameworks, reinforcing the cascading benefits of reducing wildfire spread capacity within civil protection policies.

In terms of governance, the communication on managing disaster risk indicates how legal and policy frameworks for DRM extend beyond civil protection as various EU sectoral laws and policies contribute to this aim. Accordingly, policy coherence becomes key to effective DRR by means of inclusive governance mechanisms involving sectoral policy representatives under comprehensive risk management strategies. Under a whole-of-government approach, DRM offers the chance to connect, by means of risk assessment and planning processes, the providers (land managers) with the beneficiaries of wildfire protection ecosystem services. As stated in the communication, throughout the process, involving authorities from other sectoral policies and stakeholders may favor risk awareness. Proper risk understanding and education for fostering risk culture is addressed in the guidelines for wildfire risk awareness and communication [172] that emphasize the need for strategic

communication across all actors and society, considering both the damaging and beneficial aspects of fire. Such a promotion of an EU wildfire risk culture could be part of the European Skills Agenda initiative, which can support the adaptation of land management practices to the growing wildfire risk while disseminating the contribution of fire-smart land management to DRR. Risk culture also should encompass 'living with' the wildfire residual risk, which may become relevant in the case of EWEs or unprecedented events, not only overwhelming the suppression capacity but the whole prevention, preparedness and recovery capacities and collapsing the wildfire-proofed 'solutions' in place.

4.6. Anticipating Environmental and Liability Conflicts

WFRM interacts with a diversity of land activities and the environmental assessment directives offer the chance to consider wildfire risk in related projects and plans. The guidance on integrating climate change and biodiversity into environmental assessment [128,173] includes WFRM measures like the creation of fire-adapted spaces around the assets or the need to account for evolving risk. The same provisions have been included in the technical guidance on climate proofing. When applying environmental assessment to wildfire risk planning procedures, timelines must be reasonable considering overlaps with the wildfire high-risk season and nesting limitations on forestry work. A double assessment of the same prevention measure across strategic and local planning, or a lack of adequate skills and staff, may create additional bottlenecks. To this regard, enabling ad hoc guidance together with spatial planning tools to consider wildfire risk sensitiveness in advance could streamline procedures and administrative permitting [174], given, for instance, the need to accelerate renewable energy deployment. Inter-ministerial protocols could be defined in advance, particularly in sensitive domains like safety and biodiversity conservation, rather than relying solely on the environmental assessment process to resolve discrepancies. When conducting risk assessment and planning, liability aspects must be addressed. The Environmental Crime Directive considers large-scale forest fires as catastrophic outcomes of environmental criminal offenses. On the contrary, according to the policy text, the Liability Directive shall not apply to activities the sole purpose of which is protection from natural disasters. The legal responsibilities when prevention measures are overwhelmed, about injuries and fatalities due to evacuations, confinements or consequences of access restriction to conduct fire prevention in protected areas, are some of the potential conflicts that may become more frequent in the emerging EWE context. Appropriate guidance and sectoral strategies with the participation of the private sector [175,176] could serve to prevent liability risks while favoring wildfire DRR. Similarly, the technical robustness (or lack thereof) of risk assessment and planning may have legal consequences, which may hinder, for instance, the political capacity to conditionate urban development or the trade-off between biodiversity and wildfire prevention for safety reasons.

4.7. Towards an 'All Policies' Fire-Smart Governance Framework

Within the European Green Deal (EGD) and the Environment Action Programme to 2030 (8th EPA), climate and biodiversity ambitions are addressed alongside sustainable economic development in an interconnected and systemic manner. Both roadmaps state the need to enhance prevention and preparedness for climate risks (mentioning wildfires) and public and private investments in NbSs for DRR. As with flood risk, WFRM could be included in the eligible activities (https://ec.europa.eu/sustainable-finance-taxonomy/home, accessed on 15 July 2024) of the Taxonomy Regulation, enhancing a fire-smart transition, and be proactively enhanced by State Aid legislation. A lesser financial risk of fire-smart practices could be a benefit from the Adaptation Strategy initiative to integrate macrofiscal risks from climate change into national frameworks by means of the Directive on Budgetary Framework [177]. The integration into the Better Regulation coherence approach of the 'do no significant harm' principle from the Taxonomy Regulation (Article 17) and the three principles of climate risk management policy coherence (i.e., avoiding new exposures, building resilience and increasing prevention and preparedness; managing

residual risk) should support fire-smart governance in policy design. As seen, ecosystem services from fire-smart landscape management may be extended beyond mere wildfire prevention and address a set of policy targets across climate (protecting human life, assets and environments, and mitigating GHG emissions) and biodiversity (e.g., restoring fire-adapted ecosystems) ambitions in synergy with sustainable bioeconomy and development while enhancing resilient economies and societies (Figure 3). To this aim, the envisaged EU forest and biodiversity governance frameworks, together with the 'whole-of-government' approach to DRM, air quality or health policies, could serve to synergically expand integrated WFRM and related NbSs across different policy domains and disciplines.

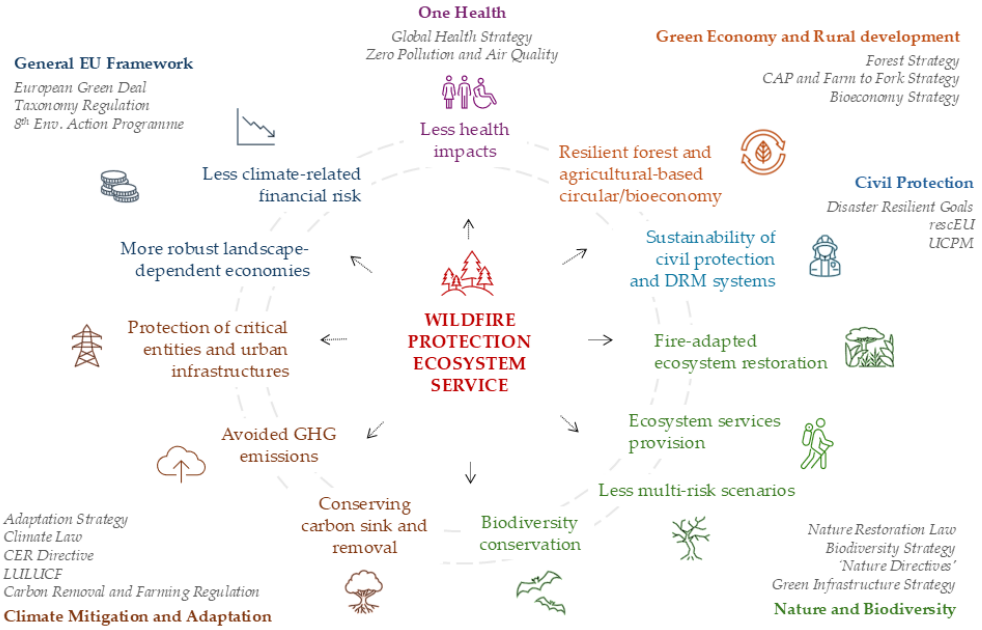

Figure 3. Policy interactions with wildfire protection function.

5. Conclusions

The analysis has shown the diversity of interactions between wildfire risk and the EU policy landscape and indicates that the principles of integrated WFRM are coherently addressed across the policies' designs. The risk of damaging wildfires is generally integrated into all analyzed laws, policies and initiatives where it is relevant to the policies' target. When not specifically mentioned, wildfires are often included under broader weather- and climate-related risks that policies aim to adapt to or mitigate, considering integrated risk management and better resilience approaches. In many cases, NbSs are promoted as cost-efficient methods for DRR, looking for legal (e.g., green procurement, climate proofing guidance) and funding mechanisms (the Taxonomy Regulation, eco-schemes, payment for ecosystem services or conditional investment frameworks) to support them. However, some areas for improvement to synergically enhance integrated WFRM and NbSs across policy implementation have been identified. Policies could benefit from a clearer definition of the contribution of fire-smart land management practices and related NbSs to protection against wildfires. A more explicit acknowledgement of the role of beneficial fire in ecosystems within law and policy texts could enhance IFM conceptualization and narratives around the restoration of fire-adapted less fire-prone forest structures as a NbS for DRR. The act of 'living with' unavoidable damaging wildfires in an EWE context calls for the expansion of wildfire-proofing to all urban and critical infrastructures, while enabling tools for safer and more resilient societies and economies. The broad scope of EU policies provides a solid foundation for implementing integrated WFRM if supported by guidelines for fire-smart land practices, comprehensive (multi-) risk assessments, vertical and horizontal planning tools, sustainable funding schemes, and governance frameworks that synergically address public health, climate and biodiversity ambitions, bioeconomy and the protection

of infrastructure and strategic economic sectors, to name the most relevant ones. In line with the strengthened focus on prevention within DRM policies, enhancing the wildfire protection function from legal, technical and funding perspectives could significantly improve policy coherence and mainstream NbSs into the policy implementation of WFRM and related NbSs for wildfire DRR.

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