

Review

# In-between Environmental Sustainability and Economic Viability: An Analysis of the State, Regulations, and Future of Italian Forestry Sector

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**Abstract:** Forest management is a complex topic at the interface between sustainability and the resilience of socioeconomic and environmental systems. The influence of market forces, supranational, country and regional policies, as well as climate change, on forest goods and services, is expected to increase in the near future. Such a complex interplay between economic and environmental forces is common to most European countries. The aim of this study is to operationally delineate and discuss the transition of the environmental sustainability and economic viability of forestry in Italy. This country encompasses the typical Mediterranean ecosystems with broad forest coverage in mountainous and hilly areas, where expanding woodland areas have been observed in the last decades mainly as a consequence of the decline of agropastoral activities, especially in disadvantaged and marginal areas. The consequent increase in wood biomass was frequently conceived as an element of environmental criticality, exposing woods to high vulnerability to wildfires and a consequent reduction in their economic value, possibly exacerbated by local warming. These dynamics usually took place in contexts where only a part of the overall forest heritage was subjected to regular management, despite the efforts made through various policies such as the Constitutional Law 3/2001 and the recent Law on Forests and Forestry Supply Chains. The latter policy tool, enhancing the concept of “active forest management” aimed to establish a sustainable approach to forest resources, leading to a broader forest area for formal planning and controlled harvesting. These dynamics took place in parallel with the inherent expansion in forest certification schemes formally promoting long-term environmental sustainability and a wider spectrum of forest ecosystems. Timber and non-wood materials and products are key elements from the perspective of achieving sustainable (climate-neutral) development in advanced economies.

**Keywords:** natural capital; supply chain; sustainability; circular economy; Italy



**Citation:** Lanfredi, M.; Coluzzi, R.; Imbrenda, V.; Nosova, B.; Giacalone, M.; Turco, R.; Prokopová, M.; Salvati, L. In-between Environmental Sustainability and Economic Viability: An Analysis of the State, Regulations, and Future of Italian Forestry Sector. *Land* **2023**, *12*, 1001. <https://doi.org/10.3390/land12051001>

Academic Editors: Per Angelstam, Andra-Cosmina Albulescu, Maria Fedoriak and Michael Manton

Received: 24 March 2023  
Revised: 27 April 2023  
Accepted: 28 April 2023  
Published: 3 May 2023



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## 1. Introduction

From a circular point of view, forest-resource management appears to be a complex exercise, being representative of the continuous interconnection between the sustainability and the resilience of socioeconomic and environmental systems. Limiting factors, and

new opportunities and challenges, imply a latent relationship between production performance, social legacy, and ecological quality [1–4]. Driven by market forces and European Union/national policies on climate mitigation and energy transition, the demand for forest products and ecosystem services is expected to increase in the future [5–10].

The forestry chain, and especially the wood-furniture sector, has faced important transformations in the last two decades. The 2007 financial crisis, the consequent globalization of markets and economic systems, the growing impact of climate change on forest stocks and the assortment quality, as well as the recent pandemic crisis, have had a considerable impact on the overall system's performance [11–14]. Nonetheless, official statistics have highlighted the growing number of forestry companies investing economic resources to improve the environmental profile of processes, products, and services [15]. In recent years, sustainable management in the forestry sector has proved to be a crucial issue for local (mainly rural) communities [16–19], becoming more and more sensitive to environmental problems [20–24].

The way in which the wood-furniture economic supply chain will respond to the increasingly volatile and unpredictable dynamics of the procurement of wood material [6] depends on the results of forest management at multiple scales of intervention (from local to national, from European to global). This will give further value to sustainable varieties, adapting the production mix to the multiple market needs, responding indirectly to the social and environmental needs of local communities, and including key aspects for a complete transition to circular economies [25–34]. The analysis of such complex transitions reflects the resilience potential of the wood-furniture supply chain in Europe, better delineating the contribution of forestry to sustainable productions and, broadly speaking, to the quality of forest ecosystems [35–40]. This study aims to review the environmental sustainability and economic viability of Italian forestry by using an environmental history approach. We discuss the past and current trends of forest management development as well as suggesting ways to meet the future needs of sustainable forest management.

## 2. Forest Resources: Recent Dynamics in Italy

Italy represents a typical Mediterranean country with broad (and increasing) forest cover (Figure 1), especially in marginal and disadvantaged rural districts (widely extending all over mountainous areas of the country).

Despite the evident increase in urban areas—which is still progressing at a rapid pace [41,42]—the recent evolution of Italian landscapes reflects the expansion of woodlands, in line with more general dynamics observed in Europe and in advanced economies [43–57]. In proportion to the national area, Italy has a forest area in line with the European average [58]. Representing an enormous wealth in terms of natural capital [59,60], official statistics confirm a long-term growth of the wooded area, which is now covering more than 11 million hectares, or 37% of the national territory, according to the latest national forest inventory [61]. Comparing national forest inventory data [61] between the period 2005–2015 shows a 5.6% increase in forest area an 18.4% increase in forest biomass and the average timber stock increased from 145 to 165 m<sup>3</sup>/ha. These values, if calculated with respect to the resident population (per capita forest stock), show a reduction against a substantial growth in resident population (about +4.76% from 2005 to 2015) [62].

The main reason behind these transformations can be traced back to the decrease in human pressure and agro-silvopastoral activities in mountainous and economically marginal areas of the country, with the consequent forest recolonization of previously cultivated areas, and to a generalized decline of forestry activity [63–72]. Despite representing a potential opportunity for the sector at large [73,74], the consequent increase in wood biomass, independently from sector policies, was more frequently seen as an element of environmental criticality, exposing woods to an increased vulnerability to wildfires and other degradation processes which inevitably reduce the economic value and the quality of the varieties for industrial use [75–82].

However, forest resources are non-homogeneously distributed throughout the national territory, being instead polarized along the elevation gradient and concentrated in mountainous districts; in fact, 62.3% of Italian forests grow in hilly and mountainous areas at more than 500 m above sea level [83]. The remaining forest resources, located in flat or hilly areas up to 500 m above sea level, show a heterogeneous spatial distribution, with less than 10% of these wood areas concentrated in relatively flat areas (<100 m a.s.l.) [84]. These results highlight how the exploitation of forest stocks concentrated in hilly and mountainous areas [85] faces systematic accessibility issues which increase the costs of cutting and clearing operations [86]. Conversely, the forests in flat areas, with high potential productivity and more suited to advanced mechanization [58], have declined since the 1950s because of the intrinsic urbanization of coastal areas and agricultural intensification of inland areas [69,87–101].

Furthermore, approximately 3.5 million hectares of woodland (representing 32% of the national forest area) fall within protected areas, testifying to an extensive protection regime characteristic of Italian forests, which can limit their exploitation [102]. This protection regime can be justified with the high ecological diversification that makes Italy the first country of the European Union in terms of tree and ecosystem diversity, due to its peculiar bio-geographical location [103–105]. Italian forests are mainly associated with pure broadleaved formations, for nearly 90% of the national forest area, with some exceptions related to the Alpine regions, where coniferous forests prevail [106]. A total of about 180 different species (corresponding to a total volume of 1.5 billion cubic meters of tree biomass) were recorded in the latest national forest inventory, although four species—three of which are deciduous: beech (*Fagus sylvatica* L.), chestnut (*Castanea sativa* Mill.) and Turkey oak (*Quercus cerris*) and a conifer: spruce (*Picea abies*)—account for half of the wood biomass of the country [61]. This diversification level, although it represents an element of further economic potential, seems to exert a variable impact on the value of the varieties and on the consequent territorial structure and logistical organization of the forestry sector and the related supply chains [107].

The damage from climate change to Italian forests can be ascribed to the increase in the frequency and intensity of extreme events (heatwaves, late frost events, and reduction and/or asymmetrical distribution of rainfall, see, e.g., [108–112], which create a favorable context for parasitic and/or phytopathological attacks [113–115]. These have long-term repercussions also on employment levels, as well as on the supply chains and on the productive and sociocultural sectors associated with forests [116,117]. The storm “Vaia”, in 2018, which struck a district of the Veneto region with a high forestry vocation [118–120], is a concrete example of the role of climate change in reducing the economic value of forested land in Italy [121–123]. The latest forest inventory recorded that 3.3% of the wooded area was affected by more or less evident damage on a portion of the tree cover of between 30% and 60% [61]. Climate change has also fueled, directly or indirectly, the damage caused by wildfires in recent years [124–135]. Since the end of the 1990s, the number of wildfires recorded in Italy was above 4000 events per year; however, there were also years when the number of fires was considerably higher, between 6000 and 8000 cases. The data relating to the last decade indicate that, every year, around 60,000 hectares of forest and woodlands were burned, with an average area per event of just over 10 hectares, which is slowly growing over time [136]. Critical years, such as 2007, recorded more than 10,000 fire events per season, involving around 220,000 hectares of wooded area, with an average area of around 20 hectares per fire [137]. Most of the economic damage is caused by fires which fall within the size class between 5 and 50 hectares and which have affected, on average, more than 40% of the burnt area [136]. Although the risk of fire is not homogeneous across the country (the most affected regions remain concentrated in the south and in some more exposed areas of central Italy), a progressive “migration towards the north” of fires, even of larger ones, can be observed [138,139]. The increase in the frequency, intensity and severity of forest fires in northern Italy—especially in the Alpine arc—is in line with what has been observed in other regions of western and central Europe, initially little (or none) affected

by the phenomenon, and relates to the long-term impact of climate change [87,140–146]. For instance, recently in western France, as well as in Germany and Sweden, fires burned through forest areas initially considered non-vulnerable for many days—confirming the trend throughout Europe and justifying a continental strategy in fighting fires that goes beyond the individual civil protection actions related to the extinguishing [147–150].

Although it has been amply demonstrated that planning and prevention activities are effective in mitigating forest fires, these activities in Italy have not yet benefited from a homogeneous and widespread application at national level, despite the cost of these interventions being significantly lower than the expenditure for extinguishing and the redevelopment of land that has been destroyed or degraded [151,152]. In this sense, the typological structure of forests and woodlands in terms of ownership represents another important element for the planning of this natural resource as well as for more rational economic exploitation [153–155]. Although 63.5% of the forest area in Italy is managed by private owners (mainly individual), public ownership (especially municipal and provincial) is dominant in three regions with a high forest coverage (Trentino, Abruzzo, Sicily, e.g., [156]). However, access to public wooded stands, at least in some areas, can represent an impediment to profitable use, albeit from a sustainability perspective [157]. In line with the picture of light and shade depicted up to now, from a silvicultural point of view, the cultivation types pertaining to coppice (in all its cultural distinctions) and high forest each occupy just over 40% of the total area [158]. The remaining area is made up mostly of stands not subjected to any form of management, at most affected by sporadic interventions and therefore not attributable to canonical forms of forest management, mainly by areas abandoned by silvicultural practices due to geographical limitations (impervious land, rocky slopes or other topographical limitations) as well as areas interested in the (spontaneous) recolonization of abandoned crops [159–161].

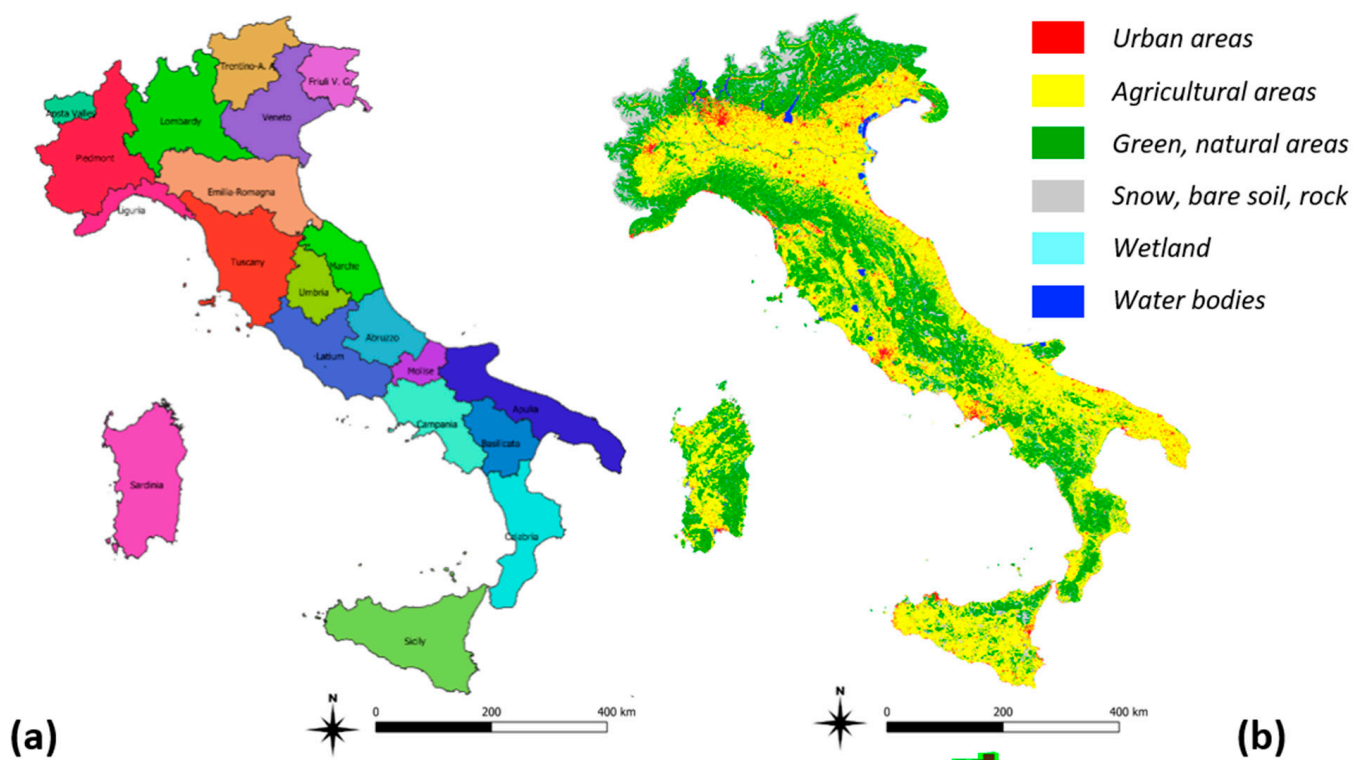
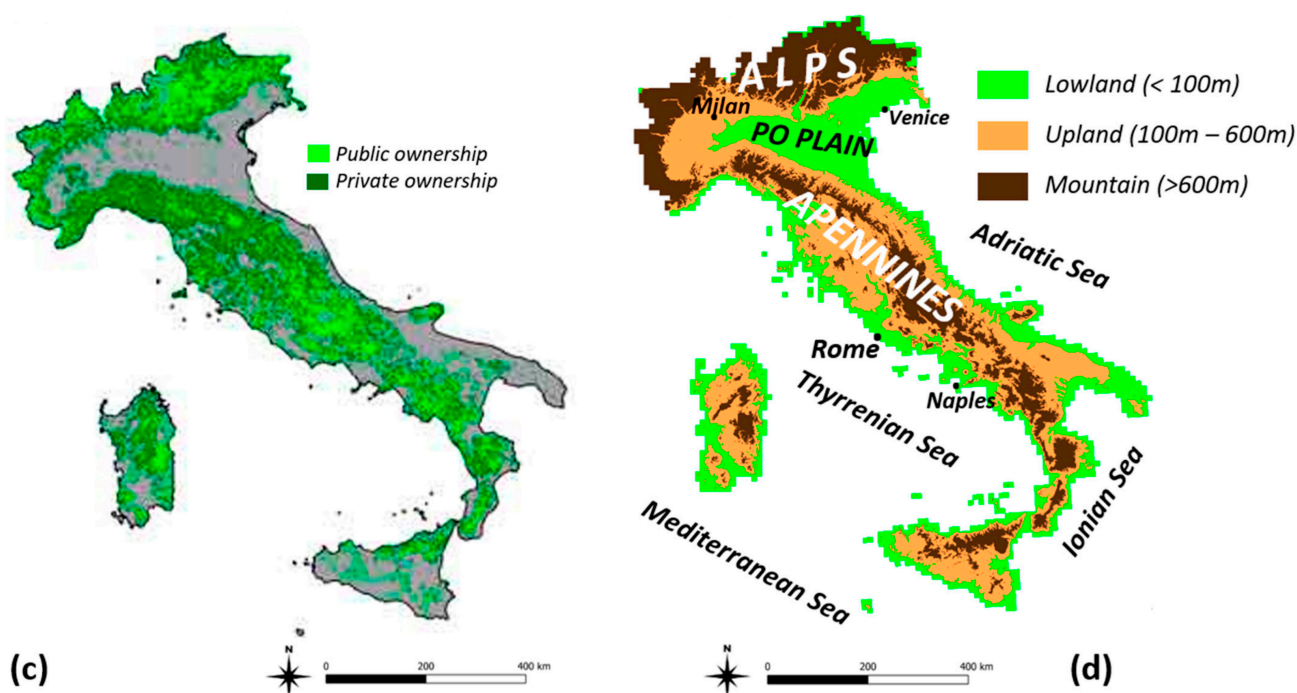


Figure 1. Cont.





**Figure 1.** Maps of the study area: (a) 20 administrative regions according to nomenclature of territorial units for statistics (NUTS-2); (b) land cover (derived from CLC2018, [162]); (c) partition of forest ownership (National Inventory of Forests and Forest Carbon pools—INFC, [62]); (d) elevation classes.

### 3. National Policies and Recent Innovations in Forest Planning: The Italian Case

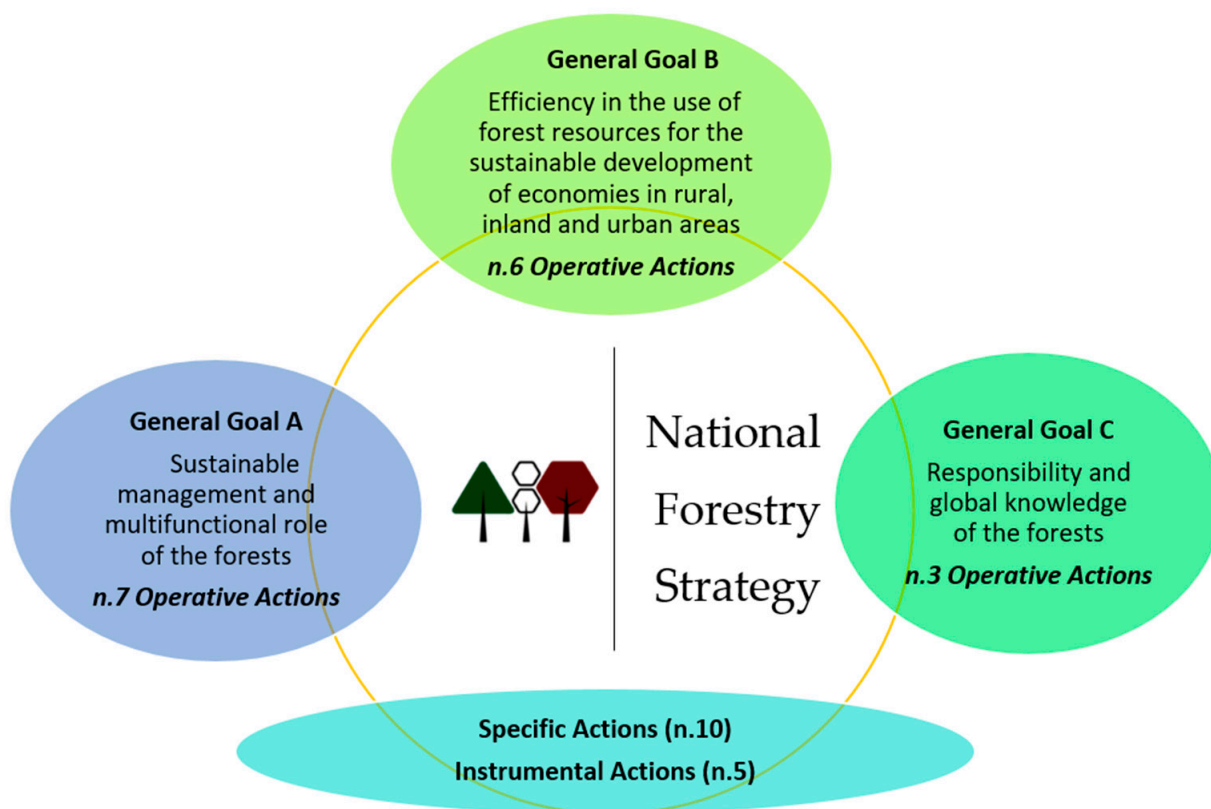
In the 2007–2013 programming period, rural development policy became the main tool for implementing forestry policies at European and national level [163]. Although the transversal role of the forest and its management for the protection of rural and mountain areas at a national level was emphasized, the regional Rural Development Plans (RDP) showed not only a clear lack of homogeneity in the strategies and interventions proposed, but also different spending powers [58]. The 2014–2020 planning phase developed in the same direction, where the same types of intervention as in the previous period were envisaged, but reorganized into a single set of measures. In Italy, the share of forestry measures on total RDP resources stood at 8.5% in the 2007–2013 programming and is estimated at 7.5% in subsequent programming [164]. The fragmentation of competences and roles in forestry matters, both at national and regional level, seems to have played a decisive role in the planning–activation–implementation process of forestry measures in the RDPs of the various regions [165].

Moreover, Italy has long since implemented the European strategic guidelines of 1998 (Legislative Decree 227/2001 on silviculture and forests), defining a national reference strategy starting from 2008 (Framework Program for the Sector Forestry) for the different regional contexts [166]. The Royal Decree 3267 of 30 December 1923 still assumes particular importance today, through which forests are recognized as having a fundamental role in water regulation, subjecting them to hydrogeological constraints with prescriptions and limitations on forestry management [167]. In addition to the environmental constraints, there is also the landscape constraint which, since 1985 (Law 431/85), falls on 100% of Italian forests (which is a unique case in Europe, see [168]). The complex structure of roles and responsibilities in forestry matters (Constitutional Law No. 3 of 2001) today still represents a limit to the implementation of a homogeneous and effective national forestry policy [165]. In fact, forestry matters, in national legislation, are today simultaneously subject to the competence of different central administrations (for example, through the Environmental Code—Legislative Decree 152/2006 and through the Urban Code—Legislative Decree 42/2004 for the part concerning landscape conservation) as well as regional ones [169].

Until the first national framework law for guidance and coordination (Legislative Decree 227/2001 entitled “Orientation and modernization of the forestry sector”), the Regions regulated and provided for specific provisions for management autonomously, on the basis of the “General Requirements and Forestry Police—PMPF” envisaged by Royal Decree 3267/1923 and the related implementation regulation (Royal Decree n. 1126/1926). With Legislative Decree 227/2001, the main forest management responsibilities were attributed to the Regions and Autonomous Provinces, within the scope of their respective regulatory powers, but in compliance with the insurmountable limits set by the State for the protection of the environment and the landscape. Although it has been updated and regulated over time, the regional legislation of reference on forest management has, however, remained uneven and fragmented [170].

In this context, the Law on Forests and Forestry Supply Chains (Legislative Decree No. 34/2018), was more recently introduced as a national framework law for the forestry sector and its supply chains. As stated in Article 1 of this Law, the national forest heritage is recognized by the Italian Republic as part of the national natural capital and as an asset of significant public interest to be protected and enhanced for the well-being of present and future generations.

The prerequisite of the new law is compliance with the environmental and landscape protection regime of the Italian forest heritage [171]. In this context, this Law has simplified the entire legislative body, guaranteeing the conservation, protection and sustainable management of Italian forests in order to “improve the protective and productive potential of the country’s forest resources and the development of local supply chains connected to forests, enhancing the fundamental role of forestry and establishing the public interest as a limit to the private interest”. The Law restates the concept of Sustainable Forest Management (SFM, see Article 3), internationally introduced in Helsinki by the Ministerial Conference on the Protection of Forests in Europe (1993). In particular, it takes up and enhances the concept of the “active management” of forest heritage, defined throughout the Decree as a synonym of Sustainable Forest Management [172]. This definition could be taken for granted, not only from a scientific point of view, but also from an educational point of view. Actually, the technical-scientific debates and the endless discussions on social media following its publication have shown how this definition is still controversial [173]. In reality, the problem that arises from the interpretative discussions is not the meaning of the word “active” but the lack of awareness of the word “management”, which does not mean “use”, or simply “cut”, but rather “take care”. In fact, an important novelty consists in the attribution, to the owner and/or owner of the management, of the principle of responsibility, the duty to make a responsible and conscious choice of management, use and maintenance of forest land in the public interest [174]. Specifically, the subject involved must “take action” in assuming responsible choices which can be “interventionist” or “integral conservation”, but, in any case, codified in a management act, or within the Forest Management Plan or equivalent instrument, thus defining the ways of intervention or non-intervention. In this sense, the law reorganizes the concept of forest planning, formalizing the obligation to define the National Forestry Strategy (Figure 2) and, more generally, the planning of forest management, enhancing the concept of public and private responsibility in the protection, conservation and valorization of forest resources. Greater attention is given to the skills and professionalism of those who work within the forest sector, to products and process certifications, to the valorization of woody and non-woody products and to the provision of ecosystem services generated by additional silvicultural interventions of sustainable management. It stimulates the activation of administrative simplification tools aimed at supporting the consolidation of land properties to promote planning and management over large areas.



**Figure 2.** Scheme of the Italian National Forestry Strategy. Image inspired by the following source: <https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/15339> (accessed on 26 April 2023).

It promotes the competence and technical skills of forest operators through the establishment of regional lists or registers and professional training. It attributes a preeminent value to research, experimentation and statistics in forestry matters and, for the first time in the national legislation, recognizes the status and protection requirements for old-growth woods.

Among the most relevant content of the implementing decrees, already in force only in part, we include the establishment of the national register of operators who commercialize the wood and products derived from it (Legislative Decree no. 178/2014) and closely connected to that on the regional registers of forestry enterprises, as well as the provisions on viability and forest planning. A specific focus is dedicated to old-growth woods, together with regulations on the restoration of former agricultural areas, also with reference to the National Forestry Strategy, recently established (2022), as well as a regulatory study on forest management in protected areas and on the best opportunities for agricultural entrepreneurs. Despite the regulatory innovations recently introduced in Italy, the forest area subjected to detailed planning (forest management and settlement plan or equivalent instruments) is still quite limited (15%) at a national level. Overall, the conditions are highly variable among the 20 Italian regions, with a marked difference between the northern ones (with a more planned area on average) and the rest of central and southern Italy [175]. Nonetheless, the percentage of surface area subject to forestry prescriptions attributable to the application of hydrogeological constraints, and therefore to a system authorizing cutting, reaches a proportion of just over 86% of the total at national level [175].

#### 4. Forest Resources and the Wood-Furniture Supply Chain

Overall, wood/timber use in Italy in the period 1946–2015 underwent a gradual reduction, more marked for firewood than for industrial timber [176], especially starting

from the early 2000s (Table 1). However more recently, the analysis of the national accounts for the period between 2000 and 2017, shows an increase in total forestry production of 36.4% (expressed in chain-linked values), while the value added at constant prices grew by 30.2%, with a more sustained increase starting from 2010 [58]. The contribution of forestry in the primary sector is 4.2% in terms of production and 5.8% in terms of added value at basic prices [58]. It should be remembered that in Italy the production trends in the various forestry-related sectors (sawn wood, wood chips, pellets and wood pulp, see Table 2) respond to different logics and rarely follow a common trend, recording highly diversified trends based on the sector reference [177].

**Table 1.** Wood use in Italy (100 tons), selected years (own elaboration on ISTAT time series).

Year	Timber			Fuel	
	Conifers	Broadleaves	Total	Firewood	Carbon
1946	1570	1753	3323	49,102	6097
1960	1105	1960	3065	36,339	1170
1980	1383	2523	3906	26,240	165
2000	1077	1905	2982	38,828	-
2015	1292	756	2048	23,469	-

**Table 2.** Production and imports of the main wood products in Italy (source: FAOSTAT, 2021; see <https://www.fao.org/faostat/en/#data/FO>, accessed on 27 March 2023). The measurement units differ according to the product considered.

	2017		2018		2019		2020		2021	
	Production	Import	Production	Import	Production	Import	Production	Import	Production	Import
Wood chips, particles and other wood waste, (m <sup>3</sup> )	5,280,000	662,281	5,280,000	907,141	5,546,218	653,244	3,500,000	760,736	3,600,000	725,500
Pellets (t)	445,000	1,894,847	495,000	2,350,352	497,000	2,661,605	420,000	1,901,037	425,000	1,999,199
Sawn wood (including railway sleepers) (m <sup>3</sup> )	1,520,000	5,203,619	1,554,200	4,811,411	1,604,641	5,701,382	1,504,200	4,050,689	1,600,000 *	4,793,080
Wood-based panels (m <sup>3</sup> )	3,777,975	2,625,525	4,705,486	2,784,416	4,387,935	3,173,687	4,263,246	2,596,623	4,350,000 *	2,913,777
Wood pulp (t)	388,347	3,202,650	369,148	3,499,348	333,776	3,550,000	222,581	3,269,703	243,000	3,306,603

\* provisional data.

Nonetheless, in contrast with the growth of the forest area, the harvesting rate of Italian forests, estimated at between 18.4% and 37.4% of the annual increase, is much lower than the average in southern Europe and, more generally, than the continental average (62–67%) [106]. The limited exploitation of the extraordinary Italian forest heritage constitutes a serious threat to its sustainable viability, as the harvesting rate has further decreased in recent decades, from 1990 (48%) to 2010 (39%), making it necessary to resort massively to imports from abroad to satisfy the wood needs of the processing industries (Table 2, [178]). Indeed, Italy is classified as a net importer of forest products [179]. This is related not only to the low utilization rate of national forest resources, but also to the limited qualitative value of the Italian forestry product [180]. Historical data also demonstrate how wood imports have decreased in the last decade, probably as a result of the economic crisis [157].

Another aspect that limits forest species composition and wood quality in Italy is the dominance of coppicing, an indirect forest management action, which affects about 42% of the total forest area. In total, >27% is matriculated coppice, 4% is compound coppice and as much as 10% is non-matriculated coppice, while less than 30% of the total area can be classified as high forest [158,181,182]. Furthermore, at a national level, approximately 66% of the woods are in the hands of private operators, with a greater diffusion of the same on a territorial scale in Liguria, Tuscany, Emilia Romagna and the Marche; this fact is reversed for Trentino Alto Adige, Abruzzo and Lazio, where public ownership dominates [183].



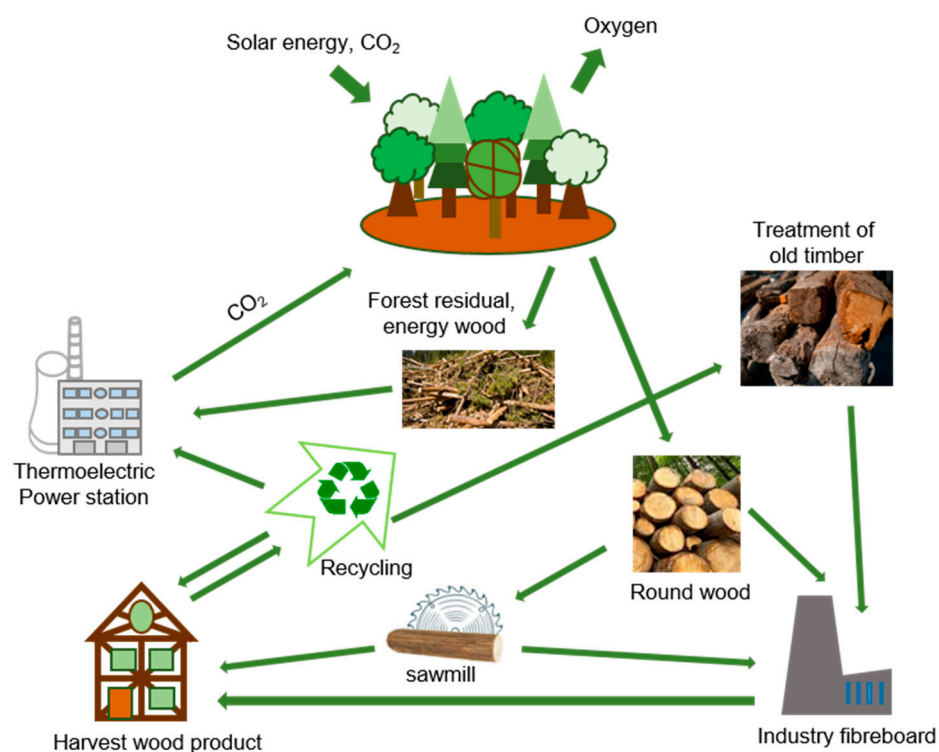
Civic use—land subject to collective ownership and title of use—is, in contrast, rather small, representing about 5% of the national surface area, including in this estimate not only forest formations, but more generally all properties for agricultural use [58]. The prevalence of private ownership is particularly evident for wood arboriculture plantations, which, however, have rather limited total areas [18,184]. According to a 2017 inventory, the total area destined to specialized poplar cultivation for the production of varieties for the plywood industry was estimated to be approximately 460 km<sup>2</sup>, mainly concentrated in the Po Valley, with an average cultivation shift of 10–12 years [185].

Considering the business register and focusing on the “Forestry and use of forest areas” enterprises, in the last decade, we observed a growth of companies of more than 10%, spread over numerous regions, with the exceptions of Basilicata, Lazio and Molise [58]. The historical trend in the number of employees was the opposite, with a loss of almost 2000 operators, in all regions with the exception of the Public Administration of Bolzano, Valle d’Aosta, Sardinia and Sicily [58]. The fact that over 60% of the wood harvested in Italy is made up of firewood, implies a strong dependence on foreign countries for the supply of industrial wood. The same supply of firewood was guaranteed by intense imports; for example, in 2018, Italy was the fourth largest importer of pellets in the world with about 2.6 million tons [186]. However, the firewood and industrial wood sector has recorded a constant (or even growing) trend in terms of production volumes in recent years [83]. This trend, in 2019, saw a further confirmation of growth due to the quantity of available material from the Vaia Storm [187]. The value of raw wood imports amounted to EUR 305,233 thousand in 2016 and remained high in 2021 (EUR 238,334 thousand) against a value of exports of EUR 24,622 thousand in 2016 and EUR 35,320 thousand in 2021, respectively. Italy imported wood mainly from neighboring countries (Slovenia, but also France, Bosnia-Herzegovina, Austria, Switzerland, Croatia) and exported mainly to Austria, Slovenia and, to a lesser extent, to China and France [106].

### 5. Forestry and the Wood-Furniture Supply Chain in the New Challenges of the Circular Economy

Italy, which is the main recipient of the resources of the Recovery Plan [188], is also called to play a leading role for this reason. The furniture sector has been at the forefront for many years, worldwide, due to its rate of circularity and the high content of recycled material in its products [189]. For example, Italian chipboard panels are made with techniques that allow the use of a higher percentage of recycled wood than the European average [190]. In this sense, the European Union has set a goal of 30% by 2030 for the recycling of wooden packaging and Italy is already at 64% of the target today, far above EU expectations [191].

Unlike the situation in other countries, where post-consumer wood is mainly “burned” to produce energy, in Italy, there is a supply chain that involves citizens, municipalities, small and large companies (see Figure 3, [180]). About 95% of the wood is recycled to produce panels for furniture, without the need to consume virgin wood [192]. In environmental terms, this allows for savings in CO<sub>2</sub> consumption of almost two million tons/year. Overall, the economic impact on national production activities for post-consumer wood recovery and the recycling chain is estimated at around EUR 2 billion, with over 11,000 jobs in Italy (<https://lavocedinyork.com/arts/arte-e-design/2021/05/15/riciclo-quindi-sono-sostenibile-la-battaglia-contro-chi-brucia-il-made-in-italy/>, accessed on 9 March 2023). The importance of recycling then becomes crucial in this phase, in which the increase in the cost of wood for the supply of raw materials is creating considerable problems for companies [193].



**Figure 3.** Scheme of the wood-furniture supply chain. Image inspired by the following source: <https://www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/16437> (accessed on 26 April 2023).

Adherence to certification is an equally important issue with regard to the requests of the reference markets. In this direction, Italy is the only European country that has made the Minimum Environmental Criteria (CAM) mandatory for public purchases [179]. CAM are the “technical indications” consisting of general and specific considerations of an environmental and ethical/social nature linked to the different phases of the tendering procedures which, once implemented by the designated offices, will be beneficial to classify a contract purchase or assignment as sustainable. This represented a challenge for companies, but it also made it possible to raise the average quality, triggering a virtuous circle that also influences products destined for the private sector [194]. The certifications are also continuously updated: recent years have seen an increase in the number and complexity of certifications at European and global level in order to be able to export furniture [195]. The Product Passport, with environmental information useful for enabling the circular economy, and new directives that set the minimum environmental criteria aim to guide the choices of funds and investors interested in operations in the sector; these represent the near future in the regulation and certification of sustainability of product and process in the wood-furniture supply chain [196].

In regard to Sustainable Forest Management, the certification systems active in Italy are FSC (Forest Stewardship Council, see [197]) and PEFC (Programme for Endorsement of Forest Certification schemes, [198]), which currently cover a total area of approximately 9% of national forest area, according to the RAF preliminary estimates (2019). There are eleven regions with at least one FSC or PEFC certified forest and those with the greatest diffusion of these systems include Trentino-Alto Adige, Friuli-Venezia Giulia, Lombardy, Tuscany and Piedmont (see [https://annuario.isprambiente.it/sys\\_ind/report/html/151](https://annuario.isprambiente.it/sys_ind/report/html/151), accessed on 23 February 2023). An important sector is that of the certification of the sustainable management of wood plantations, and in particular of poplar cultivation: this type of certification concerns, in particular, three regions (Friuli-Venezia Giulia, Lombardy, Piedmont), for a total of over 4000 ha, equal to about 10% of all specialized poplar groves

in the Po-Veneto Plain. The phenomenon of “double certification” (FSC + PEFC) is also interesting, which, at the end of 2017, involved two public and four private forests [182,185].

Professional training in the sector for the circular economy plays a central role for trade associations in accompanying all players, especially smaller companies, towards the transition to a totally sustainable model, creating various opportunities to innovate the entire sector [180,199–201]. In this context, we note, for example, FederlegnoArredo, the trade association that represents the industrial supply chain of wood and furniture. FederlegnoArredo is committed to professional training both through research and service projects aimed at identifying the knowledge necessary for the various new figures required, and through collaborations with universities and system support activities of Higher Technical Institutes linked to the wood supply chain for furniture in the different regions. In the context of continuous training, FederlegnoArredo also contributes to product and process innovation, working with operational projects on the life cycle, with the aim of extending the duration and consequently the sustainability of the products, as well as on the recovery of materials and energy, with reference both to the production activity itself and to the products themselves [202].

Lastly, the wood-furniture supply chain has shown a strong interest in supporting and developing forms of valorization for the ecosystem services, increasing interest in forest resources, their maintenance and all services that can benefit from them; offering protection to those of sequestration and conservation of carbon, to those of tourism and nature, up to the suppliers of renewable material for the furniture and construction industries [122,203]. The contribution of the Italian forest heritage to the wood supply chain could take place through the application of the PEF (Product Environmental Footprint) methodology to some products of this chain, with the creation of a credit system to finance the ecosystem services themselves [204,205]. In this context, the integrated research actions conducted by FederlegnoArredo are noteworthy for analyzing and evaluating forest ecosystem services, through a detailed measurement of the carbon stock and sink, measuring and improving the environmental footprint of products belonging to the supply chain of wood (wood packaging, initial wood processing), as well as transferring to SMEs, in the supply chain, some methodologies and tools to improve the environmental footprint of their products and to contribute to the definition of a certification standard for ecosystem services (<https://www.federlegnoarredo.it/it/servizi/centro-studi-dati-e-ricerche>, accessed on 26 April 2023).

## 6. Discussion

Considering the economic, social and environmental dynamics together, the framework of forest dynamics in Italy presents light and shade, if seen from an ecosystem or more strictly economic point of view. Indeed, there is no doubt that the expansion of forests in Italy greatly supports the European Green Deal from a climatic point of view [206,207], with the function of carbon sink exercised by national forests which leads to the subtraction of approximately 46.2 million tons of carbon dioxide (the overall amount is about 430 million tons for Europe, see [208]) which translates to 12.6 million tons of stockpiled carbon (for the year 2018, see [192]). This is an important positive contribution to the balance of national climate-changing emissions which should be further promoted, as, to date, there are no direct structural support measures for agroforestry carbon sinks and also the voluntary carbon credit markets are not adequately regulated [209]. Despite this, the agroforestry sector guarantees an estimated absorption (for 2018) of 36,266 KT CO<sub>2</sub> equivalent, contributing to a reduction of 8.4% of the national balance of climate-changing emissions [210]. The trend observed for this parameter is highly variable for Italian land, reaching a peak in 2015 and a strong reduction in 2017 (for a complete picture, see [211]).

Regarding Europe, the LULUCF net sink has declined over the last few years (about 249 MMt CO<sub>2</sub> eq for the year 2019) due to several factors: aging forest stocks and increasing natural disturbances of forests, and increased wood harvest. The National Inventory of Greenhouse Gas Emissions provides a domain for estimating removals and emissions of

greenhouse gases from land use, land-use change and forestry (LULUCF), based on Regulation (EU) 2018/841 [212].

From a strictly economic point of view, the latest report on the state of Italian forests estimates the harvesting rate of our forests, highlighting a value between 18.4% and 37.4% (source Eurostat for the years 2016–2017, see <https://ec.europa.eu/eurostat/web/forestry/data/database>, accessed on 26 April 2023) of the yearly increase; in any case, it is a third (or even less) of the available biomass volume [58]. An important aspect is given by the fact that less than 10% of the European forest area, and even less in Italy, is made up of intensively managed plantations [213]. Precisely with regard to intensive forest management, the increasing criticism toward intensive forest management is generally linked with biodiversity loss, especially when natural ecosystems are transformed into anthropogenic covers to produce industrial raw material [214–219] consisting of mimicking the outcome of natural disturbances to reconcile business interests (i.e., timber production) with the provision of other ecosystem services and the conservation of biodiversity [220].

Despite the prevalent negative effects of intensive forest management, the economic role of anthropic plantations could grow with the incentives offered by the new European Union policies for forest management, for example, for regulating the accounting of carbon on the ground and energy, while harmonizing the volume of biomass withdrawal in order to contain its import. This value is significantly lower than the average for southern European countries. Furthermore, from the latest national inventory, it can be deduced that only 14.6% of forests see an ordinary regime of silvicultural practices (including both logging when the production cycle ends, and specific actions to improve the stands), while 37.4% do not envisage any practices and 41.4% only minimal practices (e.g., urgent safeguarding interventions, see [61]). These data show an increase in the withdrawal of timber is totally desirable, and it is possible to implement it in a sustainable way, i.e., without affecting—if not minimally—the other functions of the forest (landscape, environment, recreation).

## 7. Concluding Remarks

Italian forests represent a huge stock of natural capital, especially today after a large period of uninterrupted expansion linked to national reforestation plans and the land abandonment phenomena of marginal areas. The management of Italian forests has experienced a long phase of confusion connected to the fragmentation of competences that has prevented the implementation of a homogeneous and effective national forestry policy. The innovative aspect of the Law on Forests and Forestry Supply Chains (2018) is the effort produced towards the simplification of the entire legislative body to foster active forest management aimed at improving the protective and productive role of forests and the development of efficient local supply chains. Even though Italian forests hold an increasing biomass volume, the harvesting rate is much lower than the average of the other European countries, determining a serious constraint to their sustainable viability and implying a large share of imports from abroad. We observed how wood production and forest management in a considerable share of the forests take place within the framework of forest certification schemes. Even though they aim to promote long-term environmental sustainability, what is observed is that too often they are excessively focused on aspects of pure production, missing key environmental aspects for maintaining functional habitat networks.

Sustainably sourced raw timber and non-wood materials and products are therefore crucial for the transition of advanced countries towards a sustainable climate-neutral economy.

**Author Contributions:** Conceptualization, L.S.; methodology, M.G.; software, V.I.; formal analysis, R.T.; investigation, M.P.; resources, B.N.; data curation, R.C.; writing—original draft preparation L.S. and V.I.; writing—review and editing, M.L. and R.C.; visualization, R.C., supervision, M.L.; funding acquisition, B.N. and L.S. All authors have read and agreed to the published version of the manuscript.



**Funding:** This study was partially supported by MULTIFOR “Multi-scale observations to predict Forest response to pollution and climate change” PRIN 2020 Research Project of National Relevance funded by the Italian Ministry of University and Research (prot. 2020E52THS).

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Conflicts of Interest:** The authors declare no conflict of interest.

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