D 7.2 – Second draft on policy recommendation framework

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Abstract:	This deliverable within the SILVANUS project builds upon the foundational insights of Deliverable D7.1, advancing the discussion by focusing specifically on forest governance aspects. Rather than repeating previous content, it provides a comprehensive framework that addresses challenges in deforestation, climate adaptation, and biodiversity conservation through a multi-level governance approach aligned with international, EU, and national policies. Key recommendations emphasize policy coherence, participatory governance, and green financing, contributing to resilient and ecologically sound forest landscapes across Europe and beyond.

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List of acronyms and abbreviations

AI	Artificial Intelligence
APP	Permanent Preservation Areas
CBD	Convention on Biological Diversity
CCF	Continuous Cover Forestry
CCTV	Close Circuit Television
CFM	Community Forest Management
CNCCI	National Coordination and Command Centre for Interventions
CNPF	Centre National de la Propriété Forestière
COP	Conference Of the Parties
DETER	Real-Time Deforestation Detection System
DSU	Department for Emergency Situations
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
ECOSOC	United Nations Economic and Social Fund
ES	Ecosystem Services
ESG	Environmental, Social, and Governance
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FLETG	Forest Law Enforcement Governance and Trade
FSC	Forest Stewardship Council
GBF	Kunming-Montreal Global Biodiversity Framework
GEF	Global Environment Facility
GHG	Greenhouse Gasses
GIS	Geographical Information System
HŠ	Hrvatske šume LLC
IBAMA	Brazilian Institute of Environment and Renewable Natural Resources
ICMBio	Chico Mendes Institute for Biodiversity Conservation
ICNF	Instituto da Conservação da Natureza e das Florestas
IFC	International Finance Corporation
IFG	International Forest Governance
IFM	Integrated Fire Management
IGSU	General Inspectorate for Emergency Situations
INPE	National Institute for Space Research

IPM	Integrated Peat Management
IRFMS	Integrated Rural Fire Management Strategy
ISTAT	Italian National Institute of Statistics
ITTA	International Tropical Timber Agreement
ITTO	International Tropical Timber Organization
IUCN	International Union for the Conservation of Nature
LiDAR	Light Detection and Ranging
MA	Millennium Ecosystem Assessment
MAI	Ministry of Internal Affairs
MLG	Multi-Level Governance
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NbS	Nature-based Solutions
NGO	Non-Governmental Organization
NLBI	Non-Legally Binding Instrument on All Types of Forests
NLP	National Forestry Programme of the Slovak Republic
NSCCA	National Strategy for Climate Change Adaptation
ONF	Office National des Forêts
ORSEC	Organization of Civil Security Response
PEFC	Programme for Endorsement of Forest Certification schemes
PES	Payment for Ecosystem Services
PLANAVEG	National Plan for the Recovery of Native Vegetation
PPRIF	Forest Fire Risk Prevention Plan
PREVFOGO	National Centre for Prevention and Combat of Forest Fires
PRODES	Deforestation Monitoring Project in the Legal Amazon
R&I	Research and Innovation
REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RL	Legal Reserves
SDG	Sustainable Development Goals
SDIS	Departmental Fire and Rescue Services
SDIS	Services Départementaux d'Incendie et de Secours
SFM	Sustainable Forest Management
Siscom	Shared Environmental Information System
SNIF	National Forest Information System

SWOT	Strengths Weaknesses Opportunities and Threats
UAV	Unmanned Aerial Vehicle
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
UNSPF	United Nations Strategic Plan for Forests
WSSD	World Summit on Sustainable Development

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Executive Summary

Forests are vital to global environmental health, biodiversity, and human livelihoods, yet they face escalating threats from deforestation, climate change, and severe wildfires. This deliverable, developed under the SILVANUS project, proposes an updated policy recommendation framework for forest governance that aligns with international, EU, and national policies. It aims to provide policymakers and stakeholders with a comprehensive approach to sustainable forest management, promoting resilience, climate alignment, and robust conservation practices. This framework highlights the urgent need for enhanced coordination, transparency, and enforcement across governance scales to support effective forest protection and sustainable practices.

The landscape of international forest governance has evolved through frameworks aimed at promoting sustainable forest management and reducing deforestation. The REDD+ initiative, established by the UN Framework Convention on Climate Change (UNFCCC), incentivizes sustainable forest practices by financially supporting countries that curb deforestation. The Paris Agreement integrates forest conservation into climate action plans, acknowledging forests as a fundamental part of global climate mitigation strategies. These frameworks collectively highlight the need for a unified global response to forest degradation; however, implementation varies due to differences in policy coherence, funding, and enforcement mechanisms across countries. The integration of international, regional, and local efforts is therefore essential to address the complex challenges facing forest governance.

At the European level, the EU has taken strides in safeguarding forests and fostering ecosystem resilience. Core policies, such as the EU Biodiversity Strategy for 2030, embedded in the European Green Deal, set ambitious targets for conserving and restoring ecosystems, including forests, with a focus on sustainable resource use and ecosystem resilience. Meanwhile, the Forest Law Enforcement, Governance, and Trade (FLEGT) initiative targets illegal logging, ensuring that only legally sourced timber enters EU markets. Together, these policies underscore the EU's commitment to sustainable forest governance, but challenges remain, particularly around policy fragmentation, cross-border coordination, and variable enforcement across Member States. Achieving EU-wide forest governance requires stronger policy coherence, sectoral integration, and effective collaboration across national boundaries, allowing the EU to meet its climate and biodiversity targets more effectively.

In addition to EU initiatives, a range of forest governance models exists across Europe, reflecting diverse ecological and socio-economic contexts. National policies in countries like Italy, Greece, and Portugal highlight the importance of localized approaches, with community-based forest management (CFM) emerging as a valuable model. CFM actively involves local communities and indigenous populations in forest stewardship, fostering conservation, sustainable practices, and ecological resilience. Despite their effectiveness, national and regional governance models face constraints such as limited funding, infrastructure, and capacity. Supporting participatory governance and enhancing local capacities to implement policy measures aligned with EU and international objectives is essential for improved forest governance outcomes across all levels.

This deliverable identifies several key challenges to effective forest governance. Policy fragmentation across governance levels hinders unified management approaches. Limited integration of climate adaptation and biodiversity goals within forest policies leaves forests and related ecosystem services vulnerable to environmental risks. Enforcement remains weak, with many existing regulations hampered by inadequate punitive measures, voluntary compliance frameworks, and insufficient clarity in enforcement mechanisms. Additionally, sustainable forest practices are constrained by limited financial and technical resources, and there is insufficient involvement of local communities and stakeholders in policy formulation. Monitoring and compliance tracking also require strengthening, as current efforts lack the tools to ensure consistent adherence to forest governance norms. Cross-border collaboration presents another challenge, as forest ecosystems often span national boundaries, yet coordination among EU Member States remains limited.

In response to these challenges, the deliverable offers a set of targeted recommendations. Enhancing policy integration is critical, with a call for aligning forest, climate, and biodiversity policies to create a cohesive framework for forest management across the EU. Capacity building across Member States is emphasized, with EU-wide programs needed to support resource-limited regions in adopting advanced governance tools and innovative technologies. Economic incentives are proposed, including green financing options such as Payments for Ecosystem Services (PES) and carbon markets to drive sustainable forest management and align economic development with ecological sustainability. Multi-level and cross-border collaboration should be prioritized to foster cooperation among local, national, and EU actors, particularly in managing shared forest ecosystems. Expanding financial resources for sustainable forest management is also vital, with recommendations to mobilize EU funds toward green financing initiatives and stakeholder engagement programs.

Technological and policy innovations hold significant potential to advance forest governance. The adoption of tools like GIS, remote sensing, and AI can enhance monitoring, compliance tracking, and risk mitigation. Increased investment in forest resilience technologies is recommended to bolster the capacity of forests to withstand climate-related threats. In addition, strengthening forest-based bioeconomy initiatives through technological innovation can ensure that sustainability and biodiversity objectives remain paramount. Monitoring and reporting frameworks should be enhanced, enabling stakeholders to assess policy impacts and refine strategies based on up-to-date data and insights.

Lastly, fostering inclusive governance practices is essential. Greater efforts to involve local communities and other stakeholders in policy formulation can help ensure that forest governance frameworks are representative and responsive to the needs of those directly affected. Building public awareness and political support for sustainable forest management is necessary to counter skepticism around climate and environmental strategies. The role of the European Green Deal should be strengthened within forest management policies, ensuring alignment with climate neutrality targets by 2050.

The SILVANUS policy recommendation framework has aimed to establish a holistic, multi-level governance approach that bridges international, EU, and local policies, placing a strong emphasis on climate resilience, biodiversity conservation, and participatory governance. Highlighting the need for coordinated actions, capacity building, and economic incentives, this deliverable contributes to the EU's broader environmental and climate objectives, paving the way for resilient, sustainable, and ecologically sound forest landscapes across Europe and beyond.

1 Introduction

Global environmental stability, biodiversity and socio-economic well-being is heavily dependent on forests. Deforestation, increasingly severe wildfires and the alarming impacts of climate change pose a significant threat to those ecosystems. This deliverable aims to address these challenges by developing a comprehensive and stratified approach that aggregates key policies; this approach is to serve as a strategic guide for policymakers and stakeholders, emphasizing the importance of effective coordination, transparency and implementation across all administration scales to enhance forest protection and promote sustainable practices.

Several policies and initiatives form the foundation of the global forest governance. The REDD+ Framework (formed by the United Nations) encourages developing nations to implement measures that reduce emissions from deforestation and forest degradation, encouraging sustainable land management and conservation efforts. Furthermore, the Paris Agreement explicitly recognizes the critical role of forests in diminishing climate change and lists them as main elements of global climate strategies; actions such as forest conservation and restoration. These international agreements highlight the need for a unified global response and financial mechanisms that support sustainable forest management and integrated fire management, which are integral to the objectives of the SILVANUS project.

Within the EU, crucial policies such as the Forest Law Enforcement, Governance, and Trade (FLEGT) initiative and the EU Biodiversity Strategy for 2030; attempt to tackle problems regarding forest conservation. The FLEGT initiative combats illegal logging by promoting sustainable practices and ensuring that only legally sourced timber enters EU markets, while the EU Biodiversity Strategy (described in the European Green Deal), establishes ambitious targets for forest protection, ecosystem resilience and sustainable resource use. By integrating these international and EU policies with localized governance practices, the SILVANUS Policy Recommendations aim to create an effective strategy for managing forests and wildfires, reinforcing resilience and advancing sustainable development goals across different regions.

1.1 Deliverable Scope

The primary objective of this deliverable is to build upon the foundational mapping of policies and practices related to forest governance established in deliverable D7.1 of WP7 and provide a more detailed framework for forest governance. This is achieved by refining and enhancing policy recommendations for sustainable forest governance, wildfire management and forest restoration across International, European, and National levels. It aims to provide an in-depth analysis of the existing frameworks and emerging trends in forest governance, globally, addressing challenges such as policy fragmentation, market influences and the financialization of forest resources. The deliverable examines the correlation between forest governance and wildfire management, more specifically in the context of climate change and the evolving landscape of international environmental agreements.

Based on the work performed in D7.1, the present deliverable, D7.2, provides an enhanced revision of the literature resources from the perspective of forest governance. Additionally, the experience gained from the performed pilots and the stakeholder engagement provide a more detailed view of current forest governance models at a national level. With a focus not only in the EU, but also other international states (Brazil, Indonesia), the scope of the deliverable is to provide an inclusive and integrated forest governance framework. Particular attention is given to collaborative, anticipatory and participatory governance models that support the integration of cross-sectoral strategies and stakeholder involvement.

This updated policy provides recommendation guidelines that mainly target the enhancement of the efficiency and coherence of forest governance policies. The demand for improved coordination between International, European and National actors is highly outlined, and can be achieved by establishing common policy objectives that can address the complicated socio-economic and environmental dynamics. These dynamics tend to influence the overall forest management of the region. Moreover, this deliverable

highlights opportunities for advancing sustainable finance mechanisms, promoting "greener" management practices, and enhancing public awareness and stakeholder cooperation, with the goal of ensuring effective, sustainable and resilient forest governance.

1.2 Overview of the Working Methodology

The working methodology utilized for this deliverable can be summed up as a combination of literature review, data collection from pilot sites and stakeholder engagement, that can be used to develop a complete framework for forest governance in relation to integrated fire management. The methodology is designed to ensure a comprehensive understanding of the current practices and challenges across various governance levels, from international to local regions. The literature review forms the basis of this approach, examining relevant policies, academic studies and technical reports to establish the foundational knowledge regarding sustainable forest management, forest resilience and post-fire restoration strategies. Furthermore, questionnaires administered to pilot sites and stakeholders provide valuable data that introduce a feedback loop into the analysis. These questionnaires provide an organized information gathering process, which enables an evaluation of the practical implementation of policies and the effectiveness of governance models in diverse contexts.

The questionnaires attempt to cover a wide range of topics, essential for understanding and improving forest governance, i.e. the evaluation of existing forest management practices, the effectiveness of current wildfire prevention and response strategies and the implementation of post-fire restoration measures. Moreover, the application of sustainable forest management principles, such as "greener" approaches and the involvement of local communities and their knowledge in decision-making processes is further explored. Additionally, the perceived challenges found in managing forest resources are assessed, including financial constraints, policy fragmentation and stakeholder coordination issues. Finally, by examining the data collected through these questionnaires, valuable insights into both the strengths and limitations of current practices contribute to the development of more robust and context-sensitive policy recommendations. The complete questionnaire is provided as an **Appendix "Template – Forest Governance in Pilot Sites"** at the end of the deliverable. Using the provided template, respondents from each pilot site provided their feedback and insights regarding the national forest governance frameworks.

1.3 Deliverable structure

The remainder of this document is organized as follows: Chapter 2 provides the key definitions of the main forest governance concepts discussed in this document. Chapters 3, 4, and 5 provide the detailed analysis of the current state-of-art, challenges and opportunities of forest governance at international, EU and national level, respectively. The content of Chapters 3 and 4 is based on the extensive literature review that has been conducted, while the content Chapter 5 provides insights based on the data collected from the employed questionnaires. Lastly, Chapter 6 presents the recommendations and final conclusions extracted from the previous chapters.

2 Definitions

Due to the complexity and breadth of the governance domain, this chapter will provide a clear definition that will provide the foundation for understanding its multifaceted nature. Forest governance, in particular, is not a singular concept but rather an umbrella term that encompass a wide range of interrelated sub-topic such as policy frameworks, management strategies, stakeholder engagement and other. By identifying the key factors and actors involved and the relevant topics that influence governance outcomes, this chapter aims to put forward a comprehensive understanding that will inform the subsequent analysis at International, European and National level.

According to the United Nations Committee of Experts on Public Administration (2006), governance refers to the processes, structures, and institutions through which societies manage collective affairs, make decisions, and ensure accountability. It encompasses the mechanisms, policies, rules, and practices used by government entities, private organizations, and civil society to administer public affairs and distribute power.

2.1 What is forest governance?

Forest governance refers to the processes and institutions that guide the management, conservation, and sustainable use of forests. It involves a range of stakeholders such as governments, businesses, Indigenous communities, and non-governmental organizations (NGOs). The focus is on ensuring the equitable distribution of forest resources, protecting ecosystems, and achieving sustainability goals. Forest governance incorporates a variety of stakeholders from different levels of government (local, regional, national, global). It can include (FAO, 2024):

- rules for governing forests, governmental regulations regarding beneficiaries of forest resources, as well as traditional and customary rights;
- private-sector mechanisms employment for supporting Sustainable Forest Management (SFM) and legal timber supply; and
- international measures for supporting timber legality and good governance, such as the European Union's Forest Law Enforcement.

2.2 What Makes Forest Governance "Good"?

"Good" or responsible forest governance is characterized by:

- Adherence to the rule of law.
- Transparency and low levels of corruption.
- Stakeholder participation in decision-making.
- Equal rights for stakeholders.
- Accountability.
- A low regulatory burden.
- A coherent set of laws and regulations—both within the forest sector and in other sectors that influence forest management.
- Proper implementation of laws.
- Political stability.
- Capacities to govern efficiently and effectively.

Attempting to assess the quality of forest governance in a particular country, PROFOR and FAO developed in 2011, the "*Framework for Assessing and Monitoring Forest Governance"* (FAO, 2011). The PROFOR/FAO forest governance framework tries to describe, diagnose, monitor, assess, and report the current status of

forest governance in a specific country. It is widely used for appraising forest governance and facilitates the implementation of Sustainable Forest Management (SFM). It can provide forest governance insights for improvement by identifying areas of weakness, developing and deploying adequate solutions, monitoring outcomes, and continuously adapting to ensure ongoing progress. It can be used by national and local governmental agencies, non-governmental organizations or a variety of actors with different interests. It is built on widely accepted pillars and principles of "good" forest governance (Figure 1). The six principles are: 1. Accountability, 2. Effectiveness, 3. Efficiency, 4. Fairness/equity, 5. Participation and 6. Transparency. Their assessment cuts across three fundamental pillars of forest governance that include thirteen basic components, as follows:

Pillar 1- Policy, legal, institutional and regulatory frameworks: concerns the clarity and coherence of long-term systems of policies, laws, rules and regulations to assess the overall context for forest use, management and forest-related decision-making. It includes the following components:

1.1 Forest-related policies and laws

1.2 Legal framework to support and protect land tenure, ownership and use rights

1.3 Concordance of broader development policies with forest policies

1.4 Institutional frameworks

1.5 Financial incentives, economic instruments and benefit sharing

Pillar 2- Planning and decision-making processes: examines transparency, accountability and inclusiveness of key forest governance processes and institutions. It includes the following components:

2.1 Stakeholder participation

2.2 Transparency and accountability

2.3 Stakeholder capacity and action

Pillar 3-Implementation, enforcement and compliance: regards the effectiveness and efficiency of the implementation of policy, legal, institutional and regulatory frameworks. It includes the following components:

3.1 Administration of forest resources

3.2 Forest law enforcement

3.3 Administration of land tenure and property rights

3.4 Cooperation and coordination

3.5 Measures to address corruption

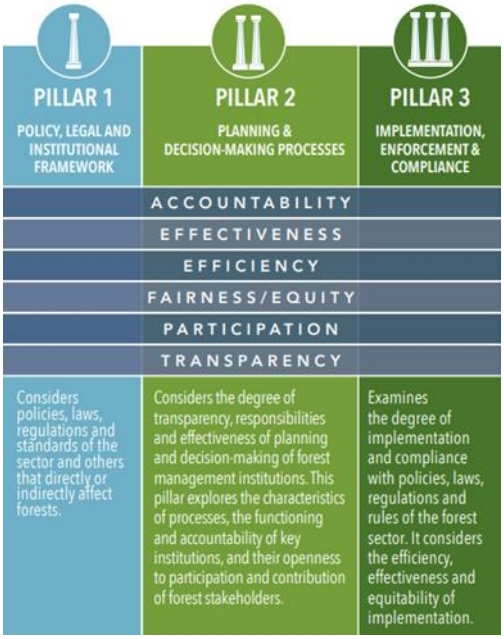

Figure 1: Framework for Assessing and Monitoring Forest Governance-Principles and Pillars (PROFOR, 2017)

Each of the above-mentioned components is analysed into subcomponents. Already, the framework has been applied in various countries, such as Armenia, Azerbaijan, Belarus, Georgia, Indonesia, Moldova, Russia and Ukraine to mainly assess forest law enforcement and governance (Gritten et al., 2019). Overall, forest managers should recognize that the forest sector does not operate in isolation. Other sectors, policies, and land uses can affect how forests are governed at various scales, from local to global. Good forest governance acknowledges and integrates these influences.

Forest governance is effective when it creates clear policy and legal frameworks that encourage meaningful participation in decision-making from all interested stakeholders, including forest-dependent communities, to drive progress towards common objectives. At this point it must be noted that forest governance includes both formal (laws and regulations) and informal (customary practices, local norms) systems. Particularly, forest policy is a complex and multi-disciplinary domain.

Forest policy is defined by FAO as: *"a negotiated agreement between government and stakeholders (i.e., all those who depend on or benefit from forests or who decide on, control or regulate access to these resources) on the orientations and principles of actions they adopt, in harmony with national socioeconomic and environmental policies, to guide and determine decisions on the sustainable use and conservation of forest and tree resources for the benefit of society".* A forest policy provides direction, whereas legislation comprises the instrument for implementing it, establishing rights and responsibilities, and formalizing governance arrangements. A forest policy:

- establishes a long-term vision that protects, maintains enhances the values of forests for present and future generations;
- establishes a strategy for addressing emerging challenges and responding to new opportunities;
- facilitates balancing the needs of various stakeholders and clarifying the roles and responsibilities of all stakeholders, both within and outside the public forest sector, i.e., from forest managers to government agencies overseeing forests; and
- specifies a framework for institutions, including laws and regulations (FAO, 2024).

2.2.1 Wildfire Governance

Although there is no distinct definition of wildfire management in the literature, wildfire governance can be understood as the policies, laws, and collaborative strategies that regulate how societies prevent, manage, and respond to wildfires. It involves risk assessment, land management practices, response planning, and stakeholder coordination to mitigate the destructive impacts of wildfires (Kirschner et al., 2023). It is a key element of forest governance, and its importance grows in present situation of climate change and devastating effect of forest fires.

Within governance theories and concepts, wildfire governance can be further categorized to express its various aspects, as described in the following paragraphs.

2.2.1.1 Adaptive Governance

Adaptive governance emphasizes adaptation, flexibility, and learning processes, acknowledging the limited capacity of any system to respond to constantly changing biophysical and social components (Folke et al., 2005). It is closely related to resilience, where social-ecological systems are governed to build capacity to adapt, reorganize, reshape, and transform after disturbances (Folke, 2006; Chaffin et al., 2014).

2.2.1.2 Collaborative Governance

Collaborative governance brings together public and private stakeholders to share resources, knowledge, and decision-making responsibilities. This model allows for joint efforts between state and non-state actors to address wildfire risks that cross political, ecological, and jurisdictional boundaries. It promotes the co-production of policies and strategies through shared ownership and decentralized decision-making. According to Gray (1985) and Bodin (2017), collaborative governance refers to self-organized sharing of resources and information by actors across institutional and biophysical scales to achieve a common goal.

2.2.1.3 Network and Participatory Governance

Network governance refers to formal and informal communication and cooperation patterns between actors affecting decision-making (Howlett & Ramesh, 2014; Benedum & Becker, 2021). Networks consist of autonomous actors with varying access to resources, including formal authority (Provan & Kenis, 2008), jurisdictional responsibilities (Steelman & Nowell, 2019), and finances, connected through shared values (Ostrom, 1990), and flows of information, services, or goods (Carlsson & Sandström, 2008).

2.2.1.4 Multi-Level Governance

Multi-level governance envisions state and civil society connecting in complex networks across local, national, and International scales to negotiate decisions leading to more representative outcomes (Berkes, 2008; Jessop, 2013). Originating from studies of the European Union, it involves patterns of coordination and cooperation among autonomous supranational, national, and local actors (Bache et al., 2016).

2.2.1.5 Polycentric Governance

Polycentric governance (Ostrom et al., 1961; Ostrom, 2010) is characterized by collaboration and competition across multiple centers of semi-autonomous decision-making (Carlisle & Gruby, 2019). It is used in commons scholarship, where centralized institutions work with distributed decision centers holding differing values and knowledge to address natural resource conflicts (Folke et al., 2005; Abrams et al., 2017).

2.2.1.6 Anticipatory Governance

Anticipatory governance (Quay, 2010; Boyd et al., 2015) is a future-focused decision framework used in contexts of uncertainty. It contrasts with conventional "predict and plan" approaches, emphasizing anticipation, flexible strategies, and ongoing review to shape policy scenarios.

Evolution:

- **Early 20th Century:** Focus on fire suppression as the primary strategy, with little attention to ecological impacts.
- **Late 20th Century:** Recognition of fire as integral to ecosystems led to incorporating fire ecology, controlled burns, and balanced risk-reduction strategies.
- **Recent Years:** Climate change and urbanization prompted a shift towards integrating cross-sectoral collaboration, emphasizing resilience and adaptation.

2.2.2 Forest Restoration Governance

Forest restoration governance refers to the frameworks and processes guiding the restoration of degraded forests, focusing on ecological recovery, community engagement, and sustainable development. It aims to restore ecosystems, biodiversity, and the socio-economic functions of forests (Wiegant et al., 2022).

Evolution:

- **Mid-20th Century:** Forest restoration was primarily viewed through reforestation for timber production.
- **Late 20th Century:** Shifted focus to include ecological restoration, recognizing the importance of biodiversity and ecosystem services.
- **21st Century:** Expanded to encompass global initiatives like the Bonn Challenge and UN Decade on Ecosystem Restoration, integrating local and Indigenous knowledge with global climate and biodiversity goals.

2.3 Key actors affecting forest governance

Effective forest governance is influenced by a multitude of factors, primarily shaped by the various actors involved in managing forest resources. As depicted in Table 1, Understanding the roles and interactions of these actors is crucial for developing policies and practices that promote sustainable forest management, restoration efforts, and effective wildfire management.

Table 1: Actors involved in Forest Governance – Roles and Impact

Actors Involved in Forest Governance		Role	Impact
Government Entities	National Governments	Develop and enforce national forest policies, laws, and regulations; allocate resources for forest management; participate in international agreements.	Set the legal and institutional framework for forest governance; influence land-use planning and conservation efforts.
	Regional and Local Governments	Implement national policies at local levels; manage public forests;	Adapt policies to local contexts; facilitate community

		oversee land-use decisions; engage with local communities.	involvement; address region-specific challenges.
	Indigenous and Local Communities	Stewards of traditional knowledge and sustainable practices; manage community forests; participate in decision-making processes.	Contribute to biodiversity conservation; implement community-based forest management; advocate for rights and equitable resource access.
Private Sector	Forestry Companies and Timber Industries	Engage in logging, timber production, and reforestation; adopt sustainable practices through certification schemes.	Influence forest resource utilization; drive economic aspects of forestry; potentially contribute to deforestation or sustainable management.
	Agriculture and Plantation Businesses	Convert forest land for agricultural use; implement agroforestry systems.	Affect deforestation rates; contribute to landscape-level planning; can adopt sustainable land-use practices.
	Certification Bodies (e.g., FSC, PEFC)	Develop standards for sustainable forest management; certify companies that meet environmental and social criteria.	Encourage adoption of sustainable practices; influence market preferences toward certified products.
Non-Governmental Organizations (NGOs)		Advocate for conservation and sustainable management; monitor policy implementation; engage in restoration projects; provide technical assistance.	Raise awareness; influence policy development; support community initiatives; hold stakeholders accountable.
Civil Society Organizations		Represent various interest groups; facilitate stakeholder engagement; promote transparency and accountability.	Enhance participatory governance; ensure that diverse voices are heard in decision-making processes.
International Organizations	United Nations Agencies (e.g., FAO, UNEP, UNDP)	Provide guidelines and frameworks for sustainable forest management; support capacity building; facilitate international cooperation.	Influence national policies through international agreements; provide funding and technical support.
	International Financial Institutions (e.g., World Bank, IFC)	Fund forestry projects; set environmental and social safeguards; influence policy through lending conditions.	Support large-scale initiatives; promote sustainable development goals; potentially impact governance through financial leverage.
Academic and Research Institutions		Conduct research on forest ecosystems, management techniques, and policy impacts; provide data and evidence for decision-making.	Inform policy development; advance technological innovations; contribute to capacity building and education.

Donor Agencies and Development Partners	Provide financial and technical support for forest-related projects; promote best practices; support policy reforms.	Enable implementation of large-scale programs; influence governance through funding priorities.
General Public and Consumers	Influence market demand for forest products; participate in public consultations; support conservation efforts.	Drive sustainable consumption patterns; hold companies and governments accountable; contribute to grassroots movements.

2.4 Interconnections with forest management, wildfire management and forest restoration

The interconnections between forest governance, forest management, wildfire management and forest restoration are complex and essential for the sustainability of ecosystems, promoting biodiversity, reducing the risk of natural disasters and catastrophic wildfires, and enhancing the resilience of forests. Some of these interconnections are described in detail as follows.

2.4.1 Forest Management

Forest governance can directly influence forest management strategies in multiple ways, such as the following:

- **Sustainable Forest Management (SFM):** Policies and participatory action plans are crucial for the successful deployment of SFM (Sarfo-Adu, 2021). Policies can encourage SFM practices for balancing environmental, economic, and social needs. Also, policies can provide regulations for protection from deforestation and keeping biodiversity. Particularly encouraging cultivational adaptive thinning to the local conditions of natural forest can reduce wildfire risks ensuring effective natural regeneration (Keenan et al., 2021; Brodie et al., 2024).
- **Community Forest Management (CFM):** Forest governance and policies can be more inclusive of indigenous perceptions in forest management. Community forest management influence how forests are governed, used, and conserved. Legal recognition of indigenous land rights can empower local communities and make local forest management more responsive to community needs and priorities and contribute to in situ conservation of indigenous forest resources. Moreover, it can promote capacity building of local communities to manage their resources effectively, enabling them to develop the skills and knowledge necessary for SFM (Savari et al., 2020; Sheppard et al., 2020).
- **Conservation and Maintenance of Protected Areas:** Forest governance and policies can regulate activities like logging, mining, agriculture expansion or other land uses within protected areas, such as national parks, wildlife reserves, and conservation zones, for preserving old-growth forests, safeguarding critical habitats, and enhancing sustainable land use and ecosystem resilience (Loveridge, 2021).

2.4.2 Wildfire Management

Forest governance and policy can have a direct impact on wildfire management in several ways, including the following:

- **Resource Allocation:** Forest governance is essential for effectively managing and directing the resources needed for wildfire management. It ensures that sufficient funding is allocated to critical areas, such as firefighting operations, equipping and training personnel to respond to fires, and educating communities about fire prevention and safety. By enforcing policies, prioritizing needs, and coordinating efforts between government agencies, local communities, and other stakeholders, forest governance can ensure that resources are used efficiently to reduce wildfire risks and enhance preparedness in fire-prone landscapes (Kirschner et al., 2023).
- **Risk Assessment and Planning:** Forest governance can facilitate the development of wildfire management plans that involve an integrated approach (e.g., fuel load, vegetation type, climate and weather patterns, fire behaviour modelling) in order to reduce the risks of wildfires. After assessing fire risks, policies can prioritize the identified high-risk areas for prevention and preparedness and allocate efforts efficiently. It must be noted that there are recent policies including approaches that align with complex risk frameworks, and not only technical risk assessments that do not reflect the complexity of contemporary wildfire risk (Essen et al., 2023).
- **Collaborative Multi-Stakeholder Approach:** The complex nature of wildfire management, requires collaboration for its successful implementation. Forest governance can promote the creation and cooperation of multi-stakeholder groups (e.g., government agencies, fire management agencies, local communities) not only to coordinate interagency efforts and work with external organizations/groups, but also to develop integrated wildfire management strategies that incorporate the experiential knowledge, expertise, priorities and resources of local stakeholders (De Abreu, 2021).

2.4.3 Forest Restoration

Forest governance and policy can significantly affect forest restoration in several ways, including the following:

Reforestation and Afforestation: Forest governance can promote replanting trees in deforested or degraded areas, as well as create forests in areas where they did not previously exist. Well-structured policies can help to develop efficient wildfire strategies that restore ecosystems, enhance forest/ landscape functionality and resilience, preserve biodiversity and native species (Brancalion and Chazdon, 2017).

Landscape-Scale Restoration or Rehabilitation: Given the that ecological processes are dynamic, it is not possible to create the same conditions of the pre-disturbance landscape. However, polices can encourage landscape-scale restoration initiatives that regard entire ecosystems, rather than specific forests, to repair dysfunctional processes, manage watersheds and achieve more stable and self-sustaining systems. Rehabilitation policies may incorporate measures for management of watersheds, ecological and wildlife conservation corridors, and forest patches to restrict the catastrophic results from large-scale wildfires (Tongway and Ludwig, 2012; Salviano et al., 2021).

3 Forest Governance at International level

This chapter provides an overview of the forest governance at international level. Given the growing interest in forests and forested areas, understanding international forest governance is crucial, given the forests are global commons with impacts that transcend national borders. The chapter explores the state-of-the-art, highlighting the frameworks, agreements and institutions that shape how forests are managed and protected worldwide.

The complexity of forest governance at international level is a result of the various interactions among diverse actors, including sovereign states, international organisations, NGOs, and private sector entities. Such interactions are governed by a variety of agreements and initiatives aiming to address global challenges such as deforestation, climate change and biodiversity loss. However, the effectiveness of these frameworks is often challenged by the differing interests across the different sectors, as conservation objectives could differ from renewable energy objectives, and scale, as national interest could differ from international ones, as well as the enforcement issues and resource constraints.

This chapter outlines the current state of the art of international forest governance (3.1), examines the key challenges (3.2) and identifies emerging opportunities for enhancing global cooperation (3.3).

3.1 History of International Forest Governance

International Forest Governance (IFG) has evolved significantly over the past decades, reflecting the changes in global priorities, the emergence of environmental challenges and the increased interest in forests that led to the involvement of multiple and diverse stakeholders. To properly grasp the complexities of current forest governance frameworks and the trends shaping future directions it is crucial to understand the evolution of IFG.

The beginning of the early 1900s marked the beginning of International Relations, with initial focus on political, social and security issues such as the balance of power, diplomacy and the causes of war (Carr, 1939; Porter, 1972). The main discourses during this period mainly revolved around state behaviour, power dynamic and the management of international conflicts, with little attention given to environmental concerns (Dunne et al., 2020).

It was not until the rise of environmental awareness and the global environmental movement in the 1960s and 1970s that environmental issues began to gain significant traction in International Relations. Influential work such as Rachel Carson's *Silent Spring* (1962) mobilized this shift by highlighting the interconnectedness of environmental sustainability with global security and political stability (Slocombe, 1984, Dunne et al., 2020). This growing recognition culminated in the first formal consideration of environmental concerns at the international level during the 1972 United Nations Conference on the Human Environment in Stockholm. This conference brought to the creation the United Nations Environment Programme (UNEP), marking the beginning of international forest governance as a significant global issue. This event set the stage for a series of evolving policies, frameworks and institutions designed to manage and conserve forest resources.

3.1.1 Early initiatives and frameworks (1970s-1980s)

In the early 1970s, growing awareness of the environmental impact of human activities market a pivotal shift in global consciousness. As industrialization and urbanization accelerated, it became increasingly evident that these activities were having profound and often detrimental effects on the environment. This period of heightened awareness set the stage for international cooperation aimed at addressing environmental challenges on a global scale. Before this era, international environmental governance was

virtually non-existent. However, the 1970s witnessed the development of a more organized approach to environmental issues, laying the foundation for future frameworks and agreements.

One of the first and most significant milestones that was achieved in the 1970s was the United Conference on the Human Environment that was held in June 1972 in Stockholm, usually referred to as the **Stockholm Conference**[1]. This conference was the first world conference to recognise the environment as a critical issue deserving global attention and action. The increasing concerns over pollution, deforestation and the degradation of natural resources, combined with the growing environmental movements that began to raise awareness about the environmental impacts of human activities are the main discourses that led to the convening of the conference.

The conference brought together representatives from 113 countries, alongside various international organizations and NGOs (UN, 1972). However, the acceptance of the conference was not universal at first, as the Global South was initially sceptical about the agenda. Particularly, these countries that were facing poverty and underdevelopment viewed the emphasis on environmental concerns as potentially undermining their economic aspirations and their development. For many countries of the Global South, the priorities at the time were economic growth and poverty alleviation and not environmental conservation. They questioned the need for such a conference, viewing it as a distraction from more pressing concerns. Their worry originated from the lack of trust in the industrialized North, thinking that they were using the agenda to maintain existing economic inequalities and limit their industrial progress. This feeling was clearly illustrated by the famous statement from the Ivory Coast, that expressed a preference for "more pollution problems" as they were seen as evidence of industrialisation, that was opposed to the poverty that these nations sought to escape (Rowland, 1973). Despite the initial reservations from the Global South, the Stockholm Conference ultimately provided an unexpected opportunity for it to articulate their concerns and present their position on global environmental issues.

The two major outcomes from the Stockholm Conference were the establishment of the UNEP and the formulation of 26 guiding principles for environmental action (UN, 1973). These outcomes marked a turning point in international environmental governance.

Specifically, the creation of UNEP was pivotal as it became the first international organization dedicated uniquely to environmental issues. The establishment of UNEP demonstrated a formal acknowledgement by the international community that environmental protection was a global priority requiring coordinate action. The organisation was tasked with promoting environmental sustainability, fostering international collaboration and ensuring that environmental considerations were integrated in the development processes of nations around the world.

Additionally, the 26 principles provided a foundational ethical and pragmatical framework for environmental action at the international level. They emphasized the need for environmental protection to be balanced with economic and social development, a concept that would later evolve into the notion of sustainable development. The principles also underscored the importance of international cooperation in addressing transboundary environmental issues, thus establishing a starting ground for the collaborative efforts that would shape global environmental governance in the decades to follow.

Despite the initial relocation from the Global South, the outcome of the conference, including the establishment of UNEP in Kenya, helped to bridge the gap between developed and developing nations on environmental issues. The inclusion of principles that recognized the right to development and the importance of alleviating poverty resonated with the concerns of developing countries. Over time, this laid set the ground for a more inclusive approach to environmental governance, where the needs and perspectives of all nations were considered.

The Stockholm Conference not only marked the beginning of a global environmental consciousness but also laid the institutional and conceptual foundations for IFG. The establishment of UNEP and the adoption of the 26 principles were crucial steps toward the creation of a more integrated and comprehensive approach

[1] https://www.un.org/en/conferences/environment/stockholm1972

to manage the planet's natural resources, including forests. As the first formal recognition of the environment as a global issue, the conference set the stage for future international agreements and frameworks that would further shape the landscape of IFG in the years to come. These initiatives and frameworks were crucial in moving environmental issues from the periphery to the centre of international policy discussions.

Following the Stockholm Conference and the establishment of UNEP, the 1980s saw further development in international environmental governance, particularly concerning forest conservation. While the Stockholm Conference laid the foundation for global environmental consciousness, the specific challenges facing tropical forests came into sharper focus as the international community recognized the growing threats posed by deforestation, especially in regions like the Amazon (Myers, 1980; Hecht, 1981). The alarming rate of deforestation in the Brazilian Amazon was documented early on (Fearnside, 1982; Fearnside, 1985), highlighting the ecological and environmental risks of rapid forest loss that was caused by increased industrial demand for timber and biomass (World Bank, 1991). This concern was further supported by the growing use of satellite imagery and advances in remote sensing, which revealed the extent of habitat fragmentation and amplified global concerns about biodiversity loss and climate impact (Skole and Tucker, 1993). Concurrently, the broader social, political, and economic forces driving deforestation, including large-scale development projects, were also analysed during this period (Hecht and Cockburn, 1990).

In response to these growing concerns, the **International Tropical Timber Agreement (ITTA)** was negotiated and adopted in 1983 (ITTA, 1983). This legally binding agreement marked a crucial step towards balancing the economic interest of timber-producing countries with the imperative of forest conservation. The ITTA was not just a product of environmental concern, but a reflection of the urgent need to address both environmental and economic challenges associated with tropical forests. Recognizing these forests as a vital component of Earth not only for the biodiversity but also for their critical role in regulating the global climate, the agreement sought to foster sustainable practices in timber production while promoting the preservation of these invaluable ecosystems. The role of the United Nations Conference on Trade and Development (UNCTAD) was pivotal in this process, providing a crucial platform for dialogue and negotiation. By bringing together, timber-producing and consuming countries, UNCTAD facilitated discussions that integrated trade polices with environmental sustainability, ensuring that the ITTA addressed the complex interplay between trade and the preservation of tropical forest. During the negotiations, key discourses centred around finding a balance between economic development and environmental conservation. The agreement sought to address issues such as sustainable management of forests, illegal logging and the promotion of alternative livelihoods for communities reliant on timber resources. The objective was the establishment of a cooperative framework that would guide the interactions between producing and consuming countries, aiming to address these issues comprehensively.

A key outcome of the ITTA was the establishment of the International Tropical Timber Organization (ITTO) that was created to oversee the implementation of the agreement. The ITTO provided a framework for cooperation among member countries, focusing on sustainable management and utilization of tropical forests. The ITTA outlined several objectives for the ITTO, including the promotion of sustainable forest management, the prevention of illegal logging, and the support of alternative livelihoods for communities dependent on timber resources. It also aimed to improve market transparency and encourage increased processing of tropical timber in producing countries to boost industrialization and export earnings. Through these measures, the ITTA sought to foster a balanced approach that recognized the economic importance of tropical timber while prioritizing the conservation of these vital ecosystems. The agreement emphasized the need for national policies geared towards the sustainable utilization and conservation of tropical forests, and it set the stage for ongoing international cooperation.

Table 2 provides a summary of IFG developments in the decades of 1970s and 1980s.

Table 2: Summary of IFG developments in the 1970s and 1980s

	1970s	1980s
Key Drivers	• Growing awareness of environmental degradation • Rise of environmental movements and activism • Industrialization and urbanization highlighting environmental issues	• Alarming deforestation rates, especially in tropical forests • Economic interest in timber production • International pressure for more sustainable practices
Main Discourses	• Recognition of the environment as a global issue and need for shared global environmental responsibility • Challenges faced by developing countries regarding environmental priorities	• Sustainable management of forests • Balancing timber production with conservation
Key Outcomes	• Stockholm Conference (1972) considered the birth of environmental diplomacy • Establishment of UNEP • Formal recognition of the environment as a global issue	• ITTA (1983) that introduced the concept of balancing economic and environmental goals • Establishment of ITTO (1985) • Focus on sustainable timber management and prevention of illegal logging

3.1.2 The rise of global agreements and summits (1990s-2000s)

Following the beginning of international relations to address the impacts caused by the world population on forests in the 1970s and the 1980s, the early 1990s marked a significant evolution in the development of global environmental governance, particularly with respect to forests. This decade was characterized by the rise of formalized global agreements and summits aimed at addressing a wide range of environmental challenges. These frameworks and agreements laid the foundation for increased international cooperation, financial support and the creation of institutions to foster sustainable forest management.

In 1991, the **Global Environment Facility** (GEF)[2] was established as the first financial mechanism dedicated to providing funding for environmental projects on a global scale. As the first international financial institution focused exclusively on environmental issues, the GEF played a pivotal role in mobilizing resources for these projects on an unprecedented scale. Its creation marked a departure from previous funding mechanisms by directly addressing global environmental challenges and sustainable development, and it was designed to tackle pressing concerns such as global warming, biodiversity loss, international waters, and ozone depletion (Streck, 2001). Initially, responsibility for implementing the GEF was shared by three major organizations: the World Bank, the UNEP, and the United Nations Development Programme (UNDP). While the GEF made ground-breaking contributions, it faced criticism over the dominant role of the World Bank, lack of formal recognition for NGOs, insufficient transparency in decision-making, and the limited inclusion of diverse stakeholders. Nonetheless, despite these criticisms, the GEF can be considered a pioneering initiative in the field of IFG, providing essential financial resources and technical assistance to address key environmental issues across the globe (Streck, 2001).

The following year, in 1992, the **Rio Earth Summit**, formally known as the United Nations Conference on Environment and Development (UNCED)[3] was held, representing a landmark moment in international

[2] https://www.thegef.org/
[3] https://www.un.org/en/conferences/environment/rio1992

environmental diplomacy, marking a pivotal shift towards the integration of environmental concerns into the broader development agenda. The Summit was notable as it produced a series of significative outcomes that have had a lasting impact on global environmental policies.

One of the major results of the Earth Summit was **Agenda 21**, a program of action aiming to achieve sustainable development in the 21st century by calling for new strategies to invest in the future. Agenda 21 provided recommendations such as new methods of education, new ways of preserving natural resources or new ways for participating in a sustainable economy (UN, 1992). The Summit also resulted in the adoption of three major international agreements: the **Convention on Biological Diversity** (CBD)[4], the **United Nations Framework Convention on Climate Change** (UNFCCC)[5], and the **United Nations Convention to Combat Desertification** (UNCCD)[6]. Both the CBD and UNFCCC continue to play a key role in shaping today's IFG agenda, particularly in promoting forest conservation, sustainable use and the integration of forests into global climate action strategies (Sotirov et al., 2020).

Additionally, the Earth Summit also produced the **Rio Declaration on Environment and Development**, consisting of 27 principles outlining key concept for achieving sustainable development, emphasizing the need for integrating environmental protection in economic and development policies and highlighting principles such as *polluter pays* and the *right to development* (UN, 1992a). Furthermore, the Forest Principles, while non-legally binding (Sotirov et al., 2020), set out recommendations for the conservation and sustainable management of forests. Despite not being legally enforceable, these principles were a major step forward in raising global awareness of the need for sustainable forest management and established a basis for ongoing international cooperation on forest issues (Kleinschmit et al., 2024).

The 1990s also saw the rise of voluntary certification systems as a response to the growing global focus on sustainable forest management and the increasing role of non-state actors in IFG. Among the most significant developments were the establishment of the **Forest Stewardship Council** (FSC)[7] in 1993 and the **Programme for the Endorsement of Forest Certification** (PEFC)[8] in 1999. These initiatives represented a departure from traditional, state-centric governance models by introducing market-driven approaches to address deforestation and promote responsible forest management.

The FSC, spearheaded by environmental NGOs, businesses, and other stakeholders, emerged as a pioneering effort to set global standards for sustainable forestry through third-party certification. Its certification process provided consumers and businesses with a mechanism to support forest conservation by ensuring that the products they purchased were sourced from responsibly managed forests. This market-oriented approach allowed forest governance to expand beyond state regulation, placing a new emphasis on transparency, accountability, and consumer responsibility.

Similarly, the PEFC was established in response to the demand for a more flexible and regionally adaptable system, particularly from European forest owners. While the FSC took a centralized, global approach, the PEFC worked to endorse national certification systems, allowing for greater adaptation to local contexts and forest management practices. Together, these certification schemes introduced a new dynamic into the IFG landscape, where market mechanisms and private sector engagement played a critical role in promoting sustainable forestry.

The establishment of the FSC and PEFC laid the groundwork for today's IFG by integrating sustainability standards into global markets, empowering non-state actors to influence forest governance, and increasing the role of certification as a key tool for achieving environmental goals. The rise of certification schemes has brought market dynamics and their linked consequences in forest management. However, nowadays the two certification standards compete on whose interpretation of Sustainable Forest Management (SFM)

[4] https://www.cbd.int/
[5] https://unfccc.int/
[6] https://www.unccd.int/
[7] https://fsc.org/en
[8] https://www.pefc.org/

is more valid and appropriate, despite not knowing yet their true impact on the ground (Visseren-Hamakers and Pattberg 2013). Nonetheless, they have been recognised by international agreements (e.g., CBD) and have gained significant influence, particularly on the EU (Pülzl et al., 2013).

The **United Nations Forum on Forests** (UNFF) emerged in 2000 from the outcomes of the 1992 Rio Earth Summit, which, despite its landmark status, failed to produce a legally binding agreement on forests. The UNFF emerged from the recognition that prior forest-related discussions were often fragmented and lacked a central coordinating body. As outlined in ECOSOC Resolution 2000/35, its mandate to promote the management, conservation, and sustainable development of all types of forests underscored the growing importance of forests in the global sustainability agenda. By facilitating cooperation among member states, international organizations, and other stakeholders, UNFF aimed to foster a more cohesive and effective approach to forest governance. Despite these advancements, UNFF has often played a background role compared to other environmental frameworks, with forests receiving more attention and funding under the UNFCCC and the CBD than under the UNFF itself (Blaser et al., 2014). Nonetheless, UNFF's efforts in advancing global forest policies, setting norms, and encouraging collaborative efforts represent a crucial step in enhancing international efforts to safeguard and sustainably manage forest resources.

In 2002, the **World Summit on Sustainable Development** (WSSD)[9] in Johannesburg marked a significant moment in the evolution of IFG by setting the **2010 biodiversity target**[10], a key objective under the CBD. This target was a landmark commitment aimed at halting the loss of biodiversity and improving the conservation and sustainable management of forests. The WSSD built upon earlier global environmental agreements, including those established at the 1992 Rio Earth Summit, and sought to renew and strengthen international commitments to sustainable development. The Summit's key outcomes included the Johannesburg Plan of Implementation, which emphasized the need for urgent action to address environmental degradation and promote sustainable use of natural resources (UN, 2002). The 2010 biodiversity target, in particular, called for a significant reduction in the rate of biodiversity loss by 2010, setting one of the first international benchmarks for biodiversity conservation. This target reflected a growing recognition of the critical role that biodiversity plays in maintaining ecosystem services and human well-being. The relevance of the 2002 WSSD for today's IFG lies in its role in setting a global agenda for biodiversity and forest management. Although the 2010 target was not fully achieved (Butchart et al., 2010), it paved the way for subsequent international commitments and frameworks, including the Convention on Biological Diversity's post-2010 strategic plan and the Aichi Biodiversity Targets (Tittensor et al., 2014), described in 3.1.3. The WSSD's focus on integrating environmental and developmental goals continues to influence contemporary IFG efforts by reinforcing the importance of balancing conservation with sustainable development objectives.

The **Millennium Ecosystem Assessment** (MA), launched in 2001 and published in 2005, was a landmark initiative aimed at evaluating the consequences of ecosystem changes for human well-being and providing a scientific basis for necessary actions to conserve and sustainably use these systems. One of its key contributions was the formalization of the concept of **ecosystem services** (ES), specifically defining them as "*the benefits people obtain from ecosystems*" (MA, 2005). The MA classified the ESs into four (4) main types: provisioning services (e.g., food, water), regulating services (e.g., climate regulation, flood control), supporting services (e.g., nutrient cycling, soil formation), and cultural services (e.g., recreation, spiritual value). The MA reported widespread degradation of ecosystems globally, including deforestation, loss of wetlands, and declining biodiversity, documenting that many ecosystems were being altered at an unprecedented rate. This degradation significantly impacted their ability to provide essential services, with consequences for human health and economic stability. The assessment emphasized the importance of integrating ESs into decision-making processes and the need for more sustainable and integrated management practices (MA, 2005). The MA's findings led to policy recommendations advocating for better data and indicators, increased stakeholder engagement, and the incorporation of ecosystem services into

[9] https://www.un.org/en/conferences/environment/johannesburg2002
[10] https://www.cbd.int/2010-target

economic and policy frameworks (TEEB, 2010). These recommendations influenced subsequent international frameworks and targets, including CBD's post-2010 strategic plan and the Aichi Biodiversity Targets.

In 2007, the UNFF adopted the **Non-Legally Binding Instrument on All Types of Forests** (NLBI), also known as the "Forest Instrument" (UN, 2008, FAO, 2013). The agreement aimed to advance SFM by enhancing the economic, social, and environmental values of forests globally. It responded to the urgent need for a unified approach to forest issues, driven by concerns over climate change, deforestation, and the benefits forests provide to human well-being. Its purpose was to strengthen political commitment and action for SFM at all levels, support the achievement of development goals like poverty eradication, and provide a framework for national and international cooperation. The NLBI is guided by principles that emphasize its voluntary nature, the responsibility of each state for its forests, and the need for increased financial resources and international cooperation. It encouraged member states to develop national forest programs, promote good governance, and enhance stakeholder participation (Rayner et al., 2010).

Table 3 provides a summary of IFG developments in the decades of 1990s and 2000s.

Table 3: Summary of IFG developments in the 1990s and 2000s

	1990s	2000s
Key Drivers	• Increasing environmental degradation • Urgent need for international cooperation • Emergence of non-state actors in environmental governance • Demand for regional and flexible certification systems	• Continued focus on sustainable development • Emphasis on biodiversity and ecosystem services • Recognition of ecosystem degradation and services • Need for political commitment to forest management
Main Discourses	• Integration of environmental concerns into development • Market-driven approaches in forest management • Need for unified frameworks for forest management • Balancing state and non-state roles in forest governance	• Need for coordinated global action on forest management • Integration of biodiversity and ecosystem services into policies • Need for scientific assessment and integration into decision-making • Need of a unified approach to face climate change and deforestation

Key Outcomes	• Establishment of GEF (1991) providing funding for global environmental projects
	• Rio Earth Summit (1992):
	  ○ Agenda 21
	  ○ CBD
	  ○ UNFCCV
	  ○ Forest Principles
	• Establishment of forest certification schemes FSC (1993) and PEFC (1999)
		• UNFF (2000) promoting SFM and cooperation among stakeholders
		• WSSD (2002) setting the 2010 biodiversity targets and the Johannesburg Plan of Implementation
		• MA (2001-2005) formalizing the concept of ecosystem services
		• NLBI (2007) enhancing SFM through voluntary principles and encouraged national programs

3.1.3 Recent frameworks and initiatives (2010s-present)

The decade beginning in 2010 saw increased attention to forests as part of global environmental strategies, especially within the framework of climate change mitigation and biodiversity conservation. The introduction of **REDD+**[11] under the UNFCCC in 2010 marked a significant step in recognizing forests as essential in reducing emissions and combating deforestation. This mechanism incentivized developing countries to implement policies that avoid deforestation and degradation, emphasizing the co-benefits of forest conservation and carbon sequestration. In parallel, the **Aichi Biodiversity Targets**[12], established as part of the CBD's post-2010 strategic plan, aimed to halt biodiversity loss by 2020. These targets included specific goals related to forests, such as reducing forest loss (target 5), increasing the area of protected ecosystem (target 11) and to improve the status of biodiversity (strategic goal C). Despite their ambition, many of the Aichi Targets were not fully achieved by the 2020 deadline[13]. However, they played a crucial role in raising awareness, setting global benchmarks for conservation efforts and informing subsequent framework such as the Post-20202 Global Biodiversity Framework. The Aichi Targets helped drive national action plans and policies promoting more integrated approaches to biodiversity and forest management globally (Buchanan et al., 2020).

Twenty years after the Rio Earth Summit, the **United Nations Conference on Sustainable Development**, also known as **Rio+20**[14] **or Rio 2012**, marked an important milestone in the evolution of global environmental governance. The preparation for it highlighted seven areas that needed priority attention: decent jobs, energy, sustainable cities, food security and sustainable agriculture, water, oceans, and disaster readiness. Although it did not lead to major new agreements, Rio+20 was significant in reaffirming the global commitment to sustainable development, aiming to reconcile the economic and environmental goals of the global community. The two main themes that were discussed during the conference where: a green economy on the context of sustainable development poverty eradication and the institutional framework for sustainable development. The discussions that took place in Rio+20 led to the release of the document "**The Future We Want**[15]" that reaffirmed the international community commitment to sustainable development and laid the foundation for the creation of the Sustainable Development Goals (SDGs)[16]. This document was central in shaping the development agenda post-2015 by providing a comprehensive vision for balancing economic growth with environmental protection and social inclusion, leading directly to the development of the SDGs.

In 2014, the **New York Declaration on Forests**[17] was launched at the UN Climate Summit in New York, marking a significant commitment to addressing global deforestation. This declaration, signed by over 200 governments, businesses, and civil society organizations, aimed to accelerate efforts to end deforestation and restore 350 million hectares of degraded land by 2030. The declaration was a pivotal moment in forest governance, focusing on halting deforestation and advancing reforestation and afforestation efforts. It underscored the critical role of forests in mitigating climate change, enhancing biodiversity, and supporting local communities. The New York Declaration on Forests set ambitious targets, including the commitment to **halve deforestation rates by 2020 and to eliminate it by 2030**. It emphasized the need for both public and private sector involvement in achieving these goals and called for enhanced international cooperation and financing. The declaration also highlighted the importance of integrating forest conservation into broader sustainable development strategies and promoting innovative solutions for forest management

[11] https://redd.unfccc.int/
[12] https://www.cbd.int/sp/targets
[13] https://www.theguardian.com/environment/2020/sep/15/every-global-target-to-stem-destruction-of-nature-by-2020-missed-un-report-aoe
[14] https://www.un.org/en/conferences/environment/rio2012
[15] https://sustainabledevelopment.un.org/rio20/futurewewant
[16] https://sdgs.un.org/
[17] https://forestdeclaration.org/

and restoration[18]. Despite these commitments, progress has been disappointing as by 2019 there was little evidence that the goals were on track (NYDF, 2019). The continued conversion of forests to other commercial uses and slow implementation of restoration efforts highlighted a gap between the pledged ambitions and actual outcomes. While there have been positive actions by various stakeholders, such efforts often lack sufficient ambition or coherence to drive the systemic changes needed to address the root causes of deforestation effectively (NYDF, 2019).

The **Paris Agreement**[19], signed in December 2015 during the COP21 conference organized under the leadership of the UNFCCC, represents a landmark in the global fight against climate change. The agreement set **legally binding targets**, aiming to substantially reduce global greenhouse gas emissions to limit the rise in global temperatures to well below 2°C, with efforts to limit it to 1.5°C above pre-industrial levels. This goal was established to significantly reduce the risks and impacts of climate change. The agreement also introduced a mechanism for countries to periodically assess their progress towards achieving these goals and emphasized the need for financial support to assist developing nations in their mitigation and adaptation efforts. The Paris Agreement is a **legally binding international treaty** that entered into force on November 4, 2016, with 195 Parties committing to work together to reduce emissions and adapt to climate change impacts. The agreement outlined a pathway for **transparent monitoring and reporting** of climate actions and created a framework for **financial, technical, and capacity-building support** for developing nations. While closely aligned with the SDGs, particularly those concerning climate action (SDG13) and ecosystem protection (SDG15), the Paris Agreement also stands as a durable framework guiding the global transition towards a net-zero emissions world. The Paris Agreement also established a framework for countries to **report on their progress** through an Enhanced Transparency Framework, and regularly assess the collective impact of their efforts through the Global Stocktake[20]. The first Global Stocktake, conducted at COP28 in December 2023, revealed that we are not on track to meet the 1.5°C target, with the window for significant action narrowing rapidly. The stocktake emphasized the need for bold actions during this critical decade, offering benchmarks and guidance for the next round of climate action plans, due in 2025[21]. The Paris Agreement marked a turning point in IFG by recognizing forests as essential elements for climate mitigation. It reinforced the integration of SFM into global climate strategies, emphasizing the need to protect and restore forest ecosystems as part of broader efforts to combat climate change. Additionally, it has encouraged the incorporation of Nature-Based Solutions (NbS) in climate strategies, with many signatories including NbS in their Nationally Determined Contributions, further highlighting the role of ecosystem-based approaches in addressing climate challenges (Seddon et al., 2020).

The **UN Decade on Ecosystem Restoration** (2021-2030)[22], launched in March 2019, represents a global commitment to **restoring** degraded and destroyed ecosystems to combat climate change and biodiversity loss. Launched by the UNEP and the Food and Agriculture Organization (FAO), the Decade aims to prevent, halt, and reverse the degradation of ecosystems worldwide. This initiative supports global goals such as the SDGs and the Paris Agreement by highlighting the critical role of restored ecosystems in providing climate resilience, enhancing biodiversity, and supporting sustainable development. The Decade emphasizes the importance of restoring ecosystem functions to deliver environmental, social, and economic benefits. By focusing on large-scale restoration efforts, the Decade addresses key challenges such as climate change mitigation, biodiversity conservation, and the enhancement of ecosystem services, reinforcing the relevance of these strategies in contemporary environmental governance. The success of the Decade will depend on **robust implementation**, **adequate financing** and the **integration of restoration goals into**

[18] https://iucn.org/news/forests/201611/new-york-declaration-forests-progress-report-highlights-close-linkages-between-forest-landscape-restoration-and-climate-action
[19] https://unfccc.int/process-and-meetings/the-paris-agreement
[20] https://unfccc.int/topics/global-stocktake
[21] https://unfccc.int/topics/global-stocktake/about-the-global-stocktake/why-the-global-stocktake-is-important-for-climate-action-this-decade
[22] https://www.decadeonrestoration.org/

broader policy agendas to ensure meaningful progress and address the complex drivers of ecosystem degradation.

The 2021 Glasgow Leaders' Declaration on Forests and Land Use (UNFCCC, 2021), unveiled at the UN Climate Change Conference (COP26), represents a significant collective commitment to addressing deforestation and land degradation. The Declaration, endorsed by 141 countries, underscores the global commitment to halt and reverse forest loss and land degradation by 2030. It highlights the critical role of forests, moving them in a more central position in global effort to combat climate change and that are essential for other global challenges, including biodiversity loss. The Declaration calls for enhanced financial support and cooperation to protect and restore forests and emphasizes the need for effective monitoring and reporting systems. It acknowledges the importance of integrating forest and land use policies into broader climate and development strategies. Despite its ambitious targets, the Declaration faces challenges, including the lack of enforcement mechanisms, leaving progress untracked; insufficient urgency in addressing the rapid rate of deforestation; and failure to address key deforestation drivers, such as beef, soy and timber industries (Abdenur, 2022). By recognizing these challenges and addressing them, the Glasgow Declaration can serve as a powerful tool in advancing more effective and coordinated global forest governance.

Adopted during COP15 in December 2022, the **Kunming-Montreal Global Biodiversity Framework**[23] (GBF) sets out an ambitious pathway to reach the global vision of a world living in harmony with nature by 2050. The framework has four long-term goals for 2050 to achieve the 2050 vision which are: protect and restore (**goal A**), prosper with nature (**goal B**), share benefits fairly (**goal C**), and invest and collaborate (**goal D**). The framework has established also 23 urgent targets to be achieved by 2030, enabling the achievement towards the long-term goals for 2050, including the restoration of at least 30% of degraded ecosystems (target 2) and to ensure that knowledge is available and accessible to guide biodiversity action (target 21)[24]. The framework builds on the lessons of previous biodiversity strategies, such as the Aichi Biodiversity Targets, which were criticized for lacking clear implementation pathways and effective monitoring mechanisms, leading to widespread underachievement (Maney et al., 2024). In contrast, the GBF focuses on creating more explicit action plans with measurable outcomes, placing a greater emphasis on accountability[25], monitoring[26], and resource mobilization (e.g., target 19), representing a shift toward a more structured and enforceable approach. Moreover, the GBF highlights a more integrated approach to biodiversity governance, linking ecosystem restoration with broader social and economic goals. Its recognition of the roles of Indigenous Peoples, the private sector, and civil society underscores the importance of inclusive governance.

Table 4 briefly outlines the main drivers, discourses and outcomes that took place from 2010s to present.

Table 4: Summary of IFG developments from 2010s to the present

	2010s	Present (2020s onward)
Key Drivers	• Need of climate change mitigation measures • Global awareness of biodiversity loss • Push for sustainable development • Pressure to halt deforestation	• Recognition of the failure to meet the Aichi Targets • Increased urgency to combat biodiversity loss and deforestation • Increased demand for concrete climate actions to meet the 1.5°C limit from Paris Agreement

[23] https://www.cbd.int/gbf
[24] https://www.cbd.int/gbf/targets
[25] https://www.cbd.int/gbf/responsibility
[26] https://www.cbd.int/gbf/implementation

		• Global call for ecosystem restoration and improved forest governance • Economic recovery post Covid-19
Main Discourses	• Forests as key tool for climate mitigation and adaptation (e.g., carbon sinks) • Role of biodiversity for sustainable development • Role of market-based mechanism and financial incentives for forest conservation • Sustainable Forest Management	• Need for measurable outcomes for international targets • Integrating social equity and justice in forest governance • Emphasis of NbS in climate strategies • Recognition and addressing of deforestation drivers • Holistic ecosystem restoration and resilience
Key Outcomes	• Launch of REDD+ under UNFCCC (2010) aiming to reduce emissions from deforestation and forest degradation • Adoption of Aichi Biodiversity Targets (2010) to increase biodiversity conservation • Revision of Forest Principles by UNFF (2011) • Rio+20 conference (2012) renewing the focus on sustainable development • New York Forest Declaration (2014) aiming to halve deforestation rates by 2020 and to eliminate it by 2030 • Paris Agreement (2015) setting the legally binding global target to limit temperature increase to 1.5°C above pre-industrial levels • UN Decade on Ecosystem Restoration (2021-2030) aiming to accelerate efforts to restore degraded ecosystems	• Glasgow Leaders' Declaration on Forests and Land Use (2021) further increasing the commitment to halt and reverse forest loss. • Adoption of Kunming-Montreal GBF (2022) setting 4 goals to achieve a world living in harmony with nature by 2050 and 23 targets to be reached by 2030 to enable the achievement of this vision. • Recognition of Indigenous and local communities in forest governance • Increased focus on NbS in national climate commitments

Table 5 present a short timeline with the main events that took place from the 1970s to the present that have contribute to shaping today's IFG.

Table 5: Timeline of the main events that shaped the current IFG

Year	Key milestones in IFG
1972	Stockholm Conference – First global recognition of environmental issues; UNEP established
1983	Establishment of ITTA – Balancing timber trade with conservation efforts
1985	Formal establishment of ITTO – Oversees the sustainable management of tropical timber

1991	Establishment of GEF – Financial mechanism to support global environmental projects
1992	Rio Earth Summit – Produced Agenda 21, CBD, UNFCCC and the Forest Principles
1993	Establishment of FSC – NGO that promotes responsible management of forest via timber certification
1999	Establishment of PEFC – NGO that promote SFM through independent third-party certification
2000	Establishment of UNFF – promoting the "*management, conservation and sustainable development of all types of forests and to strengthen long-term political commitments to this end*"
2002	Earth Summit 2002 – Established the 2010 biodiversity target and the Johannesburg plan of implementation
2005	Delivery of MA, 2005 – it evaluated the consequences of ecosystem changes on human well-being and formalized the notion of ecosystem services
2007	Adoption of NLBI – aiming to advance SFM through enhanced political commitment, cooperation and stakeholder engagement
2010	REDD+ under the UNFCCC – it was introduced as a mechanism for reducing emissions from deforestation and forest degradation by providing financial incentives to developing countries Aichi Biodiversity Targets – setting ambitious goals for biodiversity conservation
2011	Revision of Forest principles – the UNFF revisited the Forest Principles, emphasizing the need for stronger implementation of SFM
2012	Rio+20 Conference – It renewed focus on sustainable development and the role of the green economy to achieve it
2014	New York Declaration on Forests – setting the objective to halt deforestation by 2030 and restore 350 million hectares of degraded land
2015	Paris Agreement – It set global targets for climate action (global average temperature well below 2°C above pre-industrial levels) and recognized the importance of forests in achieving climate goals
2019	UN Decade on Ecosystem Restoration (2021-2030) – aiming to accelerate global efforts to restore degraded ecosystems
2021	Glasgow Leaders' Declaration on Forests and Land Use – Committed to halting and reversing forest loss and land degradation by 2030, highlighting the role of forests in climate mitigation
2022	Adoption of Kunming-Montreal GBF – setting 4 goals to achieve a world living in harmony with nature by 2050 and 23 targets to be reached by 2030 to enable the achievement of this vision

3.1.4 Emerging Trends and Topics

Having presented an overview of the history that led to the most recent frameworks and initiatives affecting today's IFG in chapter 3.1.3, this section will provide more details regarding the most influential governance frameworks, providing an overview of the emerging trends, discourses, and topics that shape the current IFG landscape.

Among the most influential frameworks that guide today's forest governance are REDD+, the CBD, and the UNFF. Each of these frameworks brings a distinct focus, shaping global forest management in different ways while addressing interconnected issues like climate change, biodiversity, and sustainable development.

REDD+ was developed as a mechanism to reduce emissions from tropical deforestation and forest degradation, particularly in developing countries. It offers financial incentives to countries that demonstrate measurable reductions in deforestation, creating a direct link between forest management and climate change mitigation. REDD+ has been adopted by several countries, with many reaching also the final phase of the implementation, were results-actions are implemented measured, reported and verified, allowing countries to access results-based payments after completing UNFCCC processes (Parotta et al., 2022). The assessment of the impact of REDD+ on deforestation indicates a moderately lower deforestation rate in REDD+ countries compared to non-REDD+ countries. However, there is considerable uncertainty in attributing these differences directly to REDD+ actions (Korhonen-Kurki et al., 2019; UNFCC. 2023). The lack of shared performance indicators to assess the impact of REDD+ increases the challenges in evaluating its efficiency (Kleinschmit et al., 2024). Finding how to assess the results of REDD+, as well as the role of REDD+ in achieving the result, will strongly benefit the framework, allowing the comparison and interpretation of the results.

The **UN CBD** focuses mainly on three objectives: to conserve biological diversity, to use its components sustainably, and ensure the equitable sharing of benefits from genetic resources. As describe in section 3.1.3, the Aichi targets were created with the aim of halting biodiversity by 2020. However, none of the targets were reached and just six were partially achieved (CBD Secretariat, 2020, Diaz et. al, 2020, IPBES, 2019). Several reasons have been identified for this failure, in particular one of the problems has been that while the targets where global, the parties agreed to translate them to national and subnational contexts, that allowed free interpretation, leading to confusion and non-alignment (Jørgensen, 2013; Logmani-Aßmann et al., 2021). Building on this, the new Kunming-Montreal GBF was adopted to replace the Aichi targets, particularly advancing in three main points: (i) it is set to establish a monitoring system; (ii) it committed to expanding protected areas to cover 30% of global land by 2030, including recognition of Indigenous and traditional territories, which was quite intricate with the Aichi targets, reaffirming their rights in biodiversity decision-making, earning praise from the International Indigenous Forum on Biodiversity (IIFB); and (iii) within the GBF parties agreed to close the biodiversity finance gap of USD 700 billion annually by 2050, with a target to mobilize USD 200 billion per year by 2030, including a commitment to transfer at least USD 30 billion annually by 2030 from high-income to low- and middle-income countries in international biodiversity aid (Kleinschmit et al., 2024; Abulu and Ghosh, 2022). Although this positive evolution, there remains a significant lack of coordination between UNFCCC's REDD+ and the CBD. These two platforms represent different forums, drawing in various actors, ideas, interests, and institutions.

UNFF in a special session endorsed the **United Nations Strategic Plan for Forests (UNSPF**) that provides a global framework for actions at all levels aiming to sustainably manage all types of forests and trees outside forests, as well as to halt deforestation and forest degradation. The framework includes six Global Forest Goals[27] and 26 associated targets to be achieved by 2030, all of which are voluntary. Notably, Global Forest Goal 5 focuses on governance. In summary, the goals seek to improve sustainable forest management, strengthen the forest-related economy, and expand conservation areas. An initial assessment of the progress carried out by Prins (2023) highlight several challenges, especially regarding the ongoing and growing competition for forest land by other land uses.

While traditional state-led governance remains central, the rise of private and hybrid governance models has added new dimensions to forest management. These changes have also led to a change in the type of instruments used for forest management, with an increased interest on the financialization of IFG such as Payment for Ecosystem Services (PES). At the same time, certification schemes like the FSC and PEFC, voluntary sustainability initiatives, and corporate environmental responsibility programs are playing an increasingly influential role in shaping sustainable forest practices. This has led to a significance growth of

[27] https://www.un.org/esa/forests/wp-content/uploads/2019/04/Global-Forest-Goals-booklet-Apr-2019.pdf

the complexity of the forest-related finance landscape in the last decade, following the recognition of more services and products that are delivered by forest, that led to an increased number of actors being interested in them. This has led to an increased financial flow for the forest sector, but at the same time an increasing number of actors expecting to contribute and influence decision-making, that adds market-related dynamics in IFG. This complex environment resulted in different sources of income provisioning, varying types of funding flows and diverse motivations for providing financial support, as depicted in Figure 1. One existing issue is that there can be a mismatch between the objective that leads an entity to provide the funding and the goals that are achieved after the implementation following the funds distribution. For example, funds could be distributed to support local communities but could end up leaving local communities in their current situation for lack of transparency in the funding distribution and implementation, corruption or other causes. Challenges linked to the forest-related finance and depending on factors such as institutional challenges will be addressed in chapter 3.2.2 and 3.2.3, while potential opportunities that can support forest finance will be addressed in chapter 3.3.2.

The acceleration of the financialization of forest governance, with green finance mechanisms such as carbon markets, green bonds, and Environmental, Social, and Governance (ESG) standards, have unlocked new sources of funding for conservation, but at the same time have raised concerns about the balance between financial returns and long-term sustainability. An emerging counterpoint to market-driven finance is the concept of **just finance**, which emphasizes fairness, equity, and the need to address inequalities (Galaz, 2022) and redress historical and current injustices (Táíwò, 2022). Just finance seeks to ensure that the financial mechanisms used in forest governance prioritize social and environmental justice, ensuring the concept of equity and that local communities benefit from the global push toward sustainability, rather than bearing the costs. The increasing recognition of the role of local communities, indigenous people and marginalized groups in decision-making has also led to a growing emphasis on **participatory processes** in forest governance. These processes help balance power dynamics and promote environmental justice by giving voice to underrepresented groups. The rise of this approach aligns with the broader trend toward the recognition of the **social dimension** of forest governance. This shift recognizes that the role of forest conservation is not just about the preservation of ecosystem, but also to secure the rights and livelihoods of the people living within and around forested areas. The involvement of local actors in governance frameworks allow the creation of more effective and resilient outcomes, leveraging the local knowledge and as these communities have a direct stake in forest-related decisions. Participatory approaches play also a key role in addressing **equity** and **empowerment** by ensuring that policies are not imposed form top-down approaches but are **co-created** with input from actors that will experience the impact first-hand.

Two additional emerging trends in IFG are the increasing adoption of **Payment for Ecosystem Services** (PES) and the extensive integration of **Nature based Solution** (NbS). Both approaches offer innovative ways to align conservation goals with economic objectives while addressing the challenges of climate change and biodiversity loss. Both these concepts are in line with neoliberal logic of market that considers that nature can be saved by selling it (Buizer et al., 2014, p. 4).

PES schemes are used to assign economic value to the different forest ecosystem services (FES) provided by forests by translating them in marketable value, creating a win-win scenario between environmental protection and economic goals. At the same time, as mentioned before, the commodification of FESs brings market policy dynamics in IFG. This might lead to conflicting FESs, confronting forest managers and owners with conflicting demands, such as the use of forest for biodiversity provision or allowing the transition to renewable energy provision (Beland Lindahl et al., 2017). For example, the use of forest for carbon storage and sequestration via *carbon credits* is able to enhance the mitigation potential of forests (van der Gaast et al., 2018) while also creating generating opportunities for local communities (Senadheera et al., 2019). However, questions have been raised regarding the concept of *carbon colonialism*, where richer and more-emitting countries from the Global North impot standards on Southern and poorer countries who were not the cause of man-made climate change (Forsyth and Sikor, 2013). Despite these critics, PES can be a strong tool to be used in IFG to promote SFM by providing financial incentives for conservation efforts, enhancing

ecosystem resilience and encouraging the equitable distribution of benefits among local communities, forest owners and global stakeholders.

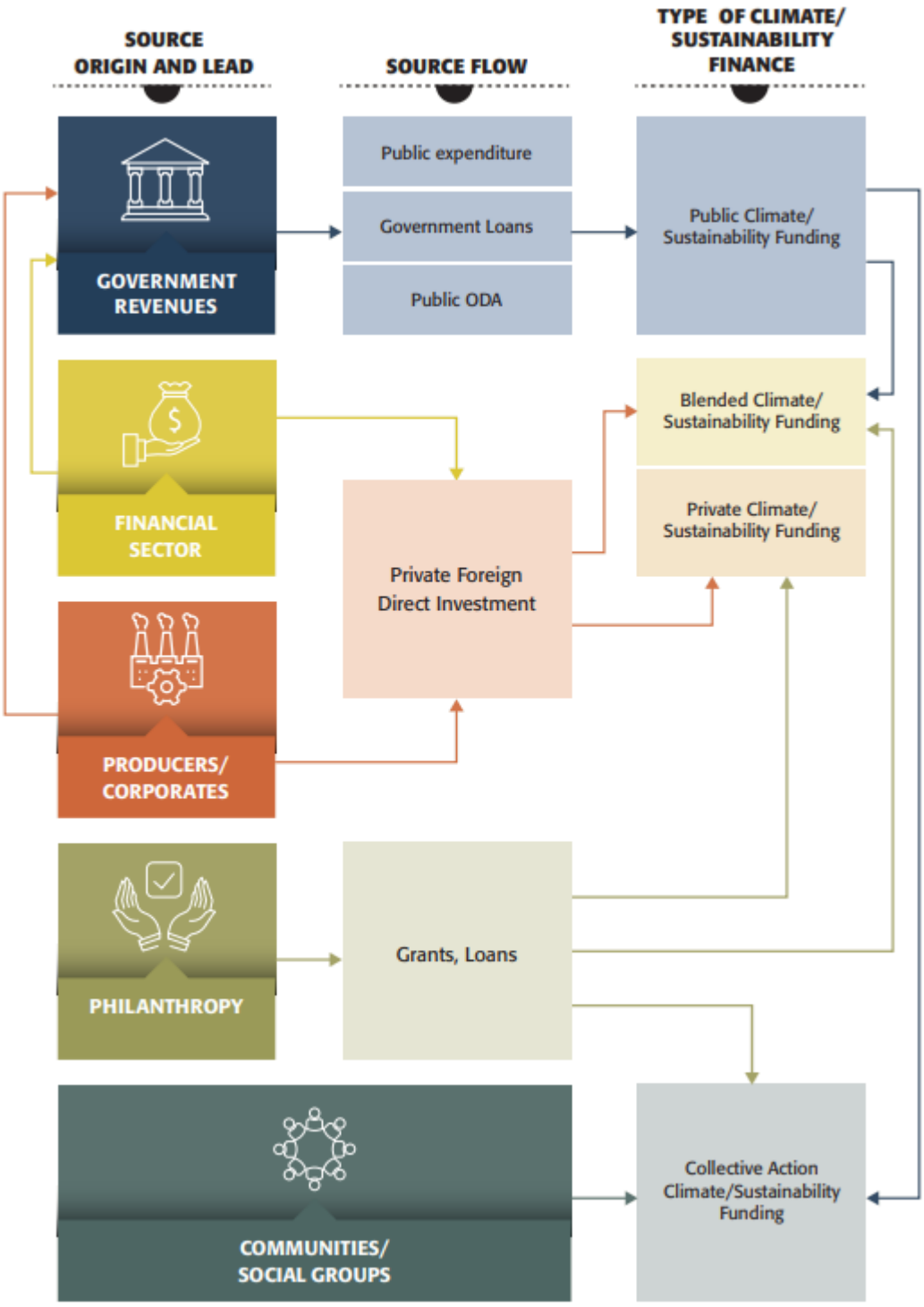

Figure 1: Types of financial sources, flows and motivations for the provision of funding (Kleinschmit et al., 2024)

NBS on the other hand aims to leverage ESs to tackle societal challenges (Cohen-Shacham et al., 2019) by fostering the preservation, enhancement and restoration of biodiversity and ecosystem in a holistic manner, addressing simultaneously multiple issues (Kabisch et al., 2016). The idea of multifunctionality is crucial as forest ecosystems are considered multifunctional providers of NbS (Salvatori and Pallante, 2021). Being a relatively new concept, there is not yet a clear and globally accepted definition of NbS and of what type of action can be considered a NbS and which one cannot, that might cause confusion and different interpretations that can result in increased vertical integration challenges. NbS are a positive tool as they leverage the power of nature to bring socio-economic and environmental benefits, but at the same time the confusion around their definition can lead to them becoming a dangerous distraction as they are "co-opted to continue with what is seen as unsustainable, unjust, status quo" (Melanidis and Hagermana, 2022; Kleinschmit et al., 2024). To optimally leverage the power of NbS it is necessary to consider and mitigate these potential risks, as well as provide more guidelines and standardization of the terminology of NbS. Doing so will reduce the chance of well-intentioned projects that might prioritize short-term gains (due to market dynamics), over long-term ecosystem health, such as favouring monoculture plantations over more diverse forest restoration efforts (Seddon et al., 2020).

3.2 Current challenges

IFG faces an increasing number of challenges as it seeks to balance different environmental, economic and social goals, as described in the previous chapter. With a wide range of actors and interests now involved, these challenges have become more intricate, particularly in the coordination of policies across various governance levels and sectors. As a result, IFG must address issues of **fragmentation** and **alignment** both **vertically and horizontally**.

Vertical integration challenges arise from the gap between international agreements and their implementation at the national and local level, leading to inefficiencies in the enforcement of forest-related policies. Horizontal integration, on the other hand, involves overcoming sectoral silos, where conflicting land-use priorities complicate cohesive governance, such as disputes between increased agricultural expansion and conservation efforts.

Moreover, the increasing influence of **market dynamics** in forest governance adds another layer of complexity. Market-based mechanisms, such as carbon trading**,** Payment for Ecosystem Services (PES), and voluntary certification schemes (FSC, PEFC), have introduced profit-driven incentives into forest management. While these mechanisms offer new opportunities, they also pose challenges in balancing financial interests with long-term sustainability and equity in forest governance.

Finally, **institutional and governance challenges** also remain at the core of IFG. Weak governance frameworks, limited financial and technical resources, and the often overlapping or competing mandates of international organizations hinder progress. The lack of consistent monitoring and enforcement mechanisms exacerbates these issues, further complicating coordinated efforts.

3.2.1 Fragmentation in forest governance

Forest governance is characterized by a significant fragmentation that is caused by the multiple interests of both public and private sector, the numerous mixes of international agreements that do not coordinate effectively (e.g., CBD and REDD+ as mentioned in chapter 3.1.4) and the complex policy problems that need to be addressed (IUFRO, 2010). This makes IFG particularly complex, leading to high levels of vertical and horizontal complexity.

Particularly, the **vertical complexity** is primarily caused by the significant differences between governance at the international level and its downscale to the national or local level. Despite the existence of global frameworks such as REDD+, translating these agreements into effective national policies and on-the-ground

actions remains challenging (Kanowski et al., 2011). Local enforcement mechanisms are often weak, and there is a significant gap between international commitments and the capacity to implement them locally, particularly in developing countries. Challenges exist both from local to international level and vice versa from international level to local level. Regarding the first one, while frameworks to assess the effectiveness of governance frameworks exists, they are mainly related to national or subnational governance rather than to IFG (Kleinschmit et al., 2024), not allowing to measure the effectiveness of the framework in contributing to international objectives. At the same time, there are challenges around the up-scaling of practices that worked in a local scenario to a wider scale (Werden et al., 2024). This can be due to the increasing number of elements and connection between them that exist at regional level, that furthers increase complexity. Regarding the second challenge, the critics regard the implementation of international agreements at the local level (Perino et al., 2022). In this case, the issues could be linked to divergences between the needs and priorities of the local level and the overall international objectives, that could lead to a non-commitment from the firsts (Kleinschmit et al., 2024). This is further enhanced by the majority of soft-laws that are set in IFG compared to the almost absent hard laws. Soft laws are often perceived as not able to induce a strong obligation to the state and unable to raise the level above the lowest common denominator (Pokorny et al., 2019). On the other hand, there is a reluctancy in the introduction of hard-law as institutions that emits them are often criticized for limited outcomes due to scarce implementation at the domestic level (Perino et al., 2022).

Currently, IFG is mostly assessed indirectly, e.g., by its contribution to end global deforestation and degradation that has led several authors to conclude that several global forest initiatives have been ineffective (Bull et al., 2018; Mansourian and Parrotta, 2019). To summarise, **the development of a robust assessment methodology for monitoring and evaluating the efficiency of IFG across different scale, along with improving inclusiveness, coordination and integration across vertical levels, could reduce vertical integration challenges.**

On the other hand, **horizontal integration** refers to the alignment of policies and actions across different sectors, such as forestry, agriculture, energy, and infrastructure. In practice, however, these sectors often operate in silos, pursuing conflicting objectives that hinder cohesive governance. One of the primary challenges arises from sectoral conflicts. For example, agricultural expansion, often driven by the need to meet growing global food demand, frequently encroaches on forest lands, contributing to biodiversity loss (Henle et al., 2008). Similarly, the energy sector, particularly biofuel production, can result in land-use changes that directly conflict with forest conservation goals (Pileninger and Bens, 2007). These conflicting land-use priorities create barriers to effective governance and complicate efforts to address deforestation, biodiversity loss, and carbon sequestration in a coordinated manner. At the international level, the existence of separate governance frameworks, as described in chapter 3.1, for different sectors exacerbates this fragmentation. International agreements, such as the UNFCCC (focused on climate change) and the CBD (focused on biodiversity), often promote policies within their specific areas of concern, developing largely in parallel, with differing priorities on funding for forest carbon initiatives (UNFCCC) and biodiversity conservation (CBD) (Kleinschmit et al., 2024). This sectoral siloing creates a disconnection between efforts to combat climate change and the one aimed at protecting biodiversity or promoting sustainable agriculture, resulting in a fragmented policy landscape. Furthermore, the inclusion of different actors, with different interests, increases the risk that personal objectives are pursued over the collective aim of achieving common goals (Gupta, 2012), further hindering cooperation and coordinated governance. **Holistic approaches, such as landscape approaches could offer promising solutions by allowing a comprehensive analysis of the different objectives, identifying both synergies and trade-offs. Conflict resolution can be integrated in these approaches to provide a framework for the resolution between the different expectations from stakeholders, while a coordinated and inclusive approach could reduce sectoral fragmentation, supporting a more cohesive forest governance.**

3.2.2 Market influence and financialization in forest governance

The increasing role of market dynamics in IFG has introduced both opportunities and challenges. On the one hand, the involvement of markets has brought much-needed financial resources to support forest conservation and restoration through mechanisms like carbon credits and PES. On the other hand, the growing financialization of forest resources has also created significant challenges that affect the long-term sustainability and equity of forest management.

The situation is complicated as there are challenges posed by different funding sources. While **state funding** for forest conservation can provide stability, it is often limited by the capacity of governments to raise taxes without reducing public compliance (Karsenty, 2010). There is a delicate balance between imposing enough taxes to fund large-scale forest governance programs and not overburdening the population with taxes that reduce compliance. On the other hand, private investment can mobilize significant capital, but the market dynamics associated with private funding often prioritize short-term financial returns over long-term sustainability goals. This tension between profit and sustainability creates a fundamental challenge in balancing market-driven initiatives with the broader goals of forest governance. Other financial sources such as philanthropy and community led-finance rely too much on individuals and entrepreneurship and the amount brought is, for the moment, considerably lower compared to state and marked-led finances.

A major challenge posed by the increasing market presence in IFG is the tendency to focus on **quick returns on investment over long-term sustainability**. Since the major finance power is capitalist there are concerns that a market-based forest sector could lead to capitalist economic and ecological crises. This is caused because market-based mechanisms often prioritize short-term profit, e.g., favouring agricultural incentives of forest conservation, which can undermine the broader social and environmental objectives (Kleinschmit et al., 2024). Investors and private actors, driven by the need to generate fast returns, may favour projects that yield immediate financial gains, such as carbon trading, rather than initiatives focused on restoring degraded forests, which require time to deliver tangible benefits. At the same time, the confusion around the classification of what is consider as sustainable forest related finance, as well the different definitions among different entities, further concerns forest experts (Begemann et al., 2023). The sustainability and ESG financial sectors can certainly be positive in providing financial resources to the forest sector, but at the same their credibility is challenged due to concerns over their reporting and disclosure practices that also evidence the risk of green washing of the sector (Kleinschmit et al., 2024; Baldi and Pandimiglio, 2022; Boffo and Patalano, 2020).

Additionally, the financialization of forests as tradable assets introduces the risk of **commodification**, where forests are valued purely for their economic benefits rather than their ecological, social, and cultural significance. While treating forests as commodities can attract investment, it also raises equity concerns, particularly for Indigenous peoples and local communities who rely on forests for their livelihoods and cultural heritage (Kopnina, 2016). Commodification is positive as it can create employment, especially in low-and-middle-income countries, however risks exist globally, as for example vulnerability might be turned into a commodity. This can potentially be used by national elites in their negotiation over climate finances, such as carbon credits, however it might often be disconnected from the local level and leave root causes of vulnerability unchallenged, thus shifting the focus from the real issue and maintain the status quo (Kleinschmit et al., 2024, Brockhaus et al., 2021). Market dynamics tends to naturally create winners and loser, as they favour wealthier actors who have the financial means to participate in market-based mechanisms, leading to question concepts of justice and equity. Particularly, marginalized communities are often left out of the financial benefits generated by these markets, further exacerbating existing **inequalities** within forest governance.

A related challenge is the disconnection between market goals and its implementation on the ground. The objectives of market investors often do not align with the conservation needs of local ecosystems or the priorities of local communities. Market-based initiatives may focus primarily on generating income for participants without ensuring that the conservation goals are truly achieved. This misalignment between investor goals and actual outcomes leads to situations where the financial mechanisms fail to deliver

tangible environmental benefits, undermining the overall purpose of these programs. This can be caused by several reasons ranging from corruption (Sundström, 2016) lack of accountability and transparency in fund use (Kumeh et al., 2019). At the same time, the difficulty in monitoring the achievements on the ground from market-based actions and the confusion around the definitions of measurable objectives might lead to a failure in reaching the real objectives for what the funding is provided. This can potentially lead to greenwashing and in undermining the credibility of these mechanisms. Additional limits, to the market-based forest finances such as carbon credits can be due to the increased benefits of not-protecting the forest as the incentives provided to protect the forest can be lower compared to the profit that can be obtained by chopping the trees for timber or to clear them for farming (The Economist, 2021, Langston et al., 2017).

Community-led finance in forest governance offers a promising alternative for fostering **inclusive and equitable systems**, particularly for Indigenous and local communities. Unlike large-scale market-driven mechanisms, these initiatives directly benefit local populations, empowering them to manage forests sustainably while addressing their socioeconomic needs (Sze et al., 2022). One key challenge for their implementation is **scalability**. Community-led initiatives struggle to attract the large-scale investments needed for significant global impact, leaving a gap that neither state nor private finance has been able to fill (Kleinschmit et al., 2024). Additionally, many community finance models remain rooted in entrepreneurial or market-based frameworks, limiting their transformative potential. For these schemes to become a more powerful force in forest governance, innovative funding models that prioritize ecological justice and reparation over profit are needed (Kleinschmit et al., 2024).

Another significant challenge introduced by market dynamics is the **power imbalance between the Global North and the Global South**. Wealthier countries and corporations, primarily from the Global North, dominate market mechanisms such as carbon offset markets, where they purchase carbon credits from the Global South to compensate for their emissions. While this enables the Global North to continue developing and meeting their emission reduction targets, it places the burden of mitigation on the Global South (Hein et al., 2018, Benjaminsen and Svarstad, 2021). Countries in the Global South, where forest conservation is critical for carbon sequestration, are pressured to sell carbon credits instead of pursuing their own development goals. This dynamic reinforces global inequalities, as the Global South bears the costs of reducing emissions while limiting their opportunities for sustainable development (Kleinschmit et al., 2024). These dynamics also extend to local communities within these countries. Many Indigenous and rural communities are excluded from decision-making and financial benefits in market-based mechanisms like carbon offset markets (Benjaminsen and Svarstad, 2021). Wealthier actors, including international corporations, often acquire forest rights, diminishing community control over their land and resources (Gilbert, 2016). This deepens social and economic inequalities, as local communities lose both governance authority and opportunities for sustainable development. Forest areas might be restricted for carbon sequestration, limiting their use for livelihoods and cultural practices, further marginalizing these communities (De La Fuente and Hajjar, 2013). Nonetheless, if planned appropriately, and taking in consideration the social dimension as well as the concepts of equity and justice, market-based approaches, such as carbon credits, can provide interesting opportunities for Indigenous communities (Stewart et al., 2011; Nikolakis et al., 2022; Walker et al., 2020).

In conclusion, while the increasing presence of market dynamics in forest governance offers opportunities for generating financial resources, it also introduces a series of challenges that must be addressed. The focus on quick returns, the power imbalances between the Global North and South, the commodification of forests, and the fragmentation of governance all create significant obstacles to achieving equitable and sustainable forest management. To address these challenges**, IFG must find a balance between leveraging market opportunities and ensuring that financial mechanisms contribute to both environmental sustainability and social justice**.

3.2.3 Institutional and governance challenges

The increasing number of stakeholders that are involved in forest governance due to the increased interests in forests and forested areas, combined with the weaknesses in international institutions and their fragmentations poses additional challenges in IFG. These issues are further complicated by the lack of an efficient mechanism for accountability, monitoring and enforcement.

The diverse range of stakeholders involved in forest governance increases the number of potential **conflicts that might arise between the different interests** of international, national and local actors, including governments, NGOs, private sector companies and marginalized communities. The goal of international actors may be different from the needs of local communities (Hovik and Hongslo, 2016), as the first may prioritize conservation goals, local communities may focus on livelihoods and economic development (Acciaioli and Afiff, 2018). Ensuring that marginalized and local communities have a voice in decision-making processes is crucial, yet many remain excluded from governance structures, further weakening the legitimacy and inclusiveness of IFG (Hovik and Hongslo, 2016; Aishing, 2014). The growing political and economic **competition for land** also exacerbates these challenges. Sectors such as agriculture, infrastructure, and extractive industries often place immense pressure on forested areas (Juniyanti et al., 2021), leading to conflicting priorities that undermine conservation efforts (López-Carr, 2021). In developing regions, where land-use conflicts are particularly acute, governance systems are frequently too weak to mediate these competing interests effectively, further driving deforestation and forest degradation (De Long et al., 2021).

Many international institutions exist that are responsible, to some extent, of international forest governance, each with their own role, actors and responsibilities, as described in 3.1.4. However, they suffer from **limited mandates, inadequate resources, and insufficient authority** to enforce policies in an international level. For example, REDD+ and the Aichi Biodiversity Targets have been widely criticized for lacking standardized systems to measure impact and ensure compliance (Logmani-Aßmann et al., 2021; UNFCC, 2023). Without clear mandates and resources, these institutions struggle to fulfil their roles effectively, leading to fragmented implementation of policies at the national and local levels. The fragmentation of governance structures further hampers decision-making, reducing policy coherence and complicates efforts to develop unified and coherent forest management strategies. The lack of coordination among these institutions often results in overlapping mandates and inefficient use of resources, making it difficult to create cohesive policies that address forest conservation, climate change, and biodiversity holistically (Kleinschmit et al., 2024).

Another critical governance issue is the lack of **accountability and monitoring mechanisms**. As observed by Kleinschmit et al. (2024) criticisms around monitoring in IFG mentions the limited impact of already established criteria and indicators, since time frames for implementation and performance targets are missing. This limits the clarity and can lead to confusion in how to define if an objective is reached and if the results have been achieved by the contribution of the framework or by other factors. This can lead to not having sufficient evidence to claim that a framework is in fact contributing to the achievement of its set objectives (McDermott, 2014). Additionally, further criticisms have been directed at the widespread absence of institutions capable of measuring and monitoring impacts at the domestic level, as well as the lack of effective enforcement mechanisms (Sotirov et al., 2020).

While the lack of monitoring an enforcement framework poses challenges, the type of legal framework in place, such as **soft or hard law**, also has a role in shaping governance outcomes. International agreements provide important frameworks for action, however many remain non-binding, relying on soft law principles rather than enforceable regulations, such as the New EU Forest Strategy (Gordeva et al., 2022). Soft law agreements offer flexibility, allowing parties to decide how to meet agreed-upon targets without the constraints of legal obligations. This flexibility can be advantageous for countries with limited capacities, as it reduces the pressure of strict compliance. However, the non-binding nature of soft law agreements also means that states may not feel compelled to adhere to their commitments, leading to poor enforcement and minimal progress in achieving forest governance goals. At the same time, hard law institutions are often

criticized for their limited effectiveness at the domestic level. Legally binding agreements, while theoretically stronger, face significant challenges in their implementation, especially in countries with weak governance systems. In many cases, hard laws do not translate into meaningful outcomes, as domestic institutions lack the capacity or political will to enforce them effectively (Wolfslehner et al., 2020).

Institutional weaknesses at the national level further complicate forest governance. Many countries, particularly in the Global South, struggle with limited technical expertise, financial resources, and governance structures to implement international forest policies. At the same time, the limited participation, or the lack of publication, from the Global South in research on IFG also reduces their point of view in setting targets at the international level. Particularly, Kleinschmit et al. (2024), mentions that their extensive review of IFG has not considered the vision of Global South researchers, as their voices were not so prominent because they do not publish in peer-reviewed journal or because they do not engage in social science research. Corruption and weak rule of law are also major barriers, undermining enforcement efforts and contributing to continued deforestation and degradation (Cozma et al., 2023; Miller, 2010). These institutional shortcomings make it difficult for countries to align their domestic policies with international commitments, resulting in a persistent gap between global targets and local realities.

In conclusion, the institutional and governance challenges in IFG are deeply interconnected and multifaceted. Weak international institutions, fragmented governance structures, limited accountability, and the lack of enforceable regulations all contribute to the inefficiency of current governance systems. **Addressing these challenges will require stronger coordination, better monitoring and enforcement mechanisms, and a greater emphasis on including marginalized communities in decision-making processes**. Without significant improvements in institutional capacity and governance frameworks, efforts to achieve sustainable forest management will continue to fall short of their goals.

3.3 Opportunities

IFG offers several opportunities to address the complex challenges described in the previous chapter. As more actors and interests become involved, forest governance can evolve by enhancing coordination across sectors and levels of governance, promoting innovative financial mechanisms and expanding participatory approaches.

The **enhancement of coordination and integration** provides opportunities to address fragmentation in forest governance. By improving both vertical and horizontal integration, forest management can better align with agricultural, energy, and environmental goals, identifying potential synergies and addressing trade-offs. **Holistic strategies** like landscape approaches can help balance competing land-use priorities, while **multi-level governance frameworks** can improve alignment between international goals and local implementation. Strengthening these mechanisms will enable more effective coordination across sectors and governance levels. Expanding **participatory and collaborative approaches** offers a path toward more inclusive governance. By ensuring the active participation of Indigenous Peoples and local communities, and fostering multi-stakeholder platforms, forest governance can become more equitable and effective. Furthermore, the use of **technological innovations**, such as satellite monitoring and data-sharing platforms, can improve accountability and transparency in forest management.

Innovative financial mechanisms present new ways to advance sustainable forest management and promote **equity**. **Green finance**, such as green bonds, ESG investments, and PES, can channel resources to local conservation efforts. These mechanisms, when combined with equity-focused policies, offer the potential to address power imbalances and ensure that local and marginalized communities benefit from financial opportunities tied to forest conservation.

3.3.1 Enhancing coordination and integration

The fragmentation of IFG is mainly caused by the complexity of this field that brings integration challenges across multiple domains (vertical integration challenges) and aligning policies across governance levels (horizontal integration challenges), as described in section 3.2.1. To address horizontal integration challenges, it is essential to improve the coordination across sectors by employing holistic approaches like **landscape approaches**, that can identify and balance synergies and trade-offs. These could be complemented by conflict resolution mechanisms and an inclusive framework that include diverse stakeholder perspectives, further mitigating sectoral fragmentation. On the other hand, vertical integration challenges often arise by a weak connection between governance levels and a lack of efficient monitoring system to enforce policies at the local level. Strengthening **multi-level governance frameworks** can enhance coordination, ensuring that international goals are implemented at national and local levels. Additionally, developing of a **robust assessment methodology** can improve enforcement and accountability across governance levels by being used as a mean to monitor and evaluate policy effectiveness. Furthermore, technological innovations such as satellite monitoring and digitalisation can play a crucial role in enhancing accountability and transparency, enabling better tracking of forest management outcomes and policy implementation.

Landscape approaches are promoted as governance frameworks that integrate policy and practice for multiple and often competing land uses. These approaches aim to balance economic, environmental, and social objectives, identifying synergies and negotiating trade-offs (Pedroza-Arceo et al., 2022). They create opportunities for cross-sectoral collaboration by involving stakeholders from different sectors and fostering adaptive management systems. However, the implementation of landscape approaches faces challenges. One of the major issues is the lack of coincidence between landscapes and jurisdictional boundaries, which complicates the coordination of policies across regions (Arts et al., 2017). Additionally, landscape approaches have been critiqued for downplaying power imbalances, treating landscapes as depoliticized spaces, and not fully addressing the political dynamics that shape land use (Ros-Tonen et al., 2018). To address these challenges, **jurisdictional approaches** can complement landscape strategies by aligning forest governance within political and administrative boundaries. This allows for more effective enforcement and policy coherence, as governance actors operate within clearer and more enforceable legal frameworks (Pedroza-Arceo et al., 2022).

Integrated landscape approaches are also gaining traction in recent discourses. These approaches are governance strategies aimed at reconciling various and conflicting land-use claims to balance the needs of people and the environment while creating more sustainable and equitable multi-functional landscapes (Reed et al., 2020). Integrated Landscape Approaches apply long-term thinking and employ multi- and trans-disciplinary approaches, allowing for a holistic vision that reconciles competing land-use demands. This forward-thinking perspective ensures that landscape development considers present needs and future sustainability, promoting adaptive management and resilience. These approaches facilitate inclusive governance by bringing together multiple stakeholders, including marginalized groups, to negotiate solutions that address social, economic, and environmental challenges. However, long-term and inclusive approaches might increase the costs of implementation, both in terms of financial investment and the increased cost required for stakeholder coordination (Reed et al., 2020). Additionally, the complexity of managing diverse stakeholder interests and the absence of robust empirical evidence on some aspects resent further challenges. It is crucial, therefore, to ensure that the costs of these approaches do not outweigh their benefits, and that the financial and economic aspects are carefully considered (Pedroza-Arceo et al., 2022). Landscape approaches, as well as integrated landscape approaches, can provide a sustainable framework for balancing diverse land-use priorities, but without sustained funding and effective implementation, their potential could remain unrealized.

Multi-level governance (MLG) is a governance system that operates across multiple layers of decision-making, from international bodies up to the national or local level, ensuring that international goals are aligned with local conditions (Daniell & Kay, 2017). This approach recognizes the diversity of the actors

involved in forest governance and the need for each level to have a clear role in implementing and enforcing forest policies, thus contributing to addressing both vertical and horizontal integration challenges (Mwangi & Wardell, 2012). This approach ensures that forest policies are both adaptable and context-specific, aligning international goals with local realities. While global frameworks, such as CBD or UNFCCC, set broad targets for conservation and sustainability, local governments are crucial for the implementation and enforcement of these objectives by tailoring policies to their unique environmental and socio-economic conditions. Decentralization is a key feature of MLG as it shifts decision-making authority from central governments to local actors, increasing the responsiveness and accountability of governance systems (Mwangi & Wardell, 2012). This requires institutional support and the availability of adequate resources to ensure that local governance structures are able to handle the additional responsibilities. Effective MLG fosters a nested governance system, where decisions made at the local level are informed by and aligned with national policies and global frameworks, creating a dynamic feedback loop that allows for more adaptable governance (Mwangi & Wardell, 2012). To maximise the efficiency of MLG, strengthening communication and coordination mechanisms across governance levels is required, along with more robust monitoring systems. These are essential for assessing the implementation and effectiveness of international agreement at the local level. Without these mechanisms, local governments may struggle to enforce international agreements, while national governments risk developing policies that do not reflect local realities. Furthermore, MLG might also benefit from an increased synergies between the different institutions affecting forest governance. As mentioned in chapter 3.2.1, fragmentation in forest governance is exacerbated by the lack of coordination between the most renown frameworks. Improved cooperation among international institutions, such as CBD and UNFCCC, can allow the development of more coherent policy approaches, e.g., by addressing simultaneously biodiversity conservation and climate change mitigation, and can lead to a more efficient allocation and use of resources to achieve these interconnected objectives.

The governance models described above depend on **the involvement of a wide range of actors** to function effectively, requiring the coordination of multiple stakeholders across sectors and scale. The growing need for participation increased the interest in including a broader group of stakeholders in decision-making processes, ensuring that the policies and strategies are more inclusive, equitable and representative of the realities on the ground. Participatory approaches offer promising mechanisms to enhance the social impact of forest governance, particularly regarding the inclusion of Indigenous Peoples and local communities in decision-making processes. This can ensure that solutions are tailor-made for the local conditions, exploiting local knowledge and cultural practices, while addressing historical imbalances. Particularly, by using mechanisms such as Free, Prior, and Informed Consent[28], Indigenous communities are involved in the decisions that affect their land and resources.

However, while these approaches have been successfully in fostering social inclusion, there is currently limited empirical evidence about their contributions to achieving sustainability objectives (Kiss et al., 2022). Similarly, research about the increased participation in policymaking has not provide evidence supporting better policy implementation through increased participation, but neither the opposite can be confirmed (Fischer 2010; Pülzl et al., 2013). Particularly, Pülzl et al. (2013) observed that the positive impact caused by an increased participation depends both on the policy field, as some fields are more mature in collaborative effort and thus more receptive to participatory approaches, and on existing conditions that could either facilitate or hinder the establishment of these approaches. Regarding the latter point, if the existing conditions are not favourable, preliminary actions should be taken to improve the willingness and capacity to adopt participatory approaches. By creating an enabling environment first, stakeholders will be more likely to commit to these collaborative efforts, increasing the likelihood of long-term commitment.

Effective **monitoring systems** are crucial to ensure that global objectives are implemented at the local level and for assessing the effectiveness of the policies on the ground. The complexity of IFG significantly complicates monitoring and the lack of an efficient monitoring systems is among the critics that are

[28] https://www.fao.org/indigenous-peoples/our-pillars/fpic/en/

addressed to IFG as it is not possible to measure its effectiveness (Kleinschmit et al., 2024). **Technological innovations** such as remote sensing and Geographical Information Systems (GIS) can provide reliable and updated data for monitoring forests by tracking deforestation or forest degradation. These can also enhance transparency and accountability in forest management, ensuring that local actions are aligned with global objectives. Additionally, the **digitalization** of monitoring systems can facilitate the creation of shared platforms, such as Global Forest Watch[29], that promote collaboration between local, national, and international institutions. These platforms enable stakeholders to access and share relevant data, enhancing cooperation and fostering a more integrated governance approach. By supporting the flow of information, digital tools can empower local communities and governance bodies (Correa Gonzaga et al., 2024), allowing them to take informed action and ensure compliance with established policies. **Artificial Intelligence** (AI) might also contribute to enhancing IFG by introducing new governance tools, such as decision-support systems for policy-making (Vacik et al., 2013; Rana & Varshney, 2021). These systems can analyse large and complex datasets and are able to identify the trends and provide insight to stakeholder that can support stakeholder to adopt a data-driven approach to forest governance, helping them to take informed decision with a deeper understanding of the trade-offs involved.

3.3.2 Advancing sustainable finance and promoting equity

One of the challenges faced by the implementation of conservation policies at the local level is the **lack of funding**. This can originate from several reasons, including a divergence between local needs and the objectives of funding or corruption at the local level, as described in chapter 3.2.2. Among the funding mechanism that had been described in chapter 3.3.2, **community-led finance** has been praised for the direct benefits that it brings to local communities (Kleinschmit et al., 2024). This funding mechanism fosters local ownership of forest management, ensuring that communities can develop solutions that addresses both international objectives and local needs concurrently. Although still underfunded compared to larger public and private funding models, community-led finance favours **long-term investments** over the short-term profits that are often sought by more traditional mechanisms. This approach has the potential to change power relations away from business-as-usual practices, empowering communities and reducing the influence of market dynamics (Kleinschmit et al., 2024).

Green finance also has the potential to boost local conservation efforts while addressing global environmental challenges. Mechanisms such as PES, carbon credits and NbS presents opportunities for directing financial resources towards forest conservation. Stakeholder can use these models to monetize the ecosystem services that are provide by forests both tangible and intangible ones. Particularly, **PES schemes** allow to exploit the economic value owned by forest by monetizing the ecosystem services that are provided by forests, particularly the intangible ones. While several PES schemes are being developed and implemented for regulating services, economic incentives for the promotion of cultural ecosystem services are quite limited (Wunder et al., 2018; Maier et al., 2021). Regarding cultural ecosystems services, Maier et al. (2021) in their analysis concluded that a strong role is played by individual entrepreneurship, as for example a hotel owner that provides access to its forest for mushroom picking to hotel guests (Ludvig et al., 2016). The analysis also highlighted that the exploitation of cultural FES usually takes place in rural contexts, favouring rural development, and are often associated with provisioning services (such as the mushroom picking in the previous example). PES schemes are able to foster the provision of regulating and cultural FES, thus increasing financial resource for conservation. Reducing the challenges associated with the design and implementation of these scheme could enhance the trust, fairness and others' perception increasing their establishment (Mann et al., 2022; Loft et al., 2017; Primmer et al., 2014; Prokofieva and Wunder, 2014).

Carbon credits are becoming a trending mechanism within green finance, presenting significant opportunities for directing fund from private organisations to forest conservation. Companies are allowed

[29] https://www.globalforestwatch.org/

to offset their emissions by investing in green project, such as forest conservation and restoration. On the one hand, this can bring significant financial resources to regions that are crucial for global conservation efforts such as tropical regions. Companies can use carbon credits to achieve carbon neutrality, allowing them to compensate their emissions by financing projects that absorb or reduce equivalent amount of CO2 from the atmosphere. This can be pursued on a voluntary basis or for compliance to some GHG reduction obligations (Trouwloon et al., 2023). At the same time, the monetization of the carbon sequestered by forest can incentivize local communities and landowners to preserve forested areas as they will be able to obtain economic returns by doing so. Bringing an economic recognition to efforts spent in conservation or restoration might increase the perceived value of forests by local communities and landowners, providing an alternative to the deforestation or the sale of these areas to develop land for agriculture, energy production or other infrastructures (Langston et al., 2017).

On the other hand, while carbon credits have the potential to be a powerful driver to increase conservation efforts, several **challenges** exist, hampering their deployment. Considering and addressing such challenges is vital to ensure the impact brought by this funding scheme. First of all, carbon credits **increase market influence on forest governance**, raising concerns about the commodification of forest ecosystem, as describe in chapter 3.2.2. Forests risks to be valued as economic asset in the global market, instead of being valued by the services that it provides, e.g., cultural and other regulating ecosystem services. Additionally, their implementation presents a significant challenge on its own. By paying for the offset of emissions, there is **not a real reduction of emissions**, which can increase the risk of greenwashing by diverting attention from the need of significant changes in high-emitting sectors. Furthermore, carbon credits might also exacerbate **power imbalances** between wealthier and poorer countries. Wealthier companies, usually from the Global North, can continue business-as-usual practices and buy carbon credits from poorer countries, usually from the Global South, to compensate for their emissions. This allows the former to continue to develop, while the latter might focus on the generation of credits rather than pursuing other economic activities that could foster development, risking to create a dependency on carbon credits (Kleinschmit et al., 2024). Concurrently, developing countries often present **weak governance** (Korhonen-Kurki et al., 2013) that can lead to mismanagement or corruption in the allocation of funds.

For carbon credits to be an effective solution all these challenges must be addressed. **Equity and just finance principles** should be integrated to mitigate the risks associated with the increased market influence on forest governance. Carbon scheme should be structure in way to ensure that the long-term sustainability of forest ecosystem is pursued and not just the short-term economic returns. **Fair benefit-sharing** mechanism might ensure the effectiveness and equity of carbon credit schemes. These mechanisms refer to the equitable distribution of financial and non-financial benefits derived, e.g., from conservation efforts, among all relevant stakeholder (Tsioumani, 2020). This can increase the commitment to long-term conservation efforts to the actors that are actively involved in these efforts, as they will directly benefit from the success of the project. Additionally, increased **transparency** for monitoring, reporting and assessing carbon credits is essential for increasing the trust in these mechanisms, especially regarding the distribution of funds in countries with weak governances. Technological innovations, such as blockchain and digital platform might be considered to further enhance the transparency, for example for measuring, reporting and verifying (Woo et al., 2021). These technologies can be used to track the flow of funds and ensure that the financial resources are reaching the intended stakeholders, providing transparency and thus enhancing trust in these schemes. Increasing the transparency in decision-making processes can support in addressing trade-offs and in working towards finding integrated solutions (Mann et al., 2021).

Nature-based Solutions (**NbS**) are another tool that is gaining traction in addressing environmental challenges, with many nations including some kind of NbS, mainly focusing on forests, in their pledges to the Paris Agreement (Seddon et al., 2021). These solutions present unique opportunities for integrating conservation with sustainable development, thus being a vital part of the green finance landscape. Particularly, the EU has shown a strong commitment in advancing NbS, aiming to position itself as a leader in this emerging market at the global level (Kleinschmit et al., 2024; European Commission, 2015). The EU

aims to exploit NbS to make Europe more climate-resilient and considers their use as a key in achieving major EU priorities, particularly the EU Biodiversity Strategy for 2030[30] and the EU Adaptation Strategy[31, 32].

On the main challenges in scaling NbS lies in the **lack of standardized and globally accepted definition**. This result in debates over the classification of the interventions that can be considered NbS based on their scope and type (Sowińska-Świerkosz and García, 2022). Particularly, three reasons have been identified by Sowińska-Świerkosz and García (2022) regarding this ambiguity. First of all, the definition of NbS requires the involvement of multiple scientific fields and expert and the integration of their different points of view, which are often biased by their own base discipline. Second, there is an inclination in classifying existing related action as NbS, which might also contribute in use of NbS as a justification in continuing with business as usual, using them as a distraction to continue with the unsustainable, unjust status quo (Melanidis and Hagermana, 2022; Kleinschmit et al., 2024). And third, the establishment of a clear standard for NbS and practical guidelines for implementation have been delayed.

Therefore, the primary urgency to ensure that the positive impact expected by NbS is achieved is the **establishment of standardized and globally accepted definition of NbS**. Several definitions have been presented at this moment by worldwide recognized institutions such as the EC (EC, 2021) and IUCN (IUCN, 2020), but a commonly accepted one has not yet been agreed upon (Kleinschmit et al., 2024). The IUCN Global Standard (IUCN, 2020) provides criteria that can be used for the design and the verification of NbS, which is a promising step towards standardization of these tools. To further the adoption of NbS, future actions should aim to increase the understanding of the long-term functionality of NbS, as well as the identification of trade-offs and synergies (Sowińska-Świerkosz and García, 2022).

[30] https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en
[31] https://climate.ec.europa.eu/eu-action/adaptation-climate-change/eu-adaptation-strategy_en
[32] https://research-and-innovation.ec.europa.eu/research-area/environment/nature-based-solutions_en

4 Forest Governance at EU level

The governance of forests within the European Union (EU) is recognized as an essential component in addressing global environmental challenges, such as climate change, biodiversity loss, and rural development. Forests, which cover almost 43% of the EU's land area, play a central role in carbon sequestration, the provision of ecosystem services, and maintaining biodiversity (Wolfslehner et al., 2020). However, forest governance is a complex process, shaped by the varying landscapes, climates, political systems, and socio-economic conditions across Member States (Wolfslehner et al., 2020; Seppälä et al., 2013).

A core pillar of the European Green Deal is its emphasis on sustainable environmental management to achieve carbon neutrality by 2050. Spun off in 2019, European Green Deal sets out to, and promoting stewardship of the natural resources, making the EU to be the first climate neutral continent. Such will be by focusing on the preservation of natural habitats, reduction of air, water, and land pollution due to human activities and promotion of the use of green technologies (Eillim, 2010). Fulfilment of these narratives requires forests to be effectively managed because successful processes aimed at reducing the amount forests and wooded spaces meeting 25 underlying subsidies will fail. This will also secure the content of forests by way of ample supply of trees from plantations, further defined by sustainable availability of forest plantation In Botswana it is 30% by 2030. In support of forest management, the August 2019 report on Communication of the "Green Deal at Networking of NGOS" by the Pontis foundation, Slovakia, contends that a centralized approach is ineffective.

The EU Forest Strategy for 2030, European Green Deal, and Biodiversity Strategy 2030 provide a comprehensive framework for managing and protecting European forests. These policies aim to promote sustainable forest management (SFM), reduce the impact of climate change, and protect biodiversity. However, achieving these goals largely depends on the ability of individual Member States to align their national policies with EU frameworks while addressing local environmental, financial, political, and social needs and requirements (Wolfslehner et al., 2020; Stubenrauch et al., 2022).

Reconciling the idea that forests belong to individual countries while also being a shared resource transcending borders presents a significant challenge in global and European governance. Forests, as national assets, are often deeply intertwined with a country's identity, economy, and sovereignty. Governments typically prioritize national interests when managing forest resources, focusing on economic development, timber production, and land use, with policies reflecting internal socio-political needs. However, this nationalistic perspective can conflict with the broader environmental and ecological roles that forests play globally. The benefits of forests, such as carbon sequestration, biodiversity conservation, and climate regulation, are not confined to a nation's borders but contribute to the well-being of humanity as a whole. This duality—of forests being both a national asset and a global good—creates tension in the governance structures designed to manage them.

The intrinsic difficulty lies in aligning national forest policies with global and European environmental goals. While a country may view its forests primarily as economic assets to be exploited for short-term gains, the international and European community often sees those same forests as critical to addressing global challenges like climate change. This divergence in priorities can lead to conflicting policies, where local governments may resist international regulations that seem to infringe upon their sovereign right to manage their resources. The complexity increases when forest ecosystems span across national borders, as is the case with many European countries. Forest degradation in one country can have direct ecological

consequences in neighbouring countries, necessitating cross-border cooperation that may conflict with national interests.

Moreover, viewing forests as a shared human resource rather than a national one demands a shift in how environmental stewardship is perceived. This shift requires nations to adopt a more global perspective, recognizing that the health of their forests contributes not just to their own citizens' well-being but to the global commons. Such a perspective would encourage stronger international cooperation and collective action in forest conservation, yet it challenges deeply held notions of sovereignty and economic self-determination. Bridging this divide requires innovative governance models that respect national rights while fostering international responsibility for forests as shared ecosystems critical to the survival of humanity.

In this context, enhancing public awareness and education about the intrinsic value of forests is essential. European Green Deal points out that the public support and education are necessary in good practical terms, since active citizens are better oriented to the goals of and more ready to join the measures of environmental protection. Basically, by developing environmental ethics, the European Union can motivate local populations to help in the preservation of forests and its users, thus reducing the existing gap between political and global environmental integration.

Also, one may not fail to notice that today the development of forest governance often comes in tandem with advances in information and communication technologies or the ICT. Tools such as remote sensing, graphic information systems, GIS, and data analytics are of utmost importance in conservation, forest health monitoring technologies, and monitoring of carbon stocks. They have this propensity of assisting the targeted rules towards the attainment of the desired goals and objectives, keeping on updating the performance over time, and dealing with new challenges at the level of policy such as global warming or ash die-back.

4.1 State of the art

4.1.1 EU Forest Policies and Frameworks

A number of EU Regulations, Directives, Communications and relevant Policies form the basis of the state of play at EU level, as also extensively presented and discussed in deliverable D7.1 of the SILVANUS project (Sykas et al., 2023). These include:

- *European Commission, Communication on the European Green Deal, COM(2019) 640 final.* European Green Deal - COM(2019) 640
- *European Commission, New EU Forest Strategy for 2030, COM(2021) 572 final.* EU Forest Strategy for 2030 - COM(2021) 572
- *European Commission, EU Biodiversity Strategy for 2030 - Bringing Nature Back into Our Lives, COM(2020) 380 final.* EU Biodiversity Strategy for 2030 - COM(2020) 380
- *EU Green Infrastructure Strategy*. EUR-Lex - 52013DC0249 - EN - EUR-Lex
- *Green Infrastructure – Support to ecosystem services*. European Commission - Ecosystem Services
- *CAP support for rural development*. European Agricultural Fund for Rural Development
- EUR-Lex - 52013DC0249 - EN - EUR-Lex
- *Effort Sharing Regulation (Regulation (EU) 2018/842).* Effort Sharing Regulation (EU) 2018/842

- *Land Use, Land Use Change and Forestry (LULUCF) Regulation (Regulation (EU) 2018/841).* LULUCF Regulation (EU) 2018/841
- *Directive (EU) 2018/2001 of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast).* Directive (EU) 2018/2001 - RED II

The EU Forest Strategy for 2030 (European Commission, 2021a) is the central policy guiding the management of European forests. This strategy is directly linked to the European Green Deal, which sets the goal of achieving climate neutrality by 2050, and the Biodiversity Strategy 2030, which targets the restoration of ecosystems and the protection of 30% of land and sea areas across the EU (Wolfslehner et al., 2020; Seppälä et al., 2013). Together, these frameworks aim to promote sustainable forest management, ensuring that forests continue to provide economic, ecological, and social benefits while contributing to the EU's climate and biodiversity goals (Stubenrauch et al., 2022).

Sustainable Forest Management (SFM) is a core principle of the EU Forest Strategy. SFM ensures that forests are managed in a way that maintains their biodiversity, productivity, and regenerative capacity. This approach balances the ecological functions of forests, such as carbon sequestration and water regulation, with their economic uses, such as timber production and tourism (Wolfslehner et al., 2020; Seppälä et al., 2013).

However, recent studies (Stubenrauch et al., 2022) show that the potential of forests for climate mitigation, particularly by afforestation and reforestation, are often overestimated. While these strategies are considered effective strategies for carbon sequestration, their long-term success depends on maintaining biodiversity within these forest ecosystems. According to Stubenrauch et al. (2022), only biodiverse and resilient forests can serve as long-term carbon sinks. Therefore, the EU Forest Strategy must focus not just on afforestation but on creating and preserving diverse and resilient forest ecosystems that are capable of sustaining carbon sequestration over time (Stubenrauch et al., 2022).

4.1.2 Institutional Framework

Forest governance within the EU operates across multiple levels, involving the European Commission (EC), national governments, and local authorities. The EC is responsible for developing and overseeing forest-related policies at the EU level, but the actual management of forests is carried out by member states (Wolfslehner et al., 2020). This decentralized governance model allows for flexibility, but also creates challenges related to policy fragmentation and inconsistent implementation (Seppälä et al., 2013).

Organizations like Forest Europe play a significant role in promoting cooperation between EU and non-EU countries in forest governance. This cooperation is particularly important for addressing transboundary challenges such as wildfires, pests, and diseases, which require coordinated responses across borders.

Despite the existence of EU-wide frameworks, the decentralized nature of forest governance means that Member States retain significant autonomy over how they manage their forests which is emphasized by the principle of subsidiarity (Pülzl et al., 2013). This can lead to discrepancies in the implementation of EU policies, particularly in regions where local governments prioritize short-term economic gains over long-term sustainability (Wolfslehner et al., 2020).

4.2 EU-specific challenges

The governance of forests across the EU is shaped by a range of challenges, many of which are exacerbated by the diversity of landscapes, political systems, and economic conditions across the region. The following section explores these challenges in detail, highlighting both structural and operational difficulties in managing forests effectively at the EU level.

4.2.1 Fragmentation and Inconsistency

A key challenge in EU forest governance is the fragmentation of policies and practices across Member States. While the EU Forest Strategy provides an overarching framework, the decentralized nature of governance means that implementation varies significantly from country to country (Wolfslehner et al., 2020; Seppälä et al., 2013). This fragmentation is particularly evident in how Member States manage forest risks such as wildfires, pests, and diseases (Wolfslehner et al., 2020), as well as in how well they respond to major incidents involving the forest, and their efforts in managing the aftermath of those incidents.

For example, northern European countries like Finland and Sweden have developed advanced forest management systems that prioritize timber production and biodiversity conservation. In contrast, southern European countries, which face a higher risk of wildfires due to climate change, may lack the resources and infrastructure needed to implement comprehensive fire prevention strategies (Seppälä et al., 2013).

In addition to geographic differences, the institutional capacities of member states vary widely. Wealthier countries tend to have more resources to invest in advanced forest management technologies and infrastructure, while less wealthy countries may struggle to implement the necessary measures. This disparity can lead to uneven outcomes across the EU, making it difficult to achieve the region-wide goals set out in the EU Forest Strategy (Seppälä et al., 2013).

4.2.2 Differences in Terrain, Location, and Geography

The geographical diversity of Europe's forests adds another layer of complexity to governance. The continent's forests range from the boreal forests of Scandinavia to the Mediterranean woodlands of southern Europe, each with unique ecological characteristics and vulnerabilities (Wolfslehner et al., 2020). These differences necessitate tailored forest management strategies that take into account local environmental conditions, such as soil type, water availability, and climate patterns (Seppälä et al., 2013).

For instance, in northern Europe, where forests are often managed for timber production and carbon sequestration, forest management practices focus on maintaining productivity and minimizing the impact of logging on biodiversity. In southern Europe, however, where forests are more vulnerable to wildfires and drought, management strategies must prioritize fire prevention and the restoration of degraded landscapes.

4.2.3 Differences in Capacity, Preparedness, and Resources

The capacity of EU Member States to manage their forests effectively varies significantly. Wealthier countries are better equipped to invest in advanced forest management technologies, such as remote sensing and Geographic Information Systems (GIS), which are critical for monitoring forest health and detecting threats such as wildfires and illegal logging (Wolfslehner et al., 2020). These technologies enable countries to respond more quickly and effectively to emerging risks, improving the resilience of their forests (Seppälä et al., 2013).

However, in less wealthy countries, the availability of these technologies is often limited, and governments may lack the financial resources or technical expertise needed to implement advanced forest management practices. This disparity in capacity is particularly evident in regions where the risk of wildfires is high, but the resources needed to manage these risks are scarce.

Preparedness for addressing forest-related risks also varies across member states. Some countries have well-developed disaster management systems for handling forest fires, pest outbreaks, or extreme weather events, while others may lack the infrastructure or institutional capacity to respond effectively (Seppälä et al., 2013). This uneven preparedness can lead to significant differences in how forest risks are managed across the EU, further complicating efforts to create a cohesive forest governance framework (Wolfslehner et al., 2020).

4.2.4 Differences in Political Governance Models

Another major challenge in EU forest governance arises from the differing political systems of Member Dtates. Some countries operate under highly centralized governance models, where forest management decisions are made at the national level. Others, such as Germany and Belgium, have more decentralized or federal systems, where regional governments play a key role in managing forests. These differences can make it difficult to implement uniform forest management policies across the EU, particularly in countries where regions have significant autonomy over land-use decisions (Wolfslehner et al., 2020).

Local politics and internal conflicts further complicate forest governance. In many countries, there are tensions between local stakeholders—such as private landowners, conservation organizations, and government agencies—over how forests should be managed. These conflicts often reflect broader debates about the balance between economic development and environmental protection, and they can hinder the implementation of EU forest policies (Wolfslehner et al., 2020).

4.2.5 Preexisting Historical Conflicts and Cross-Border Issues

Shared forest ecosystems that cross national borders present additional governance challenges. In regions where historical tensions or political conflicts exist between neighbouring countries, cross-border cooperation on forest management can be difficult to achieve. This issue is particularly relevant in the context of wildfire prevention and response, where fire risks in one country can easily spread to neighbouring countries, necessitating coordinated efforts. Without effective cooperation between countries, efforts to prevent and manage wildfires are less likely to succeed, leading to greater environmental and economic damage.

4.2.6 Inability to Align Local Legislation with EU Frameworks

Although the EU provides a comprehensive legal framework for forest governance, aligning local legislation with these frameworks can be challenging. National and regional governments often prioritize short-term economic gains, such as logging or land development, over long-term sustainability. This misalignment can result in inconsistent implementation of forest management policies across member states (Seppälä et al., 2013).

In some cases, local legislation may lag behind EU standards, particularly in regions where forestry practices have historically been less regulated or poorly funded. The challenge for the EU is to encourage member states to adopt more sustainable practices while respecting the autonomy of national and regional governments (Wolfslehner et al., 2020).

4.2.7 Inability of the EU to Enforce or Oversee Local Policy and Implementation

While the EU sets overarching forest policies, its ability to enforce these policies at the local level is limited. The responsibility for forest management ultimately rests with Member States, and while the European Commission can monitor progress and issue recommendations, it lacks the authority to enforce compliance (Gordeva et al., 2022). This reliance on member states to implement and enforce policies creates a gap between the EU's goals and the realities of local forest management (Seppälä et al., 2013).

For example, while the EU Forest Strategy for 2030 sets ambitious goals for forest restoration and biodiversity conservation, some countries may lack the political will or financial capacity to fully implement these policies. In regions where economic interests outweigh environmental concerns, the enforcement of forest management policies may be weak or inconsistent (Wolfslehner et al., 2020).

4.2.8 Voices Questioning and Doubting the Need for Measures Against Climate Change

In recent years, there has been growing scepticism in some member states regarding the need for stringent climate action. This scepticism is often driven by political and economic interests that prioritize short-term growth over long-term environmental sustainability. In regions where forestry is a significant economic sector, there may be resistance to policies that limit logging or require large-scale reforestation efforts (Seppälä et al., 2013).

This resistance can slow the implementation of critical forest management policies, particularly those aimed at mitigating the impacts of climate change. Overall, there appears to be concrete and pressing evidence of the need for proactive measures to address the growing risks posed by climate change, including increased wildfire activity and the degradation of forest ecosystems (Wolfslehner et al., 2020).

4.3 Opportunities

4.3.1 Integration of Forest Management with Broader EU Goals

Despite the many challenges facing forest governance in the EU, there are significant opportunities for improvement. One of the most promising avenues is the integration of forest management with the EU's broader climate and biodiversity goals. Forests play a crucial role in carbon sequestration, biodiversity conservation, and climate adaptation, making them a key component of the EU's efforts to become climate-neutral by 2050 (Wolfslehner et al., 2020; Stubenrauch et al., 2022).

In addition to their role in achieving climate neutrality, forests could play a broader role in providing both provisioning and cultural services. Adoption of sustainable forest management systems that integrate these multi-dimensions of ecosystem services will enhance synergies among environmental goals and social-economic expectations. The EU Forest Strategy for 2030 emphasizes the need for forests to contribute to climate resilience, and there is significant potential for aligning forest management practices with these objectives. By adopting fire prevention and mitigation measures, Member States can protect forest ecosystems while contributing to the EU's climate goals (Wolfslehner et al., 2020).

4.3.2 Technological Innovation and AI in Forest Governance

Technological advancements offer significant opportunities to improve forest governance across the EU. The use of remote sensing technologies, Geographic Information Systems (GIS), and drones allows for real-time monitoring of forest health and the early detection of threats such as wildfires, pest infestations, or illegal logging. These technologies enable more effective forest management, helping countries to respond quickly to emerging risks (Stubenrauch et al., 2022; Seppälä et al., 2013).

Furthermore, blockchain technology may revolutionize forest governance by enabling the transparent and secure monitoring of forest resources. This would not only enhance accountability but also better lock in green finance contributions with the provision of independently verified information on ecosystem service deliveries. The integration of Artificial Intelligence (AI) in forest governance is also showing promise in enhancing predictive models for forest management. AI-driven predictive models can analyse vast amounts of data from satellites, sensors, and climate models to anticipate potential risks such as wildfires, pest outbreaks, or illegal logging activities. By identifying these risks early, AI allows for more proactive management strategies, potentially reducing environmental damage and improving forest resilience.

AI can also be used to optimize the deployment of resources, such as firefighting teams or conservation efforts, by analysing patterns of forest degradation or fire risks in real time. This constitutes a part of the broader trend of AI development in monitoring processes and its integration into policy formulation as part of excellence in governance at local and international levels. This kind of precision management is crucial in regions with limited resources or where the terrain poses additional challenges to traditional monitoring methods. The application of AI in forest governance is still emerging but holds significant potential for transforming how forests are managed and protected across the EU.

4.3.3 Harmonizing Policies Across Member States

Harmonizing forest management policies across Member States is another key opportunity for improving forest governance. While the principle of subsidiarity allows countries to tailor policies to their local contexts, there is a growing recognition of the need for greater policy coherence across the EU. Novel governance arrangements, such as participatory approaches, have the potential to achieve this policy harmonization with local needs and yet still meet wider EU goals. By promoting a more consistent approach to forest management, the EU can ensure that Member States work towards common objectives, such as reducing carbon emissions, protecting biodiversity, and restoring ecosystems.

4.3.4 Green Finance and Payments for Ecosystem Services (PES)

Green finance mechanisms, such as carbon credits and payments for ecosystem services (PES), offer promising opportunities for supporting sustainable forest management. These financial incentives encourage landowners and communities to engage in forest conservation and restoration efforts, helping to bridge the gap between economic development and environmental protection (Seppälä et al., 2013).

Linking PES schemes with innovative governance models that ensure equitable benefit sharing of the gains arising from ecosystem services between different stakeholders and local and indigenous communities can better implement PES schemes.

5 Forest governance at national/regional level

This chapter provides an overview of National Forest Governance schemes by examining the situation in all SILVANUS pilot owner countries. **The data on national forest governance was collected through a template shared with and filled by the pilot owners**, which is reported in Appendix A1. Information was gathered on the following aspects: i) key legislation, ii) government agencies involved, iii) policy objectives, iv) ownership distribution, v) integration of EU Forest Strategy for 2030, vi) management practices, vii) conservation areas, viii) economic and financial aspects, ix) participation and inclusiveness of key stakeholders, x) monitoring and enforcement, xi) social and environmental impacts, xii) alignment with EU policies, and xiii) a SWOT analysis. Consequently, this chapter builds upon these inputs as its main source.

The complexity of forest governance at the national level is mainly due to the various regional geographical peculiarities and interactions among various stakeholders. However, the effectiveness of forest management and conservation is a common interest and therefore a high degree of cooperation is registered. Understanding forest governance at the national level is crucial to infer what the opportunities and challenges may be. The chapter explores this issue, providing an overview of policy objectives and of social and environmental impacts of forest fires. After that, the state-of-the-art is outlined for each country, highlighting the distribution of forest ownership and conservation areas frameworks, key legislation, the stakeholders that shape how forests are managed and protected, economic aspects, and alignment with EU policies. Finally, the main challenges connected to national forest governance, as well as key opportunities in the field are discussed in two separate sections.

5.1 State of the art

Generally, the main objectives of the examined National Forest Policies can be summarized as follows:

I. **Sustainable forest management**. Ensuring that forest resources are managed sustainably to balance environmental, economic, and social benefits. This includes maintaining forest health, productivity, and biodiversity.
II. **Conservation of biodiversity**. Protecting and enhancing the biodiversity of forest ecosystems, including the conservation of endangered species and habitats.
III. **Climate change mitigation and adaptation**. Using forests to mitigate climate change by enhancing carbon sequestration and promoting forest resilience to adapt to changing climate conditions.
IV. **Fire prevention and control**. Implementing effective strategies to prevent, manage, and control forest fires, safeguarding forest health and reducing economic losses.
V. **Strengthening institutional frameworks**. Enhancing the governance and institutional frameworks for forest management, including improving coordination among various stakeholders and ensuring effective implementation of policies and regulations.
VI. **Research and innovation**. Encouraging R&I in forestry practices, technologies, and management strategies to improve forest health and productivity.
VII. **Promotion of forest-based economy**. Supporting the development of the forest-based economy by promoting sustainable forestry practices, enhancing the value of forest products, and supporting rural development and employment.
VIII. **Public awareness and education**. Raising public awareness about the importance of forests and promoting environmental education to foster a culture of conservation and sustainable use of forest resources.

Overall, these general goals aim to ensure that forests continue to provide essential ecological, economic, and social benefits to present and future generations. These objectives are also in line with European Union goals. The EU emphasises sustainable forest management, biodiversity conservation, climate change mitigation, and socio-economic benefits derived from forests. Aligning with EU strategies and policies creates several social and environmental impacts on local communities. These impacts are diverse,

affecting economic opportunities, cultural heritage and preservation, community empowerment, and public health.

National forest governance models demonstrate a strong commitment to biodiversity conservation and play a significant role in climate change mitigation through sustainable forest management and ecosystem protection. Forests are essential for carbon sequestration and storage. Proper forest management practices, including sustainable forestry and afforestation efforts, enhance the capacity of forests to absorb and store carbon dioxide from the atmosphere. Furthermore, States incorporate climate-adaptive forestry practices to increase the resilience of forests to climate change impacts. This includes promoting diverse tree species, managing forest composition and structure, and adapting silvicultural techniques. By integrating conservation efforts with climate policies and engaging stakeholders, authorities aim to enhance resilience to environmental changes and promote sustainable development for future generations. However, continued efforts and innovation will be crucial in achieving long-term conservation and climate goals.

5.1.1 Italy

According to ISTAT (Italian National Institute of Statistics), in 2020 the forest area represented 31.7% of Italy's total land area, showing improvement compared to ten years prior. Additionally, in the same year, the Italian system of protected areas covered 35.1% of the country's entire forest area. In Italy, the general distribution of forest ownership between public and private entities is approximately as follows: approximately 40% for public owned forests, and approximately 60% for private owned forests[1]. These percentages reflect the overall ownership structure of forests in Italy, where a significant majority of forests are privately owned. Public ownership includes forests managed by state, regional, provincial, and municipal entities, while private ownership encompasses forests owned by individuals, families, corporations, and other private entities.

5.1.1.1 Key legislation

The primary national normative sources that regulate forest in the Italian Republic are the following:

Legge 21 Novembre 2000, n. 353, Framework Law on Forest Fires. Overall, this law aims to ensure coordinated and effective management of forest fire risk throughout Italy, emphasising proactive measures to reduce the incidence and impact of wildfires on forests, biodiversity, communities, and economic activities. It also integrates various stakeholders and resources to enhance resilience against forest fires and protect forest ecosystems. The law serves as a framework with provisions for each of the Italian regional authorities to develop further regulations or legal provisions. It establishes the general principles governing firefighting activities aimed at the protection and conservation of forests. It requires regional authorities to approve and implement programs related to forecasting, prevention, and control of fires, including the identification of forest areas affected by fires in the previous year and those considered at risk of future fires. The law specifies firefighting techniques and requires effective information dissemination by the government and regional authorities to promote sound forest fire management practices. Based on this law, all Italian regions enact regional legislation on forests.

Decreto ministeriale 20 Dicembre 2001, Guidelines for Regional Plans for Planning Activities to Anticipate, Prevent and Actively Combat Forest Fires[2].This plan specifies actions and strategies for preventing and combating wildfires, including coordination among national, regional, and local authorities.

Decreto legislativo 3 Aprile 2018, n. 34, Consolidated Law on Forests and Forestry Supply Chains. It aims to provide a comprehensive regulatory framework to ensure the sustainable management and use of Italy's forest resources, balancing environmental protection, economic development, and social benefits. It consolidates various legislative provisions into a unified text to streamline governance and promote integrated approaches to forestry.

National Forest Strategy for the Forest Sector and its Supply Chains. It is a comprehensive strategic plan adopted in 2022 and designed to guide the sustainable management and use of the Italian forest resources. The strategy identifies three general objectives: (I) sustainable management and multifunctional role of forests; (II) efficient use of forest resources for sustainable development of economies in rural, inland, and urban areas; (III) responsibility and global knowledge of forests.

In addition, each Italian region has competencies in forest management. Consequently, there are regional laws and regulations that detail the methods of management, protection, and prevention of forest fires at the local level, in accordance with national legislation. Italian regional authorities can also adopt "Forest management plans" or "Regional plans for forecasting, preventing and actively fighting forest fires" which are technical and administrative tools that regulate the sustainable management of forests at the local level.

5.1.1.2 Government agencies and other stakeholders

In Italy, forest management involves various stakeholder groups, including government institutions which oversee policy implementation and enforcement. Private and public forest owners and managers adhere to Forest Management Plans and participate in sustainable practices. Forest-based industries comply with regulations and certification schemes like Forest Stewardship Council and Programme for the Endorsement of Forest Certification (PEFC). Research institutions conduct scientific research on forest ecosystems and provide data and analysis to support forest management, while environmental NGOs advocate for conservation and participate in monitoring activities.

Forest management is overseen by several primary institutions at different levels of government. These institutions play a crucial role in regulating, protecting, and promoting sustainable forest management practices. The main institutions involved and responsible during all phases as defined by the Italian regulatory framework (*prevention, response, recovery, and restoration*) of wildfire events are the following:

Prevention

I) Ministry of Agriculture, Food Sovereignty and Forests. It oversees national policies related to forestry, including wildfire prevention strategies and regulations. **II) Regional forestry authorities**. They are responsible for implementing regional forest fire prevention plans, conducting fire risk assessments, and organising prevention activities such as controlled burns and clearing firebreaks. **III) Regional Environmental Agencies**. They monitor environmental conditions, including weather and fire danger indices, to provide early warnings and support fire prevention efforts. **IV) Municipalities**. They may be responsible for land use planning, issuing permits related to fire-prone activities, and ensuring compliance with fire prevention regulations at the local level. This is particularly the case for Mountain Municipalities and Mountain Communities. **V) Command of the Forest, Environmental and Agri-food Units**, as a department of the Arm of Carabineers. The department is involved in enforcing laws related to forestry and fire prevention, conducting patrols, and educating the public about fire safety. **VI) Environmental and conservation organisations**. Several non-governmental organisations (NGOs) and associations also play a role in advocating for forest conservation, biodiversity protection, and sustainable forestry practices. They often collaborate with government agencies and local communities to promote responsible forest management

Response

I) Civil Protection Department. Under the Presidency of the Council of Ministers supervision, it coordinates emergency response efforts at the national level, including mobilising resources, managing communication, and supporting firefighting operations. **II) National Fire Brigade Corps**. Under the Ministry of Interior jurisdiction, firefighters are responsible for responding to and extinguishing wildfires, often working in collaboration with other agencies and volunteers. They are organised into local fire brigades, which lead firefighting efforts at the regional and local levels, deploying personnel and equipment, and coordinating with national agencies and volunteers. **III) Command of the Forest, Environmental and Agri-food Units**, as

a department of Arm of Carabineers. It provides specialised support during firefighting operations, such as aerial surveillance, coordination with ground units, and investigation of fire causes.

Recovery

I) Ministry of Agriculture, Food Sovereignty and Forests. It provides support for post-fire recovery efforts, including funding for restoration projects and implementing measures to prevent future wildfires. **II) Regional forestry authorities**. They assess fire damage, plan and implement rehabilitation measures, including reforestation and soil stabilisation to prevent erosion. **III) Regional Environmental Agencies**. They monitor environmental impacts post-fire, including water quality, air pollution, and ecological recovery of affected areas.

Restoration

The main authority responsible for forest restoration in Italy is the **Ministry of Agriculture, Food Sovereignty and Forests** along with **regional forestry authorities**.

5.1.1.3 Management practices, monitoring and enforcement

Italy implements and promotes a variety of sustainable forest management (SFM) practices aimed at preserving forest health, enhancing biodiversity, and ensuring long-term ecological and economic benefits. Some key sustainable forest management practices in use include:

I) Selective logging. It is focused on maintaining forest structure and biodiversity by selectively removing certain trees rather than clear-cutting entire areas. Trees are chosen for harvest based on factors like age, health, and species, which helps to promote natural regeneration, to maintain the ecological balance and to reduce environmental impact. **II) Continuous cover forestry (CCF).** This approach ensures continuous canopy cover, which helps maintain forest ecosystem services such as soil protection, water regulation, and habitat provision. Practices include selective thinning and gap creation, allowing for natural regeneration and maintaining a diverse age structure within the forest. **III) Agroforestry.** Integrating trees and shrubs with agricultural crops and/or livestock to enhance biodiversity, soil health, and productivity. Techniques include alley cropping, silvopasture (combining forestry and grazing), and forest farming (cultivating non-timber forest products). **IV) Protected areas.** Designation of national parks, nature reserves, and protected landscapes to conserve biodiversity and prevent deforestation. **V) Reforestation and afforestation.** Planting native species and mixed-species plantations, using techniques that mimic natural forest regeneration processes, in order to restore degraded forests or create new forested areas. **VI) Integrated pest management (IPM).** The purpose is to reduce the impact of pests and diseases on forest health through environmentally friendly methods. Its implementation combines biological control (using natural predators), cultural practices (such as thinning and sanitation), and chemical treatments as a last resort.

The combination of **integrated fire management** (IFM) with **sustainable forest management** (SFM) practices in Italy aims to create a framework that addresses the challenges posed by wildfires while promoting the health and resilience of forest ecosystems. This holistic approach not only addresses immediate fire threats but also promotes ecological balance, biodiversity, and sustainable use of forest resources. Wildfire management in Italy thus follows a comprehensive approach encompassing risk assessment, prevention strategies, response plans, and post-fire restoration. These practices not only aim to mitigate immediate wildfire impacts but also to bolster forest resilience against future fires, ensure efficient incident responses, and restore ecosystems. Specific practices include:

Risk Assessment:

I) Climate and weather monitoring. Continuous monitoring of weather conditions, such as temperature, humidity, and wind patterns, to predict and prepare for periods of high fire risk. **II) Fire hazard mapping**. Creating detailed fire hazard maps using geographic information system (GIS) and remote sensing technologies, considering factors like vegetation type, topography, climate conditions, and historical fire

data. **III) Vegetation and fuel load assessment**. Regular assessments of forest vegetation and fuel loads (dry leaves, branches, and underbrush) to identify areas that may require fuel reduction treatments.

Prevention strategies:

I) Controlled burns. Prescribed burning is used to reduce fuel loads in a controlled manner, which can help prevent larger, uncontrollable wildfires. **II) Fuel breaks and firebreaks**. Creating cleared strips (firebreaks) and managed zones (fuel breaks) in forests to slow or stop the spread of wildfires. **III) Forest thinning and pruning**. Selectively removing trees and underbrush to reduce fuel density and improve forest health, making them less susceptible to intense fires. **IV) Regulations and permits**. Enforcing regulations on activities that could cause wildfires, such as agricultural burning, construction, and recreational fires. Permit systems ensure these activities are conducted safely. **V) Public awareness**. Educating the public about wildfire risks, prevention measures, and safe practices (e.g., campfire safety, proper disposal of flammable materials) through media campaigns, community programmes, and school education.

Response plans:

I) Early warning systems. Utilising advanced technologies such as satellite imagery, ground sensors, and drones to detect fires early and monitor their spread. **II) Coordination and communication.** Establishing clear communication channels and protocols between local, regional, and national firefighting agencies to ensure coordinated and effective response efforts. **III) Rapid response teams.** Deploying specialised firefighting units equipped with the necessary tools and training to quickly respond to and contain wildfires. **IV) Evacuation plans.** Developing and regularly updating evacuation plans for communities at risk, including clear routes, shelter locations, and communication strategies to ensure public safety.

Post-fire restoration:

I) Damage assessment. Conducting thorough assessments of the affected areas to determine the extent of damage and prioritise restoration efforts. **II) Reforestation and rehabilitation.** Planting native tree species and other vegetation to restore ecosystems, stabilise soil, and prevent erosion. Special attention is given to species that are resilient to fires. **III) Soil stabilisation.** Using techniques such as mulching, contour trenching, and planting cover crops to prevent soil erosion and promote water retention in post-fire landscapes. **IV) Promoting biodiversity.** Encouraging the growth of diverse plant species to create a more resilient forest structure that can better withstand and recover from fires. **V) Selective breeding and planting.** Using fire-resistant tree species and varieties in reforestation projects to reduce the overall flammability of forests.

Italy employs a comprehensive suite of methods, procedures, and technologies for **forest monitoring**, encompassing remote sensing, field surveys, and automated systems. Satellite imagery enables continuous monitoring of forest cover and health, while aerial photography from unmanned aerial vehicles (UAVs) and LiDAR technology provides detailed 3D maps of forest structure and biomass[3]. Field surveys, including permanent sample plots and periodic "Inventario nazionale delle foreste e dei serbatoi forestali di carbonio" (National Inventory of Forests and Forest Carbon Pools), gather critical data on tree species, health, and biodiversity[4]. In wildfire management, specific measures include deploying IoT sensors to monitor environmental parameters such as temperature, humidity, and soil moisture, which can indicate fire risks, and using camera traps for real-time surveillance[5]. Advanced geographic information system (GIS) software integrates spatial and non-spatial data to map fire-prone areas and manage response strategies. For monitoring the effectiveness of forest restoration, Italy uses a combination of remote sensing to track changes in forest cover and composition over time, field assessments to evaluate the survival and growth rates of planted trees, and ecological surveys to assess biodiversity recovery[6]. These tools and measures ensure a thorough and dynamic approach to forest monitoring, wildfire management, and restoration effectiveness, supporting sustainable forest management and conservation efforts.

In Italy, the **enforcement of forest management** laws and ensuring compliance is achieved through a multifaceted approach involving legislative frameworks, regular inspections, technological tools, and community engagement. The national legislation, complemented by regional regulations, provides a robust

legal framework that mandates sustainable forest management practices. Moreover, the Forest Management Plans are compulsory for forest owners, outlining specific conservation and management strategies[7]. Compliance is monitored through regular inspections by forest authorities, who conduct on-the-ground checks and environmental audits to verify adherence to legal standards and certification schemes like Forest Stewardship Council (FSC)[8] and Programme for the Endorsement of Forest Certification (PEFC)[9]. Violations such as illegal logging, non-compliance with management plans, and other violations are met with fines, penalties, and, in severe cases, legal prosecution[10]. Technological enforcement tools, including satellite imagery, UAVs, and IoT sensors, are integrated into forest monitoring platforms to provide real-time data and automated alerts for unauthorised activities, enabling rapid response[11]. Public awareness campaigns and community involvement also play a role in fostering a culture of compliance, where local communities actively participate in monitoring and reporting illegal activities. This comprehensive enforcement strategy ensures the sustainable management and protection of Italian forest resources.

5.1.1.4 Alignment with EU policies

While overall Italy is **well aligned with EU forest strategy and policies**, there are some challenges related to meeting specific EU targets, integrating policies at regional levels, and adapting strategies to local ecological and socio-economic conditions. Addressing these gaps requires continuous dialogue and collaboration between national authorities, regional stakeholders, and the EU institutions to ensure sustainable forest management and conservation across Country. Italy demonstrates alignment with **EU wildfire management policies and strategies**, albeit with some shortcomings. These include resource allocation, integration with land use planning, adaptation to climate change impacts, community engagement, and advancing scientific understanding through research and monitoring. Addressing these issues could enhance Italy's ability to effectively manage wildfires while promoting sustainable forest management practices in alignment with EU objectives. In general, Italy also demonstrates a good degree of alignment with **EU forest restoration policies and strategies**. However, not all EU targets are met and some need to be adapted to the country's specific characteristics. Problematic areas include funding, coordination, and climate adaptation. Addressing these issues will enhance Italy's ability to restore forests effectively and sustainably, contributing to broader EU goals of biodiversity conservation and climate resilience.

5.1.1.5 Economic aspects

Forest management in Italy is supported by various sources of funding and economic incentives aimed at promoting sustainable practices, conservation, and restoration efforts. Italian forest management governance involves multiple levels of government (EU, national, regional) and sectors (public, private, NGOs). This integrated approach ensures coordinated actions and resource sharing, reducing duplication of efforts and enhancing cost-effectiveness. As a general statement, the relatively efficient use of financial, human, and technical resources in Italy's forest management, coupled with a cost-effective governance model, results in several environmental, economic, and social benefits. However, differences in resource management exist between Italian regions. The economic and financial benefits of sustainable forest management in Italy are substantial, particularly for local communities. These benefits include income from timber and non-timber forest products, employment opportunities, PES, local development and infrastructure improvements, and agricultural and agroforestry benefits. Programmes and initiatives such as forest certification schemes, rural development funds, and ecotourism development further enhance these economic opportunities, ensuring that forest management practices contribute to both environmental sustainability and economic prosperity.

5.1.2 Croatia

Considering only land surface, forests cover 48%, nearly half of terrestrial Croatia. The general distribution of forest ownership between public and private entities in Croatia is approximately as follows: 76% for public owned forests, 24% for private owned forests. 73% of state forests are managed by the only state-owned commercial company Hrvatske šume LLC (HŠ), where 16.4% of Croatian forests are managed under protection. There are seven categories of protected forests and forest lands: strict reserve, national park, special reserve, nature park, regional park, natural monument, significant landscape, and forest park.

5.1.2.1 Key legislation

The primary national normative sources that regulate forest in the Croatia Republic are the following:

National forestry policy and strategy (Official Gazette 120/2003). Croatia's national forestry policy and strategy focus on the sustainable management, use and protection of forest resources and biodiversity with the aim of contributing to the national economy while respecting international trends and the rights of local communities. The text includes various aspects, such as authorised institutions and their tasks and responsibilities, monitoring, inspections and financial provisions. The policy and strategy are divided into several areas, including forest ecosystem management, forest administration and legislation, non-timber products such as tourism and hunting, the timber industry, the environment and physical planning, education, research and international cooperation, and public relations and promotion. The main objective is to maximise the contribution of forest resources to the economic growth of the country, following research results and meeting international standards.

Law on Forests (Official Gazette 68/2018, and amendments to the law). Among the many issues, this Law regulates the system and the competent management authority, use and monitoring of forests and forest land, based on the principles of sustainable management, economic and environmental acceptability and social responsibility, remediation and artificial restoration within a certain time frame; forest management plans; monitoring of the health status of forests and consequential protection measures; forest fires; securing; administrative, inspection and expert supervision and forest inspector related issues and provisions; and offences and penalties.

Fire Protection Act (Official Gazette 92/2010 and amendments). Overall, this Law provides planning for fire protection, also prescribing measures for fire protection of natural and artificial goods, setting up entities for fire protection, fire protection funding, training and accreditation, prevention of the fire risk, early detection, notification and containment and effective firefighting, prevention and reduction of the harmful effects of fire, determining the cause of the fire and the elimination/reduction of its consequences to the environment.

Law on Forests Ordinance on forest fire protection (Official Gazette 37/2015). In accordance with Croatian Fire Protection Act, this regulation specifies technical, preventive and other measures and rules for fire protection of all forests, which are to be implemented by owners or users of forests and forest land, holders or other users of forests and forest land. This to reduce the risk of the origin and rapid spread of forest fires and to provide a procedure for the detection, monitoring and timely notification of the occurrence of forest fires and the timely action to extinguish such fires.

5.1.2.2 Government agencies and other stakeholders

Forest management involves government institutions which oversee policy implementation and enforcement. The main institutions involved and responsible for forest management are **Ministry of Agriculture, Forestry and Fisheries**, and the state enterprise **Hrvatske šume**. Established in 1991, the latter is responsible for forest management. The company is fully owned by the state, with the Headquarters in Zagreb, with 16 regional forest administrations, 169 regional forest offices and 7255 employees. The area of management is about 2 thousand ha.

The main agencies responsible for forest fire management in the three phases (*prevention, response, recovery*) of wildfire events are the following: **Hrvatske šume**, **Croatian Fire Brigade Association**, and Directorate of Civil Protection. All activities and participants are described in the *Program of Activities in the Implementation of Special Fire Protection Measures of Interest to the Republic of Croatia* (annual document release from the Government of the Republic of Croatia).

The agencies responsible for forest restoration are **Hrvatske šume**, the **Ministry of Agriculture, Forestry and Fisheries**, and the **Directorate for Private Forests is responsible for private forests**.

5.1.2.3 Management practices, monitoring and enforcement

Annual forest fire protection plans for state forests are drawn up within the organisational units of **Hrvatske šume**. The annual and ten-year plans include work on restoring forests from fires and prevention activities: construction and maintenance of fire roads, monitoring stations, forest protection, video surveillance of forests to observe the occurrence of fires and other activities. Local and regional self-government units are obliged to implement forest fire protection within their jurisdiction. Large private forest owners are also obliged to prepare forest fire protection plans.

The approach used for ecological restoration, for example, involves planting tree species that are as fire-resistant as possible (native species, mainly conifers, in habitat conditions that allow this). The aim is always to cultivate mixed forests of the highest quality, suitable for a specific habitat. Forest care is accompanied by cultivation operations.

The knowledge brought by modern science has been incorporated into current fire management and forest restoration practices. The greatest progress has been made with the introduction of forest video surveillance, a system developed in Croatia in cooperation with the scientific community (FESB in Split), a technology company for the application of video surveillance (Odašiljači i veze d.o.o.), the State Forest Management Company (HŠ) and the fire brigade (HVZ).

The measures and tools used for monitoring in forest fire management include video surveillance of forests managed from regional centres and monitoring from permanent monitoring stations in the forests and patrolling by vehicles and on foot. As a result, Croatian forests are constantly monitored, especially during the summer months or during the fire season. To monitor the effectiveness of forest restoration, the regulations prescribe the restoration of forests after a fire under the supervision of the Inspection Service of the Ministry of Agriculture.

5.1.2.4 Economic aspects

Regarding economic aspects, state forests are managed by the company HŠ. HŠ is not on the state budget, but its operations enable sustainable management of forests, respecting all legal obligations. The company pays the excess funds into the state budget. There is a mechanism called OKFŠ (general utility functions of forests) which serves as compensation for payment of ecosystem services based on which larger economic entities pay into the state budget, and a part of these funds is used for the protection and restoration of forests.

5.1.3 Czech Republic

State the forest ownership in the Czech Republic is divided among various categories, reflecting a mix of state, private, municipal, and church ownership. Approximately 60% of forests in Czechia are state-owned. These forests are primarily managed by the *Lesy České Republiky* (Czech Forest Administration), a state enterprise responsible for the stewardship of state forests. Other state-owned forests are managed by national parks and military forest administrations. Around 20% of forests are privately owned (individuals,

families, and private companies). Municipalities own about 17% of the forests, which are managed by local governments, often focusing on community needs, local economic development, and recreation. Approximately 3% of forests are owned by churches and religious organizations. Many church-owned forests were returned to religious organizations as part of the restitution process after the fall of communism.

Forest conservation in the Czech Republic involves the designation and management of protected areas to preserve biodiversity, ensure ecosystem services, and mitigate climate change. Forest conservation areas in Czechia include national parks, protected landscape areas, nature reserves, and Natura 2000 sites. Approximately 20-25% of the country's territory is designated as protected areas, with forests making up a significant portion of these areas. By focusing on these areas, Czechia aims to enhance the conservation and sustainable management of its forests, ensuring their resilience and continued provision of essential ecosystem services.

5.1.3.1 Key legislation

The key legislation, official documents, and strategies for forest and wildfire management in the Czech Republic encompass a range of national laws, policies, and strategies that align with broader EU directives.

Forest Act (Law No. 289/1995 Coll.). Defines the principles of sustainable forest management, forest protection, and reforestation. Establishes responsibilities for forest owners and managers.

Nature and Landscape Protection Act (Law No. 114/1992 Coll.). Addresses the conservation of nature and landscape, including forest ecosystems. Provides a legal framework for protecting biodiversity and natural habitats.

Act on the Environment (Law No. 17/1992 Coll.). Provides overarching principles for environmental protection, including forests. Establishes the basis for environmental policies and measures.

Act on Integrated Rescue System (Law No. 239/2000 Coll.). Defines the organization and responsibilities of the Integrated Rescue System in Czechia (emergency services), which includes wildfire response.

Crisis Act (Law No. 240/2000 Coll.). Governs the management of crises, including natural disasters like wildfires. Details the roles of various authorities and organizations in crisis management.

National Forest Programme for the Period until 2035. Outlines strategic objectives for sustainable forest management in Czechia. Emphasizes biodiversity conservation, climate change adaptation, and socio-economic benefits of forests.

National Action Plan for Climate Change Adaptation. Includes measures for increasing forest resilience to climate change. Focuses on enhancing the adaptive capacity of forest ecosystems.

National Biodiversity Strategy. Aims to conserve biodiversity, including forest species and habitats. Promotes sustainable use of natural resources.

National Programme for the Protection against Forest Fires. Details preventive measures, preparedness, and response strategies for forest fires. Includes public awareness campaigns and coordination mechanisms among various agencies.

State Environmental Policy. Sets out the strategic direction for environmental protection, including forests. Integrates EU environmental policies and directives into national practice.

5.1.3.2 Government agencies and other stakeholders

Forest management is overseen by institutions at different levels of government. These institutions play an essential role in regulating, protecting, and promoting sustainable forest management practices. The main institutions involved in forest management include: the **Ministry of Agriculture,** that is responsible for forest policy and management, oversees the implementation of the Forest Act and related regulations; the

Ministry of the Environment which manages nature conservation and environmental protection policies and coordinates efforts to integrate biodiversity and climate adaptation into forest management; the **Czech Forest Administration (Lesy České Republiky)** which runs state-owned forests and implements sustainable forest management practices and wildfire prevention measures; the **Fire Rescue Service of the Czech Republic** which leads wildfire response and crisis management and coordinates with other agencies for effective wildfire management.

5.1.3.3 Management practices, monitoring and enforcement

The Czech Republic promotes some SFM practices aimed ensuring long-term ecological and economic benefits. These practices are aimed at balancing ecological, economic, and social functions of forests and include selective logging, maintaining forest cover, and protecting old-growth forests, which are critical for biodiversity. In **wildfire management**, risk assessment and prevention are promoted through activities such as continuous monitoring of forest conditions and climate data to assess wildfire risks, creation of firebreaks and implementation of controlled burns to reduce fuel loads and prevent the spread of wildfires and campaigns to educate the public about wildfire risks and prevention measures. Furthermore, as far as preparedness and response, Czechia supports investments in firefighting equipment and infrastructure, including aerial firefighting capabilities, training programs for firefighters and coordination between different agencies and local communities for effective wildfire response and implementation of early warning systems and real-time monitoring to detect and respond to wildfires quickly.

For the restoration phase, practices on reforestation and afforestation are pursued. The focus is on planting native tree species that are well-adapted to local conditions to enhance forest resilience and biodiversity. Moreover, the promotion of mixed-species forests is pursued to increase ecological stability and reduce vulnerability to pests, diseases, and climate change. Within ecosystem restoration activities, the Czech Republic is encouraging natural regeneration processes where feasible to restore forest ecosystems, and restoration of specific habitats, such as wetlands and riparian zones, within forest areas to support biodiversity. Finally, the **Sustainable Forest Management** implements selective logging practices to minimize environmental impact, promote forest health and maintain continuous forest cover to protect soil, water resources, and biodiversity.

Czechia has enacted various laws and regulations to protect its forests and biodiversity, such as the Forest Act and Natura 2000 network. These legal frameworks provide guidelines for conservation and sustainable use of forest resources. Effective enforcement of these laws is essential. There can be gaps between policy and practice, often due to limited resources, lack of coordination among agencies, and varying levels of compliance. Regular monitoring and research are critical for understanding the health of forest ecosystems and the status of biodiversity. The Czech Republic promotes several initiatives and institutions dedicated to ecological research and biodiversity monitoring. Sustaining long-term research programmes requires continuous funding and support. Additionally, data collected must be integrated into policymaking and management practices.

5.1.3.4 Alignment with EU policies

The Czech Republic's strategy **aligns well with the EU's overall goals**, especially in promoting sustainable forest management and biodiversity conservation. Both strategies emphasize the importance of cross-border cooperation and knowledge exchange. EU recommendations are tailored to local conditions, considering the specific ecological and socio-economic context of Czech forests. The strategy incorporates wildfire prevention measures such as firebreaks, public awareness campaigns, and forest management practices that reduce wildfire risk. Forest restoration focuses on reforestation with native species, improving forest health, and resilience to climate change.

In some areas, national policies may lag EU recommendations, particularly in integrating innovative technologies and practices. Furthermore, training for firefighting personnel could be improved and greater

investment in advanced wildfire detection and management technologies is needed. Emphasis on ecological restoration principles and integration of climate change adaptation strategies should be enhanced.

5.1.3.5 Economic aspects

Forest management in Czechia plays a significant role in the country's economy, particularly in sectors like timber production, tourism, recreation, and ecosystem services.

Timber and Wood Industry - The forestry and wood industry is one of the most important sectors in Czechia's economy. The country has a long tradition of timber production, with forests covering about 34% of its total land area. The sector provides employment opportunities not only in timber extraction but also in wood processing and manufacturing industries. Thousands of people in rural areas depend on forestry for their livelihoods.

Tourism and Recreation - Czechia's forests attract both domestic and international tourists for activities like hiking, bird-watching, cycling, and nature exploration. National parks and protected areas, such as the Moravian-Silesian Beskydys are very popular destinations. These activities contribute significantly to local and national economies. Investing in sustainable tourism can increase the economic value of forests without degrading their ecological integrity, ensuring long-term benefits for local communities.

Ecosystem Services and Carbon Markets - Forests provide essential ecosystem services, including water regulation, soil protection, and air purification, which have indirect economic benefits. Though these services are often not directly monetized, they reduce costs associated with water treatment, flood prevention, and soil conservation. Czechia's forests play a role in carbon sequestration, storing significant amounts of carbon and helping to mitigate climate change. There is growing interest in developing payments for economy services schemes, where landowners and forest managers are financially compensated for maintaining and enhancing the ecological functions of their forests.

Economic Policies and Subsidies - The Czech government supports forest management through subsidies and financial incentives aimed at sustainable forestry practices, reforestation efforts, and forest health restoration after natural disturbances (like pest outbreaks and storms). Czechia also benefits from European Union funds, such as those from the Common Agricultural Policy and Rural Development Programs.

Economic Challenges - One of the most significant threats to the economic stability of the forestry sector in Czechia is the bark beetle crisis. Large-scale infestations have led to substantial financial losses due to reduced timber quality and increased management costs for pest control and forest regeneration. Climate change poses risks to forest health, including increased droughts, pest outbreaks, and fires. These factors can reduce the economic value of forests and increase the costs of maintaining healthy ecosystems.

5.1.4 France

The general distribution of forest ownership between public and private entities in France is approximately as follows: 25% for public owned forests, 75% for private owned forests. 1.8% of France forests areas is classified as protected areas.

5.1.4.1 Key legislation

In France, forest fire management is governed by a set of laws and regulations aimed at preventing fires, supervising disaster response, and organizing reforestation after fires. Here is an overview of the main legal and regulatory provisions concerning prevention, response, and reforestation:

> *Forest fire prevention*. Forest fire prevention is one of the pillars of public policies for forest protection in France. Several laws and measures govern this issue:

Forest Code. The French Forest Code defines a set of obligations concerning fire prevention. Landowners in risk areas are required to brush around buildings, infrastructure, and land. The law requires clearing within a 50-meter perimeter around homes (Art. L.131-10 of the Forest Code). In high-risk periods, access to certain forest areas may be prohibited or restricted to prevent fires caused by human activities.

Forest fire risk prevention plan (PPRIF). The municipalities that are most exposed to fire risks may have a Forest fire risk prevention plan (PPRIF). This urban planning document imposes restrictions on land use in risk areas, for example by prohibiting construction in the most vulnerable areas.

Awareness and regulation of human practices. Awareness campaigns are regularly conducted to inform the public about behaviours to avoid in the forest (lighting fires, throwing cigarette butts, etc.). In addition, prefectural decrees regularly prohibit certain dangerous practices in the summer, such as campfires or the incineration of plants.

Fire response

Emergency response organization. The fight against forest fires is governed by a rigorous organization and a distribution of skills. The Departmental Fire and Rescue Services (SDIS) are responsible for direct intervention in the event of a fire. They coordinate firefighters on the ground and, if necessary, aerial intervention with water bombing planes and helicopters. The law enforcement agencies (police and *gendarmerie*) are often mobilized to secure evacuated areas, regulate traffic and participate in the operations. In the event of a major crisis, the Armed Forces may be called in as reinforcements to help contain fires.

ORSEC Forest Fire Plan. The ORSEC (Organization of Civil Security Response) Forest Fire Plan is triggered in the event of a major fire. It allows for optimal coordination between the various response services (firefighters, civil protection, law enforcement, etc.), with increased resources. The plan also includes provisions for the evacuation of populations and the protection of infrastructure.

Air resources and equipment. France has air resources to fight forest fires, including Canadair crafts and other water bomber aircrafts. French laws provide specific funding to maintain and renew these fleets of aircrafts as well as land equipment for firefighters.

Reforestation and restoration after a fire

Reforestation obligations. After a fire, provisions of the Forest Code sometimes require the reforestation of damaged land, particularly in private forests. This obligation depends on the type of forest and the species present. Forest owners are often required to replant trees destroyed by fires, except in cases where natural regeneration is deemed more appropriate.

Prohibition of land use change. Burnt land is subject to restrictions to prevent it from being transformed into building zones. Under the law, it is forbidden to change the use of burnt land for a period of 15 years. This helps to avoid abuses that would consist of starting deliberate fires in order to build on forest land.

Financial support for reforestation. The State, through the National Forest Fund or regional programs, grants aid to forest owners for reforestation after a fire. Subsidies can also be granted to encourage the planting of species that are better adapted to climatic conditions and more resistant to fires.

Forest fire management in France is based on strict legislation that considers all aspects of the problem: prevention, intervention and reforestation. The emphasis is on the responsibility of owners and local authorities, the coordination of rescue operations and the preservation of forest land after a fire. These measures are reinforced by awareness campaigns and permanent monitoring systems, particularly during the summer periods when the risk is high.

5.1.4.2 Government agencies and other stakeholders

In France, forest management and wildfire control involve various institutions and organizations, each with specific responsibilities in the prevention, intervention, and restoration wildfire phases. Here's an overview

of the main institutions and how they coordinate efforts before, during, and after a forest fire. The main institutions responsible for forest management in France are: the **National Forestry Office (Office National des Forêts, ONF)**, a public agency responsible for managing public forests in France, including state-owned forests and those owned by local authorities; the **National Centre for Forest Ownership (Centre National de la Propriété Forestière, CNPF)**, a public organization dedicated to managing private forests. It helps private landowners with sustainable forest management, fire prevention strategies, and reforestation after wildfires. The **Ministry of Ecological Transition,** which defines national policies related to the environment, including forest management and wildfire control. It coordinates the actions of national stakeholders, especially in terms of regulations and funding.

The organizations responsible for wildfire management during the *prevention, intervention, and restoration* phase of wildfire events are the following:

Prevention

I) Departmental Fire and Rescue Services (Services Départementaux d'Incendie et de Secours - SDIS). The SDIS play a crucial role in fire prevention. They organize awareness campaigns and help plan preventive measures (firebreaks, access roads, brush clearing). **II) ONF and CNPF**. Both institutions are actively involved in prevention by maintaining forest infrastructure (firebreaks, roads), conducting brush clearing operations, and monitoring forests. **III) Météo France**. This agency provides weather forecasts, particularly related to conditions favourable to wildfires (heatwaves, strong winds). It plays a role in activating alert systems during high-risk periods. **IV) Prefectures**. These local government offices coordinate fire prevention efforts. They can issue orders to restrict certain activities during high-risk periods (e.g., banning access to certain forest areas, prohibiting open fires).

Intervention

I) SDIS The SDIS are the main actors in fighting wildfires. They coordinate firefighter deployments and manage both ground and air resources (e.g., water bombers) to contain fires. **II) Armed Forces (including aerial firefighting units)**: specialized units of the Civil Security, such as Canadair crews and other aircraft, are mobilized to reinforce ground operations. The military can also be called in during major crises. **III) Law enforcement (police, gendarmerie):** These forces help secure evacuated areas, control access, and sometimes assist directly in firefighting efforts. **IV) ORSEC Forest Fire Plan**: Coordinated by the Prefecture, this plan is activated in case of a large wildfire. It ensures optimal coordination between the various actors (firefighters, police, military, municipal services).

Restoration

I) ONF. The ONF is responsible for reforestation in public forests after a fire. It implements restoration plans based on sustainable management principles, often promoting natural regeneration. **II) CNPF**. The CNPF assists private landowners in restoring their forests, offering technical advice on species selection and regeneration methods, and helping them access grants. **III) National Forestry Fund**. This government-managed fund finances reforestation and prevention actions in forests. It offers subsidies for post-fire replanting projects. **IV) Local governments and regions**. Local authorities play a role in coordinating reforestation efforts in their territories and may provide financial aid to affected landowners and municipalities.

Forest and wildfire management in France involves a broad set of **stakeholders**, including government agencies, private owners, local communities, NGOs, and industry. While most relevant groups are represented, small landowners and marginalized communities may be underrepresented. Efforts are made to distribute the benefits and burdens of forest management and wildfire prevention fairly, though regional disparities exist. Local communities are actively involved in wildfire management, particularly through awareness campaigns, volunteer fire programs, and mandatory vegetation clearing. Community-based risk reduction strategies and educational efforts play a critical role in reducing fire risks and promoting sustainable forest practices.

5.1.4.3 Management practices, monitoring and enforcement

In France, the 'qualitative' restoration of forests is considered, beyond mere quantitative criteria. A network of primary forests is protected from **logging and forest management.** France seeks to ensure multifunctional management that enhances all the ecological services of forests, placing **biodiversity at the heart of forestry policy** to facilitate management adaptation. Attention is also placed on equipping forests and foresters to meet the challenges of the climate crisis, while also integrating forests into spatial planning as green infrastructure for the economy. The forestry code requires owners to renew the forest status within five years of felling. Forest restoration includes all activities, such as reforestation and afforestation, that contribute to returning a forest to a healthy state. This involves combating invasive species, maintaining tree diversity, restoring the composition and structure of the forest to a more natural state, and thinning or removing underbrush that competes with trees. A wildfire is also seen as an opportunity to rethink the overall management and planning of the area affected by the fire (firebreaks, improved access and water management, choice of forest species used). There is increasing recognition of the need for an **integrated approach to fire management**, assessment (monitoring and analysis), risk reduction (prevention), preparedness, response (extinguishment) and recovery.

France employs a comprehensive suite of methods, procedures, and technologies for **forest monitoring**, encompassing field surveys, and automated systems. Satellite imagery enables continuous monitoring of forest cover and health, while aerial photography from unmanned aerial vehicles (UAVs) and other tools for Wildfire Prevention enables an early detection. The **enforcement of forest management** laws and ensuring compliance is achieved through a multifaceted approach involving legislative frameworks, regular inspections, technological tools, and community engagement as following. This comprehensive enforcement action safeguards the sustainable management and protection of French forest resources.

5.1.4.4 Alignment with EU policies

Thanks to the implementation of **France 2030**, France aims to make the forest-wood sector a strategic area to drive the French economy towards an essential transition and achieve the goals of a decarbonized economy by 2050. France's national forest strategy generally aligns with the EU Forest Strategy in several key areas, such as sustainable management, biodiversity conservation, climate adaptation, and the protection of ecosystems. However, there are specific areas where gaps or mismatches between national policies and EU objectives can be observed. These discrepancies arise due to the unique geographical, climatic, and social characteristics of France, as well as the complexity of certain issues like wildfire management and forest restoration. Addressing these challenges will require tailored national policies that work within the broader EU framework but consider local realities, especially for regions like the Mediterranean where the risks and priorities differ from other parts of Europe.

5.1.4.5 Economic aspects

In France, forest management is supported by a variety of funding sources and economic incentives aimed at ensuring sustainable practices, wildfire prevention, and forest restoration. France's forest management funding model is comprehensive, involving public funds, private contributions, and innovative mechanisms like **Payment for Ecosystem Services (PES)**. These resources are generally used efficiently, although challenges remain in reaching smaller landowners. The governance model promotes cost-effective actions, and the economic benefits for stakeholders – particularly local communities – are significant. As forest services are increasingly valued from an economic perspective, PES and carbon markets offer new opportunities for sustainable management and forest restoration. The overall system provides a balance between protecting natural resources and creating economic opportunities.

5.1.5 Greece

The general distribution of forest ownership between public and private entities in Greece is approximately as follows: 74,1% for public-owned forests, 6,5% for privately owned forests, 10,4% for monasteries and joint forestry properties, and the 9% is municipal land (Ministry of Agriculture, 1992). In terms of protected areas, according to the Joint Ministerial Decision 50743 (Government Gazette 4432B/15-12-2017), the extent of the 446 protected areas of the Natura 2000 network in Greece covers an area of 58,773.25 sq. km, which corresponds to 44.5% of the total country.

5.1.5.1 Key legislation

The primary national normative sources that regulate forest in Greece are the following:

With the 170195/758/2018 Ministerial Decision **"Forestry Strategic Development Plan 2018-2038 (National Strategy for Forests)"**, the principles and directions of the forestry policy for the period 2018-2038 and the specific objectives of this policy are determined, as well as the necessary resources and means of its implementation. In the framework of this strategy, a model of Mediterranean forestry is adopted in the country with the aim of "ensuring sustainability and increasing the contribution of forest ecosystems to the country's economy through multifunctionality, adaptability and strengthening their socio-economic role, in the light of climate change". The Forestry Strategic Development Plan is the framework for the national forest protection and development, takes into account the considerations of the European Union legislation and Agenda for 2030.

Law 4662/2020 "National Crisis and Hazard Management Mechanism, restructuring of the General Secretariat of Civil Protection, upgrading of the civil protection volunteer system, reorganization of the Fire Department and other provisions", a National Crisis and Hazard Management Mechanism is established which covers the entire disaster management cycle and constitutes all the concurrent operational and administrative structures and functions of Civil Protection. Article 36 of the above law establishes a National Operations Coordination and Crisis Management Center which also has the responsibility of dealing with forest fires.

Law 4685/2020 "Modernization of environmental legislation, integration into Greek legislation of Directives 2018/844 and 2019/692 of the European Parliament and of the Council and other provisions", new provisions were established for the protection of the environment and forests in accordance with European legislation.

Law 5075/2023 "Restructuring of Civil Protection - National Mechanism for Air Rescue and Air Transport and other emergency provisions for state aid" and Article 35 "Fire Department and Forest Service Cooperation for Large Area Fire Management - Establishment of Large Area Forest Fire Management Support Teams" partially re-established the participation of the Forest Service in forest fire fighting. In addition, there is an obligation with older provisions for patrols of the Forest Service during the fire season for the prevention and detection of forest fires.

Law 5110/2024 and articles 67, 68, and 69 provide for the implementation of measures to reduce the fire risk around military camps by clearing vegetation and thinning the forest. Issues related to the prevention of wildfires from the use of fire in the countryside for agricultural or other purposes are regulated by special Fire Regulations issued annually, such as 9/2024 "Definition of measures and means for the prevention and avoidance of fires in forests, forest, grassland, and rural areas, parks and groves of cities and residential areas, areas with special protection status, other areas located near these areas as well as in plots of land".

Also, for the first time, **Fire Regulation 21837/2024** "Determining measures and means to prevent and avoid the occurrence of fires in forests, forest, grassland, and rural areas, parks and groves of cities and residential areas, areas with a special protection regime, other areas located near these areas as well as in plots of land" provides for the cleaning of vegetation around buildings to protect them and to prevent fire from spreading to neighbouring areas.

5.1.5.2 Government agencies and other stakeholders

In Greece, forest management and wildfire control involve various institutions and organizations, each with specific responsibilities. The **Ministry of Environment and Energy** is engaged through the following government agencies: General Secretariat of Forest, where the Directorates of Coordination and Inspection of Forests are responsible for the coordination, supervision, and control of all Forestry Services and personnel. The Forest Offices and the Forest Directorates to which they are not affiliated, regulate procedures, take measures, and approve Acts and Administrative Decisions on matters concerning Wildlife, Hunting, and Grazing, Forest Management, in the National Forests and Pastures, and Forestry Projects. The **Ministry of Climate Crises and Civil Protection**, from which the entire National Crisis Management Structure is derived.

Here's an overview of the institutions coordinate the efforts before, during, and after a forest fire.

Before the fire, the Forest Service is responsible for increasing the forest resilience and reducing fire risks inside forests. This is achieved through adaptive forest management, construction of forest roads, and in general by keeping forest roads in good condition. For areas such as Wildland Urban Interfaces, Civil Protection Agency and Municipalities have the responsibility to reduce the probability of wildfire ignition, by keeping areas inside or near the urban areas and managed parks clean from dead vegetation. Also, citizens are obliged to keep their land properties free of flammable materials. In this phase, the coordination of the participating agencies, when necessary, is carried out by the special coordinating body directed by the Region. Public services are involved in forest and land guarding against fire ignition. Specifically, Fire Brigade, Forest Service, Police, and if necessary, military personnel participate in the form of mixed patrols. Citizens in the form of organized groups of volunteers, in collaboration with civil protection agencies, can participate in protecting the forest from fire and report the start of a fire.

During a fire, the Fire Brigade is responsible for firefighting in the urban and rural areas. The Forest Service participates in this phase with an advisory role. Many other agencies may participate in the protection and/or evacuation of citizens, e.g., Police and Port Authority Corps, while health services may also participate if necessary to treat injured personnel or citizens. The coordination of the agencies for this phase is implemented, at the higher level, by the Operations and Crisis Management Coordination Centre of Civil Protection. For the local Service, the coordination is implemented by the Fire Brigade, which requests assistance from other services. Especially regarding the evacuation of citizens, the Fire Brigade recommends the evacuation of citizens and suggests escape routes, but the final decision is taken by the Municipality.

After the fire, the Forest Service is responsible for the burned public forest. In the case of private forests, the Forest Service only has a supervisory role for the restoration process, but the responsibility for the forest restoration as such belongs to the owner of the area. For the restoration of city damages or agricultural lands or infrastructures, the responsible are the Public Services that have the conventional management of each sector. The coordination in this phase, if needed, is carried out by the Region services.

For forest management planning there is no formal participatory process of local communities or local authorities, even though local society needs are taken into consideration. The participation of local communities in fire protection focuses on the prevention of the ignition of fire during fire season and removing dead vegetation from the courtyard. Local authorities have a significant role in the protection of local communities and organize places for human concentration in case of disaster. Forest restoration is administrated by the local forest service and implemented either by it or private organizations with the supervision of the forest service. Fire risk reduction is the responsibility of the state both for the prevention phase and the firefighting phase.

5.1.5.3 Management practices, monitoring and enforcement

Forest management in public forests is implemented by the Forest Service, while private forests are managed by the owners based on management plans approved by the Forestry Service, while the Forest

Service supervises the correct application of the management plans. These processes relevant to forest management are followed in any case before or after a fire. For forest protection, complementary fire protection plans can be applied in wider areas around the forested area, such as clearing the vegetation along the roads and around towns. Owners of private land inside cities must keep them free of flammable materials including dead vegetation.

In the case of particularly large fires, comprehensive long-term plans for the restoration of the environment and the development of the wider area are drawn. In these plans, the needs of different groups of the population are considered, but the citizens do not participate in the final planning of the restoration of the area.

In practice, only productive forests are managed, either public or private. Under the consideration of forest fire risk reduction, an attempt is being made to manage non-productive forests as well. This attempt aims at reducing dead biomass in forests to minimize conditions leading to wildfires, as well as to create firebreaks to facilitate firefighting actions. The start has been made from the lowland forests that are considered more vulnerable to fire. Moreover, the aim of the management is to exploit forest ecosystem services to enhance local and national economies and improve the lives of local communities in terms of safety from fires, recreation for the urban population, and forest product sharing for the local population.

The legal framework already exists but some improvements and adaptations of forest management planning standards are under discussion. As stated in the Forestry Strategic Development Plan 2018-2038 (National Forest Strategy), continuous monitoring of forest evolution and the effectiveness of applied strategies and tactics is implemented. For forest monitoring and any license to use forest functions, the responsibility belongs to the Forest Service. The monitoring of forests is primarily based on direct local inspection on a regular basis by the personnel of the Forest Service. In a medium and long-term base, remote sensing methods, typically with aerial photographs, are used. In some cases, satellite images are also used.

The monitoring of the application of fire prevention measures related to forests is fulfilled by the Forest Service by local inspection. During the fire season, patrols from groups of the Fire Brigade, the Forest Service, Police, and Military personnel, as well as volunteer citizens, guard the forest. The Fire Brigade also distributes manned fire trucks near or inside the forest for wildfire ignition prevention and quick intervention. For wildfire monitoring, also manned and Unmanned Aerial Vehicles (UAV) are used. These means are also used in the case of serious fire events for direct image transmission and/or for local command centres. In some cases, cameras with remote data transmission are used for monitoring areas with high wildfire risk.

The Forest Service monitors the effectiveness of the burned forest restoration for the public and private forests. The commonly preferred method for forest restoration is through natural regeneration. In cases of failure of natural regeneration, artificial planting is applied. The preference for natural vegetation recovery is firstly due to ecological reasons, since it is preferable to re-establish the forest with locally adapted species, and secondly due to the high cost because of the prevailing steep terrain and the extended dry summer season that implies the need for extensive irrigation.

The application of forest management laws is carried out by all hierarchical levels of the Forest Service and penalties are issues in case of violation of the application of the laws and/or the approved forest management plans.

5.1.5.4 Alignment with EU policies

Alignment with EU policies is included in the Forestry Strategic Development Plan 2018-2038. However, the adaptation of the current public mechanism and the investments in personnel training, processes changing, and the adoption of new methods and technology investment is a matter of the real capabilities of public services, not only of the legislative and administered framework.

In terms of legislation and structure of administration, considerable progress has been made, but the acceptance of innovations and their adoption in practice is a matter that needs more time.

5.1.5.5 Economic aspects

The direct income from forest timber production is low. This is due to low machinery use in the timber production cycle because of two main characteristics: i) the steep terrain of the most productive forests; and ii) most of the forests are natural of all ages type. These two characteristics make the use of machinery in timber collection problematic. Almost all the income from timber production goes to the local loggers to strengthen and maintain the local workforce. The most significant income from the public forests comes from the taxation systems through the commercial activity of the forest products, including veterinary products, the grazing flocks in the forest and the tourist activity in forested areas. Most of the funding for forest administration, management, and protection, especially for firefighting, comes from the central governance budget. Restoration of fire damages usually refers to the aid and compensation to citizens and businesses that have suffered damage from fires, as well as for the restoration of damage to public infrastructure. Usually, damaged forests are recovered by natural regeneration, but in cases of repeated burned areas the initial vegetation community may be replaced by a degraded plant community.

5.1.6 Portugal

In Portugal the general distribution of forest ownership between public and private entities is as follows: approximately 20% for public owned forests, and approximately 80% for private owned forests. Additionally, the Portuguese system of protected areas covered 25% of the country's entire forest area.

5.1.6.1 Key legislation

National Plan for Integrated Rural Fire Management, Resolution of the Council of Ministers NO.45-A/202, of 16 June 2020. The Plan envisages new fire prevention methods with an impact on spatial planning and new spatial planning options, forms of fuel management and forest planning. These new directives must be gradually implemented by public authorities, but also by private operators who in some way exploit forest resources. This implies reviewing forest fire protection planning instruments, such as Municipal Plans and Intermunicipal Forest Fire Protection Plans. Indeed, the new System will only be fully operational when the guidelines have been implemented at local level, which are dependent on such reviews.

The rewriting of **Decree-Law No. 124/2006**, of 28 June 2006, also involves changing all the operational choices it established that require review, particularly those concerning rural fire prevention. In this case specifically, it should be noted that the future legislative act should lawfully set out only matters that, pursuant to the Portuguese Constitution, require legal provision, leaving technical and non-statutory matters and aspects to the regulatory sphere, providing the flexibility required to facilitate the continuous updating thereof.

Pursuant Forest Policy Law (No. 33/96, of 17 August 1996), the Integrated Rural Fire Management Strategy (IRFMS) aims at the national, regional and sub-regional organisation of the planning and coordination of fire prevention and detection and collaboration in fire suppression, which is now provided for under the organic law published for Instituto da Conservação da Natureza e das Florestas (ICNF). However, there are other implications when it comes to legislative acts that govern the operation of public authorities, which require the approval of legal norms. Particular attention should be paid to legal frameworks for the operationalisation of new mechanisms for the coordination and financial implementation of the IRFMS, which includes reviewing the Regulation on the Permanent Forest Fund, creating a special framework for financing and granting public subsidies (related to Decree-Law No. 167/2008, of 26 August 2008) to ensure they are in line with the IRFMS's new goals.

5.1.6.2 Government agencies and other stakeholders

There was a system in place in 2017 and at the time this chapter was written. A system that, according to that same PNDFCI and to Decree-Law No. 124/2006, of 28 June 2006, is based on three pillars of action: one for structural prevention, overseen by ICNF, I.P., an intermediate pillar for surveillance, detection and inspection, overseen by the GNR, and, finally, the suppression, mop-up and fire surveillance pillar, overseen by ANEPC9. In 2006 this system was known as **the Forest Fire Protection System (SDFCI)**.

Under the SDFCI, ICNF, I.P., vested with the functions of national forestry authority and the pillar of prevention, is responsible for coordinating the planning and monitoring of the implementation of the PNDFCI. It was incumbent upon ICNF, I.P. to define the principles and methodology for designing municipal sector plans which would assess and approve, and also replace the civilian governments in district sector planning. ICNF, I.P. was also given the responsibility of monitoring the development and use of forest fire protection systems (RDFCI) which comprises all the rural forest fire protection infrastructures and the implementation thereof (or development of the instruments required for implementation) and all preventive interventions on the lands it directly managed.

The GNR, responsible for coordinating prevention, surveillance, detection and inspection, in the overlap between the SDFCI and the Integrated System for Protection and Relief Operations (SIOPS), approved by Decree-Law No. 134/2006, of 25 June 2006, permanently made available decision support information to the national and district civil protection commands through their military personnel posted there. Operational prevention initiatives are coordinated by forming a Forestry Information Maintenance and Exploitation Team (EMEIF) which works together with each district command, with the GNR also ensuring the operation of the National Lookout Tower Network (RNPV), forest patrols and fire suppression interventions. The GNR also plays a key collaborative role in the implementation of exceptional measures included in the declarations of a State of Alert issued pursuant to the Basic Law on Civil Protection and also collaborates when required by the engagement plans, or when the seriousness of the situation so requires, always as part of the respective command and within the framework of specific legislation.

It is incumbent upon ANEPC to plan, coordinate and implement emergency and civil protection policies (namely for prevention and response to major accidents and disasters), policies for the protection and relief of populations and those for the coordination of civil protection officers, as provided for by law. ANEPC is, therefore, competent and responsible for the cross-cutting organisation and coordination of all civil protection operations that significantly exceed the domain of rural fires and coordinates the suppression pillar, as established under the SDFCI.

As indicated above, this model is still in force and aims to prevent, detect and suppress fires. To this end, it was consolidated by means of vast and increasing annual public expenditure which, for 2016, is estimated to have reached €143 million[10]. With only about 20% of the annual budget earmarked for prevention (if one considers the average annual expenditure to be €31 million for 2016), the reduction of the fuel load in forests and scrublands was insufficient, although there was a slight change in the behaviour of the population, demonstrated by the reduced number of ignitions (<5%/year). Improved detection, surveillance and suppression also resulted in a system that ensured a better initial attack: 96% of ignitions become fires covering less than 10 ha. However, the concentration in 2 to 3 weeks of the year of only 4% of uncontrolled ignitions explains more than 90% of the burned area. We know that the more demanding situations occur over a few days of the year, when weather conditions decisively limit ignition, progression, effective prevention and successful suppression.

5.1.6.3 Management practices, monitoring and enforcement

This shared vision, *of a **Portugal protected from severe rural fires***, allows us to embrace the challenge with determination and confidence, knowing that only by working together will we achieve the intended goals.

This vision acknowledges that rural fires cannot be completely avoided and, as such, we must prepare the territory, the people and operational personnel to work the land in a way that improves safety for all, while at the same time using fire[7], in a technically sustainable manner, as an environmental factor commonly used in agricultural, forest and habitat management.

With a focus on prevention, by educating and raising awareness among communities to change behaviours and with an ambitious vegetation management programme, any severe rural fires that may occur will be in fewer in number, destroy much less property and will be a lesser threat to people's lives and safety.

This vision sees fire as a tool for managing wild land and an ecological element, provided that technical fires are used, encouraging its replacement as a tool for eliminating scrublands and slash with alternative solutions, such as collecting slash for energy generation or composting.

This vision is in line with the mission to ***protect people and property from rural fires and develop wild land, ensuring ecosystems are properly tended to by*** identifying strategic guidelines and their respective goals, for which a unified action plan and projects for the 2020-2030 period must be continuously implemented, replacing the current National Forest Fire Protection System (SDFCI).

The IRFMS and its processes are designed for greater simplicity, flexibility, specialisation and rigour, allowing the entities to see the results of their actions by using integrated resources and efforts at the service of the community, in strict collaboration therewith, to carry out complex operations efficiently and effectively.

The NPIRFM applies to the entire territory[8], linking all public and private entities and all citizens and encouraging them, through an action programme with sufficient resources, to fastidiously undertake their responsibilities and duties.

The IRFMS is based on principles that embody its culture. This culture should be internalised by the various entities involved in the IRFMS, and by citizens. It is embodied in the initiatives of the entities for the community and the action of citizens to ensure their own safety.

The principles governing IRFMS initiatives are described below, are in line with the principles of the Food and Agriculture Organization (FAO) (2006).

5.1.6.4 Alignment with EU policies

To this end, the Plan's strategy is rooted in other public policies, thereby finding coherence and consistency. First in the **PNPOT**, a very important instrument of the Territorial Management System and which emphasises the concern with the territory and its vulnerability to fires in its various technical components, including diagnosis and scenarios and, particularly, the strategic thinking that shapes it. By prioritising the importance of the value of natural assets for nature conservation, the economy of the forestry and agroforestry sectors as anchors for the development of rural land, and by encouraging the improvement of territorial governance, emphasising its criticality as a tool for preventing and mitigating the increased risk of climate change, the PNPOT is an excellent framework for designing the strategic guidelines of this Plan.

However, another preceding framework was also considered in this regard, the **Portuguese Forest Policy Law** (Law No. 33/96, of 17 August 1996), which contains a set of guidelines, two of which have already been implemented in the transformation process that started after 2017 and which will contribute significantly to solving the problem of fires, in particular the approval of the Regional Forest Planing Instruments (PROF) and organic law of ICNF, I.P. in 2019, which establishes the institution as a national, regional and sub-regional organisation tasked with planning and coordinating fire prevention and detection initiatives and collaboration in rural fire suppression operations.

Another related policy instrument is the **National Forest Strategy** (Resolution of the Council of Ministers No. 6-B/2015, of 4 February 2015) which, in 2015, recommended 'that irrespective of the ongoing interim evaluations, the core measures of the PNDFCI (2006-2018) must continue to be implemented, particularly the full operation of the organic structures created for the harmonious implementation thereof'. **The**

reports published by ITC1 and ITC2 recommend systemic changes, including at strategic level (specialisation of the RFM and RFP pillars), in risk governance and risk management processes, and establishing priorities, particularly those that effectively and harmoniously ensure the link between and coordination of policies and initiatives. At the end of 2019, an audit report published by the Audit Court (2019) highlighted the lack of coherence between the national and municipal levels of the DFCI planning structure, thus strengthening the case for improving the fire risk governance structure.

In addition, the **National Nature Conservation and Biodiversity Strategy** (Resolution of the Council of Ministers No. 55/2018, of 7 May 2018) recognises the value of natural heritage, promotes the improvement of the conservation status and encourages society to appropriate natural values and biodiversity.

With regard to national, European and international emission commitments, of note is the **Roadmap for Carbon Neutrality 2050** (RNC 2050), published in July 2019, which is the long-term strategy submitted to the United Nations Framework Convention on Climate Change, stating that '*the goal is to reduce Portugal's GHG emissions between 85% and 90% by 2050, compared to 2005, and offsetting remaining emissions with agriculture and forestry, through a trajectory that reduces emissions between 45% and 55% by 2030 and between 65% and 75% by 2040*'.

In this regard, the Portuguese strategy is based on reducing emissions and increasing forest sequestration, where a critical success factor is a 60% reduction of burned area (from an average of 164,000 ha between 1998 and 2017 to 70,000 ha per year in 2050), thereby ensuring that burned areas do not become scrublands, that the average yield increases with better management, the afforestation of 8,000 ha of non-forest areas and that small ruminants are used to reduce fuel loads. In view of the fact that peak emissions are linked to years with a larger burned area, 2017 explains the marked rise in emissions (more than 10 Mt of Co2e), making it crucial to design strategies that reduce the likelihood of the events of 2003, 2005 and 2017 repeating themselves. The monitoring of emissions, resulting from changes in land and forest use for the 2021-2025-2030 period, is enhanced by the pledge made by Portugal (Regulation (EU) No. 2018/841 of the European Parliament and of the Council of 30 May 2018).

Finally, it is important to note that the **National Strategy for Preventive Civil Protection** (Resolution of the Council of Ministers No. 160/2017, of 30 November 2017) sets five strategic goals aligned with the priorities of the **Sendai Framework**, namely a) strengthen risk management governance, b) improve knowledge of risks, c) design strategies to reduce risk, d) improve preparedness to face risks, and e) engage citizens in understanding the risks.

5.1.6.5 Economic aspects

From an economic and financial perspective, harmonisation between the forest and fire management and the National Investment Plan, and other sectoral investment plans, is important given the common strategic approach to the sustainability of rural territory. As such, common pathways for cooperation should be sought in innovation, research, qualification, sustainability of the rural territory and development of the interior using resources to diversify the economic base, for competitive rural development, risk prevention, enhancing the environmental and economic potential of forests, biodiversity and promoting agri-environment measures and the circular economy.

5.1.7 Romania

At the end of 2023, the Romanian national forest fund occupied an area of 6,616 thousand hectares, representing 27.8% of the country's area. In 2023, public ownership represented 64.3% of the total area of the national forest fund, being primarily managed by the National Forest Administration – Romsilva, while private ownership represented 35.7%, mostly managed by private forestry structures. Over 40% of Romania's forests are included in different types of protected areas, which is well above the European average.

5.1.7.1 Key legislation

The Romanian legal framework currently includes the following reference normative acts in the field:

Law no. 307/2006 on fire protection, with subsequent amendments and completions.

Law no. 481/2004 on civil protection, republished, with subsequent amendments.

Law no. 95/2006 on healthcare reform Title IV, The National Emergency Medical Assistance and Qualified First Aid System, republished, with subsequent amendments and completions.

Government Emergency Ordinance no. 21/2004 on the National Emergency Situations Management System, approved with amendments and completions by Law no. 15/2005.

Government Ordinance no. 88/2001 on the establishment, organization, and functioning of public community services for emergency situations, approved with amendments by Law no. 363/2002, with subsequent amendments and completions.

Government Emergency Ordinance no. 1/2014 on certain measures in the field of emergency management, as well as for amending and completing Government Emergency Ordinance no. 21/2004 on the National Emergency Situations Management System, approved by Law no. 104/2014, with subsequent amendments and completions.

Government Decision no. 94/2014 on the organization, functioning, and composition of the National Committee for Special Emergency Situations, with subsequent amendments and completions.

Government Decision no. 1.490/2004 for the approval of the organization and functioning regulation and the organizational chart of the General Inspectorate for Emergency Situations, with subsequent amendments and completions.

Government Decision no. 1.492/2004 on the principles of organization, functioning, and responsibilities of professional emergency services, with subsequent amendments and completions.

Government Decision no. 557/2016 on risk management.

Government Decision no. 768/2016 on the organization and functioning of the national platform for disaster risk reduction.

5.1.7.2 Government agencies and other stakeholders

In Romania, forest management involves various stakeholder groups, including government institutions which oversee policy implementation and enforcement. In the event of forest fires, the coordination of national-level actions is exercised by the head of the **Department for Emergency Situations** as the commander of the operation, or by a person designated by them. The decision-making components are supported in the decision-making process by the following: the **National Coordination and Command Centre** for Interventions, the **National Integrated Command Centre of the Ministry of Internal Affairs (MAI)**, operational centres, and emergency operational centres organized at central and territorial levels, technical support groups, and/or command centres. The operational coordination of all forces and resources involved in response actions is carried out by the **Department for Emergency Situations (DSU)**, with technical support from the **General Inspectorate for Emergency Situations (IGSU)**. The coordination of intervention operations at the national level is carried out by the commander of the action through the **National Coordination and Command Centre for Interventions (CNCCI),** while at the county level, the coordination of intervention structures is carried out by the intervention commander through the county operational centres. The coordination for ensuring logistical support of the aerial resources is the responsibility of the person designated by the aviation structure. The implementation of emergency management measures caused by the occurrence of forest fires is carried out based on the Risk Analysis and Coverage Plans, action plans, and cooperation plans between MAI units, **Forest Directorates**, and the

Forest Guard in the field of fire prevention and extinguishing, prepared at the level of each county and the Municipality of Bucharest.

The development of the strategy and concept for forest fire defence falls under the responsibility of the **Ministerial committee for emergency situations** within the central authority responsible for forestry, which is subordinated to the **National Committee for Emergency Situations**.

Monitoring emergency situations, evaluating information, notifying, warning, pre-alerting, alerting at the national level, as well as coordinating the uniform implementation of measures for preventing and managing emergency situations are ensured by the **Operational Centre for Emergency Situations**, a technical body with permanent activity established within the central authority responsible for forestry.

5.1.7.3 Management practices, monitoring and enforcement

Romania has a long-standing tradition in the sustainable management (natural regeneration) of its forest resources. From a forestry practice perspective, forest management must be carried out according to national regulations and technical parameters, regardless of the size or type of ownership. Forest management plans, which are valid for a period of 10 years, include management provisions for each forest stand. These plans are prepared by firms specialized in forest management and are approved by the national forestry authority. Their implementation is mandatory. In Romania, there is a Catalogue of Virgin Forests that includes the most valuable forests. As of May 12, 2023, the 14th edition of the Catalogue of Virgin and Quasi-Virgin Forests includes a total area of 72,279.43 hectares, of which 8,579.8 hectares are virgin forests and 63,699.63 hectares are quasi-virgin forests. The increase of 1,202 hectares is due to the approval of two new identification studies based on the provisions of new forestry arrangements.

Actions to prevent and extinguish forest fires are carried out in accordance with the provisions of the Regulation on Emergency Situation Management as a result of forest fires, approved by Order no. 551/2006 and the Order of the Minister of Environment and Forests no. 2579/07.09.2012 for the approval of the information-decision flow for warning and alerting in cases of emergency situations generated by specific risks associated with the Minister of Environment and Forests. Forest holders, regardless of the title of ownership, are obligated to take measures for preventing and extinguishing fires and to equip themselves with specific technical means for fire prevention and extinguishing. Measures to limit, eliminate, or counteract forest fires are an obligation for public administration authorities at the central and local levels with responsibilities in this area and for all individuals and legal entities, except for persons with disabilities, the elderly, children, and other disadvantaged categories.

5.1.7.4 Alignment with EU policies

The Ministry of Environment, Waters, and Forests has adopted, through a Government Decision, the National Strategy for Climate Change Adaptation (NSCCA) for the period 2024-2030, with a perspective toward 2050. This essential strategy, developed with the support of the Presidential Administration and the Interministerial Committee for Climate Change within the Government of Romania, strengthens Romania's capacity to respond to the challenges posed by climate change while aligning with international commitments made through the Paris Agreement and European legislation.

The NSCCA aims to improve the adaptive capacity of Romania’s socio-economic and ecological systems, with the goal of reducing the impact of climate change on the population and the environment. The strategy provides a coherent and sustainable framework for society and the national economy to adapt dynamically to climate challenges, ensuring sustainable development and citizen protection.

One of the main benefits of this strategy is the protection of citizens and vulnerable communities against the effects of climate change, such as droughts, floods, and extreme weather events. The NSCCA promotes nature-based solutions and ecosystem adaptation, emphasizing the importance of conserving biodiversity and ecosystem services for sustainable development.

5.1.7.5 Economic aspects

The adoption of the NSCCA was a crucial condition for obtaining a loan of 466.9 million € from the World Bank, with the aim of developing policies for disaster risk management. This financial support will facilitate the implementation of necessary measures to reduce Romania's vulnerability to climate risks and promote a sustainable development model. In addition, other types of financial support for the forestry sector can be found through the Ministry of Agriculture's National Rural Development Program, Ministry of Environment funds for offsets in protected natural areas, the Environment Fund (although it provides minimal funding for the forestry sector), and the NRP Funding for afforestation. Furthermore, the budgets of the forestry offices are also a fund to be drawn from the proceeds of timber sales.

5.1.8 Slovakia

In 2022, the state owned 779,900 hectares of forests, 39.9% of the total forest area in Slovakia. The forest ownership in Slovakia is divided among various categories, reflecting a mix of state (49,9%), private (8%), community (32,9%), municipal (0,9%), agricultural cooperatives (0,2%), and church ownership (8,1%). The area of protective forests in 2022 reached 340.5 thousand ha, i.e., 17.4% of the forest stand area of Slovakia.

5.1.8.1 Key legislation

Slovakian forest management legislation integrates the forest fire prevention and mitigation measures. The key provisions include:

Národný lesnícky program Slovenskej republiky (NLP) 2022-2030 (National Forestry Programme of the Slovak Republic 2022-2030). The National Forestry Programme of the Slovak Republic is a basic forestry policy document, an important tool for ensuring sustainable forest management, inter-ministerial cooperation and the fulfilment of international commitments related to forests and forestry.

The key act concerning the forest management in Slovakia is the **Act of the National Council of the Slovak Republic No. 326/2005 Coll. on Forests, as amended**. This Act regulates the definition of forest land and its protection, ownership of forest land and use of forests, professional forest management, promotion of sustainable forest management from public resources, the competence of state forestry administration bodies and state supervision in forests, penalties for violation of the obligations set out in this Act. The purpose of this Act is to preserve, improve and protect forests as a component of the environment and natural wealth of the country for the fulfilment of their irreplaceable functions, to ensure differentiated, professional and sustainable forest management, to reconcile the interests of society and forest owners, to create economic conditions for sustainable forest management, to implement a special regulation in the area of the legal origin of timber harvested on forest land. It also regulates, preserve, improve, and protect forests as a component of the environment and natural wealth of the country for the fulfilment of their irreplaceable functions; to ensure differentiated, professional, and sustainable forest management; to reconcile the interests of society and forest owners; to create economic conditions for sustainable forest management.

The **Decree of the Ministry of Agriculture of the Slovak Republic No. 453/2006 Coll. on the Forest Management and Forest Protection, as amended**. This Decree lays down details on forest management and forest protection, in particular on the categorisation of forests and the characteristics of forest subcategories, criteria and conditions for declaring protective forests and special purpose forests, the principles for determining and the method of submitting proposals for declaring protective forests and special purpose forests, the classification of forests under the influence of pollutants into danger zones and the characteristics of danger zones, the determination of the economic form of the forest, the division and use of management methods and their forms, forest reconstruction, criteria for assessing a secure forest stand, determination of the spatial division of the forest, including the delimitation of forest areas and sub-

areas, timing and harvesting of forests, implementation of forest management, the procedure for drawing up a forest management plan, its approval and control, early renewal of the plan, amendment of the plan and modification of the plan, and the method of conducting the national forest inventory and forest monitoring, the principles of forest protection against the impact of pollutants, abiotic and biotic harmful agents and forest protection measures, including forest protection against fires.

The generally binding legal regulation in area of forest fire prevention and mitigation from fire from the side of Ministry of Interior of the Slovak Republic is the **Act No. 314/2001 Coll. of the National Council of the Slovak Republic. No. 121/2002 Coll. on Fire Protection, as amended**, and **Decree of the Ministry of the Interior of the Slovak Republic No. 121/2002 Coll. on fire prevention, as amended.** The President of the Fire and Rescue Service in the form of an order (**Order of the President of the Fire and Rescue Service no. 8/2007 on protection of forests against fires**) issued specific measures to ensure a unified procedure in the implementation of tasks related to the protection of forests against fires; measures to ensure the protection of forests against fires in localities affected by disaster disturbance; conditions and procedure of the district directorate of the Fire and Rescue Service in carrying out ground monitoring and patrolling activities (monitoring); guidelines for the evaluation of the implementation of measures to ensure the protection of forests against fires; templates of forms for the evaluation of the implementation of measures to ensure the protection of forests against fires.

5.1.8.2 Government agencies and other stakeholders

In Slovakia, forest management and wildfire control involve various institutions and organizations, each with specific responsibilities in the prevention, intervention, and restoration wildfire phases. Here's an overview of the main institutions. The main Institutions Responsible for Forest Management are the **Ministry of Agriculture and Rural Development of the Slovak Republic** the supreme national authority on forests. At the district level, there are eight departments dealing with forestry attached to district offices in regional centres and forty-nine Land and Forestry Departments based at district offices. Military forests are managed by the **Ministry of Defence of the Slovak Republic**. **The Slovak Forestry and Timber Industry Inspection** supervises timber trading at a national level and, through its procedures, ensures that timber and timber products imported to Slovakia from countries outside the EU originate from legal felling.

The agencies that are responsible for wildfire management are as follows.

Prevention and preparedness

I) National Forest Centre. Contributory organisation of the Ministry of Agriculture responsible for forest fire risk assessment in state forests, collecting information on forest fires and updating the fire statistics. **II) Slovak Hydrometeorological Institute.** Budgetary organisation of the Ministry of the Environment, providing graphical information on Fire Weather Index daily from April to October. **III) Forests of the Slovak Republic, SE**. Fire forestry patrolling, fire prevention measures. **IV) Fire and Rescue Service**. For fire prevention education and firefighting campaigns. **V) Voluntary Fire Protection of the Slovak Republic, civic association**. For fire prevention education and firefighting campaigns. Forest fire patrolling is based on information on Fire Weather Index provided by the Slovak Hydrometeorological Institute. The information on forest fire risk provided by the National Forest Centre is calculated based on fire history data, it is only used to identify the fire prone areas – static data.

Fire detection and monitoring

I) Forest departments (including state forests offices, private forests offices). They are responsible for patrolling in days with higher fire danger index and reporting the fire to the nearest operational centre of the Fire and Rescue Service or the coordination centre of the Integrated Rescue System. **II) Forests of the Slovak Republic, SE**. Territory of the organizational units OZ Saris, OZ Tatry, OZ Karpaty – smoke detection based on CCTV system with 24/7 operational centre and fire reporting to the nearest operational centre of the Fire and Rescue Service. **IV) Fire and Rescue Service departments**. They are responsible for firefighting and fire suppression. Specialized Ground Fire Fighting Module to fight the intensive forest fires in steep

terrains. **V) Volunteer Fire Brigades**. They provide supporting firefighting activities, providing the assistance to the professional fire and rescue services.

Forest restoration

I) Forest departments. State forests offices, and private forests offices are responsible to forest restoration. **II) National Forest Centre** – **Forest Research Institute**. They provide research on forest monitoring, forest restoration, forest protection, adaptation on climate change. **III) District Offices – Land and Forest Departments**. They are responsible for state inspection activities.

Forest and wildfire management in Slovakia involves a broad set of **stakeholders**. In the forest management planning process, there are involved forest managers, private forest owners, nature conservancy workers as professional firefighters to consider all the relevant forest and fire protection features in the forest. The local communities are not involved. However, in last years, when the forests of the national parks underwent under administration of Ministry of Environment, there were several negotiations with private forest owners and municipalities representatives, which were nor very successful because of different view on further use of those territories.

5.1.8.3 Management practices, monitoring and enforcement

The activities that are implemented in forestry practice are fully corresponding with the structure of the strategic and specific objectives of the National Forestry Programme of the Slovak Republic (NLP) 2022 – 2030, such as: improving the effectiveness of the implementation of forest protection measures in the most vulnerable stands, developing the conversion of stands with inappropriate tree composition to more resilient mixed forests, ensuring the conservation of the forest tree gene pool and its use in assisted migration, introducing nature-close forest management, utilising tree species on non-forest land for landscape adaptation to climate change, optimising the energy use of woody biomass, and increasing the share of environmentally sound and modern technologies and techniques.

In wildfire risk management, emphasis is given to fire prevention and preparedness for firefighting activities. From the fire prevention point of view, the fire weather index assessment provided by the Slovak Hydrometeorological Institute is important for forest fire patrolling activities provided by foresters as well as for declaring an increased fire danger time by relevant Fire and Rescue Departments (at district level). Preparedness of the Fire and Rescue Service and its departments is ensured by the modernisation of the vehicle fleet, deployment of drone technology, building specialized national Ground Firefighting Module which has been integrated to the Civil Protection Mechanism of EU. The Integrated Fire Management approach is only fully deployed in some territories, i.e., Protected Landscape Area Polana or in the High Tatras Mts.

For post fire restoration of forest land, the same legal regime applies as for reforestation after planned or incidental logging. The forest manager responsible for a forest management unit is obligated to carry out regeneration of forest on a clearing or disaster disturbance affected area within two years of its origination and to secure the forest stand originated after regeneration of forest within 2 but latest up to 10 years. State authorities regularly inspect all forest management activities.

Several activities are conducted in Slovakia to prevent wildland fires. Information on the Fire Weather Index is provided through the internet page of the Slovak Hydrometeorological Institute during the fire season. When the forest fire index is of high value, i.e., the fire danger is high, the information on fire danger is also provided via TV or radio broadcasting. Several information campaigns aimed at citizens and scholars on fire prevention and self-protection against fire have been conducted. A stationary CCTV fire detection and early warning system is also installed in three high risky regions of Slovakia (High Tatras Mts., Slovak Paradise National Park, and Zahorie region). Other than this, ground patrols of firefighters and foresters are deployed to monitor the field during fire season. Wildfire detection is usually conducted by pilots of the aircrafts flying through the airspace of the Slovak Republic. Forest managers inspect forest restoration places to monitor the effectiveness of forest restoration.

Furthermore, Slovakia is committed to raising public awareness of climate change issues and building the knowledge base for more effective adaptation with some framework actions. These include: promote relevant public-private dialogue, raise awareness, support targeted training and education, use multiple information channels, create an official web portal where all relevant and verified information on adaptation issues from both international and domestic sources is collected and updated directly or through links, promote synergies between adaptation and mitigation measures and use the ecosystem approach in the implementation of adaptation measures wherever conditions allow the application of this approach.

5.1.8.4 Alignment with EU policies

The National Forestry Programme of the Slovak Republic (NLP) 2022 - 2030 is a basic forestry policy document, an important tool for ensuring sustainable forest management, inter-ministerial cooperation and the fulfilment of international commitments related to forests and forestry. NLP contributes to the fulfilment of commitments at the international level. The main international strategies, processes and programmes with an impact on NLP 2022-2030 include the "EU Forest Strategy".

The available forest fire protection legislation is a result of previous crises situations connected with extensive wildfires in conditions of the Slovak Republic. The area of forest restoration is regulated by the Act on Forests, which is fully in compliance with current European legislation, EU forest strategy and policies.

5.1.8.5 Economic aspects

In 2022, forest managers in Slovakia achieved the best financial result (€95.4 million) since 2000. The sale of wood covers up to 79% of the costs of maintaining forest ecosystem services and the employment in the forestry and timber sector. In 2022, forest enterprises and outsourced contractors achieved earnings and revenues of €1,189.1 million. Compared to 2021, they increased by 16.2%. Earnings from subject's own products and services reached 79.3 %. The total earnings and revenues of forest managers were €700.98 million and, compared to 2021, they increased by 20.4% mainly due to significantly increased average monetization of raw wood, which has the highest share in the structure of earnings and revenues of forest managers (almost 79% of market production). Outsourced contractors in forestry of the SR achieved earnings of €488.2 million. The total public funding in the forest sector (state budget, EU funds and other sources) reached €30.0 million. Forestry funding (Rural Development Program 2014-2022, developing of FMS, care for national parks, state aid and other resources) was €24.2 million; however, in recent years, it has been decreasing. Compared to 2017, it decreased to the actual 46.5%.

5.1.9 Brazil

According to the National Forest Information System (SNIF), Brazil's forest area is equivalent to 58.5% of its territory, covering an area of 497,962,509 ha, in which 98% correspond to natural forests while only 2% are planted forests. Of this total, 61.5% are public forest, which corresponds to approximately 309.4 million ha. Brazil is home to at least 56215 species of vascular plants. 3.9% of Brazil is protected under IUCN categories I-V.

5.1.9.1 Key legislation

In Brazil, legislation related to wildfires and environmental protection is primarily governed by the **Brazilian Forest Code (Law n. 12.651/2012)**. Its core goal is to promote environmental conservation, agricultural production and socioeconomic development. The law establishes general rules for the protection of vegetation and forests, Permanent Conservation Areas and Legal Reserve Areas. It regulates the exploitation of forests, the procurement of forest raw materials and the control of the origin of forest

products. It also deals with the control and prevention of forest fires and deforestation. The law also provides for economic and financial instruments to achieve its objectives. It recognises the joint responsibility of the Union, the States, the Federal District and the municipalities, working with civil society, in creating policies for the conservation and restoration of native vegetation in urban and rural areas. It encourages scientific and technological research for the sustainable use of soil and water and for the restoration and conservation of forests and other forms of native vegetation. Finally, it promotes economic incentives for the conservation and restoration of native vegetation and the development of sustainable production activities.

In 2017, Brazilian government released **PLANAVEG**, short for **"Plano Nacional de Recuperação da Vegetação Nativa" (National Plan for the Recovery of Native Vegetation)**, an initiative aimed at promoting the recovery and restoration of native vegetation across the country. It is part of Brazil's efforts to comply with environmental laws and international commitments related to biodiversity conservation and climate change mitigation. The main goals of PLANAVEG include promoting initiatives to increase the area covered by native vegetation, which is crucial for biodiversity conservation, soil protection, water resources management, and climate regulation. Implementing projects to restore areas that have been degraded or deforested, aiming to recover their ecological functions and biodiversity. Providing incentives and technical support to landowners and rural producers to comply with legal requirements regarding the preservation and restoration of Permanent Preservation Areas and Legal Reserves. Developing monitoring and evaluation mechanisms to assess the effectiveness of restoration efforts and ensure compliance with environmental regulations.

5.1.9.2 Government agencies and other stakeholders

Official entities responsible for preventing, monitoring, and combating wildfires in Brazil include:

I) Brazilian Institute of Environment and Renewable Natural Resources (IBAMA). It is the federal agency responsible for environmental protection and regulation. It plays a significant role in monitoring and enforcing environmental laws related to wildfires and other environmental crimes. **II) National Institute for Space Research (INPE)**. It is responsible for monitoring and detecting wildfires using satellite imagery and remote sensing technologies. It provides crucial data and information to support firefighting efforts and environmental management. **III) ICMBio (Chico Mendes Institute for Biodiversity Conservation)**. It is an agency responsible for the conservation and sustainable use of biodiversity in Brazil. I**V) Ministry of the Environment**. It oversees environmental policies and regulations at the federal level, providing strategic direction and coordination for wildfire prevention and management efforts. **V) State environmental agencies**. Each Brazilian state has its own environmental agency responsible for enforcing environmental laws and regulations within its jurisdiction. These agencies often collaborate with IBAMA during wildfire incidents. **VI) Municipal environmental agencies**. They may also be involved in smaller-scale restoration projects within municipalities, especially in urban-adjacent areas affected by wildfires. **VII) State fire departments**. They play a direct role in combating wildfires. They are trained and equipped to respond to emergency situations and often work alongside environmental agencies during firefighting operations. **VIII) National Centre for Prevention and Combat of Forest Fires (PREVFOGO)**. It is a specialized unit within IBAMA dedicated to preventing and combating forest fires. It coordinates firefighting teams and resources during wildfire emergencies. **IX) Non-governmental organizations (NGOs)**. They often collaborate with government agencies to support and implement forest restoration projects. They may provide technical expertise, funding, and community engagement to accelerate restoration efforts. **X) Research institutions and universities**. Academic institutions contribute to research and innovation in forest restoration techniques, providing knowledge and training to improve restoration practices.

5.1.9.3 Management practices, monitoring and enforcement

As Brazil is home to some of the most diverse ecosystems on the planet, including the Amazon rainforest, the Pantanal wetlands, and the Atlantic Forest, these ecosystems face significant threats from wildfires, often exacerbated by human activities such as deforestation, land conversion for agriculture, and climate change. The management of wildfires in Brazil requires a multifaceted approach that encompasses effective management practices, robust monitoring systems, and stringent enforcement mechanisms.

The implementation of planning and public policies for the management of forest fires in Brazil involves a series of steps and coordinated actions among different levels of government, non-governmental organizations, and local communities. The development of management plans, for example, is carried out by government agencies such as IBAMA and the ICMBio. This includes activities such as data collection (biodiversity, topography, land use, and fire risk factors in specific areas), public consultations with local communities and stakeholders, and the definition of guidelines for the sustainable use of natural resources and fire prevention.

Brazil utilizes platforms that aggregate data on wildfires, such as the BDQueimadas, which gathers information on burnings and deforestation, allowing access to detailed data for different users, including researchers and managers. The Shared Environmental Information System (Siscom) of IBAMA provides geospatial information on areas affected by fires, management policies, and protected areas.

Regarding the implementation of public policies, such as the National Policy for the Prevention and Combat of Forest Fires, there is integration among various agencies: IBAMA, state fire departments, and state and municipal civil defense and environmental secretariats work together to define strategies and actions. The formation of fire brigades in different regions and biomes, with practical and theoretical training, is also noteworthy.

Fire monitoring and detection make use of satellite images from systems like DETER (Real-Time Deforestation Detection System), PRODES (Deforestation Monitoring Project in the Legal Amazon), both provided by INPE, and MODIS (Moderate Resolution Imaging Spectroradiometer) from NASA, to monitor surface temperature, identify fire hotspots over large areas, and detect deforestation in real time. Drones are also used for surveillance and assessment of affected areas. It is important to highlight that the involvement of local communities is crucial for monitoring: the population is encouraged to report fire hotspots and illegal practices, such as burnings. Awareness programs help promote this participation, alongside volunteer training, contributing to a broader surveillance network.

5.1.9.4 Alignment with EU policies

As planned actions in relation to the EU Forest Strategy for 2030, Brazil pursues policies and initiatives aimed at conserving its biomes, including protected areas, sustainable forest management practices, and indigenous land rights. Brazil has been involved in international agreements and initiatives related to forest conservation, such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. It also engages in dialogue with the EU regarding forest-related issues through bilateral and multilateral channels. The country considers aligning its forest policies with global initiatives like the EU Forest Strategy where mutual interests in sustainable forestry and biodiversity conservation align and it plans to strengthen monitoring and enforcement mechanisms to combat illegal deforestation and promote sustainable land use practices. Brazil collaborates with international partners, including the EU, on forest management, climate change mitigation, and biodiversity conservation promotes sustainable forestry practices among local communities, industries, and agricultural sectors to reduce deforestation and promote reforestation efforts.

However, Brazil faces challenges due to political shifts and economic pressures that affect environmental policies and enforcement capabilities. The country recognizes the importance of its forests in global biodiversity and climate regulation and seeks to balance economic development with environmental stewardship.

5.1.9.5 Economic aspects

Between January and September 16, 2024, losses from wildfires reached 260 million euros, which is 33 times higher than losses during the same period last year, according to the National Confederation of Municipalities (CNM). Wildfires have a profound and immediate impact on agriculture, a sector that accounts for 25% of Brazil's GDP. They destroy crops, pastures, and forests used for farming and livestock, reducing the supply of food such as meat and grains. In the short term, this translates into significant increases in food prices, and in the long term, it harms environmental balance, which is essential for sustainable agriculture. The combination of prolonged drought and devastation of cultivated areas raises production chain costs, passing a heavier inflation burden onto consumers, especially low-income families. Energy consumption has significantly increased as more people rely on fans and air conditioning to cope with the heat and spend more time indoors due to poor air quality. This high demand, combined with lack of rainfall, directly impacts rising electricity bills. Additionally, smoke from the fires is contributing to respiratory problems, increasing government spending, affecting public finances, and raising costs for health-related companies due to increased patient visits, claims, and operational expenses.

Financial market experts warn that wildfires and drought have the potential to significantly impact capital flows to Brazil, especially in the agribusiness and energy sectors. Foreign investors, particularly those guided by sustainable investment principles, may reconsider their investments in the country due to the direct link between wildfires and environmental degradation. The loss of productivity and rising production costs could also diminish Brazil's attractiveness as a long-term investment destination. To address the issue of wildfires, Brazilian investments remain quite modest given the country's vast territory and the impact on the economy. Despite the increasing frequency and severity of wildfires, funding for prevention, management, and recovery efforts has not kept pace with the scale of the problem. The federal budget allocated to IBAMA and ICMBio for the fiscalization, prevention, control, and combat of wildfires increased from 43 million euros in 2020 to 95.17 million euros in 2023. In 2024, as Brazil faces its worst drought in 75 years, with 58% of the national territory affected and one-third of the country experiencing severe drought, the spending so far has reached 65.42 million euros.

5.1.10 Indonesia

Approximately 221,383,723 hectares are designed as State Forest area (Hutan Negara). In general, the forest areas categorized into different functions: Conservation Forest (20,500,988 ha), to maintain the diversity of animals and plants, and life supporting ecosystems. Protected Forest (33,519,600 ha), to prevent flooding, overcome erosion, and maintain soil fertility. Limited Production forest (23,057,449 ha) provides limited freedom to earn wooden and non-wood products. Fixed Production (35,197,011 ha), provides freedom of production, including plantations wood and clear cutting of forests. Conversion Production (8,078,056 ha) provides flexibility for plantations and can converted into a “non-forest area” for activities non-forestry.

5.1.10.1 Key legislation

The Indonesian legal framework currently includes the following reference normative acts in the field:

Undang-undang Nomor 41 Tahun 1999 tentang Kehutanan (Law Number 41 of 1999 concerning Forestry). This law regulates the implementation of forestry with the aim of maximizing the prosperity of the people in a just and sustainable manner. The division of forests is based on their status, consisting of state forests and private forests. In addition, forests must be managed through activities in the form of forest management and preparation of forest management plans; forest utilization and use of forest areas; forest rehabilitation and reclamation, and forest protection and nature conservation.

Peraturan Pemerintah Nomor 23 Tahun 2021 tentang Penyelenggaraan Kehutanan (Government Regulation Number 23 of 2021 concerning Forestry Implementation). This regulation regulates Forestry Planning; Changes in the Designation of Forest Areas and Changes in the Function of Forest Areas; Use of Forest Areas; Forest Management and Preparation of Forest Management and Forest Utilization Plans; Social Forestry Management; Forest Protection; Supervision; and Administrative Sanctions.

Peraturan Pemerintah (PP) Nomor 4 Tahun 2001 tentang Pengendalian Kerusakan Dan Atau Pencemaran Lingkungan Hidup Yang Berkaitan Dengan Kebakaran Hutan Dan Atau Lahan (Government Regulation (PP) Number 4 of 2001 concerning Control of Environmental Damage and/or Pollution Related to Forest and/or Land Fires). This Government Regulation covers efforts to prevent, control and restore as well as monitor the control of environmental damage and/or pollution related to forest and/or land fires.

Undang-undang Nomor 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Hidup (Law Number 32 of 2009 concerning Environmental Protection and Management). This law covers planning, utilization, control, maintenance, supervision and law enforcement in environmental protection and management.

UU No 11 Tahun 2020 tentang Cipta Kerja (Law No. 11 of 2020 concerning Job Creation). This law changes and deletes several articles in Law Number 32 of 2009 concerning Environmental Protection and Management.

Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.32/Menlhk/Setjen/Kum.1/3/2016 tentang Pengendalian Kebakaran Hutan dan Lahan (Regulation of the Minister of Environment and Forestry Number P.32/Menlhk/Setjen/Kum.1/3/2016 concerning Control of Forest and Land Fires). Forest and Land Fire Control includes efforts/activities/actions for organizing, managing human resources and infrastructure as well as operational prevention, extinguishing, post-fire handling, evacuation and rescue support, and support for forest and/or land fire control management.

Undang-undang No 5 Tahun 1990 tentang Konservasi Sumber Daya Alam Dan Ekosistemnya (Law No. 5 of 1990 concerning Conservation of Natural Resources and Ecosystems). Conservation of natural resources and their ecosystems is the responsibility and obligation of the government and society. Conservation of natural resources and their ecosystems is carried out through activities such as protecting life support systems, preserving the diversity of plant and animal species and their ecosystems, and sustainable use of natural resources and their ecosystems.

5.1.10.2 Government agencies and other stakeholders

The primary institutions responsible for forest management in Indonesia are the following:

I) Kementerian Lingkungan Hidup dan Kehutanan. The Ministry of Environment and Forestry works on the national level of forest management, including any activities related to forest production and forest fire. **II) Direktorat Jenderal Konservasi Sumber Daya Alam dan Ekosistem.** The Directorate General of Natural Resources and Ecosystem Conservation is the work unit of Ministry of Environment and Forestry. This institution has the task of formulating and implementing policies in managing the conservation of natural resources and their ecosystems. **III) Direktorat Jenderal Pengendalian dan Perubahan Iklim.** The Directorate of Climate Change Control is the work unit of the Ministry of Environment and Forestry. This institution handles climate change, especially in the implementation of mitigation, adaptation, reduction of greenhouse gas emissions, reduction and elimination of ozone-depleting substances, resource mobilization, greenhouse gas inventory, monitoring, reporting and verification of climate change mitigation actions and control of forest and land fires. **IV) Balai Taman Nasional.** The Forest National Authority manages specific area of national conservation forest, which are only 40 in Indonesia. **V) Balai Besar Taman Nasional.** The Special Forest National Authority manages a specific national conservation forest area, which is bigger and better conserved than the Forest National Authority (8 areas in Indonesia). **VI) BPBD (Badan Nasional Penanggulangan Bencana).** The National Authority of Disaster Management works on disaster related events, starting from the mitigation, preparedness, response, and recovery. **VII) Dinas Lingkungan Hidup (Provincy and Regency Level).** Regional level authorities working on environment and forest management.

5.1.10.3 Management practices, monitoring and enforcement

Indonesia's forest common management practices are displayed in the **Strategic Plan of the Ministry of Environment and Forestry for 2020-2024**. The National Forest Plan establishes a set of goals to improve the management of forests and their ecosystem. These goals include reducing deforestation and forest degradation, preventing forest fires, applying principles of environmental capacity in forest use, and aligning with the Sustainable Development Goals. The Plan promotes the participation of both men and women in forest management and proposes corrective measures to strengthen the importance of forest resources and provide better environmental quality for future generations. Key objectives include low-carbon development, peatland management and restoration, changing logging to forest ecosystem management, community-based management, and biodiversity conservation. The Plan also aims to protect endangered species and restore damage to natural resources and the environment.

Forest monitoring in Indonesia mainly accessible to the public service access which is available in the Ministry of Environment and Forestry Website. Several monitoring services exist, as follows. **I) SIMONTANA (Sistem Monitoring Hutan Nasional).** The National Forest Monitoring System was developed in 1990, and it consistently provides information to the public about forests and forest areas in Indonesia. Its quality of information has been improving in a comprehensive manner. Initially, this monitoring system started with six-year intervals for archive data (in 1990), three years (starting in 2000), and has become annual (since 2011) until now. SIMONTANA continues to be developed to produce faster and more accurate forest data that is presented in a transparent, informative and easy to use manner so that users can monitor forest data regularly. **II) SIPONGI+ (Sistem Pemantauan Karhutla)**. The Sipongi+ site provides the latest hotspot data and other information related to forest fires, so that it can be used by the wider community so that it can help the community and all related parties in efforts to prevent forest fires in Indonesia. **III) SIPALAGA (Sistem Pemantauan Air Lahan Gambut)**. The peatland water monitoring system was created by the Peatland Restoration Authority. The technologies are applied in several water stations to monitor the water level in the peatland forest. Areas which show a low level of the water table will be the area to be maintained intensively to prevent fire occurrence.

5.1.10.4 Alignment with EU Policies

Alignment with EU policies is generally encompassed in the Strategic Plan of the Ministry of Environment and Forestry for 2020-2024. Some actions undertaken by Indonesia include: promoting the sustainable forest bioeconomy for long-lived wood products ensuring sustainable use of wood-based resources for bioenergy. Promoting non-wood forest-based bioeconomy, including ecotourism. Developing skills and empowering people for sustainable forest-based bioeconomy. Protecting EU's last remaining primary and old-growth forests. Ensuring forest restoration and reinforced sustainable forest management for climate adaptation and forest resilience. Reforestation and afforestation of biodiverse forests, including by planting 3 billion additional trees by 2030. Providing financial incentives for forest owners and managers for improving the quantity and quality.

5.1.10.5 Economic aspects

The funding scheme for forest management allocated from national and regional revenue and expenditure budget as an important instrument for the government to implement its programs. The inadequacy of the government budget to finance its programs is greatly influenced by how the budget is managed.

Budget policy is closely related to forest and land management. In addition to forest and land management as part of regional revenue instruments, it is also an instrument for regional spending and financing. As a revenue instrument, forest and land management is seen through incentive policies through taxes and royalties carried out by the government for activities related to the forest and land sector. Political decisions to determine sources of state revenue reflect the government's commitment to increasing or decreasing deforestation and degradation. In terms of regional spending, the money owned by the government is

spent on programs and activities that support development goals. Specifically, ensuring that spending to finance programs and activities that support reducing deforestation and degradation is well spent. In addition, ensuring that the money that has been allocated has been spent optimally to achieve the goals of reducing deforestation and degradation.

5.2 Current challenges

While comprehensive forest governance and wildfire management plans exist in most pilot countries, several challenges remain. Firstly, many countries face **issues in promoting coordinated actions**, both in wildfire management and in forest restoration. There are two main causes: i) complexities related to governance and administration, especially in countries where several levels of government exist and share competencies in these matters; ii) and different interests among the various stakeholders, which include government agencies, NGOs, businesses, and communities in general. Secondly, **insufficient funding** significantly impedes the development of comprehensive plans. Even when funding is allocated, it does not always reach remote, fire-prone regions that would particularly benefit from such resources. Thirdly, **lack of technical equipment and specialised personnel** can limit the effectiveness of wildfire prevention and reforestation efforts. And lastly, the **decline of forest health and the reduction of forested areas** due to the effects of climate change, to deforestation, and to the consequent increase in frequency and intensity of wildfires. The health and capacity of regeneration of ecosystems is impacted by raising temperatures, extreme weather events and prolonged draughts, reducing the effectiveness of reforestation programmes. At the same time, urbanization and economic interests are resulting in a reduction of forested areas, also affecting biodiversity.

5.2.1 Challenges to coordinated actions

Effective forest governance requires coordination among all stakeholders, as well as among all administrative layers. When coordination lacks, governance becomes more complex. Stakeholder groups include government agencies at the national, regional and local levels, private forest owners and their associations, cooperatives, fire services and the civil protection, as well as NGOs and local communities. Moreover, economic actors such as businesses related to ecotourism or the timber extraction industry often have additional interests in forest management.

On the matter, Italy has reported a complex administrative structure with multiple layers of government and intricate bureaucratic processes. These issues impede effective action. Coordination among services is also inadequate in Greece, hindering the planning of responses to wildfires. Another issue in this area is related to political shifts. As noted in the case of Brazil, frequent shifts in political priorities make it harder to pursue long-term environmental policies. This is especially true if there also are strong economic pressures. It may also occur that government authorities do not recognise or understand the issues at hand. In Slovakia, for example, lack of understanding by the government on protecting forests and landscapes from climate change impact is reported. Moreover, clashing interests exist in the country, preventing effective action in the field. More specifically, as far as forest restoration is concerned, conflicts exist among foresters and state nature conservancy workers related to biodiversity and forest management.

France has reported gaps in representation for some of this actors, and chiefly small private forest owners, which may not have sufficient access to technical support or funding, and marginalised communities. Moreover, the burdens of wildfires are unevenly distributed in the country, with southern regions facing higher risks and thus higher costs for prevention measures. Issues with cooperation with private landowners, especially small ones, is a common issue. This was reported by Croatia, for example, as a problematic aspect in the context of forest maintenance as well as prevention of forest fires. Similarly, Portugal's land ownership characterised by numerous small, privately-owned land parcels complicates coordinated restoration efforts. To provide an indication of the scope of the problem, approximately 80%

of Portuguese forests are privately owned. Italy faces similar issues in restoration efforts, with the numerous small, privately-owned land parcels.

5.2.2 Budget constraints and limited resources

Comprehensive wildfire management and forest governance require adequate funding and appropriate resources. However, budget constraints occur in most pilot countries, resulting in defective policies and actions. Moreover, as the frequency of wildfire incident increases, the limited resources and budget constraints can be exacerbated.

Greece, for example, has reported that the lack of funding for forest management and the lack of management plans has caused a significant accumulation of biomass. This has also heightened the problem of large and destructive fires, as further discussed below. It should be highlighted that this takes place against the backdrop of especially high forest management costs due to the intense topographic relief which in Greece is combined with the fact that a large part of forest land is covered by natural horticultural forests. This hinders the use of machinery to harvest timber, making it uncompetitive in price compared to imported timber. In Portugal, limited funding for large-scale restoration projects severely hampers forest restoration projects. Moreover, other economic issues my divert attention and resources away from environmental initiatives. A similar issue has been reported in Italy, where economic challenges may divert attention and resources away from environmental initiatives. Italy has also reported budget constraints which limit the resources available for comprehensive wildfire management. This is also true for large-scale restoration projects.

Another concern pertains the allocation of available funds. As private land ownership is significant in most pilot countries, difficulties in distribution of public resources may arise. In France for example, ensuring that all private forest owners access available funds, particularly in smaller, fragmented forests, remains a challenge. To address this issue, efforts have been made to streamline grant application processes and increase support for private owners.

5.2.3 Inadequate infrastructures and lack of specialised personnel

The effectiveness of fire prevention and reforestation efforts can be limited by inadequate infrastructures, lack of equipment, or lack of specialised personnel. Similarly to budget constraints, shortages in personnel and equipment are especially problematic as the frequency of wildfires is intensifying, and existing capacities are put under greater pressures.

In Romania, for example, insufficient technical equipment for forestry and wood exploitation constitutes a challenge. More specifically, the insufficient number of permanent wood material depots and poor specific technical equipment of existing depots was highlighted. Additional difficulties are posed by the low density of the forest road network. Moreover, land and air vehicles for fire suppression are outdated and aerial systems for fire suppression are insufficient. In Greece, lack of personnel with adequate and updated scientific expertise on forest management means that new knowledge in the field is not put in practice. Finally, Indonesia emphasized that the effectiveness of programmes aimed at restoring degraded forests is hindered by weak institutional arrangements, which lead to problems in their implementation.

Even when infrastructures are present, they can be unevenly implemented or distributed, as noted by the Czech Republic. The issue is especially prominent in more remote areas. In France, while there is a robust network of professionals in forest management, rural areas are not as well organised. Resource constraints, particularly in human capital, can limit the effectiveness of fire prevention and reforestation efforts in remote areas, where fewer specialised personnel are present. In Italy, inadequate infrastructure has been reported especially in remote forest areas, which can hinder rapid response efforts.

5.2.4 Decline in forest health and size

Several factors are causing a decline in forest health as well as a reduction of forested areas in pilot countries, creating great challenges for forest governance and making reforestation policies less effective.

Climate change and its many effects are the primary cause of issues in this sense. Climate change leads to higher temperatures and reduced precipitations, which can cause drought and crop destruction. Degradation of agricultural and forest lands can result, as reported by Romania. Rising temperatures and irregular precipitation are also contributing to weakening Czech forests, leading to higher risks of fires and pests. This is particularly challenging for the Czech Republic, which has seen a bark beetle infestation which is significantly decreasing timber resources and is creating modifications in the ecosystem.

Romania highlighted that climate change also results in more frequent extreme weather events. These intense climate phenomena, such as El Nino, are especially challenging in Indonesia, where draughts is also threatening forest management. Climate change also has adverse effects on forest health and on its regeneration capacity, as reported by Italy. The health of forest ecosystems is affected by the occurrence of extreme climate phenomena with increased frequency and intensity (drought, strong winds, floods, etc.).

Adaptation to climate change is thus a public interest issue, which would require the involvement of local communities. Unfortunately, an indifferent approach to adaptation to this issue persists in countries, such as in Slovakia. In other cases, authorities do not recognise the magnitude of the problem. In Greece for example, it was reported that the impact of climate change on forests and on wildfires is not well understood.

Rising temperatures and prolonged droughts are increasing the frequency and severity of wildfires. Because of this, developing and implementing strategies to adapt to climate change and mitigate its impact is essential. The rise in frequency and intensity of wildfires, is one of most prominent challenge to successful forest governance, which has been reported by all partners. Other than from climate change effects, it results from the interaction of several factors.

Accumulation of biomass in forests, due to budget constraints and insufficient funding, contributes to worsening the intensity of fires, as highlighted by Greece. It should be mentioned that biomass could also be used for energy production. In Romania, a large share of renewable energy production comes from the agricultural and forestry sectors. potential for efficient use of forest biomass and wood waste, which represents over 23% of Romania's energy biomass potential.

The expansion of urban areas into forested regions is also increasing the risk and potential damage of wildfires. In the Czech Republic, for example, expansion of cities and infrastructure is leading to loss of forest land. Deforestation contributes to increasing the intensity of fires. This is a challenge in Brazil, where deforestation is growing due to agricultural expansion related to produce such as soy and cattle. In this case, it is particularly challenging to balance economic development with environmental conservation. Similarly, the Czech Republic reports increasing economic pressure to prioritize economic activity, namely timber extraction, rather than forestry, potentially leading to overexploitation of forest resources.

To address these issues, programmes to plant trees and establish new forests on degraded or deforested lands need to be implemented. There is growing interest in agroforestry systems that can incorporate fire-resistant species, reduce ignition sources and erosion, and enhance biodiversity, soil health, and carbon sequestration while providing economic benefits to farmers. Moreover, policies promoting sustainable agriculture practices aim to minimize deforestation and fire risk while maximizing agricultural productivity. This is also a way to address biodiversity loss, a problem which derives from practices such as timber extraction and monocultural planting, as registered for example in the Czech Republic. Biodiversity loss can also derive from frequent interventions with silvicultural activities on forest areas, as is the case in Romania.

5.3 Opportunities

Several opportunities exist in the field to improve forest governance and to address existing challenges. An area in which improvements could yield significant benefits is the **enhancement of cooperation among stakeholders**. This would entail finding a balance between different interests, including economic, ecological and social ones. Another field which holds a great potential relates to economic aspects. In particular, innovative **economic approaches as well access to available European Union programmes and funds** could contribute to fill gaps in funding. **Innovation** also plays an important role in this field, with new technologies and agroforestry approaches offering beneficial solutions to existing problems. Finally, **increased public awareness** on forest governance and wildfire management can result in better individual behaviour in forests, as well as in greater support from citizens for environmental policies and initiatives at the national, European and international level.

5.3.1 Enhanced cooperation among stakeholders

As noted, several stakeholders with different, sometimes clashing interests exist in the field of forest governance. Enhanced cooperation among all actors requires an integrated approach which takes all perspectives into account. In the field of forest restoration, cooperation would be required among foresters, state nature conservancy workers and other stakeholders related to biodiversity.

In Slovakia this would entail getting the relevant stakeholders together and starting the negotiations on the National Action Plan to Manage the Wildfire Risks, which still needs to be elaborated and implemented. Moreover, involvement of local communities is suggested for addressing issues related to climate change adaptation. In Croatia, where a strong stakeholder cooperation exists, collaboration between local governments and private landowners is highlighted as an area for potential improvement.

Other than among agencies, cooperation is also essential across sectors. Given the existing conflict interests in Brazil for example, it was highlighted that collaboration across sectors such as forestry, agriculture, and water management are essential to achieve restoration goals effectively and sustainably. This would require the ecological, socio-economic, and governance dimensions to be considered organically.

5.3.2 Access to EU funds and European projects/cross border cooperation

A way to leverage opportunities in the field of forestry is related to innovative economic approaches, which would contribute to covering high costs related to forest governance and attract renewed interest in, and investment to the sector. Indeed, forest management can produce benefits for local communities and for other stakeholders as well. It creates jobs, it attracts ecotourism, boosting revenue for local businesses, and innovative mechanisms such as payment for ecosystem (PES) potentially offer financial rewards. This is, of course, in addition to non-material benefits such as clean air, water regulation, and biodiversity compensation.

Romania has highlighted the possibility of developing a circular economy through the use of forestry resources, including the use of recyclable/biodegradable materials. Similarly, France, through the France 2030 programme, aims to make the forest-wood sector a strategic area to drive the French economy towards an ecological transition and to achieve a decarbonized economy by 2050, which would also mitigate climate change. Another key approach relates to carbon credits, which can potentially create revenues while simultaneously promote reforestation. In France, forest owners can generate and sell carbon credits in voluntary carbon markets, providing an additional economic incentive for sustainable management. Similarly, Italy anticipates potential revenue from carbon credits through forest restoration activities. France is also exploring the Payment for Ecosystem Services (PES) model to finance forest conservation. This approach compensates landowners or managers for maintaining services that benefit society, such as carbon sequestration and biodiversity protection.

In examining the economic dimensions, a key consideration is the potential to access funding from the European Union and participate in European programmes. European Union actions in the field of forest resilience have improved due to increased awareness on environmental issues. This has resulted in a better legal framework as well as in funding opportunities, for example for firefighting equipment and biomass management, as reported by Greece. This is showcased for example by the European Union Forest Strategy. Moreover, increased international cognizance of the consolidation of climate change effects and of the worsening of wildfires contributes to increasing cooperation between States. As noted by Greek respondents, this can come in the form of mutual assistance for wildfire extinguishing operations, as well as in the development of structures for the sharing of firefighting equipment among countries. Access to European Union funds for wildfire prevention and management projects and cross-border cooperation as well as resources have been identified by Italy . In particular, funds from the EU Green Deal can be leveraged for reforestation and restoration projects.

The Czech Republic also highlighted that financial resources from European grant programmes focused on environmental protection and climate adaptation can contribute to effective forest management. These include, for example, the European Agricultural Fund for Rural Development (EAFRD). France benefits from EAFRD funds which provide financial support for forest management, restoration projects, and climate resilience initiatives.

Outside of the European Union, other opportunities for cooperation exist. First of all, international agreements and initiatives related to forest conservation, such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement; Brazil for example is involved in both. Moreover, as effectively showcased by SILVANUS as well, countries outside of the EU can engage in dialogue with the EU regarding forest-related issues through bilateral and multilateral channels. Indonesia has indeed reported that support from institutions from abroad is a great opportunity in the field.

5.3.3 Innovation

Most countries already employ new technologies for forest governance and wildfire management. However, innovative developments in the field offer new opportunities, including technological ones as well as in governance approaches.

In Slovakia, the full deployment of new technologies to support wildfire risk management, as well as landscape and forest management is advocated for. At the moment, the country employs a smoke detection CCTV system in the most wildfire-prone areas. Moreover, a fire history database has been build based on data on fire investigation and is provided by the Fire Research Institute of the Ministry of Interior. Slovakian Fire and Rescue Service departments are also equipped with drone technology with laser scanner and software for creating 3D model of mapped area. In Croatia, while video surveillance has already been introduced in collaboration with the company FESB, its expansion is anticipated, in conjunction with an extension of fire roads. Similarly, while satellite monitoring is already employed in Italy, the use of new technologies such as drones and AI to enhance detection and response capabilities has been suggested by the country. Indonesia has also implemented new technologies. For example, Indonesian respondents have reported the use of satellites and satellite images for purposes such as early detection, warning systems and calculation of burned areas. Moreover, the Indonesian Ministry of Environment and Forestry also employs thermal CCTV technology for fire monitoring in fire-prone areas. However, it was reported that the use of satellite technology has not reached the prediction level.

Many respondents have identified the achievement of sustainable forests as a key goal for national forest governance. This would entail forests which are resistant to climate change and to wildfires. In this sense, Croatia has expressed the goal to use indigenous species, and primarily coniferous, where possible. Brazil has noted that the rehabilitation of forests contributes to mitigating floods, controlling erosion, and stabilizing slopes, thereby protecting downstream communities and infrastructure. The Czech Republic has underlined the innovation in forestry management can rely on new technology such as drones, remote

sensing and forest management software to improve forest protection and regeneration. Finally, in Brazil, there is growing interest in agroforestry systems that can incorporate fire-resistant species, reduce ignition sources and erosion, and enhance biodiversity, soil health, and carbon sequestration while providing economic benefits to farmers. This would allow to balance economic interests while also maximising agricultural productivity.

5.3.4 Increased public awareness

Public awareness on these issues is important for two main reasons. On one hand, citizens awareness leads to better individual behaviour in forests. In this sense, several countries regularly conduct awareness campaigns. Croatia for example, has noted that campaigns aimed at sensitizing citizens are carried out to promote responsible behaviour in forests. Similarly, in France awareness campaigns are regularly conducted to inform the public about behaviours to avoid in the forest (lighting fires, throwing cigarette butts, etc.). Italy too organises campaigns aimed at increasing public awareness and reducing human-caused fires. Italy has also reported that local communities are engaged in wildfire prevention and response, fostering a collaborative approach. Indeed, community engagement is one of the goals of the Italian primary national normative sources and strategies for wildfire prevention and control. Portuguese citizens have been reported as highly aware and supportive of environmental conservation initiatives. As a result of this, ecotourism can be developed as a sustainable economic activity that also supports forest restoration. Similarly, the Czech Republic has stressed that increased use of forests for recreational purposes and ecotourism is an opportunity for generating additional income and promoting conservation efforts.

On the other hand, greater public attention to these issues can lead to more initiatives from public authorities, including from the EU, with potential funding being allocated for forest governance. As Greek respondents have highlighted, consolidation of the effects of climate change and the worsening of forest fires at the European and national levels, have a significant impact on the consolidation of the importance of the environment, especially of forests. This new situation offers opportunities at the political level and mobilizes international and national policies to accelerate actions related to the protection and development of forests and funding them. The gradual recognition internationally of the value of forests in terms of biodiversity conservation and other forest ecosystem services that affect the quality of life of populations has also been highlighted.

6 Recommendations and conclusions

This chapter provides a synthesis of the main findings that have been discussed throughout the previous chapters, providing actionable recommendations for improving forest governance models at the international, EU and national levels. This chapter addresses the interconnected challenges faced at each of these governance levels and outline strategies that can improve coordination, improve the integration of financial mechanisms and enhance participatory approaches.

At the international level, forest governance is primarily affected by three major challenges:

1. **Fragmentation of forest governance.** International forest governance is characterized by significant fragmentation due to the involvement of numerous public and private actors, complex governance structures and a lack of effective coordination between international frameworks, such as CBD and UNFCCC. Fragmentation can manifest in two ways: vertically, where inefficiencies are created by the gap between international frameworks and their implementation at national and local levels, and horizontally, because cohesive governance is complicated by conflicting objectives across different sectors, e.g. agriculture and conservation. The lack of integration makes it difficult to align global conservation goals with local realities.
2. **Increasing market influence.** The growing role of market-based mechanisms such as PES and carbon credits introduces both opportunities and risks. While these mechanisms mobilize financial resources for conservation, they can also lead to the commodification of forests that might prioritize short-term financial returns over long-term sustainability. The financialization also poses risks for equity and justice, as wealthier actors tend to dominate these mechanisms and might leave marginalized communities at a disadvantage. Additionally, market objectives and on-the-ground outcomes are often disconnected, with issues such as greenwashing, misaligned incentives and corruption undermining the effectiveness of these mechanisms.
3. **Institutional and governance challenges.** The weakness of international institutions that have limited resources, fragmented governance structures and enforcement capacities hinder the effective implementation of forest policies. Additionally, many international frameworks lack the authority and standardized systems to measure impact and ensure compliance. Particularly, the non-binding nature of many international agreements, that is often based on soft law principles, further limits their effectiveness, while, on the other hand, legally binding agreements face significant implementation challenges at the domestic level, especially in countries with weak governance systems.

At the EU level, the following major challenges are present:

1. **Policy Coherence and Fragmentation**: EU forest policy suffers from fragmentation across Member States, leading to diverse and sometimes conflicting management practices. Existing governance structures are often inadequate in handling the complexity of forest ecosystems, particularly when property rights are isolated. As a result, policies and laws are inconsistently operationalized across different Member States, weakening cohesive forest governance across the EU.
2. **Limited Integration of Forest Policies with Climate and Biodiversity Goals**: Current EU forest policies insufficiently address the dual goals of climate adaptation and biodiversity protection. Forest health and ecosystem services remain vulnerable due to the lack of policy alignment and mainstreaming of climate resilience and biodiversity within forest management strategies. Consequently, sustainable forest management practices are not fully integrated into climate adaptation frameworks.
3. **Weak Enforcement and Implementation of Existing Regulations**: Many existing laws and regulations lack robust enforcement mechanisms, resulting in insufficient compliance. Forest conservation laws often lack punitive measures and are constrained by voluntary compliance

frameworks, varying widely in application across Member States. This inconsistency hampers the effective conservation and sustainable use of EU forests.

4. **Insufficient Support for Sustainable Practices**: Sustainable forest management is challenged by inadequate financial and technical resources. Current frameworks and regulations often lack the support mechanisms necessary to promote and maintain sustainable practices, limiting their uptake and long-term viability across EU Member States.
5. **Limited Stakeholder Engagement**: Insufficient involvement of local communities and other stakeholders in policy formulation impedes effective forest governance. Engaging local actors, including communities, NGOs, and private sector representatives, is essential for holistic forest management, yet these groups are often underrepresented in the EU's policy-making processes.
6. **Need for Enhanced Monitoring and Compliance Tracking**: Effective mechanisms for monitoring and enforcing compliance with forest management norms and standards are lacking. Improved tracking of policy implementation and forest management practices is crucial to ensure accountability and effectiveness in meeting forest conservation goals.
7. **Limited Cross-Border Cooperation**: Cross-border collaboration on forest management remains weak among EU Member States. This challenge is particularly critical for regions where forest ecosystems span national boundaries, where stronger cross-border dialogue and cooperation are necessary to address shared conservation and management goals effectively.

At the national level, there are multiple challenges as well:

1. **Challenges to coordinated actions.** A wide range of actors are required for effective governance, including actors from different governance levels and sectors. However, many countries face difficulties in the promotion of coordinated actions. Complex administrative structures, such as for Portugal and Italy, fragmented land ownership and divergent stakeholder interests complicate the implementation of cohesive forest governance structures. Additionally, conflicting priorities between economic actors, e.g., timber industry and ecotourism businesses, often hinder comprehensive management plans, with small private landowners frequently lacking the necessary access to technical support or funding.
2. **Budget constraints and limited resources.** Adequate funding and resources are necessary for effective forest governance. However, many countries report limited budget that hinders their ability to execute comprehensive forest governance. For example, Greece remarked a lack of funding for forest management that leads to the accumulation of biomass that might increase the severity of wildfires and increase the chance of mega-fires. Similarly, Portugal struggles with limited funding for large-scale restoration projects, while Italy faces economic pressures that divert the focus, and consequently resources, from environmental initiatives. The challenge of ensuring that available funds reach remote or highly fragmented areas further exacerbate these issues.
3. **Inadequate infrastructures and lack of specialised personnel.** Many countries report insufficient infrastructures, technical equipment and specialized personnel that hinder forest management and wildfire prevention efforts. For example, in Romania the low density of forest roads and outdated firefighting equipment limits effective fire suppression, while, on the other hand, in Greece, the shortage of personnel with up-to-date expertise in forest management prevents the implementation of new knowledge and technologies. This is particularly problematic in remote areas where resources and personnel are often sparse, which limits the effectiveness of fire prevention and reforestation efforts.
4. **Decline in forest health and size.** The health of forest is being increasingly threatened by climate change, deforestation and the rising temperatures, contributing to the growing frequency and intensity of wildfires. The increasing temperatures and the prolonged droughts are severely impacting the health and regeneration of forest ecosystems in some countries such as Italy and Romania. Additionally, the economic pressure to prioritize timber extraction and agricultural expansion over conservation efforts are reported to further reduce forested areas, increasing the

vulnerability to wildfires and the loss of biodiversity. Simultaneously, practices such as monoculture planting and deforestation undermine biodiversity, increasing the need to implement reforestation programs that integrated climate adaptation and biodiversity conservation strategies.

The key findings outlined above highlight the numerous challenges that are faced in forest governance at the international, EU and national level, revealing critical areas where improvements can be made. To address these issues enhanced coordination among stakeholders, targeted investments, capacity building and the development of innovative policies balancing environmental conservation with economic and social needs are needed. A set of recommendations for the different governance levels are presented below, offering practical strategies to overcome these challenges and promote more effective and sustainable forest governance across different contexts.

Recommendations at the **international level** include:

1. **Enhancing coordination and integration**
    a. Multi-level governance (MLG) could be used to address vertical and horizontal fragmentation. Strengthening MLG to ensure better coordination across governance levels, from international agreements to local implementation, could help bridge the gap between global goals and local conditions, enhancing enforcement at the national and local levels.
    b. Holistic approaches, such as landscape approaches, can be used to address horizontal integration challenges by balancing trade-offs and addressing trade-offs. These can be complemented by jurisdictional approaches that can align governance actions within administrative boundaries and promote more effective policy coherence.
    c. Increasing the coordination between international frameworks can lead to a more coherent and integrated policy approach and optimize resource allocation. The collaboration between international institutions is vital to reduce policy fragmentation and align different objectives, like biodiversity conservation and climate change mitigation, and achieve a more unified global forest governance.
2. **Balancing market mechanisms with equity and fairness**
    a. Recognizing the nature of market to tend to favour short-term profit over long-term objectives, such as sustainability in green finance, financial mechanisms like PES and carbon credits, should integrate principles of equity and justice to overcome potential power imbalances. Policies should consider this and ensure that marginalized communities must benefit equitably from these schemes and reduce their vulnerability to exploitation by wealthier actors. At the same time, better regulatory frameworks should be introduced to align economic incentives with conservation outcomes.
    b. In order to counter the concerns over the commodification of forest resources, transparency and accountability in financial mechanism should be promoted. Particularly, technological innovation can be used for assistance in this matter, for example blockchain can be used to track financial transactions, ensuring appropriate resource allocation.
3. **Improving monitoring and accountability mechanisms**
    a. Standardized methodologies should be developed to improve the monitoring of IFG by measuring the effectiveness of forest governance frameworks. These methodologies would allow to evaluate whether international goals are being met at local levels, holding actors accountable for the implementation of policies, thus improving enforcement.
    b. Technological innovations, like satellite monitoring and digital platforms, should be further integrated into IFG to enhance data collection, transparency and accountability. Monitoring tools can support IFG by enabling real-time monitoring of forest cover, deforestation and restoration efforts. While digital platforms can facilitate better data sharing and cooperation across different governance level and improve alignment of international goals with local action.
4. **Expanding participatory and inclusive approaches**

a. The active participation of Indigenous Peoples and local communities in forest management should be promoted in IFG. Tools like Free, Prior and Informed Consent can be used to ensure that local stakeholders have their voice represented in decisions that affect their lands and resources.
b. To ensure optimal implementation of participatory approaches, it is necessary to assess the local conditions to verify if these are ready for the implementation of such approaches. If the conditions are not ideal, effort should be spent to build local capacity and trust before implementing participatory approaches, increasing their effectiveness and sustainability in the long term.

Recommendations at the **EU level** involve:

1. Strengthening EU Forest Governance Frameworks and Enhancing Policy Coherence

- **Cross-Sectoral Integration**: Special attention should be placed on ensuring that forest governance contributes to climate neutrality while meeting biodiversity targets. Climate and ecological policy directives should be integrated across sectors within the EU Forest Strategy.
- **Expanding the Biodiversity Strategy's Scope**: The 2030 EU Biodiversity Strategy should be broadened to include a wider range of forests, such as virgin, natural, and buffer zone forests, to strengthen conservation efforts.
- **Reinforcing the FLEGT Action Plan for Sustainable Forest Management**: The structure of the FLEGT Action Plan should be revised to focus on combating illegal logging and promoting sustainable governance across all suggested forest management activities.
- **Extending Natura 2000 to Climate-Sensitive Forests**: Climate-sensitive forest areas, especially those fragmented by natural factors, should be incorporated within Natura 2000 to ensure their conservation.
- **Supporting the Birds Directive in Forest Ecosystems**: The Birds Directive should be encouraged within forested areas to balance habitat management and biodiversity goals.
- **Tailoring Local Implementation**: Governance frameworks should be developed to adapt to specific regional contexts, allowing for effective local implementation in line with EU objectives.
- **Improving Policy Coherence**: A unified EU forest policy should be proposed, focusing on biodiversity conservation and climate mitigation while aligning with all related EU protocols and regulatory documents.

2. Enhancing the Common Agricultural Policy (CAP) for Forest-Specific Development

- **Allocating Resources for Forest Sustainability**: The CAP should be reformed to allocate additional financial resources specifically for sustainable forest management and ecosystem services.
- **Introducing Binding Commitments**: Binding commitments and enforceable measures should be integrated within existing regulations to ensure compliance and accountability.
- **Accelerating Deforestation-Free Products Regulation**: The implementation of the Deforestation-Free Products Regulation should be expedited to address global warming impacts related to imported forest products.

3. Fostering Innovative Governance Models

- **Promoting Multi-Level and Participatory Governance**: Collaboration between local, national, and EU-level actors should be enhanced to ensure that policies are contextually adapted and sustainable.

- **Deepening Stakeholder Engagement**: Greater efforts should be made to engage local communities and stakeholders in forest management decisions to promote inclusive governance.
- **Strengthening Cross-Border Collaboration**: Cooperative frameworks should be strengthened to manage shared forest ecosystems effectively in transboundary regions.
- **Supporting Voluntary Forest Europe Guidelines**: Forest Europe's voluntary guidelines should be adopted to address cross-border challenges and improve transboundary forest governance.

4. Advancing Technological and Policy Innovations

- **Incorporating Technological Tools**: Technologies like GIS, drones, and AI should be utilized to enhance forest management and mitigate risks.
- **Investing in Forest Resilience Technologies**: Increased investment in technologies that bolster forest resilience should be prioritized, particularly in areas vulnerable to climate impacts.
- **Promoting Bioeconomy Initiatives in Forestry**: Innovation within the forest-based bioeconomy should be promoted, ensuring that sustainability and biodiversity objectives are prioritized.
- **Enhancing Monitoring, Evaluation, and Reporting Mechanisms**: Advanced monitoring technologies should be implemented to ensure compliance with regulations and assess the impact of forest management practices.

5. Building Capacity and Harmonizing Efforts Across Member States

- **Reducing Resource Disparities**: EU-wide capacity-building programs should be established to support Member States with limited resources in adopting advanced forest governance technologies.
- **Increasing Financial Support for Sustainable Practices**: EU funding should be increased to promote sustainable forest management initiatives and ensure equitable access to resources.

6. Creating Economic Incentives and Green Financing Mechanisms

- **Promoting Payments for Ecosystem Services (PES)**: Financial incentives for environmental management practices, such as PES, should be introduced to support both economic growth and ecological sustainability.
- **Supporting Carbon Credit Markets**: Carbon trading systems should be strengthened to improve economic efficiency in meeting EU climate and biodiversity goals.

7. Addressing Climate Change Skepticism and Enhancing Environmental Strategy

- **Building Public Awareness and Political Support**: A long-term communication strategy should be developed to build awareness and support for sustainable forest management practices.
- **Integrating the European Green Deal with Forest Management**: The European Green Deal should be fully aligned with forest management policies to meet the EU's climate neutrality goals by 2050.

Recommendations at the **national level** include:

1. **Enhanced cooperation among stakeholders** that requires an **integrated approach** that accounts for the diverse perspectives and needs of forests and their stakeholders. Effective cooperation should be pursued both across governance levels (local, regional, national and international) and across sectors (forestry, agriculture, water management, etc.), particularly for addressing existing conflicting interests.
2. **Access to funds and European projects**, such as SILVANUS itself, presents numerous opportunities for enhancing forest management, especially in reforestation and restoration initiatives. National governance bodies should **improve their capacity to access and utilize these resources efficiently**.

Furthermore, national governments should also explore innovative financial mechanisms, such as carbon credits and PES, to generate additional revenue streams that could be used for conservation efforts, supplementing national budgets. Expanding international cooperation, especially among neighbouring regions, can strengthen forest governance through shared expertise and resources.

3. **Embracing innovation in forest management like innovative and emerging technologies**, including the SILVANUS platform itself, can present numerous opportunities to enhance forest governance in several contexts. For example, UAVs and AI-enhanced sensors can improve the speed and accuracy of wildfire detection, while AI-driven solutions can provide data-backed support for decision-making. Innovation can come from other actions as well, particularly, **emerging practices** such as agroforestry and the use of fire-resistant indigenous species in reforestation for increasing forest resilience to climate change while also providing economic benefit, as demonstrated in Brazil.
4. **Increased public awareness and participation** can promote a more responsible behaviour from citizens in committing to the long-term support of environmental initiatives, such as refraining from actions that might increase the risk of wildfires and acknowledge the many roles of forests. The involvement of local communities can be carried out for different objectives, e.g. increasing the awareness and engagement regarding wildfire prevention, and by using different modalities which properly adapted to the audience. Particularly, increasing public awareness, e.g. through citizen engagement campaigns, can lead to more initiatives from public authorities that might persuade the allocation of additional funds for forest governance.

7 References

Abrams, J., Davis, E. J., & Wollstein, K. (2017). Rangeland fire protection associations in Great Basin rangelands: A model for adaptive community relationships with wildfire? *Human Ecology*, 45(6), 773–785. https://doi.org/10.1007/s10745-017-9945-y

Abulu, L., Ghosh, S., 2022. Nations adopt Kunming-Montreal Global Biodiversity Framework. Mongabay Environmental News. URL https://news.mongabay.com/2022/12/nations-adopt-kunming-montrealglobal-biodiversity-framework/

Acciaioli, G., & Afiff, S. (2018). Neoliberal Conservation in Central Kalimantan, Indonesia: Evaluating the approach to environmental education of the transnational conservation organisation Rare1. Indonesia and the Malay World, 46(136), 241–262. https://doi.org/10.1080/13639811.2018.1531968

Adeline-Cristina Cozma, Monica Maria Coroș, Ana Monica Pop, Ion Gavrilescu, Nicolae Cătălin Dinucă, Corruption, deforestation, and tourism – Europe case study, Heliyon, Volume 9, Issue 8, 2023, e19075, ISSN 2405-8440, https://doi.org/10.1016/j.heliyon.2023.e19075.

Adriana Erthal Abdenur, 2022. The Glasgow Leaders' Declaration on Forests: Déja Vu or Solid Restart?, New York: United Nations University.

Aksel Sundström, Understanding illegality and corruption in forest governance, Journal of Environmental Management, Volume 181, 2016, Pages 779-790, ISSN 0301-4797, https://doi.org/10.1016/j.jenvman.2016.07.020. (https://www.sciencedirect.com/science/article/pii/S0301479716304571)

Arts, B., Buizer, M., Horlings, L., Ingram, V., van Oosten, C., Opdam, P., 2017. Landscape Approaches: A Stateof-the-Art Review. Annual Review of Environment and Resources 42, 439–463.

Asihing, K. (2014). Actor, Interest and Conflict in Sustainable Mangrove Forest Management — A Case from Indonesia. International Journal of Marine Science, 4(16), 150-159.doi: https://doi.org/10.5376/ijms.2014.04.0016

Bache, I., Bartle, I., & Flinders, M. (2016). Multi-level governance. In C. Ansell & J. Torfing (Eds.), *Handbook on Theories of Governance* (pp. 486–498). Edward Elgar Publishing.

Baldi, F., Pandimiglio, A., 2022. The role of ESG scoring and greenwashing risk in explaining the yields of green bonds: A conceptual framework and an econometric analysis. Glob. Finance J. 52, 100711.

Baldwin, R., & Cave, M. (1999). *Understanding Regulation: Theory, Strategy, and Practice*. Oxford University Press.

Barbara Sowińska-Świerkosz, Joan García, 2022. What are Nature-based solutions (NBS)? Setting core ideas for concept clarification, Nature-Based Solutions, Volume 2, 100009, ISSN 2772-4115, https://doi.org/10.1016/j.nbsj.2022.100009.

Begemann, A., Dolriis, C., Winkel, G., 2023. Rich forests, rich people? Sustainable finance and its links to forests. J. Environ. Manage. 326, 116808.

Beland Lindahl, K., Sandström, C., Sténs, A., 2017. Alternative pathways to sustainability? Comparing forest governance models. For. Policy Econ., Alternative Pathways to Sustainability? Comparing Forest Governance Models 77, 69–78.

Benedum, M. E., & Becker, D. R. (2021). Using a network governance framework to assess the wood energy industry in times of catastrophic wildfire in Northern California. *Regional Environmental Change*, 21(2), 51. https://doi.org/10.1007/s10113-021-01779-x

Benjaminsen, T.A., Svarstad, H. (2021). Climate Mitigation Choices: Reducing Deforestation in the Global South Versus Reducing Fossil Fuel Production at Home. In: Political Ecology. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-56036-2_6

Benz, A. (2004). *Governance—Regieren in komplexen Regelsystemen: Eine Einführung*. VS Verlag für Sozialwissenschaften.

Berkes, F. (2008). Commons in a multi-level world. *International Journal of the Commons*, 2(1), 1–6. https://doi.org/10.18352/ijc.80

Blaser, J., Chipeta, M.E., Illueca, J., Lobovikov, M., Umali, R.M., 2014. Independent Assessment of the International Arrangement on Forests (IAF). Report of the Team of Independent Consultants. Bonn Challenge, New York.

Bodin, Ö. (2017). Collaborative environmental governance: Achieving collective action in social-ecological systems. *Science*, 357(6352), eaan1114. https://doi.org/10.1126/science.aan1114

Boffo, R., Patalano, R., 2020. ESG Investing: Practices, Progress and Challenges. OECD, Paris.

Boyd, E., Nykvist, B., Borgström, S., & Stacewicz, I. A. (2015). Anticipatory governance for social-ecological resilience. *Ambio*, 44, 149–161. https://doi.org/10.1007/s13280-014-0604-x

Brancalion, P. H., & Chazdon, R. L. (2017). Beyond hectares: four principles to guide reforestation in the context of tropical forest and landscape restoration. Restoration Ecology, 25(4), 491-496.

Brockhaus, M., Di Gregorio, M., Djoudi, H., Moeliono, M., Pham, T.T., Wong, G.Y., 2021. The forest frontier in the Global South: Climate change policies and the promise of development and equity. Ambio 50, 2238–2255.

Brodie, Emily G.; Knapp, Eric E.; Brooks, Wesley R.; Drury, Stacy A.; Ritchie, Martin W. 2024. Forest thinning and prescribed burning treatments reduce wildfire severity and buffer the impacts of severe fire weather. Fire Ecology. 20(1): 11770. https://doi.org/10.1186/s42408-023-00241-z.

Buizer, M., Humphreys, D., de Jong, W., 2014. Climate change and deforestation: The evolution of an intersecting policy domain. Environ. Sci. Policy, Climate change and deforestation: the evolution of an intersecting policy domain 35, 1–11.

Bull, G.Q., Boedhihartono, A.K., Bueno, G., Cashore, B., Elliott, C., Langston, J.D., Riggs, R.A., Sayer, J., 2018. Global forest discourses must connect with local forest realities. The International Forestry Review 20, 160–166.

Carlisle, K., & Gruby, R. L. (2019). Polycentric systems of governance: A theoretical model for the commons. *Policy Studies Journal*, 47(4), 927–952. https://doi.org/10.1111/psj.12212

Carlsson, L., & Sandström, A. (2008). Network governance of the commons. *International Journal of the Commons*, 2(1), 33–54. https://doi.org/10.18352/ijc.20

Carolin Maier, Wiebke Hebermehl, Carol M. Grossmann, Lasse Loft, Carsten Mann, Mónica Hernández-Morcillo, 2021. Innovations for securing forest ecosystem service provision in Europe – A systematic literature review, Ecosystem Services, Volume 52, 101374, ISSN 2212-0416, https://doi.org/10.1016/j.ecoser.2021.101374.

Carr, E. H. (1939). The twenty year's crisis, 1919-1939: An introduction to the study of international relations, Macmillan

Carson Rachel (1962). Silent Spring, Houghton Mifflin Company, Boston

Carsten Mann, Lasse Loft, Mónica Hernández-Morcillo, Eeva Primmer, Francesca Bussola, Enzo Falco, Davide Geneletti, Ewelina Dobrowolska, Carol M. Grossmann, Giorgia Bottaro, Christian Schleyer, Tatiana Kluvankova, Gino Garcia, Marko Lovrić, Mario Torralba, Tobias Plieninger, Georg Winkel, Governance Innovations for forest ecosystem service provision – Insights from an EU- wide survey, Environmental Science & Policy, Volume 132, 2022, Pages 282-295, ISSN 1462-9011, https://doi.org/10.1016/j.envsci.2022.02.032.

CBD Secretariat, 2020. Global Biodiversity Outlook 5 – Summary for Policy Makers. Convention on Biological Diversity, Montreal.

Chaffin, B. C., Gosnell, H., & Cosens, B. A. (2014). A decade of adaptive governance scholarship: Synthesis and future directions. *Ecology and Society*, 19(3), 56. http://dx.doi.org/10.5751/ES-06824-190356

Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., Maginnis, S., Maynard, S., Nelson, C.R., Renaud, F.G., Welling, R., Walters, G., 2019. Core principles for successfully implementing and upscaling Nature-based Solutions. Environ. Sci. Policy 98, 20–29

Committee of Experts on Public Administration. (2006). *Definition of basic concepts and terminologies in governance and public administration*. United Nations Economic and Social Council, New York, 27–31 March 2006.

Constance L. McDermott, REDDuced: From sustainability to legality to units of carbon—The search for common interests in international forest governance, Environmental Science & Policy, Volume 35, 2014, Pages 12-19, ISSN 1462-9011, https://doi.org/10.1016/j.envsci.2012.08.012.

Correa Gonzaga, C.A., Roquette, J. G., Angeoletto, F., Silgueiro, V. D. F., Macedo, L. O. B., Valdiones, A. P., da Silva, N. M., 2024. 'The Public Prosecutor's Office's experience using Global Forest Watch to monitor and deter deforestation in the Cerrado', Environmental Conservation, pp. 1–6. doi:10.1017/S0376892924000110.

D. Scott Slocombe (1984). Environmentalism: A modern synthesis, The Environmentalist, Volume 4, Issue 4, 1984, Pages 281-285, ISSN 0251-1088, https://doi.org/10.1016/S0251-1088(84)92432-X.

Daniela Kleinschmit, Christoph Wildburger, Nelson Grima, and Brendan Fisher (eds.), 2024.

Daniell, K. A., & Kay, A. (2017). Multi-level governance: An introduction. In K. A. Daniell & A. Kay (Eds.), Multi-level governance: Conceptual challenges and case studies from Australia (pp. 3–32). Australia and New Zealand School of Government, ANU Press.

De Abreu, S. J. (2021). Toward a holistic approach: considerations for improved collaboration in wildfire management. Open Journal of Forestry, 12(1), 107-121.

de Jong, L., De Bruin, S., Knoop, J., & van Vliet, J. (2021). Understanding land-use change conflict: a systematic review of case studies. Journal of Land Use Science, 16(3), 223–239. https://doi.org/10.1080/1747423X.2021.1933226

De La Fuente, T., Hajjar, R., (2013). Do current forest carbon standards include adequate requirements to ensure indigenous peoples' right in REDD projects? International Forestry Review, Volume 15, Number 4, pp. 427-441(15). https://doi.org/10.1505/146554813809025676

de la Porte, C., & Pochet, P. (Eds.). (2002). *Building Social Europe through the Open Method of Coordination*. Peter Lang.

Derek P. Tittensor et al. (2014). A mid-term analysis of progress toward international biodiversity targets. Science 346,241-244. https://doi.org/10.1126/science.1257484

Díaz, S., Zafra-Calvo, N., Purvis, A., Verburg, P.H., Obura, D., Leadley, P., Chaplin-Kramer, R., De Meester, L., Dulloo, E., Martín-López, B., Shaw, M.R., Visconti, P., Broadgate, W., Bruford, M.W., Burgess, N.D., Cavender-Bares, J., DeClerck, F., Fernández-Palacios, J.M., Garibaldi, L.A., Hill, S.L.L., Isbell, F., Khoury, C.K., Krug, C.B., Liu, J., Maron, M., McGowan, P.J.K., Pereira, H.M., Reyes-García, V., Rocha, J., Rondinini, C., Shannon, L., Shin, Y.-J., Snelgrove, P.V.R., Spehn, E.M., Strassburg, B., Subramanian, S.M., Tewksbury, J.J., Watson, J.E.M., Zanne, A.E., 2020. Set ambitious goals for biodiversity and sustainability. Science 370, 411–413.

Dunne, Tim, Milja Kurki, Steve Smith (2020). International Relations Theories: Discipline and Diversity. 5th ed., Oxford University Press.

Eising, R., & Kohler-Koch, B. (1999). Introduction: Network governance in the European Union. In B. Kohler-Koch & R. Eising (Eds.), *The Transformation of Governance in the European Union*. Routledge.

Eric Mensah Kumeh, Boateng Kyereh, Kwame Antwi Oduro, Lawrence Kwabena Brobbey, Samuel Kwabena Nketiah, Transparency in the governance of landscape restoration finance: A case study of Ghana's Forest Plantation Development Fund, Scientific African, Volume 6, 2019, e00185, ISSN 2468-2276, https://doi.org/10.1016/j.sciaf.2019.e00185.

Essen, M., McCaffrey, S., Abrams, J., & Paveglio, T. (2023). Improving wildfire management outcomes: shifting the paradigm of wildfire from simple to complex risk. Journal of Environmental Planning and Management, 66(5), 909-927.

European Commission, 2015. Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities. Publications Office of the European Union, LU.

European Commission: Directorate-General for Research and Innovation. (2021). Evaluating the impact of nature-based solutions: a handbook for practitioners. Publications Office of the European Union. https://data.europa.eu/doi/10.2777/244577.

European Commission (2021a). New EU Forest Strategy for 2030. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2021) 572 Final; European Commission: Brussels, Belgium, 2021. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0572

FAO (2011). The Program on Forests (PROFOR); Food and Agriculture Organization of the United Nations (FAO). Framework for Assessing and Monitoring Forest Governance; The Program on Forests (PROFOR) and the Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, 2011. Available online: http://www.fao.org/climatechange/27526-0cc61ecc084048c7a9425f64942df70a8.pdf

FAO. 2013. Implementing the Non-legally Binding Instrument on All Types of Forests. Rome, Food and Agriculture Organization of the United Nations Rayner, J., Buck, A., Katila, P., 2010. Embracing complexity: Meeting the challenges of international forest governance (IUFRO World series vol. 28). International Union of Forest Research Organizations (IUFRO), Vienna, Austria.

Fearnside, Philip (1982). Deforestation in the Brazilian Amazon: How fast is it occurring? Interciencia 7(2), https://www.researchgate.net/publication/42763270_Deforestation_in_the_Brazilian_Amazon_How_Fast_is_it_Occurring

Fearnside, Philip. (1989). Deforestation in Brazilian Amazonia: the rates and causes of forest destruction. 19. 214-218. https://www.researchgate.net/publication/292872545_Deforestation_in_Brazilian_Amazonia_the_rates_and_causes_of_forest_destruction

Fischer, F. 2010. Participatory Governance. Jerusalem Papers in Regulation & Governance Working Paper 24.

Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16(3), 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources*, 30, 441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

Food and Agriculture Organization (FAO), 2024. Sustainable Forest Management (SFM) Toolbox. https://www.fao.org/sustainable-forest-management/toolbox/modules/forest-governance/basic-knowledge/en/. Accessed: September 2024.

Food and Agriculture Organization (FAO). (n.d.). *Governance and Tenure*. Retrieved from FAO Website

Forsyth, T., Sikor, T., 2013. Forests, development and the globalisation of justice. Geogr. J. 179, 114–121.

Galaz, V., 2022. Global environmental governance in times of turbulence. One Earth 5, 582–585.

Gilbert, J. (2016). Land grabbing, investors, and indigenous peoples: new legal strategies for an old practice? Community Development Journal, 51(3), 350–366. https://www.jstor.org/stable/26165069

Goldstein, J., Kahler, M., Keohane, R. O., & Slaughter, A.-M. (2000). Introduction: Legalization and world politics. *International Organization*, 54(3), 385–399.

Gordeeva E, Weber N, Wolfslehner B. The New EU Forest Strategy for 2030—An Analysis of Major Interests. Forests. 2022; 13(9):1503. https://doi.org/10.3390/f13091503

Graeme M. Buchanan, Stuart H.M. Butchart, Georgina Chandler, Richard D. Gregory, 2020. Assessment of national-level progress towards elements of the Aichi Biodiversity Targets, Ecological Indicators, Volume 116, 106497, ISSN 1470-160X, https://doi.org/10.1016/j.ecolind.2020.106497.

Gray, B. (1985). Conditions facilitating interorganizational collaboration. *Human Relations*, 38(10), 911–936. https://doi.org/10.1177/001872678503801001

Gritten, D., Lewis, S. R., Breukink, G., Mo, K., Thuy, D. T. T., & Delattre, E. (2019). Assessing forest governance in the countries of the Greater Mekong Subregion. Forests, 10(1), 47.

Gupta, J., 2012. Glocal forest and REDD+ governance: win–win or lose–lose? Current Opinion in Environmental Sustainability, 4/6 Climate systems 4, 620–627.

Hecht, S. B. (1981). Deforestation in the Amazon Basin: Magnitude, Dynamics and Soil Resource Effects. Studies in Third World Societies, Vol. 13: 61-108.

Hecht, S. B., Cockburn, A. (1990). The Fate of the Forest: Developers, Destroyers, and Defenders of the Amazon. Verso.

Héritier, A. (2002). New modes of governance in Europe: Policy-making without legislating? In A. Héritier (Ed.), *Common Goods: Reinventing European and International Governance* (pp. 185–206). Rowman & Littlefield.

Héritier, A. (2003). New modes of governance in Europe: Increasing political capacity and policy effectiveness. In T. A. Börzel & R. A. Cichowski (Eds.), *The State of the European Union* (pp. 105–126). Oxford University Press.

Hovik, S., & Hongslo, E. (2016). Balancing local interests and national conservation obligations in nature protection. The case of local management boards in Norway. Journal of Environmental Planning and Management, 60(4), 708–724. https://doi.org/10.1080/09640568.2016.1176556

Howlett, M., & Ramesh, M. (2014). The two orders of governance failure: Design mismatches and policy capacity issues in modern governance. *Policy and Society*, 33(4), 317–327. https://doi.org/10.1016/j.polsoc.2014.10.002

International Forest Governance: A Critical Review of Trends, Drawbacks, and New Approaches.

International Tropical Timber Agreement, 1983, Nov. 18, 1983, 23 ILM 1431 (1984). https://treaties.un.org/doc/Publication/UNTS/Volume%201393/volume-1393-A-23317-English.pdf

IPBES, 2019. Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn, Germany.

IUCN (2020). Global standard for nature-based solutions. A user-friendly framework for the verification, design and scaling up of NbS. Gland, Switzerland.

IUFRO World Series Volume 43. Vienna. 164p.

James Reed, Amy Ickowitz, Colas Chervier, Houria Djoudi, Kaala Moombe, Mirjam Ros-Tonen, Malaika Yanou, Linda Yuliani, Terry Sunderland, Integrated landscape approaches in the tropics: A brief stock-take, Land Use Policy, Volume 99, 2020, 104822, ISSN 0264-8377, https://doi.org/10.1016/j.landusepol.2020.104822.

Jeremy Rayner, Alexander Buck & Pia Katila (eds.). 2010. Embracing complexity: Meeting the challenges of international forest governance. A global assessment report. Prepared by the Global Forest Expert Panel on the International Forest Regime. IUFRO World Series Volume 28. Vienna. 172 p.

Jessop, B. (2013). Hollowing out the 'nation-state' and multi-level governance. In P. Kennett (Ed.), *A Handbook of Comparative Social Policy* (2nd ed., pp. 11–26). Edward Elgar Publishing. https://doi.org/10.4337/9781782546535.00008

Jonas Hein, Alejandro Guarin, Ezra Frommé, Pieter Pauw, Deforestation and the Paris climate agreement: An assessment of REDD+ in the national climate action plans, Forest Policy and Economics, Volume 90, 2018, Pages 7-11, ISSN 1389-9341, https://doi.org/10.1016/j.forpol.2018.01.005. (https://www.sciencedirect.com/science/article/pii/S1389934117305373)

Jordan, A. (1999). European Community water policy standards: Locked in or watered down? *Journal of Common Market Studies*, 37(1), 13–37.

Jordan, A., Wurzel, R. K. W., & Zito, A. R. (2005). The rise of 'new' policy instruments in comparative perspective: Has governance eclipsed government? *Political Studies*, 53(3), 477–496.

Jørgensen, D., 2013. Ecological restoration in the Convention on Biological Diversity targets. Biodivers Conserv 22, 2977–2982.

Juniyanti L, Purnomo H, Kartodihardjo H, Prasetyo L., B., 2021. Understanding the Driving Forces and Actors of Land Change Due to Forestry and Agricultural Practices in Sumatra and Kalimantan: A Systematic Review. Land; 10(5):463. https://doi.org/10.3390/land10050463

Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S., Davis, M., Artmann, M., Haase, D., Knapp, S., Korn, H., Stadler, J., Zaunberger, K., Bonn, A., 2016. Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. Ecol. Soc. 21

Karsenty, A., 2010. Forest taxation regime for tropical forests: lessons from Central Africa. Int. For. Rev. 12, 121–129.

Kirschner, J. A., Clark, J., & Boustras, G. (2023). Governing wildfires: Toward a systematic analytical framework. *Ecology and Society*, 28(2), 6. https://doi.org/10.5751/ES-13920-280206

Kirschner, J. A., Clark, J., & Boustras, G. (2023). Governing wildfires: toward a systematic analytical framework. Ecology and Society, 28(2).

Kiss Bernadett, Sekulova Filka, Hörschelmann Kathrin, F. Salk Carl, Takahashi Wakana, Wamsler Christine, 2022. Citizen participation in the governance of nature-based solutions. Environmental Policy and Governance, 32(3), 211–225. https://doi.org/10.1002/eet.1987

Klaus Henle, Didier Alard, Jeremy Clitherow, Paul Cobb, Les Firbank, Tiiu Kull, Davy McCracken, Robin F.A. Moritz, Jari Niemelä, Michael Rebane, Dirk Wascher, Allan Watt, Juliette Young, Identifying and managing the conflicts between agriculture and biodiversity conservation in Europe–A review, Agriculture, Ecosystems & Environment, Volume 124, Issues 1–2, 2008, Pages 60-71, ISSN 0167-8809, https://doi.org/10.1016/j.agee.2007.09.005.

Knill, C., & Lenschow, A. (2000). *Implementing EU Environmental Policy: New Directions and Old Problems*. Manchester University Press.

Kooiman, J. (2003). *Governing as Governance*. Sage Publications.

Kopnina, H. (2017) 'Commodification of natural resources and forest ecosystem services: examining implications for forest protection', Environmental Conservation, 44(1), pp. 24–33. doi:10.1017/S0376892916000436.

Korhonen-Kurki, K., Brockhaus, M., Sehring, J., Di Gregorio, M., Assembe-Mvondo, S., Babon, A., Bekele, M., Benn, V., Gebara, M.F., Kambire, H.W., Kengoum, F., Maharani, C., Menton, M., Moeliono, M., Ochieng, R., Paudel, N.S., Pham, T.T., Dkamela, G.P., Sitoe, A., 2019. What drives policy change for REDD+? A qualitative comparative analysis of the interplay between institutional and policy arena factors. Climate Policy 19, 315–328.

Langston, J. D., Riggs, R. A., Sururi, Y., Sunderland, T., & Munawir, M. (2017). Estate crops more attractive than community forests in West Kalimantan, Indonesia. Land, 6(1), 12.

Leland K. Werden, Rebecca J. Cole, Katrin Schönhofer, Karen D. Holl, Rakan A. Zahawi, Colin Averill, Daniella Schweizer, Julio C. Calvo-Alvarado, Debra Hamilton, Francis H. Joyce, Miriam San-José, Florian Hofhansl, Lilly Briggs, David Rodríguez, Jeffrey W. Tingle, Fidel Chiriboga, Eben N. Broadbent, Gerald J. Quirós-Cedeño, Thomas W. Crowther, Assessing innovations for upscaling forest landscape restoration, One Earth, Volume 7, Issue 9, 2024, Pages 1515-1528, ISSN 2590-3322, https://doi.org/10.1016/j.oneear.2024.07.011.
(https://www.sciencedirect.com/science/article/pii/S2590332224003658)

Loft, L., Dung, N.L., Thuy, T.P., Anastasia, L.Y., Januarti, S.T., Grace, Y.W., 2017. Whose equity matters? national to local equity perceptions in vietnam's payments for forest ecosystem services scheme. Ecol. Econ. 135, 164–175. https://doi.org/10.1016/j.ecolecon.2017.01.016

Logmani-Aßmann, J., Lindahl, K.B., Krott, M., Burns, S.L., Giessen, L., 2021. Forest set-aside policy for international biodiversity targets? Obstructive bureaucratic territoriality in Germany and Sweden. International Forestry Review 23, 448–461.

López-Carr D., 2021. A Review of Small Farmer Land Use and Deforestation in Tropical Forest Frontiers: Implications for Conservation and Sustainable Livelihoods. Land; 10(11):1113. https://doi.org/10.3390/land10111113

Loveridge, R. (2021). Beyond Win-Wins: Understanding diverse impacts of complex protected area governance arrangements on human wellbeing and conservation in tropical forests (Doctoral dissertation, University of York).

Ludvig, A., Tahvanainen, V., Dickson, A., Evard, C., Kurttila, M., Cosovic, M., Chapman, E., Wilding, M., Weiss, G., 2016. The practice of entrepreneurship in the non-wood forest products sector: Support for innovation on private forest land. Forest Policy Econ. 66, 31–37. https://doi.org/10.1016/j.forpol.2016.02.007.

Maney, C., Guaras, D.,Harrison, J. Guizar-Coutiño, A., Harfoot, M. B., J., Hill, S. L. L., Burgess, N. D., Sutherland, W., 2024. National commitments to Aichi Targets and their implications for monitoring the Kunming-Montreal Global Biodiversity Framework. npj biodivers 3, 6. https://doi.org/10.1038/s44185-024-00039-5

Mansourian, S., Parrotta, J., 2019. From addressing symptoms to tackling the illness: Reversing forest loss and degradation. Environmental Science & Policy 101, 262–265.

Marin, B., & Mayntz, R. (Eds.). (1991). *Policy Networks: Empirical Evidence and Theoretical Considerations*. Campus Verlag.

Mayntz, R. (2004). Governance theory als fortentwickelte Steuerungstheorie? *MPIfG Working Paper*, 04/1.

Melanidis, M.S., Hagerman, S., 2022. Competing narratives of nature-based solutions: Leveraging the power of nature or dangerous distraction? Environ. Sci. Policy 132, 273–281.

Millennium Ecosystem Assessment, 2005. A Report of the Millennium Ecosystem Assessment. Ecosystems and Human Well-Being. Island Press, Washington DC.

Miller, M. J. (2011). Persistent Illegal Logging in Costa Rica: The Role of Corruption Among Forestry Regulators. The Journal of Environment & Development, 20(1), 50-68. https://doi.org/10.1177/1070496510394319

Ministry of Agriculture (1992). First National Inventory of Greece, General Secretariat of Forests and Natural Environment. Independent Edition.

Mwangi Esther, Wardell Andrew, 2012. Multi-level governance of forest resources. International Journal of the Commons, Vol. 6, no 2, August 2012, pp. 79–103. https://doi.org/10.18352/ijc.374

Myers, N. (1980). The Present Status and Future Prospects of Tropical Moist Forests. Environmental Conservation, 7(2), 101–114. http://www.jstor.org/stable/44517094

Nikolakis, W., Welham, C., & Greene, G. (2022). Diffusion of indigenous fire management and carbon-credit programs: Opportunities and challenges for "scaling-up" to temperate ecosystems. Frontiers in Forests and Global Change, 5, 967653

NYDF Assessment Partners. (2019). Protecting and Restoring Forests: A Story of Large Commitments yet Limited Progress. New York Declaration on Forests Five-Year Assessment Report. Climate Focus (coordinator and editor). Accessible at forestdeclaration.org.

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press.

Ostrom, E. (2010). Beyond markets and states: Polycentric governance of complex economic systems. *American Economic Review*, 100(3), 641–672. https://doi.org/10.1257/aer.100.3.641

Ostrom, V., Tiebout, C. M., & Warren, R. (1961). The organization of government in metropolitan areas: A theoretical inquiry. *American Political Science Review*, 55(4), 831–842. https://doi.org/10.2307/1952530

Parrotta, J., Mansourian, S., Wildburger, C., Grima, N. (Eds.), 2022. Forests, Climate, Biodiversity and People: Assessing a Decade of REDD+, IUFRO World Series Vol. 40. IUFRO, Vienna, Austria

Pedroza-Arceo N., M.; Weber N.; Ortega-Argueta A.; 2022. A Knowledge Review on Integrated Landscape Approaches. Forests. 13(2):312. https://doi.org/10.3390/f13020312

Perino, A., Pereira, H.M., Felipe-Lucia, M., Kim, H., Kühl, H.S., Marselle, M.R., Meya, J.N., Meyer, C., Navarro, L.M., van Klink, R., Albert, G., Barratt, C.D., Bruelheide, H., Cao, Y., Chamoin, A., Darbi, M., Dornelas, M., Eisenhauer, N., Essl, F., Farwig, N., Förster, J., Freyhof, J., Geschke, J., Gottschall, F., Guerra, C., Haase, P., Hickler, T., Jacob, U., Kastner, T., Korell, L., Kühn, I., Lehmann, G.U.C., Lenzner, B., Marques, A., Motivans Švara, E., Quintero, L.C., Pacheco, A., Popp, A., Rouet-Leduc, J., Schnabel, F., Siebert, J., Staude, I.R., Trogisch, S., Švara, V., Svenning, J.-C., Pe'er, G., Raab, K., Rakosy, D., Vandewalle, M., Werner, A.S., Wirth, C., Xu, H., Yu, D., Zinngrebe, Y., Bonn, A., 2022. Biodiversity post-2020: Closing the gap between global targets and national-level implementation. Conservation Letters 15.

Peter J. Kanowski, Constance L. McDermott, Benjamin W. Cashore, Implementing REDD+: lessons from analysis of forest governance, Environmental Science & Policy, Volume 14, Issue 2, 2011, Pages 111-117, ISSN 1462-9011, https://doi.org/10.1016/j.envsci.2010.11.007. (https://www.sciencedirect.com/science/article/pii/S1462901110001620)

Plieninger, T., & Bens, O. (2007). How the emergence of biofuels challenges environmental conservation. Environmental Conservation, 34(4), 273-275.

Pochet, P. (2005). The open method of coordination and the construction of social Europe: A historical perspective. In J. Zeitlin & P. Pochet (Eds.), *The Open Method of Coordination in Action*. Peter Lang.

Pokorny, B., Kleinschmit, D., Kanowski, P., 2019. Forests as a Global Commons: International governance and the role of Germany. University of Freiburg, Freiburg.

Porter, B. (1972). The Aberystwyth papers: International politics 1919-1969. Oxford University Press.

Primmer, E., Paloniemi, R., Siilä, J., Tainio, A., 2014. Forest owners perceptions of institutions and voluntary contracting for biodiversity conservation: not crowding but staying out. Ecol. Econ. 103, 1–10.

Prins, K., 2023. Assessment on actions related to the implementation of the United Nations Strategic Plan for Forests 2017–2030 (Preparations for the Midterm Review (MTR) of the International Arrangement on Forests (IAF)). UN Forum on Forests, New York.

PROFOR, 2017. Assessing Forest Governance in Mozambique. Identifying Key Challenges and Interventions to Strengthen Governance. Available online: https://www.profor.info/sites/default/files/Assessing%2520Forest%2520Governance%2520in%2520Mozambique_Policy%2520Brief.PDF

Prokofieva, I., Wunder, S., 2014. Designing economic instruments for ecosystem services. From traditional regulation to economic instruments. In: Thorsen, B.; J., Mavsar; B.; R., Tyrvainen;, L., Prokofieva, I., Stenger.

Provan, K. G., & Kenis, P. (2008). Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory*, 18(2), 229–252. https://doi.org/10.1093/jopart/mum015

Pülzl, Helga & Hogl, Karl & Kleinschmit, Daniela & Wydra, Doris & Arts, B. & Mayer, Peter & Palahí, Marc & Winkel, Georg & Wolfslehner, Bernhard. (2013). European Forest Governance: Issues at Stake and the Way Forward. EFI Series: What Science can tell us. 2013.

Quay, R. (2010). Anticipatory governance: A tool for climate change adaptation. *Journal of the American Planning Association*, 76(4), 496–511. https://doi.org/10.1080/01944363.2010.508428

Rana, P., & Varshney, L. R. (2021). Trustworthy predictive algorithms for complex forest system decision-making. Frontiers in Forests and Global Change, 3, 587178.

Rhodes, R. A. W. (1997). *Understanding Governance: Policy Networks, Governance, Reflexivity and Accountability*. Open University Press.

Richardson, J. J. (2000). Government, interest groups and policy change. *Political Studies*, 48(5), 1006–1025.

Richardson, J. J., & Jordan, A. G. (1979). *Governing Under Pressure: The Policy Process in a Post-Parliamentary Democracy*. Martin Robertson.

Rodney J. Keenan, Christopher J. Westo2 and Liubov Volkova, 2021. Potential for forest thinning to reduce risk and increase resilience to wildfire in Australian temperate Eucalyptus forests. Current Opinion in Environmental Science & Health 23:100280.

Ros-Tonen, M.A.F., Reed, J., Sunderland, T., 2018. From Synergy to Complexity: The Trend Toward Integrated Value Chain and Landscape Governance. Environmental Management 62, 1–14

Rowland, Wade (1973). The Plot to Save the World: The Life and Times of the Stockholm Conference on the Human Environment. Toronto: Clarke, Irwin

Salvatori, E., Pallante, G., 2021. Forests as Nature-Based Solutions: Ecosystem Services, Multiple Benefits and Trade-Offs. Forests 12, 800.

Salviano, I. R., Gardon, F. R., & dos Santos, R. F. (2021). Ecological corridors and landscape planning: a model to select priority areas for connectivity maintenance. Landscape Ecology, 36, 3311-3328.

Sarfo-Adu, G. K. (2021). Role of Forest Related Policies and Laws on Sustainable Forest Management Practice: A Critical Overview.

Savari, M., Eskandari Damaneh, H., & Eskandari Damaneh, H. (2020). Factors influencing local people's participation in sustainable forest management. Arabian Journal of Geosciences, 13(13), 513.

Schäfer, A. (2006). A new form of governance? Comparing the open method of coordination to multilateral surveillance by the IMF and the OECD. *Journal of European Public Policy*, 13(1), 70–88.

Schneider, V., & Kenis, P. (1996). Verteilte Kontrolle: Institutionelle Steuerung in modernen Gesellschaften. In P. Kenis & V. Schneider (Eds.), *Organisation und Netzwerk: Institutionelle Steuerung in Wirtschaft und Politik* (pp. 9–43). Campus Verlag.

Seddon, N., Chausson, A., Berry, P., Girardin, C.A.J., Smith, A., Turner, B., 2020. Understanding the value and limits of nature-based solutions to climate change and other global challenges. Philos. Trans. R. Soc. B Biol. Sci. 375, 20190120.

Seddon, N., Daniels, E., Davis, R., Chausson, A., Harris, R., Hou-Jones, X., Saleemul, H., Kapos, V., Mace, G., M., Rizvi, A., R., Reid, H., Roe, D., Turner, B., and Wicander, S. (2020). Global recognition of the importance of nature-based solutions to the impacts of climate change. Global Sustainability, 3, e15. https://doi.org/10.1017/sus.2020.8

Seddon, N., Smith, A., Smith, P., Key, I., Chausson, A., Girardin, C., House, J., Srivastava, S., Turner, B., 2021. Getting the message right on nature-based solutions to climate change. Global Change Biology 27, 1518– 1546.

Senadheera, D.K.L., Wahala, W.M.P.S.B., Weragoda, S., 2019. Livelihood and ecosystem benefits of carbon credits through rainforests: A case study of Hiniduma Bio-link, Sri Lanka. Ecosyst. Serv. 37, 100933.

Sheppard, J. P., Chamberlain, J., Agúndez, D., Bhattacharya, P., Chirwa, P. W., Gontcharov, A., ... & Mutke, S. (2020). Sustainable forest management beyond the timber-oriented status quo: transitioning to co-production of timber and non-wood forest products—a global perspective. Current Forestry Reports, 6(1), 26-40.

Skole, D., Tucker, C. (1993). Tropical deforestation and habitat fragmentation in the Amazon: satellite data from 1978 to 1988. Science (New York, N.Y.), 260(5116), 1905–1910. https://doi.org/10.1126/science.260.5116.1905

Sotirov M, Pokorny B, Kleinschmit D, Kanowski P. (2020). International Forest Governance and Policy: Institutional Architecture and Pathways of Influence in Global Sustainability. Sustainability. 12(17):7010. https://doi.org/10.3390/su12177010

Steelman, T., & Nowell, B. (2019). Evidence of effectiveness in the Cohesive Strategy: Measuring and improving wildfire response. *International Journal of Wildland Fire*, 28, 267–274. https://doi.org/10.1071/WF18136

Stewart J., Anda M., Harper R.J. (2011). Carbon management and opportunities for Indigenous Communities. In UCLan Centre for Sustainable Development (CSD) & Confucius Institute International Conference.

Streck, Charlotte. (2001). The Global Environment Facility—a Role Model for International Governance? Global Environmental Politics, 1(2), 71–94. https://doi.org/10.1162/152638001750336604

Streeck, W., & Schmitter, P. C. (1985). Community, market, state—and associations? The prospective contribution of interest governance to social order. In W. Streeck & P. C. Schmitter (Eds.), *Private Interest Government* (pp. 1–29). Sage Publications.

Stuart H. M. Butchart et al. (2010), Global Biodiversity: Indicators of Recent Declines. Science 328, 1164-1168. https://doi.org/10.1126/science.1187512

Sykas, D., Demestichas, K., Kaloudis, S., Kalapodis, N., Sakkas, G., Athanasiou, M., Lazarou, A., & Casciano, D. (2023). D7.1 - First draft on policy recommendation framework. Deliverable. SILVANUS Project (GA 101037247).

Sze, J.S., Carrasco, L.R., Childs, D., & Edwards, D.P. (2022). Reduced deforestation and degradation in Indigenous Lands pan-tropically. Nat. Sustain. 5, 123–130.

Táíwò, O.O., 2022. Reconsidering Reparations. Oxford University Press, Oxford, New York.

TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.

The Economist, 2021. The uses and abuses of green finance. URL https://www.economist.com/leaders/the-uses-and-abuses-of-green-finance/21806111.

Thorsen, B.J., Mavsar, R., Tyrväinen, L., Prokofieva, I., and Stenger, A. (2014). The Provision of Forest Ecosystem Services. Volume II: Assessing Cost of Provision and Designing Economic Instruments for Ecosystem Services. What Science can tell us No 5. EFI, pp. 59–63.

Tongway, D. J., & Ludwig, J. A. (2012). Planning and implementing successful landscape-scale restoration. Restoration ecology: The new frontier, 30-42.

Treib, O., Bahr, H., & Falkner, G. (2007). Modes of governance: Towards a conceptual clarification. *Journal of European Public Policy*, 14(1), 1–20.

Trouwloon, D., Streck, C., Chagas, T., & Martinus, G. (2023). Understanding the Use of Carbon Credits by Companies: A Review of the Defining Elements of Corporate Climate Claims. Global challenges (Hoboken, NJ), 7(4), 2200158. https://doi.org/10.1002/gch2.202200158

Tsioumani Elsa (2020). Fair and Equitable Benefit-Sharing in Agriculture: Reinventing Agrarian Justice. Taylor & Francis.

UNFCCC (2021). Conference of the Parties serving as the meeting of the Parties to the Paris Agreement, Third session, Glasgow, 31 October to 12 November 2021. Retrieved from: https://unfccc.int/sites/default/files/resource/cma2021_08_adv_1.pdf

UNFCCC (2023). REDD+. URL https://unfccc.int/topics/land-use/workstreams/reddplus

United Nations (1972). Participant List A/CONF.48/INF.5/Rev.1, retrieved from: https://documents.un.org/doc/undoc/gen/nl3/217/10/pdf/nl321710.pdf

United Nations (1973). Report of the Conference A/CONF.48/14/Rev.1, retrieved from: https://documents.un.org/doc/undoc/gen/nl7/300/05/pdf/nl730005.pdf

United Nations Economic and Social Council (ECOSOC). (2000). Resolution 2000/35: United Nations Forum on Forests. https://www.un.org/esa/forests/wp-content/uploads/2013/09/2000_35_E.pdf

United Nations. (1992). Agenda 21: Programme of action for sustainable development. United Nations Conference on Environment and Development. https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf?_gl=1*5fknva*_ga*MjA3Nzg0NTQxMS4xNzIwMTc3MDM1*_ga_TK9BQL5X7Z*MTcyNTg4ODE1My45LjEuMTcyNTg4ODg2Mi4wLjAuMA

United Nations. (1992). Rio Declaration on Environment and Development. United Nations Conference on Environment and Development

United Nations. (2002) Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August - 4 September 2002. Retrieved from: https://documents.un.org/doc/undoc/gen/n02/636/93/pdf/n0263693.pdf

United Nations. (2008). Resolution adopted by the General Assembly on 17 December 2007, A/RES/62/98. Retrieved from: https://documents.un.org/doc/undoc/gen/n07/469/65/pdf/n0746965.pdf

Vacik, H., Torresan, C., Hujala, T., Khadka, C., & Reynolds, K. (2013). The role of knowledge management tools in supporting sustainable forest management. Forest Systems, 22(3), 442-455.

van der Gaast, W., Sikkema, R., Vohrer, M., 2018. The contribution of forest carbon credit projects to addressing the climate change challenge. Clim. Policy 18, 42–48.

Visseren-Hamakers, I.J. and Pattberg, P. 2013. We don't see the forest for the trees: The sustainability of global forest certification is unknown. GAIA – Ecological Perspectives for Science and Society 22(1): 25–28

Walker, N. (2005). Legal theory and the European Union: A 25th anniversary essay. *Oxford Journal of Legal Studies*, 25(4), 581–601.

Wayne S. Walker, Seth R. Gorelik, Alessandro Baccini, Jose Luis Aragon-Osejo, Carmen Josse, Chris Meyer, Marcia N. Macedo, Cicero Augusto, Sandra Rios, Tuntiak Katan, Alana Almeida de Souza, Saul Cuellar, Andres Llanos, Irene Zager, Gregorio Díaz Mirabal, Kylen K. Solvik, Mary K. Farina, Paulo Moutinho, Stephan Schwartzman (2020). The role of forest conversion, degradation, and disturbance in the carbon dynamics of Amazon indigenous territories and protected areas. Proceedings of the National Academy of Sciences, 117(6), 3015-3025.

Wessels, W. (2005). Emergence and evolution of modes of governance: Designing a treaty-based framework—towards an index of integration. Paper presented at the NEWGOV Consortium Conference, 30–31 May, Florence.

Wiegant, D., van Oel, P., & Dewulf, A. (2022). Scale sensitive governance in forest and landscape restoration: A systematic review. *Regional Environmental Change*, 22, 25. https://doi.org/10.1007/s10113-022-01889-0.

Wolfslehner, B., Pülzl, H., Kleinschmit, D., Aggestam, F., Winkel, G., Candel, J., Eckerberg, K., Feindt, P., McDermott, C., Secco, L., Sotirov, M., Lackner, M., Roux, J.-L. 2020. 2020. European forest governance post- 2020. From Science to Policy 10. European Forest Institute. https://doi.org/10.36333/fs10

Woo, J., Fatima, R., Kibert, C. J., Newman, R. E., Tian, Y., & Srinivasan, R. S. (2021). Applying blockchain technology for building energy performance measurement, reporting, and verification (MRV) and the carbon credit market: A review of the literature. Building and Environment, 205, 108199.

World Bank (1991). The Forest Sector: A World Bank Policy Paper. World Bank Stand Alone Books.

Wunder, S., S. Feder, D. Pettenella, G. Bottaro, and M. Torralba. 2019. DELIVERABLE 1.4 "What works?" State-of-the-art synthesis report about best-practice design and implementation of PES and other IM in the European context. H2020 project no.773702 RUR-05-2017. European Commission, Brussels, Belgium. [online] URL: https://sincereforests.eu/wp-content/uploads/2020/04/D1.4.pdf

Appendix A1: Template – Forest Governance in Pilot Sites

The purpose of this template is to establish a standardized framework for collecting information from pilot sites regarding national forest governance. This approach ensures consistency, comparability, and thoroughness in the analysis. The data gathered will facilitate the comparison of various forest governance frameworks adopted by the Member States (MSs) involved in the SILVANUS pilots with the guidelines provided by the EU and their objectives related to forest governance. Additionally, the governance models will be compared with innovative governance models identified through a literature review.

Contributors to this document should provide information based on the current national governance framework of the country they represent.

General information	
Pilot country	*Specify the country that you represent*
Personal info	*Some "personal" information that allows to understand the familiarity of the person filling the template with forest governance. Could be something like "profession" or "years of activity in forest related sector", etc…*
Key Legislation(s)	*List the primary national normative sources that regulates forest in the country, providing a general overview of the topics covered by the laws. E.g., in Italy it is the "Strategia Forestale Nazionale" (National Forest Strategy) and the "Decreto legislativo 3 aprile 2018, n. 34, Testo unico in materia di foreste e filiere forestali" (Legislative Decree April 3rd 2018, n°34, Consolidated Law on Forests and Forestry Supply Chains).* • *Describe also the effectiveness of the implementation of policies and regulations* • *Describe if stakeholders are compliant with the regulation* • *Describe how strong is the enforcement of laws and policies* • *Describe the specific legislations that govern wildfire management in the country.* • *Describe the key provisions related to wildfire prevention, response and recovery*
Government Agencies	*List the primary institutions responsible for forest management.* • *Specify the agencies that are responsible for wildfire management (in all three phases) and how the coordination between them is ensured before, during and after a wildfire* • *Specify the agencies responsible for forest restoration*
Policy Objectives	*Summarise the main goals of the national forest policies* • *Describe if the goals are in line with the EU goals,* • *Describe if there are any interdisciplinary objectives, or objectives from other sectors (e.g., agriculture, energy) that affect forests.,* • *Specify for wildfire prevention and control,* • *Specify for restoration goals*

Ownership distribution	*State the national percentage of public vs private owned forests. Mention also what is the pilot site condition*
Integration of EU Forest Strategy for 2030	*Describe what actions have been taken, and the planned ones, by the country in relation to the EU Forest Strategy for 2030*
Management practices	*Describe the most common practices and certifications in use. Include:* • *Describe the sustainable forest management practices that are implemented and promoted, if any.* • *Specify if the governance models take in account adaptability to future challenges,* • *Specify the mechanism n place to resolve conflicts over forest resources and the efficiency in solving them,* • *Specific practices for wildfire management (risk assessment, prevention strategies, response plans, post fire restoration) and for enhancing forest resilience to wildfire,* • *Integration of the Integrated Fire Management (IFM) approach and of sustainable forest management practices,* • *Specify the approach that is used for ecological restoration, specifying the methods that are used for restoring forest ecosystems and biodiversity. Specify how these practices consider the adaptability of the forest to future threats/challenges.* • *Mention also the pilot site condition.* • *Describe how the knowledge brought by modern science integrated in the current wildfire management practices and in forest restoration.*
Conservation Areas	*State the percentage of forest under protection (mention pilot site conditions).* • *Detail wildfire management practices in protected areas* • *Detail forest restoration practices in protected areas*
Economic and financial aspects	*Describe the main funding sources or economic incentives for forest management (mention any innovative proposal like payment for ecosystem services)* • *Describe if the resources (financial, human, technical) are used efficiently,* • *Describe the benefits of the governance model are cost effective,* • *Describe the economic benefits for stakeholders, particularly on local communities.* • *Specify how forest services, including non-material ones, are managed from an economic perspective (e.g., payment for ecosystem services)* • *Specify for wildfire management,* • *Specify for forest restoration.*
Participation and inclusiveness of key stakeholders	*List the major stakeholder groups and how they are involved, as well as any measures taken to ensure transparency.*

	• *Specify if all the relevant stakeholder are included, and what categories are not represented or are insufficiently represented,* • *Specify if the benefits and burdens of forest management are distributed fairly among stakeholders.* • *Specify for wildfire management* • *Specify for forest restoration* • *Specify how local communities are involve in wildfire management efforts.* • *Describe if there are mechanism in place for community-based wildfire risk reduction strategies.* • *Describe also how their awareness to wildfire is managed.*
Monitoring and Enforcement	*Describe what methods, procedure and technologies are used for forest monitoring and the measures that are used for enforcing forest management laws and ensuring compliance.* • *Specify the measures and tools that are used for monitoring in wildfire management* • *Specify the measures that are used to monitor the effectiveness of forest restoration*
Social and Environmental Impacts	• *Social. Describe the social impacts brought by the governance mode, specify the impact on local communities.* • *Environmental. Describe the effectiveness of the governance model in conserving biodiversity. Specify the Role in climate change mitigation*
Alignment with EU policies	*Specify the degree of alignment with EU forest strategy and policies and what are the identified gaps (e.g., specific areas where the national framework falls short compared to the EU or where EU targets are not ideal for the countries characteristics). Specify for:* • *Wildfire management* • *Forest restoration*
SWOT analysis	*Identify Strengths, Weaknesses, Opportunities and Threats of the current forest governance models. Specify for:* • *Wildfire management* • *Forest restoration*