

REVIEW ARTICLE

Sustainable Development in Europe: A Review of the Forestry Sector's Social, Environmental, and Economic Dynamics

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Abstract

Despite their resilience, forest ecosystems become increasingly impacted by extreme climatic events, fires, and pathogen outbursts, which have considerable economic repercussions. How forest management solves these difficulties will affect human health, environmental variety, productivity, and forest ecosystem recuperation from exogenic distresses. Assuming forests provide ecosystem services essential to society and humanity along with wood, a better understanding of forest ecosystems seems essential to defining a development policy that meets ecological safeguard and energy and climate goals. According to the UN 2030 Agenda's Sustainable Development Goals, European forest management practices still don't provide a clear picture of ecological conditions, monetary estimate, and biodiversity. In light of the existing research, this article reviews and discusses recent European forestry industry trends and the environmental-economic nexus' complexity. Wood use has social consequences for regions adapting to ecological change, from rising temperatures to landscape modifications. This paper confirms that the technical-economic dimensions of forestry affect short-term economic dynamics, sector growth prospects, supply chain organization, company interconnections, and investment strategies. Forestry practices conserve species and habitats while boosting sustainable timber production. The European Commission's policy direction is to gradually encourage public and private entities to embark on worthy circular economy pathways, which will result in more jobs, material recycling, minimized carbon emissions, and community-added value. Forestry should contribute more holistically to sustainable development at diverse spatial dimensions. This includes focusing on environmental and economic aims in light of the recognition of relevant features that may guide forthcoming research and policy action while enhancing cooperation among member nations and local experts.

Keywords: Forest resources; Wood; Conservation; Circular economy; Sustainability; European Union

Introduction

The European Union's economic resurgence from the Great Recession has not been accompanied by widespread and consistent expansion across the continent. An underlying uncertainty regarding future socioeconomic dynamics is outlined by the possessions of the epidemic catastrophe and, more lately, the geo-political war on the Eastern tip of the region, with corresponding energy issues (Martinho, 2022; Raihan & Tuspekova, 2022a; Zakeri et al., 2022). The potential to shift toward a completely circular economy and an extremely sustainable development

pathway is hampered in many cases by this vagueness, which has large but similarly varied implications on the distinct production segments (Raihan & Tuspekova, 2023a; Anghel & Jones, 2023; Raihan et al., 2023a). Even before the pandemic, regional and local markets were mostly responsible for managing these difficulties, often with great effectiveness (Allam et al., 2022; Raihan et al., 2022a; Voumik et al., 2023a). Global and local climate change have made certain supply chains especially vulnerable to ecological, territorial, and community concerns (Nocentini et al., 2017; Ghadge et al., 2020; Raihan & Voumik, 2022a; Raihan et al., 2022b; Isfat &

Raihan, 2022; Voumik et al., 2022; Ghosh et al., 2023; Raihan & Himu, 2023; Sultana et al., 2023; Voumik et al., 2023b) due to their exposure to continuous transformations reflecting the ecological transition (Raihan et al., 2022c). Simultaneously, it was shown that forest ecosystems are ever more vulnerable to hazards like extreme climatic events, fire, pathological epidemics, and general anthropological actions, all of which have significant (yet poorly quantified) economic impacts (Corona, 2019; Pecchi et al., 2019; Ali et al., 2022; Raihan & Tuspekova, 2023b). How these problems are dealt with by forest management will have far-reaching consequences for human health, biodiversity, productivity (economic and ecological), and the capability of forest ecologies to withstand external distresses (Begum et al., 2020; Raihan & Tuspekova, 2022b; Raihan et al., 2023b). Forests provide numerous ecological services that are important to civilization and social interests (Raihan et al., 2018; Angelstam et al., 2019; Raihan et al., 2018; Doimo et al., 2020; Newton et al., 2020; Raihan et al., 2021a; Raihan et al., 2023c), and not just wood stuff (Raihan et al., 2021b; Raihan & Tuspekova, 2022c; Raihan et al., 2023d). Businesses and society as a whole benefit from a focus on environmental sustainability since it lowers risk, encourages innovation and entrepreneurship, and makes supply chains more competitive (Lazdinis et al., 2019; Aszalós et al., 2022; Raihan & Tuspekova, 2022d; Raihan et al., 2022d). The International Panel on Climate Change (IPCC) has reaffirmed the value of forests and associated prolific segments, showing how CO₂ emissions can be cut by as much as a third using only environmentally friendly methods (Raihan & Tuspekova, 2022e; Raihan & Voumik, 2022a). That's why it's important to support companies and management techniques that strengthen interdependent supply chains and forest ecosystems (Masson-Delmotte et al., 2021; Raihan & Tuspekova, 2022f). Europe's forestry industry serves many purposes, from creating jobs and boosting rural economies to consolidating (at least indirectly) the recreational pleasures associated with mature forests (Corona et al., 2016). Spending time in woods has been shown time and over again to be beneficial for stress reduction, mood elevation, and even health recovery (Grilli & Sacchelli, 2020). Lawbreakers, psychiatric patients, youngsters emotionally troubled, and people with psychological healthiness concerns are just some of the populations who have been the focus of numerous research that have investigated the efficacy of forest-related therapy lineups in improving their condition (Shin et al., 2010; Raihan & Tuspekova, 2022g).

Forests play an important role in delivering ecosystem facilities (Raihan & Tuspekova, 2022h), including an extensive array of recreational and tourism events like picnicking, hiking, and biking, and this fact has been widely disseminated thanks to numerous worldwide enterprises, such as the European edges COST act E39. Thus, there has been a push to acknowledge forests' potential as places for recreation, stress reduction, and relaxation (Grilli & Sacchelli, 2020). While forestry has obvious economic benefits, wood also has major manufacturing and energy uses, the latter of which is expected to rise in the current geopolitical context (Zakeri et al., 2022; Skyрман, 2022). Given our nation's rich forest history, this appears to be a beneficial development; but it is also seen negatively because it may reduce demand for wood used in higher-value manufacturing processes. Meanwhile, a structural issue of reliance on foreign supply plagues businesses, particularly furniture industries (Santos et al., 2019; Ghadge et al., 2020). Data from authoritative sources suggests, albeit in a roundabout way, that the inherent vulnerability of forest formations is becoming more apparent and increasingly accompanying with the financial and communal dynamics of confined regions, demonstrating a foundation of instability and ambiguity and diminishing the probable flexibility of whole areas to worldwide changes (MacDicken, 2015). When the adjacent circumstances (accessibility, absorptivity to modernization, networking, trade openness) are unfavorable, doing business can be extremely challenging, especially in economically underprivileged circumstances like national and peripheral zones in the ancient landmass (Bowditch et al., 2020).

The present article draws on a literature analysis to examine the changing face of European forestry and to outline the environmental and economic complexities that define the forest industry. Significant communal insinuations for resident regions familiarizing themselves with ongoing ecological alteration, from global warming to topography modifications, stem from the widespread usage of a significant natural resource like wood (Garbarino et al., 2020; Raihan et al., 2022e). In line with previous research, this review article recommends the significance of the technological-financial attribute of forestry in the sustainable development routes of regions and counties (Hazarika et al., 2019), which influences short-range economic dynamics, sector expansion possibilities, supply chain organization, interconnectedness among corporations, and financing approaches in general. Simultaneously, this review's contribution provides

evidence that simplistic interpretations based on purely ‘technical’ points of view cannot capture the nuances of forestry and its inherent interaction with additional economic segments and ecological challenges. This research, on the other hand, lends credence to the idea that including a ‘holistic’ interpretation of forestry into sustainable development pathways across spatial scales would be beneficial. Only by defining future avenues of theoretical research and empirical examination it might be possible to achieve the social, environmental, and economic goals of forestry that are essential to its success. This review article is structured as follows to answer the important query of sustainable development in every manufacturing segment with pertinent implications on the environmental quality. In the second section, this article presents a quick look at the shifting landscape of European forests. The consequences of forestry on the natural world are the subject of the third section. The fourth section summarizes authorized statistics and introduces an ephemeral examination of the prolific interconnectedness amid the forestry sector and the furniture manufacturing in Europe, outlining the financial utilization of forest resources besides the supply chain of wood-furniture. The sustainability-focused framework of European forest policy and its most recent developments are summed up in the fifth section. The review article concludes with an exposed discussion of the key questions at play in the debate over forestry’s environmental and economic influence in developed markets, potentially differentiating between central and peripheral locations, where forestry signifies a pertinent added value in country structures that might be better adjusted with the feature of ecological reinforcement.

Recent dynamics in European forest resources

Deforestation is increasing at a degree of yearly 10 million ha (FAO, 2020), while forest area is decreasing at an alarming rate of 4.7 million ha annually on average. Brazil, Congo, Indonesia, Tanzania, Angola, Paraguay, Cambodia, Myanmar, Mozambique, and Bolivia are among the nations with the biggest net (year average) forest cover losses throughout the last decade (FAO, 2020). However, over the last 30 years, there has been a greater recognition of the significance of forest conservation measures, leading to an increase of nearly 200 million hectares of protected forest areas from 1990 to 2020 (FAO, 2020). European Union (EU) land and about 6% of marine zones (encompassing roughly 850,000 km²) are protected by the Natura 2000

network, one of the newest projects introduced and the biggest coordinated network of protected sites in the EU. This system was developed in response to the Habitats Directive and the Birds Directive with the goals of protecting endangered species in their natural environments and ensuring the continued functioning of ecosystems for future generations (Evans, 2012).

Establishment of forest cover, specifically in peripheral regions of developed nations, is a feature of advanced economies (Pagnutti et al., 2013), which are consistent with trends observed in Europe’s forests. One of the most significant shifts in land use over the past two centuries in Europe was the increase in forest cover, which was spurred on by widespread reforestation efforts. However, the acceleration of technical improvements that intensified the farming systems on reduced ranges is also a result of rural emigration; these changes have freed up land-dwelling for the recolonization of forests, especially on unrestrained and formerly farmed land (Frei et al., 2020; Santarsiero et al., 2023). Western European forest cover grew by over 30 percent in the half-century after WWII (Charru et al., 2017). Central-Eastern and Southern Europe saw slower rates of growth (20% and 16%) compared to Northern Europe, where forests were before now the dominant land covering by the middle of the previous century. Still, forest area has increased practically everywhere up to now, though it has slowed down significantly meanwhile the immediate 1990s. Western Europe is the only region where this trend has reversed. There will be 10.2 million hectares more of forest in Europe by 2020 than there were in 1990. About 45% of the land cover of the European Union (EU) was comprised by forests and woodlands in 2020 (excluding inland seas), making the EU home to about 5 percent of the Earth’s total forest acreage (Forest Europe, 2020). As an illustration of long-term tendencies, less than 0.4% and 0.3% of land conversions in Europe have been accounted for by afforestation and deforestation, respectively, in current ages (Forest Europe, 2020).

Sweden’s forest assets are predicted at 30.3 million hectares in 2020 (Purwestri et al., 2020), making it Europe’s largest forest area. While the only other member state was Finland with a concentration of over 20 million hectares, Spain recorded the second-largest area at 28 million hectares (Palátová et al., 2022). Following closely behind was France, with 18.1 million hectares of forest, followed by Italy and Germany, each with roughly 11 million ha of forest (Cook, 2020). In 2020, half of the territory of the 8 member countries will be covered by forests. Slovenia (62.8%), Finland (76.2%), and Sweden

(74.5%) had the greatest rates in comparison to their respective national areas. Forests cover between 50 and 60 percent of the land in Estonia, Latvia, Spain, Portugal, and Greece, but they cover between 11 and 16 percent in the Netherlands, Ireland, and Denmark, respectively. Only Sweden saw a decline in forest cover between 1990 and 2020 (-0.4%), while three Mediterranean European nations (Italy, Croatia, and Cyprus) saw increases of more than 8% during the same time period (Forest Europe, 2020; Kumar et al., 2021).

The effects of human activity have been profound on the structure and content of European forests. Only 26 percent of wild species and 15 percent of forest ecosystems gain a positive conservation category (EEA, 2015). In addition to sequestering 13 percent of Europe’s emissions, housing an overriding portion of terrestrial biodiversity, plus making important contributions to climate change mitigation, it has been predicted that forests eliminate roughly 430 million

tons of atmospheric CO2 annually (Nabuurs et al., 2018; Raihan & Said, 2022). In 2050, cities will be home to roughly 84% of Europe’s population (Pesaresi et al., 2016), have major effects on air and soil conditions and, by extension, the health of people across Europe, particularly the young and the old. Most ecoregions in Europe can expect an upsurge in temperatures and a decrease in precipitation in the future, and this will occur at a more rapid rate compared to the remainder of the globe due to the impact of an inevitable change in the composition of the Earth’s atmosphere. Urban forestation initiatives, which involve an enormous rise in planting to improve the microclimate and quality of air in urban areas by capturing carbon dioxide and protecting the soil coming from the sun and rain, are one of the most common ways of coping with the impacts of global warming on cities (Escobedo et al., 2019; Raihan et al., 2022f). Figure 1 presents the forest dynamics components under European classifications.

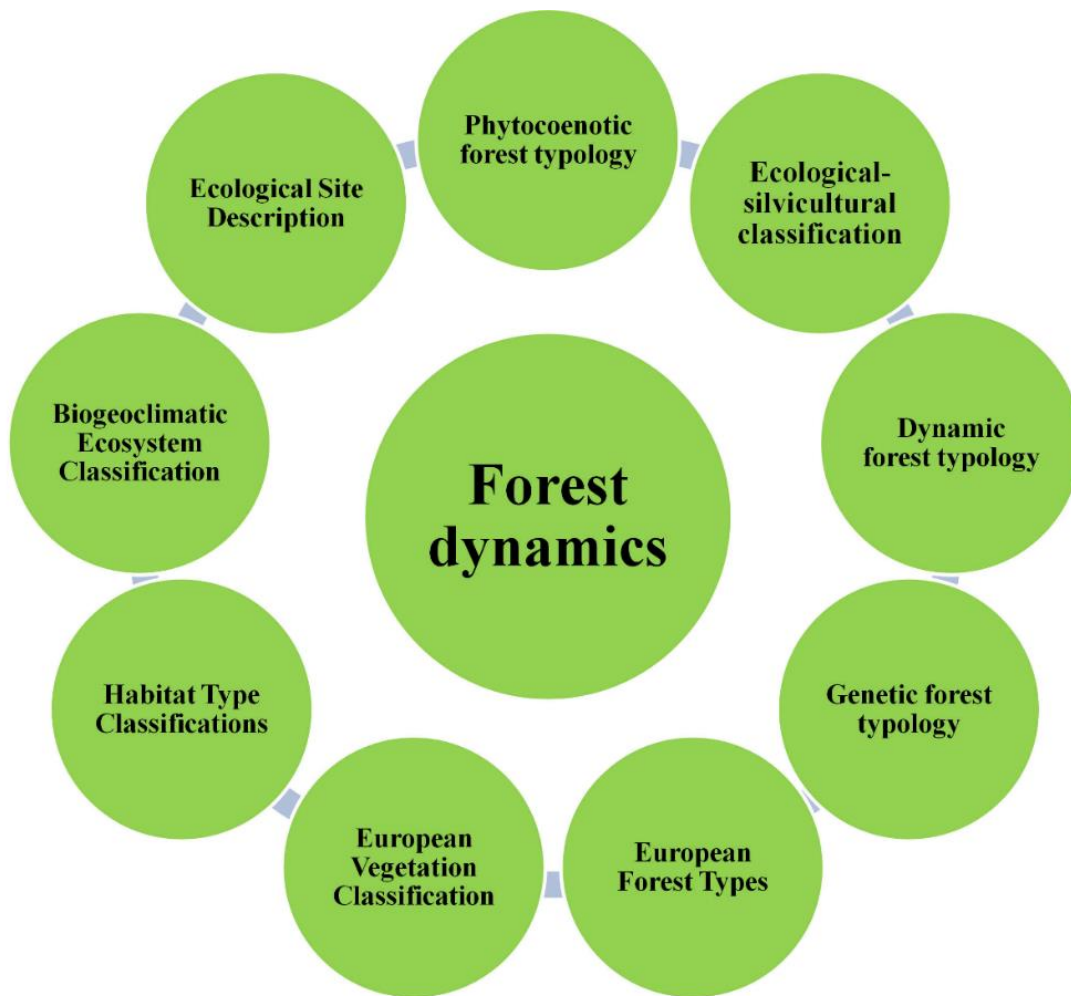


Figure 1. Forest dynamics under European classifications (Ivanova et al., 2022).

Vital ecosystem facilities and goods are provided by all urban natural areas, including a wide range of green covers (forests, botanical gardens, urban parks, street tree, plantations, and cemeteries; edifice swathe rejuvenation is a relatively new addition to this list) (Escobedo et al., 2011). These include, but are not limited to, the maintenance of habitat attributes, the control of air, soil, water, and climate, besides the provision of food and water (Raihan et al., 2023e). In addition, urban forests, particularly in developed states, may show a pivotal part in resolving resource struggles as a hallmark of modern globalization (Hayter & Clapp, 2020) that arise from the tension between manufacturing urgencies and environmental and social needs (Whiteman et al., 2015; Raihan et al., 2022g; Raihan et al., 2023f). Finally, no authorized map casing vast spatial levels can be regarded acceptable in directing the issue of forest distribution in Europe (Yousefpour et al., 2018). This question can be answered more precisely with the use of official statistics (such as fine-scale agricultural censuses and geo-spatial statistics from forest inventories) and land-use maps.

Influence of forestry on the environment

Inadequate forest management has the potential to jeopardize or even destroy forest resources and services. Still, forestry practices are a major reason why forest habitats and species are in a poor conservation position (Cutino et al., 2018; Raihan et al., 2022h; Raihan, 2023a). In this regard, forestry techniques across Europe range from total lack of managing caused by abandonment or protectionist policies to be restricted management or intensive short rotation forestry designed to provide electricity biomass (Pergola et al., 2022). However, management regimes that mimic natural disturbances can have a significant impact on stand structure, potentially leading to an increase in biodiversity over time while also reducing the rate at which forests undergo change (Kuuluvainen et al., 2021; Raihan, 2023b). Although forestry may have an effect on plant diversity and wildlife, it is generally less severe than agriculture practices due to the very inadequate usage of fertilizers, which are typically lone used for weeding prior to reforestation campaigns or to indulge conifer over broad-leafed regeneration (Muys et al., 2022). Since the use of biocides is extremely rare in the forestry industry, managed forests employ these products at a fraction of the rate and with far less frequency than agricultural systems (Freer-Smith et al., 2019; Raihan,

2023c). The absence of tree species diversity, variation of tree phase, and unusual ecosystems like deadwood all contribute to managed forests having substantially lower biodiversity than natural forests (Freer-Smith et al., 2019; Raihan, 2023d). Given that stand age is a critical factor in the delivery of forest ecosystem services (Sutherland et al., 2016), it may be unfair to label it as yet another “victim” of modern forestry practices like clearcutting of medium-aged besides old stands, which may reduce the quantity and quality of forest functions (Jonsson et al., 2020; Raihan, 2023e).

Old growth forests are threatened by intensive forestry practices, which can lead to their temporary extinction (DellaSala et al., 2022). Unfortunately, the loss of biomass from old-growth and primary forests in Europe is continuing (Svensson et al., 2019), primarily for economic reasons, leading to a typical outline of forest degradation, comprising of the transformation of these surroundings into secondary forests (Angelstam & Manton, 2021) and the extinction of individual species dependent on deadwood or old trees (Raihan, 2023f). Finally, forest utilization practices (such as extracting non-timber goods, timber harvesting, converting natural forests to plantations, and roads and amenities construction) and the slow introduction of plant species for merchantable agroforestry practices can all contribute to the foreign invasive species introduction and proliferation (Ohimain, 2022). Figure 2 presents the environmental services and economic opportunities provided by the forests.

Economic utilization of forest resources and wood furniture supply chain

Even if the total forest area in Europe has remained relatively unchanged over time, this does not rule out the possibility of significant changes in the region’s forests. Both human activities, especially the removal of biomass; and ecological maturity or other natural processes affect forest ecosystems (Jaafar et al., 2020). Statistics from across the country supply data reflecting the depiction of the light and shade in the commercial utilization of forests, which may be deemed intensive only in particular regional scenarios, despite a general tendency toward broadening and asset under-use at the local level (Canadas & Novais, 2014; Raihan, 2023g). In fact, the average rate of forest usage (comparison of yearly volume lost versus yearly volume expansion of the remaining forest stock) across Europe in recent years has stayed far below 1 (EIR, 2018).

This suggests that there are prospects for larger harvests in various contexts and that, while timber production has differed by nation, it has persisted extremely sustainably. This presumption is based on a global scale analysis that

compares national levels of GDP growth and consumer spending using varying data quality benchmarks. Some protected areas may not be viable if intensive logging is practiced on a regional scale (Bösch, 2021).



Figure 2. Environmental services and economic opportunities provided by the forests (FAO, 2023).

In some fractions of Europe (specifically in confined contexts in Eastern Europe), overexploitation of forest resources may still be an issue today (Bălăcescu, 2020). Even at a finer spatial scale (prefectures, municipalities), the situation is likely to get more convoluted. However, even in the most economically developed countries, accessible data rarely allows for such precision. In 2020,

the total volume of timber in EU-27 woods was roughly 27.6 billion cubic meters (bcm). Germany and Sweden have the largest timber stocks amongst EU countries, totaling about 3.7 bcm (13.3 percent of the total EU-27). Other countries with sizable wood reserves include France (3.1 bcm and 11.1 percent), Poland (2.7 bcm and 9.9 percent), Finland (2.5 bcm and 8.5 percent), and Romania

(2.4 bcm and 8.5 percent) (Forest Europe, 2020). In spite of the challenges it faces, these numbers show that Europe's forestry industry has room to grow economically and portray a positive function in the future of many countryside regions (Perunová & Zimmermannová, 2022). The conventional forestry segment (forest management, harvesting, sawmilling, forest products and processing) in the EU employs over 2 million people and generates a gross added value of more than €100 million per year (Tiebel et al., 2022). There are nearly 16 million private forest proprietors in the EU. Forests can be held by anybody from individual families to governments to investors in huge estates (Weiss et al., 2019; Raihan, 2023h). Yet over 60% of the forest area is owned privately (Maesano et al., 2018). By combining agricultural and forestry output, many farms provide economic diversification (Ficko et al., 2019). In 2017, the EU-27's forestry sector contributed 0.2% of the EU's entire GDP with a gross value added of 26.2 billion euros, a rise of 1.5% from the previous year. Finland, Sweden, France, and Germany accounted for just over 50% of the total value added. They were all worth between €3.2 billion and €3.8 billion. About half of the EU-27 countries had forestry account for gross value added below 0.3% of total. In contrast to the European average of 1.0%, this proportion was higher in Finland (1.9%), Latvia (1.7%), and Estonia (1.2%) (Forest Europe, 2020).

Nearly half a million Europeans have found work in the forestry sector in recent years, laying the groundwork for a wide range of rural sectors and professions, such as forest management, tourism, wood industries, and hunting (FAO, 2020). But the manpower requirements of logging and forestry vary widely among the Member States. Kajanus et al. (2019) note that the pattern and peculiarities of individual forest, tree density, species affected from the harvesting activities, and the topography landscape all have a role in the possibility for effective utilization of forest modernization. Poland (73,000), Romania (48,000), Sweden (41,000), and Germany (40,000) had the highest employment rates (Da Silva & Schweinle, 2022). There was a little drop (-0.2%) in forestry jobs in the EU between 2008 and 2018 (Cook, 2020). Eastern European countries like Hungary (+50%, with over 7,000 more employees) and Poland (+11%, with more than 11,000 new jobs, equal to +18% over the last decade) have seen increases in their employment rates in recent years. To the contrary, Croatia saw the largest decline in forestry employment (-55%, or 17,000 jobs) over a ten-year period (FAO, 2020).

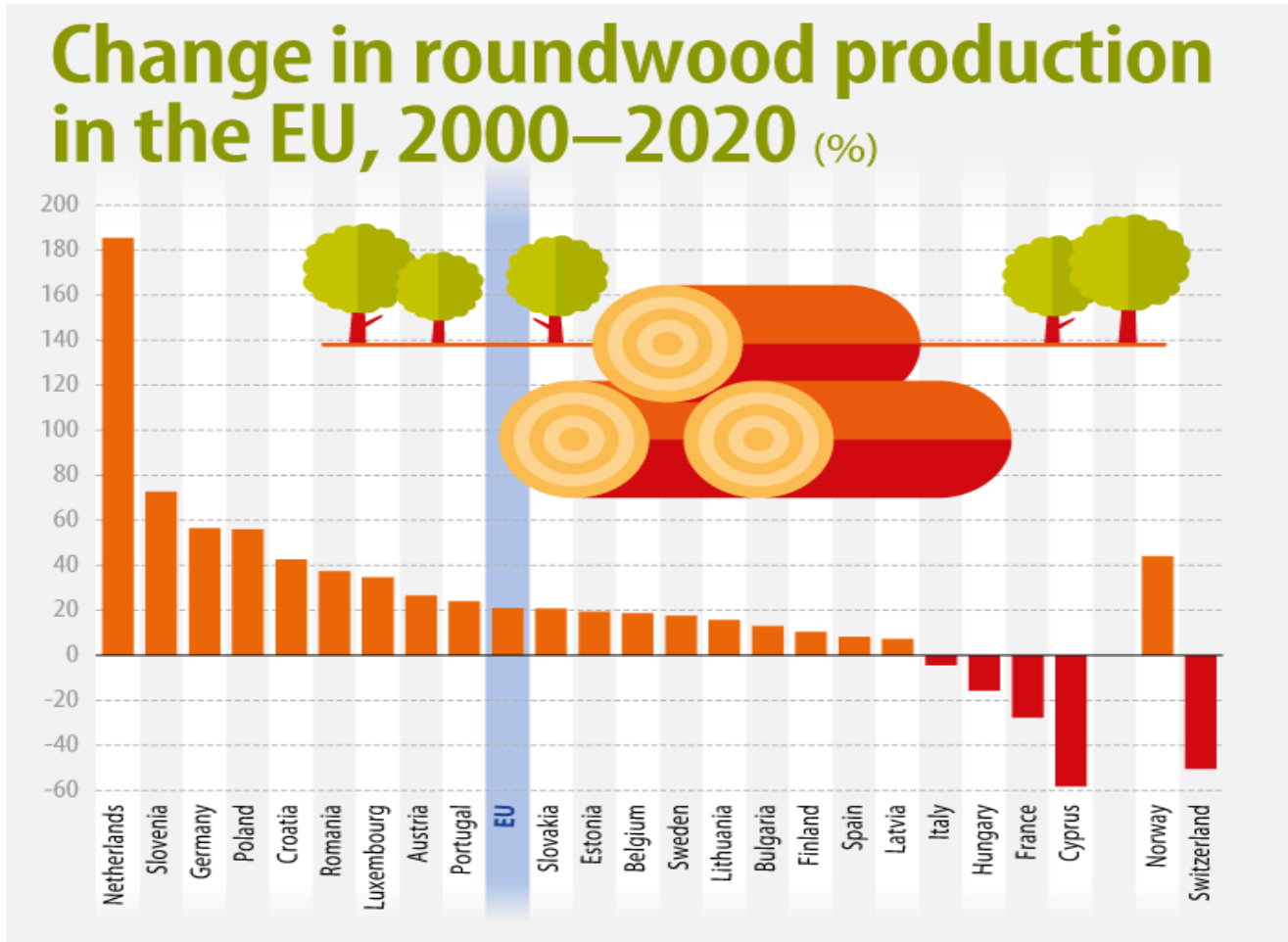
The principal goods of forestry, along with fuelwood, industrial roundwood is an essential material for the manufacturing of sawn wood and veneers. According to Brack (2018), Europe is a major player in the global roundwood market. The EU-27 countries rely heavily on the manufacturing of timber products (Lovrić et al., 2020). In 2018, the wood industry's 397,000 businesses accounted for nearly a fifth of the overall manufacturing segment. These businesses directly or indirectly employed 3.1 million people (10.5% of the manufacturing sector's workforce) and generated 138.6 billion euro in added value. According to data from 2018, 19.6% of all manufacturing establishments in the European Union were involved in the manufacture of wood commodities (Cook, 2020). When compared to the percentage of value added (7.1%), it is obvious that small and medium-sized firms (those employing between 51 and 249 people) are the backbone of the wood production industry (Socoliuc et al., 2020).

Europe's roundwood output has been on the rise over the past few decades, with a temporary dip in 2007–2008 due to the economic catastrophe. However, manufacture has shown encouraging signs of recovery since 2010, and has fully regained to pre-crisis stages (458 million m³) since 2013 (Schier et al., 2022). Recently, it was anticipated that output was 490 million m³ in 2018, an increase of 5.5 percent from 2017 and a considerable increase of 21.2 percent from 2000 (FAO, 2020). Hardwoods showed remarkable stability in output while conifers, which account for three-fifths of the entire roundwood output (60.4%, or 296 million m³), showed greater volatility (Cook, 2020). The number of cubic meters of roundwood harvested in Sweden in 2018 was 75.1% higher than in 2017, at 75.1 million. German roundwood production (71.8 million m³), Finnish roundwood production (68.3 million m³), French roundwood production (48.2 million m³), and Polish roundwood production (46.9 million m³) together account for nearly two thirds (63.3 %) of the EU's roundwood production. In 2018, it was predicted that the European Union's total sawn wood production was 109 million m³, up from a decade earlier (+11.7%). Sawn timber production in the EU remained led by Germany (21.9%) and Sweden (16.9%), as in previous years. Only Finland in the European Union (EU) recorded a double-digit percentage of global wood production (10.9%). Germany (+4.6 million m³, or +23.7 percent), Finland (+2.0 million m³, or +19.8 percent), and Romania (+1.3 million m³, or +35.9 percent) were the primary contributors

to the EU’s rising sawn wood production between 2008 and 2018.

However, total EU roundwood production fell by 2% from 2019 to 2020, to 488 million m³, ending an eight-year period of continuous growth (Eurostat, 2021). In spite of this, roundwood output is 21% higher than it was in 2000. Figure 3 presents the percentage change in roundwood production in the EU between 2000 and 2020. Since 2000,

roundwood production has increased across the board, with the largest increases being in the Netherlands (+185 percent), Slovenia (+73 percent), Germany (+57 percent), Poland (+56 percent), Croatia (+43 percent), and Romania (+37 percent). Some of those nations had quite humble beginnings. Cyprus (-58 percent), France (-28 percent), and Hungary (16 percent) saw the biggest percentage drops in their respective annual wood harvests (Eurostat, 2021).



Czechia, Denmark, Ireland, Greece, Malta: data not available

ec.europa.eu/eurostat

Figure 3. Percentage change in roundwood production in the EU between 2000 and 2020 (Eurostat, 2021)

The usage of wood as a sustainable energy source has been on the rise. In 2020, about a quarter (23 percent) of EU roundwood production was used for fuelwood, while the remaining 77% was used for industrial purposes such as sawing, veneering, or pulping and papermaking. The percentage of total wood used for fuel therefore increased by six percentage points since the year 2000. Fuelwood constituted the bulk of roundwood output in some Member

States in 2020; the Netherlands (78 percent) and Cyprus (74 percent). In contrast, over 90 percent of roundwood production in Slovakia and Sweden was reported to be industrial roundwood (Eurostat, 2021). Notwithstanding the above economic data’s testimony to the health of the wood-furniture supply chain, the European wood business has felt the effects of the decline in manufacturing employment, especially between 2000 and 2019 (9.6%)

(Marschinski & Turegano, 2019). The integer of people engaged in the production of furniture and wood merchandise fell by nearly a quarter (26.3% and 24.9%, respectively) and men progressively made up the majority of these industries' workforces (Cook, 2020). More than 80% of workers in the forestry industry were men in 2019, but only 83.4% of those employed in the production of wood and its end product were men (Cook, 2020). Similarly, only 77.3% of those employed in the furniture manufacturing industry were men.

European policy context and new developments in forestry

As deforestation is expected to cause a widespread loss of forest canopy and wooden assets in numerous regions, the European Commission is working to increase protections for forests by promoting global value channels not leading to deforestation or forest degradation. Since 1980, the European Union (EU) has established forestry sector guidelines and action programs that are sometimes applied in the Common Agricultural Policy (CAP), especially in

rural development policies (Sarvaová et al., 2019). During the 1990s, forestry went from being a tertiary component of the CAP to an integral part of European sustainable development policy, leading to the adoption of the EU's Forest Policy in 1998 (Galana et al., 2013; Raihan, 2023i). It served as the very first benchmark guideline to include Member State action instructions in line with sustainable forest management principles (Rametsteiner & Mayer, 2004; Raihan, 2023j). The 2005 Forest Action Plan (FAP) served as the primary mechanism for putting the Strategy into action, with the stated goal of "enhancing the forest heritage of the Union, maintaining and strengthening the multifunctional role of forests through active and aware management of the forests" (Aggestam & Pülzl, 2020). To increase the availability of renewable and ecologically friendly raw materials, the function of forests was bolstered in climate change mitigation and adaptation guidelines with the introduction of the new European Forest Policy in 2013 and subsequent amendments (Aggestam & Giurca, 2021). Figure 4 presents the policy areas pertinent to forest policy in the European Union.

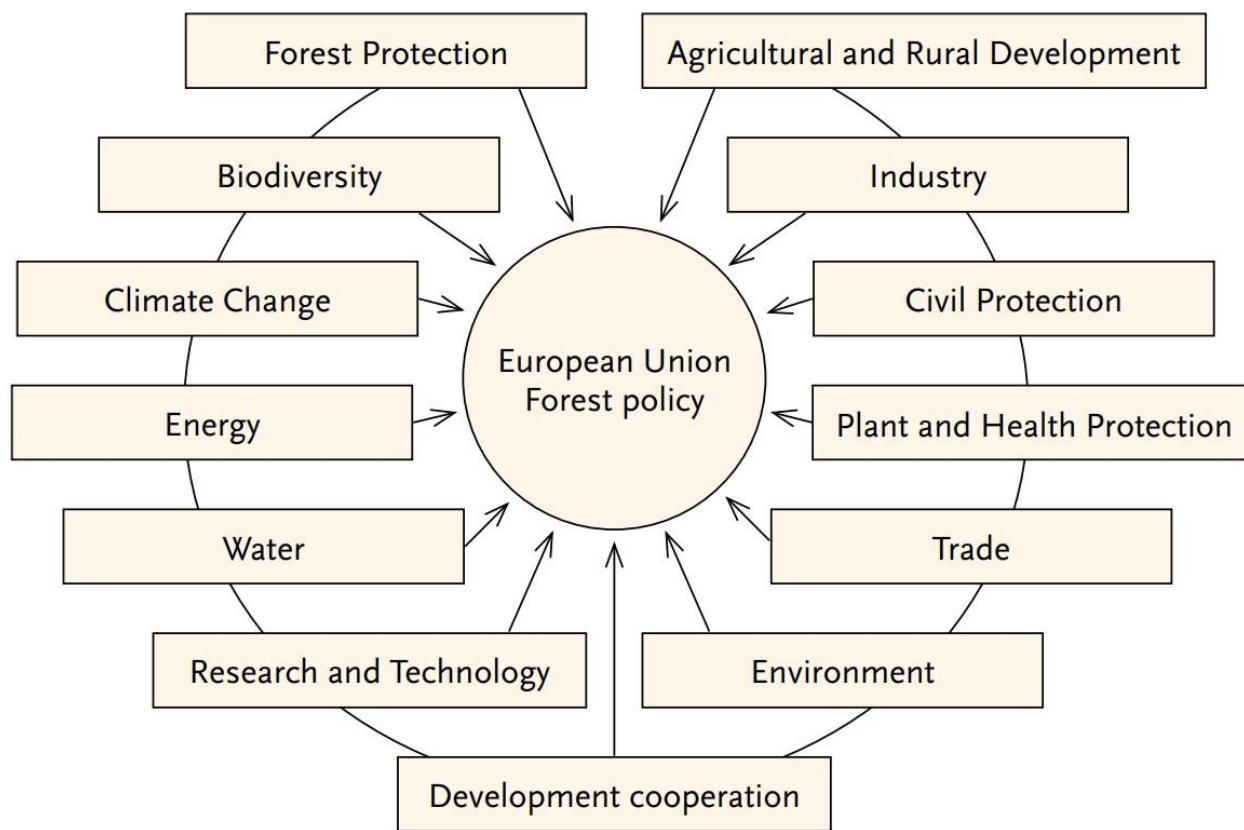


Figure 4. Policy areas pertinent to forest policy in the European Union.

The forest policy has provided a uniform structure for community strategies and a fine-tuning of the forest strategies of each member country (Falcone et al., 2020; Aszalós et al. 2022). This is all in service to fostering sustainable forest management with an eye toward effective resource utilization. Rehabilitation, resiliency, and proper preservation of all ecosystems, not only those characterized by forests, must be a primary priority to achieve a sustainable and climate-neutral economy by 2050 (Fetting, 2020; Raihan et al., 2022i). This new community strategy is strongly rooted in the Green Deal and the biodiversity policy for the 2030 Agenda objective. These measures sought to improve the conservation and restoration of forest resources, increase sustainable management, and boost monitoring and the effectiveness of distributed organizing so that these ecosystems could perform a multifunctional part in mitigating GHG emissions and sequestering CO₂ equivalents (Palah et al., 2020). This approach also includes efforts to promote the development of alternative resources and goods in addition to those of fossil sources and to encourage the growth of a forest economy that is not dependent on the harvesting of trees (Ladu et al., 2020; Viaggi et al., 2021). This is to further support a sustainable forest bio-economy for a future with zero climate impact. This included ecotourism based on the new strategy switching to the EU Forest Policy approved in 2013 and reviewed in 2018. The updated plan was released in July of 2021. Finally, a plan for planting as a minimum 3 billion more trees in the EU by 2030 was included next to the strategy's emphasis on sustainable reforestation (and afforestation) (Lee et al., 2023).

This tactic is tied to the CAP by design and benefits from the CAP's operational interventions, which help make rural areas more thriving and prosperous (Lier et al., 2022). The major financial support for the safeguarding and sustainable management of communal forests comes from these initiatives, which encourage versatile forestry and sustainable forest management and combine it with additional growth indicators (advice and offerings, education, expenditures, collaboration) that react to particular regional requirements (Gordeeva et al., 2022). These measures also encourage forest growth through reforestation and the revival of agroforestry arrangements; they furnish operative and monetary instruments for fire and disaster preclusion; restoration following damage; investments in climate change adaptation and mitigation; and economic procedures for compensation and inducements for boosting the monetary worth of

woodlands and pre-industrial timber (Ascoli et al., 2023). In a highly dynamic environment such as the present one, the European Commission has articulated the Next Generation EU as a solution to the catastrophe due to the epidemic, with the three struts being social interconnection, the green economy, and the digital transformation (Fabbrini, 2022). From this vantage point, the Carbon Border Adjustment Mechanism seeks to shield EU-made goods from less environmentally friendly imports made by countries beyond the EU's borders (Mörsdorf, 2022). The "Fit for 55" package mandates that the region become carbon neutral by 2050, with the interim objective being reached by 2030 (Köhl et al., 2021; Raihan, 2023k).

Because they are seen as vital (and steadily increasing) contributions in the shift and advancements of renewables, member nations will also be expected to meet a goal for the allocation of key basic equipment. The European Union estimates that the furniture industry could benefit from the circular economy by creating an additional 160,000 jobs, reusing or recycling an additional 3.3 to 5.7 tons of materials, preventing the emission of an additional 3.3 to 5.7 metric tons of carbon dioxide equivalent, and increasing the value of the local economy by 4.9 billion euros. Because of this, Baumgartner (2019) argues that supply of wood and the furniture business have the problem of moving quickly enough to fully capitalize on the prospects presented by a truly sustainable development. However, the EPA (Environmental Protection Agency) confirmed in 2018 that biomass burning can be classified as an emission-free energy resource (Raihan & Tuspekova, 2022i; Raihan et al., 2023g). This fundamental assertion endures to handle worldwide efforts on climate change despite the lack of scientific evidence. However, most academics agree that switching back to firewood as an energy source will significantly exacerbate the environment and pose a hazard to forests (Schlesinger, 2018; Raihan & Tuspekova, 2022j). To compound matters for businesses producing high-quality wood goods like furniture manufacturers, this political stance will have a detrimental effect on the availability of wood supplies.

Discussion

This research provides actual evidence for the intricate ecological-economic nexus that drives forestry and the forest industry as a whole. Ecologically speaking, a deeper understanding of forest ecosystems is a vital piece of data needed to support a competitive supply chain strategy

aimed at achieving the Sustainable Development Goals (Moreau et al., 2022). These goals were implemented by all nations as a feature of the United Nations 2030 Agenda and aim to protect the environment and reduce greenhouse gas emissions. Miina et al. (2020) and Rosa et al. (2023) note that current data on forest management techniques in Europe is insufficient to provide an inclusive picture of ecological health, economic assessment, and biodiversity. In addition, it is possible that national statistics are incomplete since they exclude logging operations that serve essential (and likely informal) needs, such as house heating (Picard et al., 2021). There is an immediate need for more precise statistics on forest management techniques and their influence on forest reserves, as well as more accurate measurement of forest land-use and associated change over (Gschwantner et al., 2019; Raihan, 2023i). Better data on forest area and management changes will be available thanks to remote techniques (Chirici et al., 2020; Filizzola et al., 2022). High-resolution data on forests, including the density of tree cover, type of forest, and characteristics of small woody trees, will be made available through the European Environment Agency's (EEA) adoption of the Global Monitoring and Environmental Surveillance (GMES) system (Chianucci et al., 2021). An exact monetary assessment of resource reserves, that is yet lacking at present (Loomis et al., 2019; Raihan, 2023m), requires all of this data.

Sawmills and other forest-use infrastructure are progressively disappearing across Europe, despite the region's relatively constant wood and other commodity production. The opposite is true; forest cover and volume, along with forests' ability to sequester carbon, have grown steadily over the past few decades. While this is encouraging, it also comes with a caveat: the forests are increasingly at risk from both natural disasters (such as change of climatic conditions, floods, and landslides) and agrarian desertion, that can cause economic uncertainty and ecological deprivation, particularly in poor and remote areas (Angra & Sapountzaki, 2022; Zhang et al., 2022). Official statistics face a challenge when they are tasked with assessing the forest reserve, primarily in relations to good-quality wood intended for the furniture manufacturing chain. These statistics are meant to support a broad outline of economic and environmental trends to the aggregate user, with the goal of encouraging enhancements in records inclusiveness, statistic consistency, and timely update. By working together more closely, member nations and regional authorities can improve the quality of economic analyses and plan for the

more efficient and environmentally friendly utilization of forest resources (Edwards et al., 2022). Due to the multifaceted nature of forest supply chain issues, it is challenging to keep tabs on them using only official statistics (Garcia & Hora, 2017; Raihan, 2023n). While confirming the necessity for a larger interpretation of the many organizational components, such as the problem of assessing natural resources, in the economic analysis, this paper does the opposite. For instance, incomplete statistics, inconsistent methodological definitions, and sparse geographical detail continue to define this axis in the present day.

To keep products, components, and materials as valuable as possible within the economy for as long as possible, area operatives appear to gain a heightened knowledge of the magnitude of investing at the firm level (Mhatre et al., 2021). These measures, which call for a shift in corporate, territorial, and individual perspective and a fundamental rethinking of the way we produce and consume, are intended to steer the manufacture and consumption structures toward further effectual pathways by means of incessant and reformative sequences that reduce resource use, waste, and emissions in manufacture procedures (Sahoo et al., 2019; Raihan et al., 2022j). The adoption of circular techniques that ensure environmental sustainability over the medium term is increasingly common across all industries, with circular principles progressing most rapidly across furniture manufacturing firms, the supply chain's most dynamic link (Jarre et al., 2020; Raihan & Voumik, 2022b).

Most of the resources utilized in the manufacture of lumber appear to be destined for incineration or disposal. Dead branch off, barks, residues, and debris are typically simply seen as something to be thrown away. Despite being classified as waste, these materials may have a happy ending after all, leading to a valuable second use and a strong market position (Pieratti et al., 2019; Raihan, 2023o). Most mulch on the market has traveled from far away to get to your garden. This adds a new dimension to the quest to reclaim the abandoned bark. Barks and dead branches are often burned for cheap thermoelectricity, despite the fact that they can have significant nutrient value and serve an important role in soil protection. In addition to peat and other soil conditioners, residues can be used as a high-carbon fertilizer. The usage of "cascade" timber is encouraged in a circular forest management system. It entails giving material recovery a higher priority than wood combustion for energy production. The implementation of this idea benefits the regional timber supply chain and the

economies of communities located in economically vulnerable locations near woods (Jarre et al., 2020; Raihan, 2023p). In this view, a tree trunk is a resource that should be put to good use across multiple industries, from construction and interior design to paper production and textiles.

As Mair and Stern (2017) point out, "cascade" wood is a great way to practice thinking about forests as resources with multiple uses that benefit both the environment and human society. As such, effective info campaigns and territorial passageway constructions, unspoken as vital ideologies of data and distribution of information and performs, are necessary for interventions on the timber-furniture supply chain labor market, especially in light of the sustainability of environmental and the transition of energy more generally (Marcinek & Smol, 2020; Raihan, 2023q). Companies in the supply chain have been shown to have a heightened recognition of the significance of energy and climate challenges, as well as the insistence of strategic solutions to environmental concerns (Adami & Schiavon, 2021; Lazaridou et al., 2021; Raihan & Tuspekova, 2022k). The potential for economically encouraging and promoting active enterprises from a viewpoint of not only positive environmental behavior, but also of technological advancement, ensures a fair transition on all fronts (economics, ecology, and information) toward novel manufacturing circumstances which are sustainable across a long period and resiliency to swift worldwide shifts in societies and environmental systems (Marques et al., 2020).

Conclusion

This paper looked at the many ways in which forestry contributes to society economically, including the formation of additional occupations, the revitalization of rural areas, and the improvement of people's physical and mental health through leisure activities. In addition to the direct economic benefits, forestry also benefits from the downstream input of wood, which is used extensively in the timber sector and continues to perform a large responsibility in the global energy mix. An increasing number of people are beginning to recognize the social and ecological advantages of ecotourism and additional practices of sustainable forest management. In this setting of opposites, the regulatory and institutional structure is highly variable and inconsistent in its ability to safeguard the sustainable management and protection of forests. It is strongly suggested that in the following years, new

technical and product developments, as well as new legislative and programmatic tools, be implemented.

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