



## THE ROLE AND USE OF FOREST RESOURCES IN ECUADOR: A SYSTEMATIC LITERATURE REVIEW

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### HIGHLIGHTS

- The role and use of forest resources in Ecuador are divided in exploitation and conservation.
- NTFP in Ecuador plays a key role in urban and rural areas to generate employment and income for the population.
- The production of wood and subproducts is the fifth key industry for the Ecuadorian economy.

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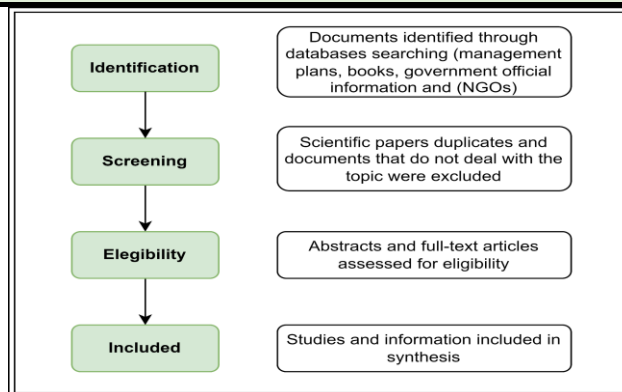
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### GRAPHICAL ABSTRACT



### ABSTRACT

*The principal use of the forest in Ecuador has been to extract wood to generate income. Based on a systematic literature review, this study presents a thematic overview of the legal framework, describes the uses of TFP and NTFP, and finally analyses the role of forest resources in the Ecuadorian economy. Methodologically, the information was divided in four stages: i) identification, ii) screening, iii) eligibility and iv) inclusion. The results of the research indicates that Ecuadorian policies can be emphasized to promote forest control with sustainable forest management practices including forest certifications. Consequently, the role and use of forest resources can be divided in exploitation and conservation. In addition, the economic contribution of forest resources to the national economy is the consequence of the policies applied with exploitation and conservation approaches. Finally, to increase the participation in national and international markets, the forest sector could be addressed in the potential use of non-timber forest products and not only in the use of timber forest products.*

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## 1. INTRODUCTION

The main use of the forest has been to extract wood in order to produce goods and services, maximizing economic income [1]. In this sense, the notion of sustainable management in the forestry sector arises from the declaration of principles for the sustainable management of forests [2] and involves stages such as: i) strategic planning, ii) monitoring, iii) evaluation, iv) human and financial resources, and v) efficacy [3-7]. Additionally, forest management includes alternatives based on the capacities, objectives and limitations of the regulatory framework for forestry activity [8], but its main challenge is the use of forests with a level of intensity that allows productivity without compromising the functioning of ecosystems [9].

The identification of benefits generated by the forest includes rights, obligations, incentives and restrictions that promote better administration and management of forest lands [10]. These benefits related with the state of forest and income must be perceived with a similar level of importance by the stakeholders: community, public and private sector [11].

In the last two decades, the relationship between forest management and protection has evolved through the incorporation of established indicators to measure and track the state and biological richness of forests [12]. Considering that the greatest forest wealth is in tropical ecosystems [13], there is great potential for harvesting timber (TFP) and non-timber forest products (NTFP) [14].

TFPs are represented as fibers (timber and wood fuel) [15], while the Common International Classification of Ecosystem Services [16], describes to TFPs as materials/biomass (timber), which are supported by forest species distributed throughout the territories [17]. Complementary, NTFPs are considered as biological components resulting from forest exploitation under natural conditions [18, 19]. For instance, the main TFP produced in Ecuador are chipboard, boards, medium-density fibreboard (MDF) panels, pulp and paper and carbon storage, while the principal NTFP are linked to ecosystem services such as regulation of the hydrological cycle and habitats to maintain biodiversity [20], and categories of use such as apiarian, food, food additive, medicinal, social and toxic (contain poisonous agents for vertebrates) [21].

The Ecuadorian continental territory has an area of 24,898,396 hectares [22], and has a classification of 91 ecosystems, of which 71.43% are forests, 12.09% shrubs and 16.48% herbaceous [23]. This classification has been provided by a combination of environmental, hydric, biotic and topographic criteria according to the national environmental authority. The most representative forest cover area corresponds to the lowland evergreen forests, located mainly in the Amazonian natural region [24]. Nevertheless, many of these forests have been affected by logging due to the preference of agricultural activities [23]. One of the government mechanisms that regulates the use of forest resources is forest certification. According to [25], there are at least 10 certified forestry companies that mainly produce products such as lumber, plywood, veneers.

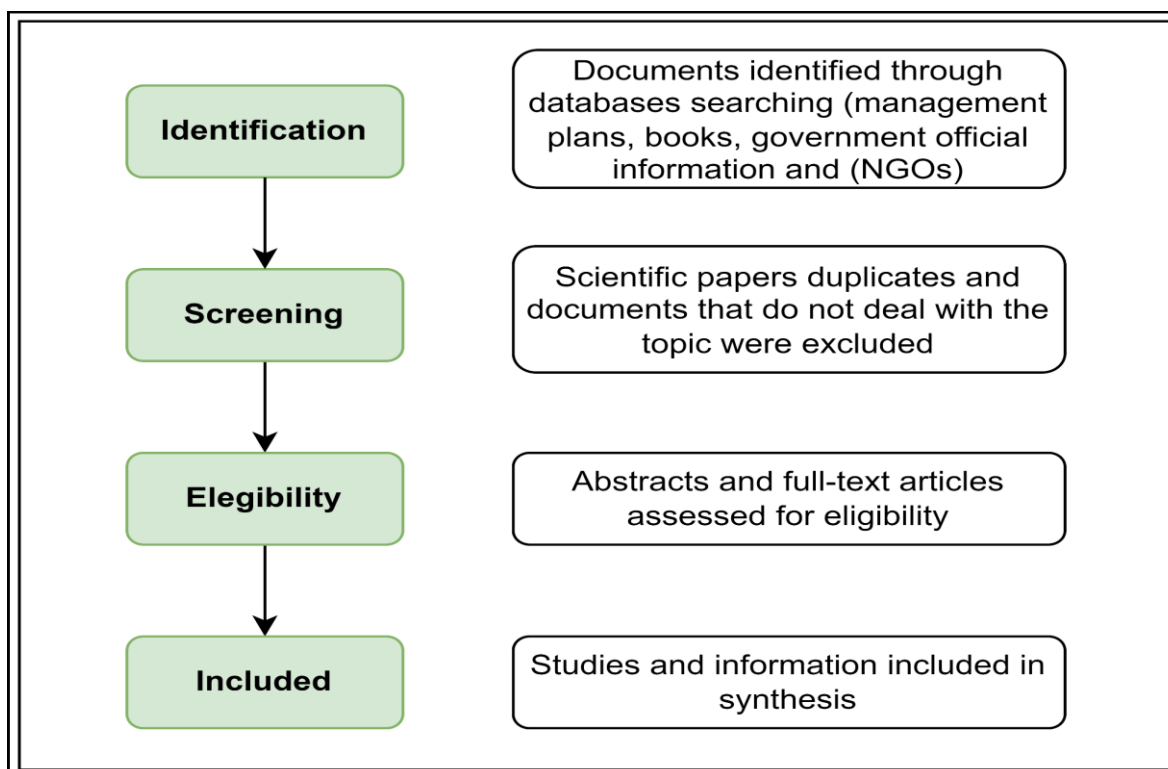
The restoration and sustainable use of forests is one of the sustainability objectives for Ecuador according to the 2030 national plan [26]. Additionally, other programs and actions that the

government is implementing are oriented towards the valuation of forests, management of native forests, reforestation, and development of an efficient system for the control of exploitation [27].

The knowledge of the reality about the use of forest resources is important in forest management because it allows developing a legal, productive and economic analysis towards the identification of benefits and their potential use. In this sense, this article conducts a systematic literature review of journal articles on forest management and the use of forest resources in Ecuador. The objectives of this paper were to: i) present a thematic overview of the legal framework in Ecuador, ii) describe the main uses of forest resources divided in timber and non-timber forest products and iii) analyze the role of forest resources in the Ecuadorian economy.

## 2. MATERIALS AND METHODS

The information related to forest management and the use of forest resources in Ecuador was collected from peer-reviewed research articles and other sources. It included sources in Spanish and English languages available in scientific databases, management plans, books, government official information and Non-Governmental Organization (NGOs). The search of information specifically mentioned “sustainable forest management”, “TFP and NTFP”, “forest governance” and “forest resources” from a social science approach. For a better understanding, the methodological process for the literature review has been divided and presented in a flow diagram sifting process, considering four parts: i) identification, ii) screening, iii) eligibility and iv) inclusion **Figure 1** [28].



**Figure 1.** Methodological research process, presented according to the Prisma Diagram [28].

The review was based on a quantitative and qualitative content analysis, summarizing the main insights for the central research topics such as: i) legal framework for the management and use of natural resources, ii) use of forest resources (TFP and NTFP) and, iii) an economic perspective.

### 3. RESULTS

#### 3.1. Legal Framework for the Management and Use of Forest Resources

The legal regulatory framework for the management of natural resources corresponds to the functions that each state has [29]. The approach of forest policies in Ecuador emerged from the 70s including criteria of community forestry, agroforestry and forest management. In the following decade, provision and cultural environmental services are recognized, trying to reduce the pressures on the territory of the communities. Finally, starting in the 1990s, legal instruments were developed for the management and use of natural resources, including forest resources. [10]. The Ecuadorian Forest policies are compiled according to their hierarchy in **Table 1**.

**Table 1. Legal framework for the use and management of forest resources.**

Type of law	Purpose of the Act	Year	Reference
Constitution of the Republic of Ecuador	It is the set of fundamental norms that protect rights and freedoms, organize the State and democratic institutions and promote economic and social development.	2008	[30]
Organic Code of the Environment	Guarantee the rights of the people to live in a healthy and ecologically balanced environment, as well as protect the rights of nature.	2017	[31]
Organic law on incentives for production and prevention of tax fraud	Provide economic incentives for afforestation and reforestation with commercial purposes	2014	[32]
Unified Text of Secondary Legislation, Environment	Establish basic environmental policies for the management of natural resources	2003	[33]
Organic Law for the reactivation of the economy strengthening of dollarization and modernization of financial management	Acquire goods related to research and technology that improve productivity	2017	[34]
Organic Law for Productive Promotion, Attraction of Investments, Employment Generation and Fiscal Stability and Balance	Regulate behaviors that are harmful to health and encourage activities for the management of natural resources	2018	[35]
Norms for Sustainable Forest Management of Humid Forests	Regulate forest management of humid forests, using the principles, criteria and indicators established to promote sustainable forest management.	2015	[36]
Procedures to Authorize the Harvesting and Cutting of Wood	It establishes the administrative procedures to authorize the sustainable use of the timber forest resources of the humid, Andean and dry natural forests; from cultivated forests: forest plantations, planted trees, trees from natural regeneration in crops; the pioneer formations; of trees in agroforestry systems; and, forest products other than wood.	2010	[37]
Norms for the Management of Andean Forests	Regulates the management of the Andean Forest, its resources and its uses.	2006	[38]

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Type of law	Purpose of the Act	Year	Reference
Standards for Sustainable Forest Management of Dry Forests	It establishes regulations for the management and sustainable forest use of dry forests, the recommended techniques, commitments and responsibilities in the execution of plans, management, forest use and the conservation of its environmental services.	2007	[39]
Standard for the procedure for the Adjudication of State Forest Heritage Lands and Protective Forest and Vegetation	Establish the parameters for the adjudication of lands of the state's forest heritage.	2007	[40]
Ministerial Agreement No. 003	Regulation before the invasion of properties subject to the forest regime	2014	[41]
Standard for Verification and Control Final Destination	Establishes the technical and administrative procedures for the legal verification of forest products	2014	[42]
Forest Seed Standard	Establishes regulations regarding forest seeds in the country.	2004	[43]
Instructions for the measuring of wood	Establishes the measuring techniques for wood transported in vehicles.	2010	[44]
Instructions for the application of tax credit payments for the afforestation program	Establishes the instructions to obtain certification by the Ministry of the Environment to apply as a tax credit, the payments made for afforestation or reforestation programs.	2012	[45]
Operational Manual for the Incentive for Sustainable Forest Management	It establishes the procedures, requirements, beneficiaries and more conditions for the application of incentives for Sustainable Forest Management.	2014	[46]
Operational Manual for the Incentive for the Conservation and Sustainable Use of the Mangrove	It establishes the procedures, requirements and conditions for the application of the incentives for the conservation and sustainable use of the Mangrove.	2014	[47]
National Program of Incentives for the Conservation and sustainable use of Natural Heritage	It integrates the incentive initiatives in a single National Program, seeking a comprehensive intervention in the territory and promoting an improvement in the living conditions of the inhabitants.	2013	[48]
"Socio Bosque" Project Creation	Creation of the "Socio Bosque" Project as a mechanism for the implementation of incentives by the State, through the Ministry of the Environment, for owners of properties covered with native forest, moors and other native plant formations in the country.	2008	[49]
Reform of the "Socio Bosque" Project	Includes plant recovery and ecological cover criteria	2011	[50]
Regulations for promoting forest plantations.	Regulate the registration, approval and execution of felling plans and forest exploitation licenses.	2018	[51]
Reform of the Requirements to grant the Forest Incentive	Amendment to the Instructions to grant the Economic Incentive for Afforestation and Reforestation for commercial purposes.	2014	[52]
Instructional Reform to grant an Economic Incentive for Reforestation for commercial purposes	Amendment to the Instructions to grant the Economic Incentive for Afforestation and Reforestation for commercial purposes.	2016	[53]
Instructions to grant the economic incentive for reforestation and afforestation for commercial purposes	Establishes the procedure for granting incentives to landowners who promote commercial afforestation and reforestation in Ecuador.	2014	[54]

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Type of law	Purpose of the Act	Year	Reference
Regulations for the zoning of land for afforestation and reforestation	Regulate the establishment of forest plantations in Ecuador on land available for this purpose.	2013	[55]
Reform to the regulations for the zoning of land for afforestation and reforestation	Reform to the regulations for the zoning of land for afforestation and reforestation.	2013	[56]
Instructions that regulate the preparation, approval and execution of felling programs, forest exploitation licenses and circulation guides for commercial forest plantations	Establish the administrative procedures for the authorization of felling programs, issuance of the corresponding forest exploitation licenses and mobilization guides, coming from commercial forest plantations.	2010	[57]
Technical sheet for commercial reforestation	Document for the presentation of commercial afforestation or reforestation proposals through the Reforestation Incentives Program for commercial purposes.	2013	[58]
Technical Protocol for the registration of the Forest Operator	It establishes the procedure and the technical and operational instruments for the qualification and registration of the Forestry Operator, its renewal, suspension and cancellation of the registration.	2013	[59]
Resolution Inclusion of <i>Persea americana</i> , Hass variety as an incentivized species	It establishes the densities and the respective cost per hectare for the establishment and maintenance of avocado plantations.	2013	[60]
Phytosanitary Measures for Wood Packaging	Establishes the procedures for the certification of raw, elaborated or processed wood packaging in the facilities authorized by the Ecuadorian Service of Agricultural Health	2004	[61]
Provisions for the use of machinery and heavy equipment in mining activities and commercial transport of heavy loads of forest products	Regulates the use of machinery and heavy equipment in mining activities and commercial transport of heavy loads of forest products	2016	[62]
Regulation for Plywood Panels	It establishes the requirements that plywood panels for general use and structural use must meet.	2014	[63]
Procedure for the Certification of Conformity with the INEN Quality Seal	Describes the activities carried out by INEN to apply the certification scheme for products with the INEN Quality Seal.	2015	[64]
Requirements Plywood Boards	It establishes the minimum requirements that plywood panels must meet for certification purposes.	2003	[65]

The information shown in **Table 1** suggests, mainly, that the legislative and executive functions, through their ministries, secretariats, and undersecretaries, are responsible for formulating policies and laws that allow forest management [66]. The main approaches of this regulation can be divided into: i) regulation of forest use, ii) regulation of illegal activities, and, iii) conservation and ecological restoration [67]. Additionally, according to the current National Development Plan, the use of renewable and non-renewable natural resources is promoted.

Regarding local governance, the decentralized autonomous provincial, municipal and parish governments have specific competencies for land use planning and management of their natural resources. This includes the distribution of space, determination of environmental and social impacts, partial studies for conservation, land use and natural resources [68].

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Despite the existence of a broad legal framework, for the industrial sector the interests are directed towards productivity and quality. This indicates that aspects such as tax incentives (penalties, exemptions and deductions) for forest use could be emphasized. That is, policies that at the same time promote forest control with sustainable forest management practices.

### 3.2. Framework and Use of Forest Resources

Forest resources are considered as a source of income for the population. Therefore, these actions generate positive and negative impacts on the environment [69]. Commonly, the human being makes use of natural resources in order to satisfy primary needs such as: food, health and leisure. [70]. Among the political-legal-administrative aspects that Ecuador has taken as a measure is to establish the principal management types and categories of forest: i) National system of protected areas (37.27%); ii) Forest with productive potential (33.91%); iii) Protective Forest (27.01%); Forest plantations (1.81%) [71]. These data show that the management for conservation approach is the main use (64.28%). **Table 2** shows one of the methodologies [67], used to classify the forest area in the country.

**Table 2. Forest classification of Ecuador by predominance of ecological region and area. Adapted from [72].**

Natural region	Area (km <sup>2</sup> )	Share (%)	Description
Western Ecuador Moist Forests	40,218	6.27	Found in Colombia and Ecuador. Forests rich in species with high levels of local and regional endemism. Threatened by logging, road construction and colonization.
Northwest Andean Montane Forests	52,937	8.26	Found in Colombia and Ecuador. Exceptionally rich in species with a high proportion of local and regional endemics. Threatened by conversion to agriculture and grasslands, mining operations and logging.
Ecuadorian Dry Forests	22,271	3.47	They have high levels of local and regional endemism. Strongly threatened by logging and grazing.
Guayaquil Flooded Grasslands	3,617	0.56	Found only in Ecuador east of the Daule River
Northern Andean Paramo	58,806	9.17	Found in Colombia and Ecuador. Restricted to high peaks; Species with particular adaptations to cold and dry conditions. Threatened by burning, grazing and conversion to agriculture.
Eastern Cordillera Real Montane Forests	84,442	13.17	Found in Colombia, Peru, and Ecuador. Exceptionally rich in species with a high proportion of local and regional endemism. Strongly threatened by conversion to agriculture and grazing, mining operations, and logging.
Napo Moist Forests	369,847	57.68	Found in Colombia, Peru, and Ecuador. They contain one of the world's richest biotas. It has extraordinary diversity. Oil operations and road construction have caused forest degradation and fragmentation and have facilitated colonization.
Galápagos Islands Xeric Scrub	9,122	1.42	Flora and fauna with a high level of endemism. Threatened by overgrazing, introduction of exotic species and burning.
Total	641,260	100.00	

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As shown in **Table 2** the largest of the forest extensions that the country has is found in the humid forests of the Napo with 57.68% including a high biodiversity [73-76]. However, the state also issues forest exploitation permits in this territory prior to the approval of a management plan. With the above mentioned, stakeholders and other state agencies are continually being integrated, with the purpose of developing alternatives that allow an efficient execution of the legal framework.

### 3.2.1. TFP in Ecuador

Ecuador has different types of forest due to the diversity of climates. Currently, there are cca. 3.6 million of hectares for reforestation, considering a potential of 63 % for productivity [77]. Of the total wood harvested only a small part comes from plantations. These are found mainly in the Ecuadorian highlands (90%), 8% on the coast and only 2% in the Amazon region [78]. Among the main exotic commercial species that have been introduced for plantations are: *Tectona grandis*, *Eucalyptus globulus*, *Eucalyptus citriodora*, *Pinus radiata*, *Terminalia superba*, *Gmelina arborea* [77].

#### 3.2.1.1. Uses of the Main Timber Forest Resources

The forestry sector directly creates around 235,000 employments. In addition, exports by the timber industry are increasing income for the economy. Despite the health emergency (COVID-19) which has affected the sector worldwide, the forestry industry has been able to recover through plans and actions taken by authorities to partially restart activities [79].

**Tables 3-5** show the main timber species used in Ecuador, divided according to the continental natural regions and their uses: industrial (transformation of raw material), energy (thermal conversion: firewood and coal), protection (conservation), agroforestry (combination with crops) and silvo-pastures (forestry-livestock) [80].

**Table 3.** List of timber species from Sierra Natural Region. Adapted from [80].

Timber Species in Ecuador						
Climate Type	Scientific Name	Main Uses				
		Industrial	Energetic	Protection	Agroforestry	Silvo-pasture
Dry Mountain Forest	<i>Eucalyptus saligna</i>	x	x			
	<i>Eucalyptus grandis</i>	x	x			
	<i>Eucalyptus deglupta</i>	x	x			
	<i>Prunus capuli</i>		x			
	<i>Parkia multijuga</i>	x	x	x	x	x
	<i>Casuarina guisetifolia</i>		x			
	<i>Acacia macrante</i>		x	x	x	x
	<i>Parquia nítida</i>	x		x	x	x
	<i>Cusalpina espinosa</i>		x	x	x	x
	<i>Jacarandá sp.</i>		x	x	x	x
	<i>Clarisla recemosa</i>	x				
	<i>Schumus molle</i>		x	x		
	<i>Cassia Fístula</i>		x	x		



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Timber Species in Ecuador						
Climate Type	Scientific Name	Main Uses				
		Industrial	Energetic	Protection	Agroforestry	Silvo-pasture
Humid	<i>Prosopis intermis</i>	x	x	x		x
	<i>Tamarindus indica</i>	x	x			x
	<i>Azadirachta indica</i>		x	x		
Montane Forest	<i>Pinus radiata</i>	x				x
	<i>Pinus psuedestrobus</i>	x				x
	<i>Pinus patula</i>	x				x
	<i>Cetrolobium patinesis</i>	x				
	<i>Acacia marguin</i>	x				x
	<i>Ochroma lagopus</i>	x				
	<i>Ochroma pyramidale</i>	x				
	<i>Cedrela odorata</i>	x				
	<i>Cedrela Fililis</i>	x				
	<i>Cadelina catenacformis</i>	x			x	
Tropical Moist Forest	<i>Triplaris guayaquilensis</i>	x				x
	<i>Tabebuia caryantha</i>	x				
	<i>Tabebuia donnel sm.</i>	x				
	<i>Pseudosamanea guachapele</i>	x				x
	<i>Cordia alliodora</i>	x			x	
	<i>Cariodendrum orionosensis</i>	x			x	x
	<i>Anacardium escelsum</i>	x	x			
	<i>Hiernyma chochoensi</i>	x				
	<i>Pinus Caribea</i>	x				x
	<i>Schizolubium parabybon</i>	x			x	x
Humid	<i>Crotom s.p</i>	x	x			
	<i>Terminaliz iborensis</i>	x			x	x
	<i>Carapa guianensis</i>	x				
	<i>Araucaria angustifolia</i>	x				
	<i>Alnus jarullensis</i>	x				x
	<i>Acacia melanoxilum</i>		x	x		
	<i>Acacia dealbata</i>		x	x		
	<i>Cupresus macrocarpa</i>	x				x
	<i>Cupresus lusitania</i>	x				
	<i>Cedrela rosil</i>	x				
Montane Forest	<i>Telcona stans</i>		x	x		
	<i>Eucalyptus saligna</i>	x				
	<i>Eucalyptus grandis</i>	x				
	<i>Eucalyptus globulus</i>	x				
	<i>Fraxinus americana</i>	x	x			
	<i>Albizzia distachia</i>		x	x	x	
	<i>Grevillea robusta</i>		x	x	x	x
	<i>Juglaris neurotropica</i>	x				
	<i>Gynoxis sp.</i>			x	x	x
	<i>Oreopanax sp.</i>			x	x	x
Humid	<i>Budd leia</i>		x	x		
	<i>Vallea Stipularis</i>			x	x	x
	<i>Polylepsis sp.</i>		x	x	x	x

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Table 4. List of timber species from Coast Natural Region. Adapted from [80].

Timber Species in Ecuador						
Climate Type	Scientific Name	Main Uses				
		Industrial	Energetic	Protection	Agroforestry	Silvo-pasture
Tropical Dry Forest	<i>Swintenia macrophylla</i>	x				
	<i>Casuarina eguisetifolia</i>		x	x		
	<i>Delonix regia</i>		x	x		
	<i>Minguaitin guianensis</i>	x				
	<i>Leucaena Leucocephala</i>	x	x			x
	<i>Saman samanea</i>	x			x	x
	<i>Tectona grandis</i>	x				
	<i>Spatodea sp.</i>		x	x		

Table 5. List of timber species from Amazon Natural Region. Adapted from [80].

Timber Species in Ecuador						
Climate Type	Scientific Name	Main Uses				
		Industrial	Energetic	Protection	Agroforestry	Silvo-pasture
Very Humid Tropical Forest	<i>Parkia multijuga</i>	x			x	x
	<i>Parquia nitida</i>	x			x	x
	<i>Jacarandá capais</i>	x			x	x
	<i>Cordia alliodora</i>	x			x	
	<i>Cariodendrum orionosensis</i>	x			x	x
	<i>Pollalista Kausteril</i>	x			x	
	<i>Crotom s.p</i>	x	x			

Table 6. Main TFP and uses. Adapted from [81,82].

Timber Forest Products	
Type	Product
The primary processing industry:	- Plywood: current, decorative, and marine, laminated, decorative veneers - Agglomerates (various thicknesses) - MDF boards - Sawn wood - Pulp and paper
The secondary processing industry:	- Furniture - Processors of balsa: panels, glued, planed wood of various dimensions
Construction industry:	- Column processing - Beams - Wooden trusses
Doors and windows:	- Mouldings - Ice cream scoops - Tongue depressor - Sticks paddles - Handicrafts

Ecuador has a high biodiversity of timber trees among which we can highlight *Tectona grandis*, *Eucalyptus globulus*, *Eucalyptus citriodora*, *Pinus radiata*, *Cordia alliodora*, *Parquia nitida* and *Swintenia macrophylla*, and which are used by the industry to create products. In addition, Table 6 shows the

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main TFP that have been identified based on the use by type of industry. With the information shown **Table 6**, it can be highlighted that within the most representative timber products for the country, the primary sector industry mainly generates chipboards (25%), plywood boards (11%), paper (6.14%) and wood chips (1.92%), whereas, in the industry of the secondary sector are balsa blocks (23%), furniture (11%), slices and strips (5%) [81, 82].

Wood is an important source of income for households and industries. Considering the progressive increase in the demand for forest resources, the Ecuadorian state has developed actions to control and monitor the movement of wood in the chain of custody. In this context, one of the main initiatives is forest certification, whose purpose is to safeguard the resource and increase its economic value.

### 3.2.2. NTFP in Ecuador

According to the Food and Agriculture Organization of the United Nations [83], NTFPs are goods of biological origin, other than wood, that come from forests or other areas with the presence of trees, but outside forests. In the country, despite various efforts, there is no adequate regulation to take advantage of these resources in a sustainable way, since the tool applied by the Ministry of the Environment to legitimize this activity is generated at the time of its mobilization through the Circulation Guides and, rarely since its origins [84].

### 3.2.3. Main NTFP Generated in Ecuador

NTFP in the country play a key role in both urban and rural areas as they generate employment and income for the population. There is a variety of products, which have historically been used by rural communities in areas for: i) food, ii) tools, iii) handicrafts, iv) medicines, v) housing materials and vi) health [85]. **Table 7** shows the main NTFP which have been identified based on the methodology proposed by [86-88].

**Table 7. Main NTFP and categories of uses.**

Non-Timber Forest Products	
Category	Main Species
Food and drinks:	<i>Bactris gasipaes</i> , <i>Opuntia ficus-indica</i> , <i>Euterpe precatoria</i> and genus <i>Pouteria</i>
Essential oils and ascents:	<i>Bursera graveolens</i> , <i>Laurus nobilis</i> , <i>Cymbopogon citratus</i> , <i>Eucalyptus citriodora</i>
Medicines and pharmaceutical principles:	<i>Uncaria tomentosa</i> , <i>Marsdenia cundurango</i> , <i>Piper aduncum</i> , <i>Phyllanthus niruri</i>
Toxic, stimulants, natural insecticides:	<i>Rattlesnake thevetia</i> , <i>Piscidia carthagensis</i> , <i>Erythroxylum coca</i>
Latex and resins:	<i>Crotton lechleri</i> , <i>Pinus caribaea</i>
Colorants and dyes:	<i>Dactilopious coccus</i> , <i>Bixa orellana</i>
Fibbers:	<i>Ceiba trichistandra</i> , <i>Carludovica palmata</i>
Utensils tools and construction materials:	<i>Guadua angustifolia</i>
Mystics, celebrations and rituals:	<i>Dracoides peruviana</i> , <i>Clusia pallida</i> , <i>Bursera graveolens</i> , <i>Banisteriopsis caapi</i> , <i>Echinopsis pachanoi</i>
Handicraft:	<i>Phytelephas aequatorialis</i>
Ornamental:	Palms of the genus <i>Chamaedorea</i>
Forage:	<i>Prosopis juliflora</i> , <i>Geoffroea spinosa</i> , <i>Acacia macracantha</i> , <i>Guazuma ulmifolia</i>

Based on the information presented **Table 7**, it should be considered that certain species may have more than one use, for example vegetable ivory (*Phytelephas aequatorialis*). This species is used by local communities, for instance, the use of its leaves, fibers and fruits for the elaboration of handicrafts stands out. Additionally, residues such as sawdust and ground waste are used to make nutritional supplements for livestock [84].

When people refer to NTFP and its main uses, most agree when naming the categories: Food and drinks, medical and pharmaceutical principle. On the other hand, categories such as essential oils, glues, toxic, stimulants, natural insecticides are not usually recognized. Unfortunately, these categories have been underestimated by the industry, despite the existence of countless favorable raw materials but scarcely used.

### 3.3 The Role of Forest Resources in Ecuadorian Economy

The Ecuadorian economy grew by 5.6% at the end of 2021. This increase was driven by the positive variation of the components of the Gross Domestic Product (GDP), mainly the category of exports related to the use of natural resources such as oil, aquaculture, treated wood products, metallic and non-metallic minerals [89]. Consequently, the production of forest products is based on the provision of native forest and plantations. This has allowed the supply to the national industry for internal consumption and exports [90]. These activities are regulated by current harvesting regulations, mentioned in the section on the legal framework for the management and use of forest resources.

The livelihoods of the population are related to forest management [91]. For instance, rainforests located in the Amazon region (e.g., Brazil, Ecuador, Colombia, Peru, Bolivia and Venezuela) have shown how the forest resource produces high economic income, because their products enter international trade, obtain government royalties, generate income for the sector and fulfill a social function [11].

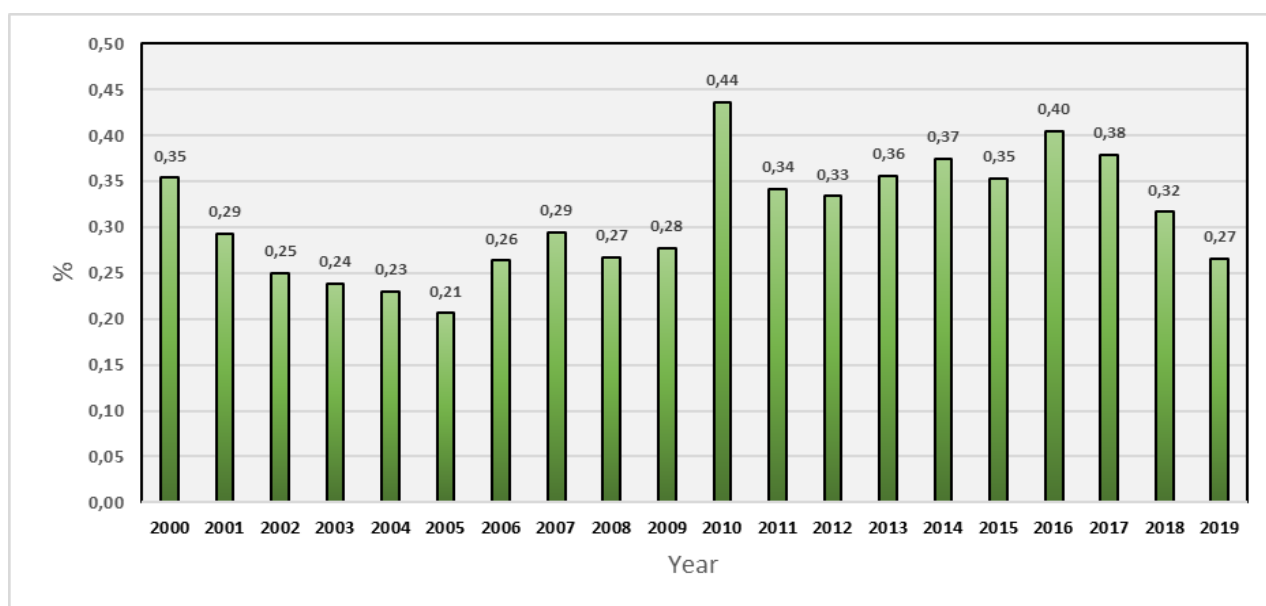


Figure 2. Share of GDP forest income from 2000 to 2019 [92].

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Forest rent is expressed as roundwood harvest multiplied by the product of average prices and the region-specific rate [92]. Ecuador has historically generated forest income due to the continuous use of this resource **Figure 2**. The trend of the contribution to the national GDP from 1970 to 1999 has been growing, due to the increase in plantations, mainly in the Amazon region [93]. However, in the year 2000 important changes were included to the forest and conservation law, where control over forest production was increased with the purpose of reducing social and environmental impacts [94]. From the 2000 to the present, this contribution has decreased, with the exception of the year 2010 where forest rents grew (0.44%) due to a greater number of forest exploitation licenses [92]. These annual monetary resources come from forest plantations, native forests and agroforestry systems [95, 84]. The way of commercialization is mainly as raw material, while private owners cede commercial use to third parties, selling standing trees to companies for industrialization [91].

According to information from the Central Bank of Ecuador, the production of wood and derivatives is the fifth key industry (demand and supply large quantities of inputs to the rest of the sectors) for the Ecuadorian economy [96]. The Ecuadorian Federation of Exporters (FEDEXPOR), declares that 19 varieties of wood are exported, but *Ochroma pyramidale* and *Tectona grandis* are the most in demand abroad; their main destinations are India, Japan, the United States and China [97].

The super-intendency of companies in Ecuador reports that there are currently 204 companies nationwide dedicated to the extraction of wood, of which 87.3% are located in Guayas, Pichincha, Manabí and Los Ríos provinces [98]. In addition, according to The International Tropical Timber Organization (ITTO), the forestry sector generates around 235,000 direct employments. Most of this employment is generated at the rural level and in small cities where much non-industrialized activity is concentrated [99]. The trade balance of the sector presented a surplus in the analysis period 2016 - 2020 (**Figure 3**). The exports of the sector were on average 73 times higher than imports, this denotes that the sector satisfies internal demand and provides resources abroad.

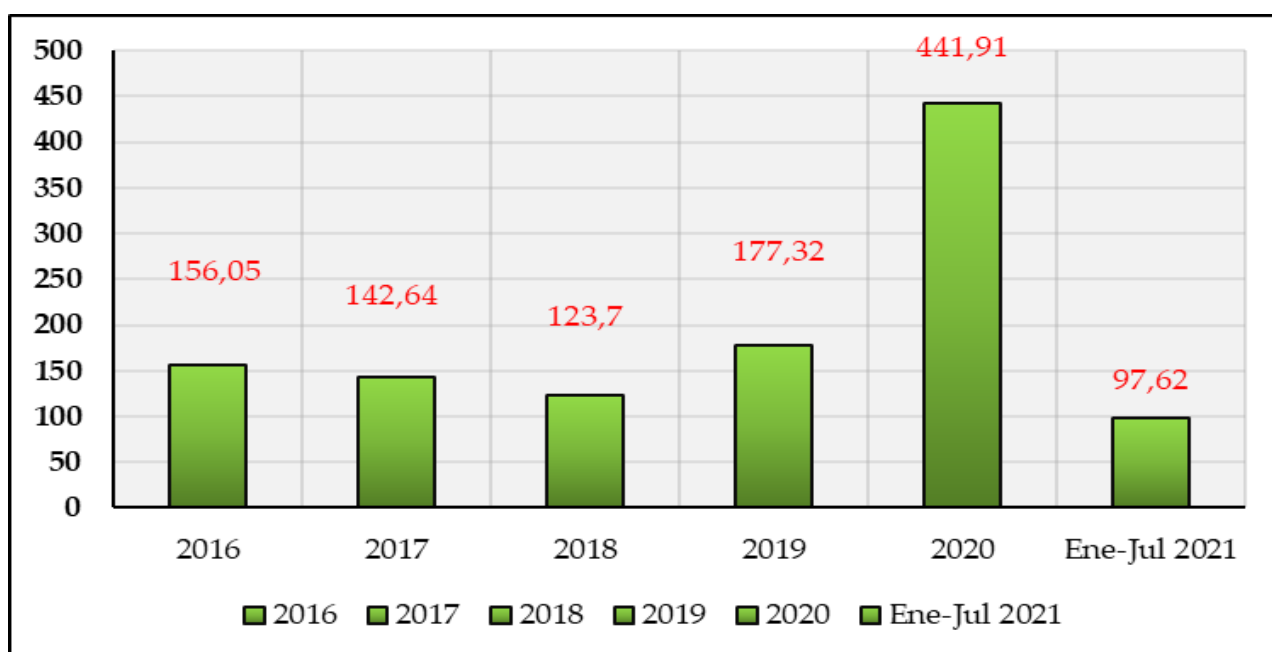
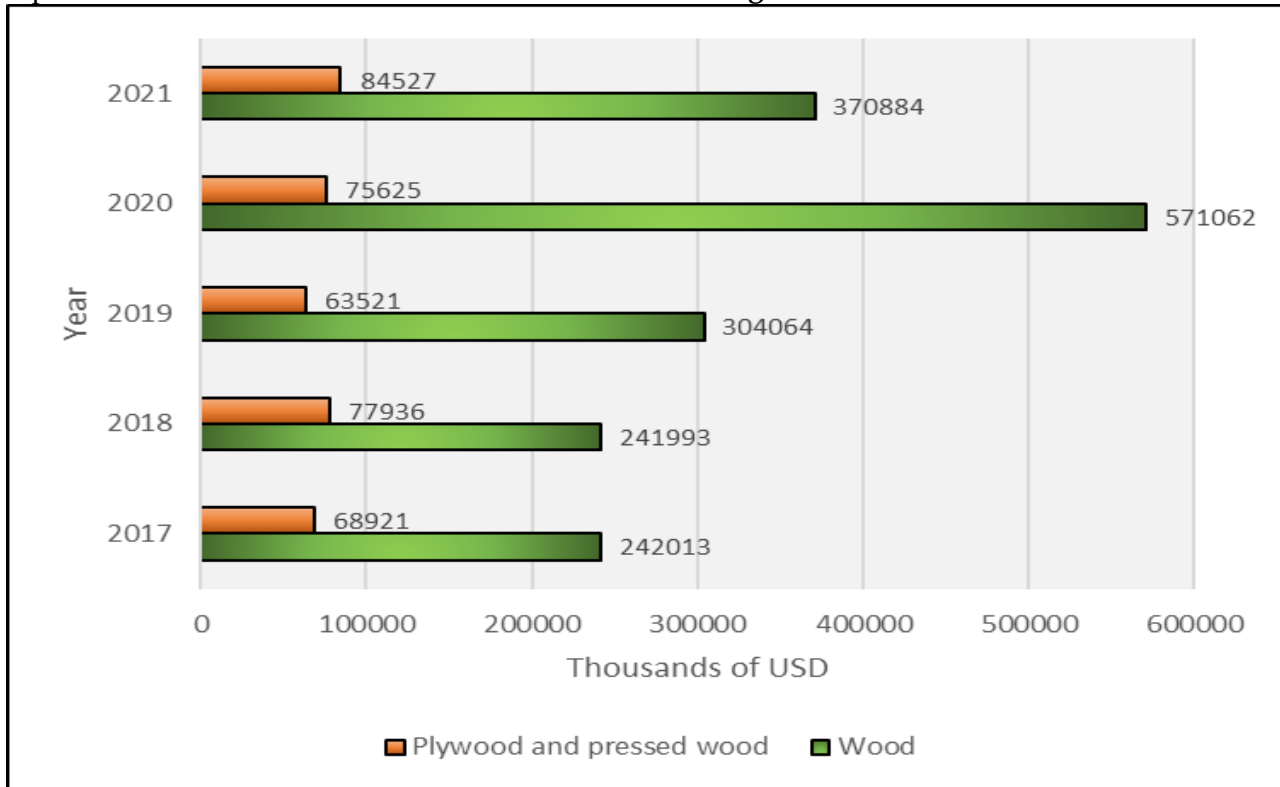


Figure 3. Trade Balance of the Forest sector (Million USD), [92].

In Ecuador's trade balance in the forestry sector, dominate mainly the export of sawn wood, prepared plywood and chipboard, doors and windows and other manufactured wood products [96, 10]. Complementary to this information, through the Free On Board (FOB) incoterm indicator, the export values of wood and its derivatives are shown in **Figure 4**.



**Figure 4.** Non-traditional FOB exports [96].

In general terms, this statistical import parameter has had a growing trend. However, in 2021 the economic value of wood exports decreased, mainly due to the drop in international prices due to the health emergency. Additionally, factors such as the cancellation of contracts due to lower demand in destination countries, the cancellation of scheduled international fairs, as well as logistical problems generated by the temporary closure of ports and airports contributed to this trend [96].

The economic contribution of forest resources to the national economy is the consequence of the policies applied with exploitation and conservation approaches. For instance, the market prices of timber products are directly related in the domestic economy to the use of inputs, machinery, infrastructure, fossil fuels and employment levels in the productive sector. Accordingly, the country's forest economic policy is influenced by factors such as: i) international agreements for imports and exports; ii) land use, and iii) the conditions of the forest resource.

The results of this study have been analyzed descriptively and systematically, despite the information gaps and outdated government platforms for forest evaluation and the national forest monitoring system. Therefore, a greater transparency of information could enrich the knowledge base and even a greater application of comparative analyzes of the forestry sector between countries.

## 4. CONCLUSIONS

Overall, the described concepts and approaches from the role and use of forest resources in Ecuador are divided in exploitation and conservation. The interests of the industries are focused towards productivity and quality, while the government prioritizes forest control policies, international agreements for imports and exports, regulation of land use, management of native forest, reforestation and evaluation of the conditions of the forest resource. Therefore, one of the joint initiatives with Ecuadorian control authorities is forest certification, whose purpose is to increase its economic value and sustainable management practices. In order to increase the participation in national and international markets, the forest sector could be addressed in the potential use of NTFP and not only in TFP.

### SUPPLEMENTARY MATERIALS

Not the case.

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### CONFLICT OF INTEREST

The author declares no conflict of interest.

### APPENDIX

Not the case.

### EXTENDED ABSTRACT – REZUMAT EXTINS

**Titlu:** Rolul resurselor forestiere și utilizarea acestora în Ecuador

**Introducere:** Identificarea beneficiilor generare de păduri necesită evaluarea drepturilor, obligațiilor, stimulentele și restricțiilor care promovează o administrare mai bună a pădurilor. Beneficiile relaționate cu starea pădurilor și nivelul veniturilor trebuie percepute la un același nivel de importanță de către toți actorii din sector. În ultimele două decenii, relația dintre utilizarea și protecția pădurilor a evoluat prin încorporarea unor indicatori consacrați pentru măsurarea și urmărirea stării și diversității biologice a pădurilor. Având în vedere că cea mai mare diversitate se regăsește în ecosistemele tropicale, există un mare potențial pentru generarea de produse lemnoase și produse accesorii. Cunoașterea realității cu privire la aceste resurse forestiere este importantă în managementul forestier pentru că permite dezvoltarea de analize de natură legală, productivă și economică pentru identificarea eventualelor beneficii și a potențialului de utilizare a acestora. Pe această direcție, lucrarea de față realizează o sinteză cu privire la managementul forestier și utilizarea resurselor forestiere în Ecuador.

**Materiale și metode:** Informațiile cu privire la managementul și utilizarea resurselor forestiere în Ecuador au fost colectate din articole științifice în limba engleză și spaniolă precum și din alte surse cum ar fi planurile de management, informații oficiale emise de guvern și alte organizații. Căutarea informației s-a realizat prin folosirea unor

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*cuvinte cheie cum ar fi „management forestier sustenabil”, „produse lemnoase”, „produse accesorii”, „guvernanță forestieră” și „resurse forestiere”. Prelucrarea informației a avut la bază analize cantitative și calitative cu privire la tematicile abordate: i) cadrul legal cu privire la managementul și utilizarea resurselor naturale, ii) utilizarea resurselor forestiere și iii) perspectiva economică.*

**Rezultate și discuții:** *Principalele direcții identificate au fost i) cadrul legal pentru utilizarea resurselor forestiere, ii) cadrul legal pentru combaterea tăierilor ilegale și iii) conservarea și ameliorarea ecologică. Interesele sectorului industrial sunt direcționate către productivitate și calitate. Situația indică faptul că aspecte precum stimulentele financiare și fiscale pentru utilizarea resurselor forestiere ar putea fi benefice în scopul promovării de politici care contribuie în același timp atât la controlul și monitorizarea activităților cât și la practici de management sustenabil. Având în vedere creșterea progresivă a cererii pentru resurse forestiere, Ecuadorul a dezvoltat acțiuni pentru controlul și monitorizarea fluxului de lemn în lanțul de custodie. În acest context, una dintre inițiativele principale este certificarea forestieră a cărei scop este să protejeze și să crească valoarea economică a resurselor. Pe de altă parte, în balanța comercială forestieră a Ecuadorului domină exportul de produse ale prelucrării lemnului și a altor produse finite și semifinite. Contribuția economică a resurselor forestiere la economia națională este o consecință a politicilor aplicate pentru exploatarea și conservarea resurselor. De exemplu, în economia autohtonă prețurile de piață pentru produsele forestiere sunt direct relaționate cu utilizarea resurselor, echipamentelor, infrastructurii precum și cu numărul de locuri de muncă în sectorul productiv. Ca atare, politica economică forestieră a țării este influențată de factori precum: i) acordurile internaționale pentru import și export, ii) folosința teritoriului și iii) condițiile resurselor forestiere.*

**Concluzii:** *Conceptele și abordările descrise pentru rolul și utilizarea resurselor forestiere în Ecuador sunt relaționate atât cu exploatarea cât și cu conservarea resurselor. Interesele industriilor sunt concentrate pe productivitate și calitate în timp ce guvernul prioritizează politicile de control forestier, acordurile internaționale pentru importuri și exporturi, legile pentru utilizarea terenurilor, managementul pădurilor naturale, reîmpădurirea și evaluarea stării resurselor forestiere. Una dintre inițiativele autorităților din Ecuador este certificarea forestieră care are ca scop creșterea valorii economice și asigurarea de practici forestiere sustenabile. Pentru creșterea gradului de participare pe piețele internaționale, sectorul forestier trebuie să aibă în vedere potențialul utilizării produselor forestiere accesorii.*

**Cuvinte cheie:** *Management forestier, produse lemnoase, produse accesorii, utilizarea pădurilor, Ecuador.*

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