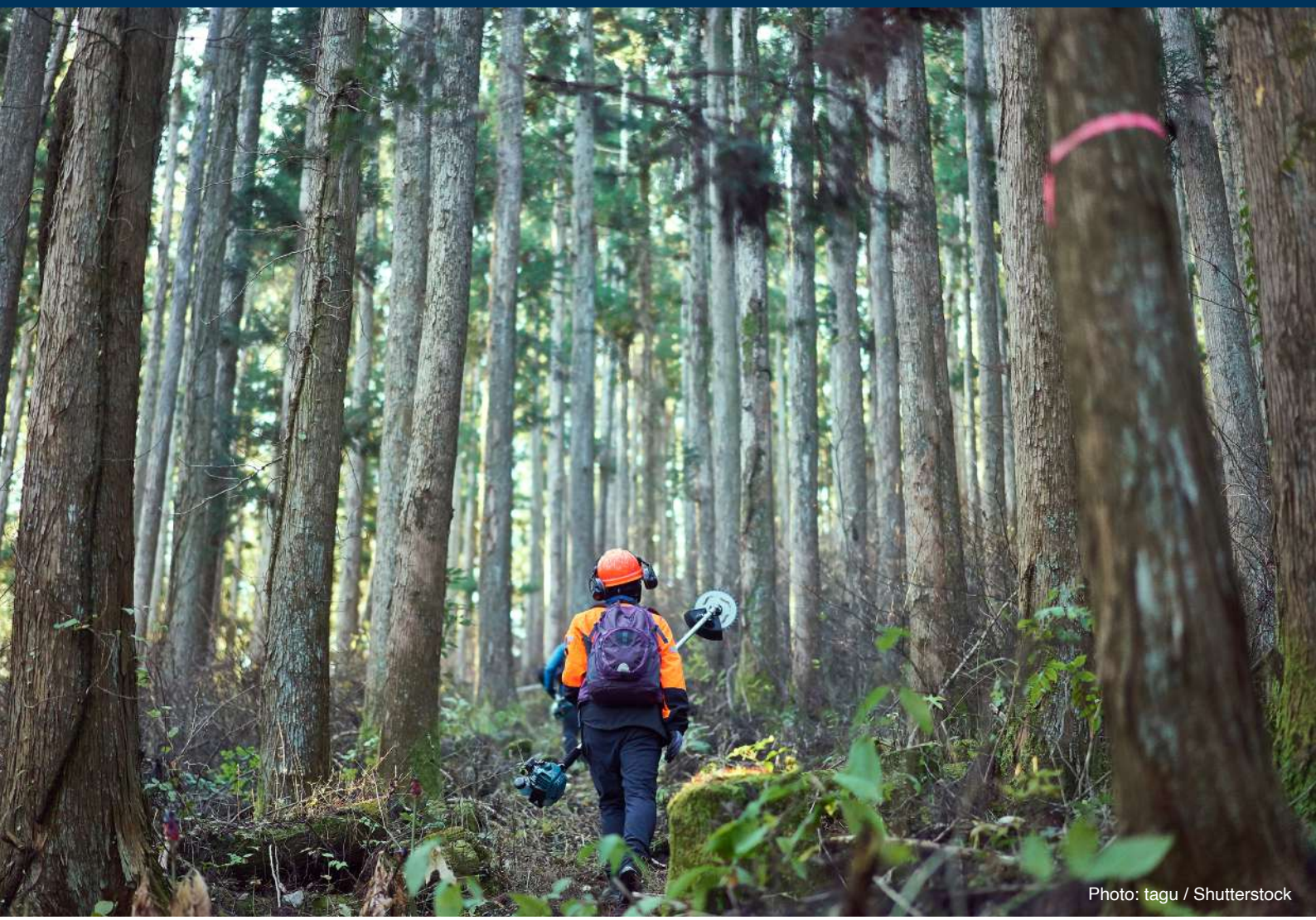
EFI

Trends in forest-related employment and tertiary education

Insights from selected key countries around the globe



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Acknowledgements

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The country chapters were prepared by groups of authors and represent their personal views and perspectives and not those of any organisation.

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Acronyms and abbreviations

B. Eng.: Bachelor of Engineering

B.Sc.: Bachelor of Science

BLS: Bureau of Labor Statistics

EFI: European Forest Institute

EU: European Union

FAO: Food and Agriculture Organization of the United Nations

FTE: Full-time equivalent

GDP: Gross Domestic Product

IBGE: Instituto Brasileiro de Geografía e Estadística (Brazilian Institute of Geography and Statistics)

IFSA: International Forestry Students' Association

ILO: International Labour Organization

IPB: Bogor Agricultural University

ISIC: International Standard Industrial Classification of all Economic Activities

IUFRO: International Union of Forest Research Organizations

KWF: Kuratorium für Waldarbeit und Forsttechnik e.V.

Luke: Natural Resources Institute Finland

M.Sc.: Master of Science

m3: cubic metre

n/a: not applicable

NR: Natural Resource

PhD: Doctor of Philosophy

SFB: Serviço Florestal Brasileiro (Brazilian Forest Service)

ToS: Team of Specialists

UNECE: United Nations Economic Commission for Europe

USA: United States of America

USD: United States Dollar

Executive summary

The contribution of forests to environmental, social and economic benefits is undisputed, but these roles are becoming more diverse as compared to the past. These changes have impacted and will continue to impact employment in the forest sector. This report highlights the trends in forest-related employment including green jobs in seven selected countries: Brazil, China, Finland, Germany, Indonesia, South Africa and United States of America. It also provides insights into how forest-related tertiary education in those countries is addressing those trends. In the following section, we summarize the main trends described in this report:

Employment in "traditional" forestry focused on timber production and logging is on the decline despite the significant increase in harvest levels. In some countries the decline happened much earlier, and the numbers have stabilized like in Finland, while it is still ongoing in others. Job losses can be attributed to the increased mechanization in logging operations and the rise in the use of contractors, especially in silvicultural as well as transport and harvesting operations. The implementation of a logging ban on natural forests in China negatively impacted the jobs in the country, while in Brazil the decline could be partly attributed to the shift from natural forest harvesting to plantation forestry.

The use of innovative wood-based products like laminated veneer lumber, cross laminated timber (CLT), substitutes for plastics and wood-based textile fibres **is on the rise**. The growing demand for these products is expected to create high number of jobs and contribute to the shift to a green economy in some countries. The market for bioenergy from forest biomass is also growing. It is the largest source of energy in Finland and is growing in China creating more job opportunities. Wooden buildings sector on the other hand plays an important role in Finland and Germany. The number of people employed has been growing from 208.000 in 2000 to 238,400 in 2017.

The importance of environmental services to society for employment is on the rise as well as demand for downstream services such as environmental education, health services, recreation and tourism based on forests. Forest-related tourism is creating a significant number of jobs in some countries and has a huge potential for growth. Forest parks in China provided 176,000 direct jobs in the forest sector and over 900,000 tourism-related jobs in 2017. In Indonesia, ecotourism in conservation areas, community forestry and bioprospecting have a significant potential for growth. The number of tourists in conservation areas grew from 4.2 million people in 2015 to approximately 7.3 million tourists in 2019. In Brazil, a payment for ecosystem services (PES) scheme has been launched that remunerates actors involved in activities that improve, conserve, and restore the native vegetation, which will promote the creation and formalization of green and decent jobs in the country. In Germany more than 1,500 forest kindergartens exist today, where children get to learn about nature from an early age.

Job quality in the forest sector remains a challenge. Forestry has been considered as a dangerous sector to work in, because of the high number of accidents. Worker's safety has improved due to the increased mechanization in forestry and logging as well as the training of workers. In Indonesia, forest officers undergo certification training in Occupational Health and Safety (OHS) offered by FSC and the Indonesia Ecolabelling Institute (LEI).

In South Africa contracting staff and growers are trained on safety issues among others. But accidents still occur and, in some cases, are not systematically reported. In some countries the sector is among the least paying, with the wages being below the national average wage in most of the countries.

A shortage of forest workers is being experienced in countries like Finland and Germany. High demand for workers to carry out harvesting, reforestation and regeneration may not be met by the domestic labour market because of the ageing workforce and the declining interest among young people to perform such work. To fill the gap these countries have been recruiting short-term foreign workers. However, these workers are often not included in the national statics and their numbers are not known.

The number of tertiary level graduates from forest-related programmes has increased in all the countries except Finland. In the US, the numbers are increasing but leaning towards environment and conservation related programmes, a trend that is also observed in Germany. There is some indication that the average education levels are going up, with more advanced degrees being obtained. In some cases, like South Africa, this increase occurs at the expense of technical level graduates.

Finally, important knowledge gaps in forest-related employment and education remain. There is an urgent need to explore ways of making the forest-related employment attractive to young people and to secure highly qualified workforce, including at graduate level. The extent to which green jobs will impact employment in the forest sector still needs to be investigated. Answers to these questions will have important implications for policies on forests, forest-related employment and education. Global studies on these topics are needed to enable comparability across countries and regions.

Photo: Andrew Tan / Pixabay

1. Trends in forest-related employment and tertiary education: challenges and emerging opportunities

Forests around the world are under growing stress while still supposed to meet rising expectations regarding the services they are to provide. Most forests are impacted by global warming, with growing frequency and intensity of droughts and floods, storms, insect calamities and forest fires. In addition, tropical forests continue to be under severe pressure from conversion to agricultural land, and from mining, expanding infrastructure and settlements. While forests are struggling, their role as harbours of much of the world´s biodiversity, protectors against soil erosion and landslides, as water reservoirs, carbon stores, a major producer of renewable raw material and energy and, last but not least as recreation areas, continues to rise in importance (FAO, 2014; UNECE & FAO, 2018; FAO & UNEP, 2020).

A growing global population is consuming more and different forest products, sourced from around the world. Global competition puts pressure on prices of forest products and enforces increases in productivity. These have largely been achieved through mechanization since the 1970s and in recent decades through the deployment of advanced automation, communication, and information technology (Lawrence et al., 2017; UNECE, FAO & Forest Europe, 2019).

Forests are central to the vision of prosperous and inclusive societies living within planetary boundaries. The pathways adopted to this future by policy makers and businesses are green growth, the greening of economies, and the bioeconomy (UNEP, ILO, IOE & ITUC, 2008; Organisation for Economic Co-operation and Development (OECD), 2011). This opens major opportunities for forests and forestry, but also poses significant challenges.

New and increasing opportunities for providing forest-based products and services, growing businesses and revenue, as well as creating jobs, arise from this transformation. Demand for environmental services is expanding, particularly carbon sequestration, biodiversity, and water. There are growing markets for products in bioenergy, modern wood-based mass construction, and a range of non-wood forest products. Moreover, demand for downstream forest services such as environmental education, health, recreation, and tourism is rising significantly (FAO & UNEP, 2020).

These major changes and trends have profound repercussions for people working in forests. While employment in traditional forestry focused on timber production and logging is likely to decline, the remaining workforce will be more critical for achieving effective sustainable forest management. Restructuring of supply chains and changes in work organization, notably outsourcing of operations to forest contractors are on the rise. This shift has fostered specialization and introduction of advanced technology, but shifted financial risk and exacerbated some of the traditional ailments of work in forests, including long working hours, low and fluctuating incomes and poor health and safety. Ageing workforces combined

with continued urbanization make it both more urgent and more difficult to attract the talent needed for the future (UNECE, FAO & Forest Europe, 2019; UNECE & FAO, 2020).

A large and growing body of evidence shows that a skilled and motivated workforce is indispensable to meeting the new and rising challenges and to seize the emerging opportunities from the new and growing environmental goods and services, as well as from greening production processes. In light of the constant changes and their multifaceted interactions, the role played by education providers in the preparation of a suitable forest sector workforce is critical (Rodríguez-Piñeros et al., 2020). At the level of tertiary education, knowledge of the number of forest-related jobs, of the numbers of graduates, and of their careers is patchy and often unreliable. While the number of students of forest-related disciplines decreases in many countries, it grows in others. Universities are diversifying education, resulting in new forest-related environmental or natural resource study programmes to attract more students. Evolving labour market demands impact the skills and competences required, and the learning outcomes defined by the education institutions (Arevalo et al., 2010; Rekola et al., 2016).

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1.1 Purpose of this report

While the changing roles of forests, diversifying market demands for forest products as well as emerging forest management strategies have been subject to research around the globe, studies on forest-related employment are scarce and trends remain unclear (Ackerknecht, 2010). In some countries or regions, especially the developed ones, relevant information exists but this is not the case for the developing countries. Even in cases where data exists, comparability is a challenge because of differences in definitions, data collection methods and the limited number of reporting countries. The high levels of informality in the sector exacerbates the problem (ILO, 2019a).

There is a scarcity of systematic and recent studies across countries as mostly single country-focused studies have been conducted, often in Europe and North America (ILO, 2019a; ILO, 2019b). Consequently, there is little knowledge on regional or even global trends, future prospects and gender distribution (ILO, 2019b). Further research is also needed on the drivers of the changes in the forest sector and their impacts on employment, including quantitative assessments of emerging fields of employment, shifts in positions and structure of the workforce as well as changes in job profiles (UNECE & FAO, 2018; Kanowski et al., 2019).

The knowledge gaps are particularly wide regarding the transition towards a green economy. While the forest sector has been identified as critical contributor towards this transition which is expected to greatly influence the operations of the sector (Hetemäki et al., 2017; Winkel, 2017), the analysis of the existing and potential green forest jobs by the UNECE & FAO Team of Specialists (ToS) on Green Jobs in the Forest Sector (UNECE & FAO, 2018) is one of the few studies that provide an overview of the landscape of green forest jobs, but detailed information on the state of green jobs in the forest sector is still missing.

The trends and developments in the forest sector not only affect workforce size and composition. They also determine the skills and competencies needed in different regions and countries. In this regard, universities have an important role in offering and adapting the necessary training needed to produce a competent future workforce in a diversifying sector (Innes 2005, Schmidt & Lewark 2008, Temu and Kiwia 2008, Bernasconi & Schroff, 2011). Yet, they have little to guide them. Some studies on skills from individual countries notwithstanding, a systematic assessment of changing skill profiles required for tomorrow's employment is missing (Nair, 2004; Arevalo, 2010; Bernasconi & Schroff, 2011; Rekola et al., 2016).

Against this background, this exploratory study aims to:

1. identify trends in forest-related employment in selected key forest countries around the globe, including adjacent and emerging fields such as green jobs, and

2. examine forest-related tertiary education in those countries with regards to universities offering forest-related tertiary programmes, and enrolment trends in terms of numbers of students and graduates, as well as new programmes developed by the universities.

2. Embracing data gaps and national specificities around the globe

2.1 Selection of countries and experts

The selection of countries for exploring trends in forest-related employment and tertiary education around the globe was based on three considerations:

- High relevance of the forest- and forest-related sectors to the national economy: Indicators for this criterion were i) high relative total forest cover; ii) significant contribution to the GDP; and iii) high number of full-time equivalent (FTE) jobs in the sector based on the FAO Global Forest Resources Assessment Report (2015).

- Existence of available and reliable formal and informal employment data: This was determined by the presence of a well-organized data collection system with clear description of the methodologies used and reputable bodies in charge of the process.

- Global coverage: Three potential countries per continent were initially selected before narrowing the choice to one except for Asia and Europe that were represented by two countries each, hence the selection of:

Table 1: Description of the key forest countries selected for the study.

Country	Global coverage	Forest area per 1,000 ha (2015)	Forest revenue in 2010 (1,000 USD)	Employment 1,000 FTE (2010)	Additional reason(s)
Brazil	South America	496,620	3,621,653	513	-
China	Asia	219,978	537,335	1,150	Well established data collection process by the National Forestry and Grassland Administration (NFGA)
Finland	Europe	22,409	593,342	22	Forest sector is a significant contributor to the bioeconomy sector Well established data collection process by Statistics Finland
Germany	Europe	11,419	-	43	-
Indonesia	Asia	91,133	334,766 (2005)	75	-
South Africa	Africa	17,050	-	63	-
USA	North America	309,795	-	55	Well-established data collection process by the Bureau of Labor Statistics

Expert identification began towards the end of the first quarter of 2019 from direct and indirect personal contacts and screening of relevant institutions. An expertise matrix was developed to create diversity in the panel drawn from research organizations, academia, the private sector, and international organizations. The selection aimed at an even distribution among three different categories of expertise i) forest sector employment, ii) green jobs and iii) forest education. Another important criterion applied in the process was the extent of the expertise resulting in two levels: global and country-specific. Three groups of experts were developed:

- General experts with experience in forest-related employment, green jobs, and forest-related tertiary education, respectively, on a global scale, including representatives from the UNECE & FAO Team of Specialists (ToS) on Green Jobs in the Forest Sector

- Senior experts with a sufficient overview of forest-related employment and green jobs in their respective countries

- Junior experts who were nearly all students, some being IFSA members, with sufficient knowledge of forest-related tertiary education in their respective countries

In addition to sharing their insights on their areas of expertise during the workshop, the general experts drafted the introduction and conclusion chapters of the present report, while the senior experts prepared presentations on the state of employment in forestry and logging, broader forest sector and green jobs in their respective countries. They also provided supplementary information needed and drafted the country chapters contained in this report. The forest-related tertiary education section was drafted by the junior experts, highlighting how tertiary education in the respective countries is responding to the trends in forest-related employment. However, invited representatives from labour organizations did not participate in the workshop.

2.2 Conceptualising forest-related employment

Forest-related employment as used in this study generally refers to employment in forestry and logging, the broader forest-related sector (including wood, paper, and furniture manufacturing), and green jobs. Trends in forest-related employment were captured in two ways. Firstly, the International Standard Industrial Classification of All Economic Activities (ISIC), Rev.4 developed by the United Nations Statistics Division was used to elicit insights into employment trends in forestry and logging as the classical core business of the forest sector (i.e. ISIC Division 02) which consists of four classes (United Nations, 2008):

- **0210: silviculture and other forestry activities:** This class consists of activities carried out in natural or planted forests and includes growing of standing timber: planting, replanting, transplanting, thinning and conserving of forests and timber tracts; growing of coppice, pulpwood and firewood and operation of forest tree nurseries.

- **0220: logging:** Activities include production of roundwood for forest-based manufacturing industries; production of roundwood used in an unprocessed form such as pit-props, fence posts and utility poles; gathering and production of firewood; and production of charcoal in the forest (using traditional methods). The output of logging can take the form of logs, chips, or firewood.

- **0230: gathering of non-wood forest products:** This class includes gathering of non-wood forest products and other wild growing plants but excludes managed production of any of these products (except growing of cork trees), growing of mushrooms or truffles, growing of berries or nuts, and gathering of firewood.

- **0240: support services to forestry:** This class includes carrying out part of the forestry operation at a fee or on contract basis. It is comprised of forestry service activities (forestry inventories, forest management consulting services, timber evaluation, forest fire fighting and protection and forest pest control) and logging service activities (transport of logs within the forests).

Secondly, in order to analyse forest-related employment trends beyond the classical forestry and logging activities, including the broader forest-related occupations as well as emerging fields, the study employed the concept of green forest jobs proposed by the UNECE/FAO ToS on Green Jobs in the Forest Sector. This outline is particularly useful in capturing both, existing as well as emerging fields of forest-related employment, which are grouped into seven thematic areas (**Figure 1)**. Due to the variations in forest-related sub-sectors among countries, this Europe-centred concept might display limitations, albeit still broad enough to accommodate similar developments in other parts of the world. Employment in wood, paper, and furniture manufacturing are also highlighted under the broader forest-related sector.

The green jobs definition used in this study is based on the ´Guidelines for the promotion of green jobs in forestry´ adopted by the UNECE in October 2019 which defines 'green jobs' "as a subset of employment in the environmental sector that meets the requirements of decent work (i.e. adequate wages, safe conditions, workers' rights, social dialogue and social protection)." The decent work dimension of jobs in the environmental sector may be measured according to relevant indicators selected from the ILO manual on Decent Work Indicators (ICLS, 2013[1]). Activities in agriculture, fisheries and forestry can be considered as belonging to the environmental sector if environmentally sustainable technologies and practices are used (ICLS 2013). The guidelines used in the preparation of the country reports are found in Annex 1.

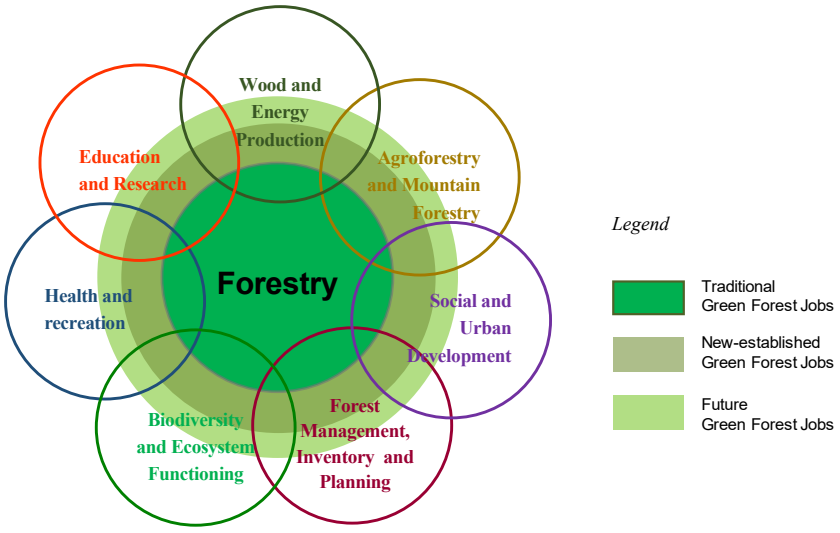


Figure 1: Categories of green forest jobs proposed by the UNECE & FAO study, 2018. (Source: UNECE & FAO, 2018)

[1] https://www.ilo.org/wcmsp5/groups/public/---dgreports/---integration/documents/publication/wcms_229374.pdf

2.3 Conceptualising forest-related tertiary education

Forest-related tertiary education as used in this study is defined as bachelor's to PhD level education related to forests, which includes forestry, forest sciences, agroforestry, environmental sciences, land use, environmental management, or any combination of these offered at the university (Rekola et al., 2016). The sections on forest-related tertiary education provide information on universities offering forest-related tertiary programmes, and enrolment trends in terms of numbers of students and graduates, as well as new programmes developed by the universities.

2.4 Limitations and structure of the report

This report does not aim to be a comprehensive, comparative, or systematically quantified treatise on forest-related employment and tertiary education trends. It rather provides an exploratory overview from seven major forestry countries to generate first insights into the trends, the commonalities as well as differences. These insights will guide future research and may also suggest the need for policy work. Data used for this study has been obtained from numerous sources such as government documents and administrative records, statistic databases and statistical yearbooks and academic articles. Full references to the original data are provided wherever possible. However, the reliability or robustness of these data is beyond the control of the lead authors, who have applied utmost care in compiling information, checking the robustness of the data and flagging apparent inconsistences.

The timeframe used in this study is from 1995 to 2018 with variations across countries. Editing for style, clarity and formatting were done to provide a measure of uniformity. In most cases the figures have been rounded to the nearest one thousand.

Each country chapter is structured as follows:

- Relevant background information on the state of the forest sector
- State of employment in forestry and logging
- State of broader forest sector employment
- Outlook on green jobs in the forest sector
- Additional trends in forest-related employment
- State and trends in forest-related tertiary education

Photo: Markus Spiske / Unsplash

3. Country insights

3.1 Brazil

3.1.1 Background

Brazil accounts for 30% of the world's tropical forests (FAO, 2018) and has a predominantly native forest cover of 497 million hectares, of which 60% is publicly owned (Brasil MAPA/SFB, 2019; FAO & UNEP, 2020). Forest plantations cover 9 million hectares, with 36% being owned by pulp and paper companies, and 29% under private independent ownership. Financial investors, mostly through Timberland Investment Management Organizations (TIMOs), own 10% of the plantations. Although relatively small in area, fast-growing plantations dominate economic output of the Brazilian forest sector, accounting for 1.2% of Brazil's GDP and gross revenues of Brazilian Real (R$) 97.4 billion, and 6% of the industrial GDP.

The forest sector is much smaller than manufacturing and agriculture, but forest-based industry experienced a high growth rate of 12.6% in 2019 amidst a deep general recession, signifying the resilience of the sector (Ibá, 2019; Ibá, 2020). The subsequent sections provide an overview of forest-related employment and tertiary education in Brazil from 1995-2018 with a projection of up to 2030.

3.1.2 State of employment in forestry and logging

In 2018, the country's plantations generated 513,000 jobs in the forest sector, including downstream processing industries, directly and indirectly impacting 3.8 million people (Ibá, 2019). Due to non-standardized reporting and high informality rates, employment numbers for natural forests, mostly in the Amazon region, is probably vastly understated in official statistics and administrative records. Based on a social accounting matrix, over 525,000* workers (full-time equivalents) were directly employed in forest products harvesting and processing as well as fishing in rivers in 2005 in the Amazon region (De-Souza-Ferreira-Filho & Poschen, 2019).

According to the Global Gender Gap Index (GGGI, 2020[2]), despite employing 60% of women in its labour market and progressing three places from its previous position in 2018 (92nd), Brazil still has one of Latin America's largest gender gaps. In some traditional forestry jobs, the gender distribution is balanced, for instance in operation of forest tree nurseries the proportion of women is 50%. In forestry and logging, 10.9% of the total of employment was occupied by women in 2010 (IBGE-PNAD, 2011), placing Brazil as one of countries with highest female employment rate in this activity, amounting to 90,000 workers (Whiteman et al., 2015). In contrast, in forest conservation and timber tracts the proportion of women is only 2%. In executive boards, women occupy 9% of director´s seats, while men occupy 100% of CEO positions (Rede Mulher Florestal, 2020).

As shown in **Figure 2**, while there has been an overall decline in forestry employment since 2012, 'forest production - native forests' grew in terms of the number of jobs created. In 2018 there were 11,600 individuals employed compared to 8,300 in 2012. This could be attributed to the effectiveness of the forest concession programmes and community-based

[2] http://www3.weforum.org/docs/WEF_GGGR_2020.pdf

forest management initiatives (Brasil MMA/SFB, 2020). Employment in forestry supporting services activities including forest inventories, forest management, consulting services, timber evaluation, logging service activities etc., decreased between 2012-2018.

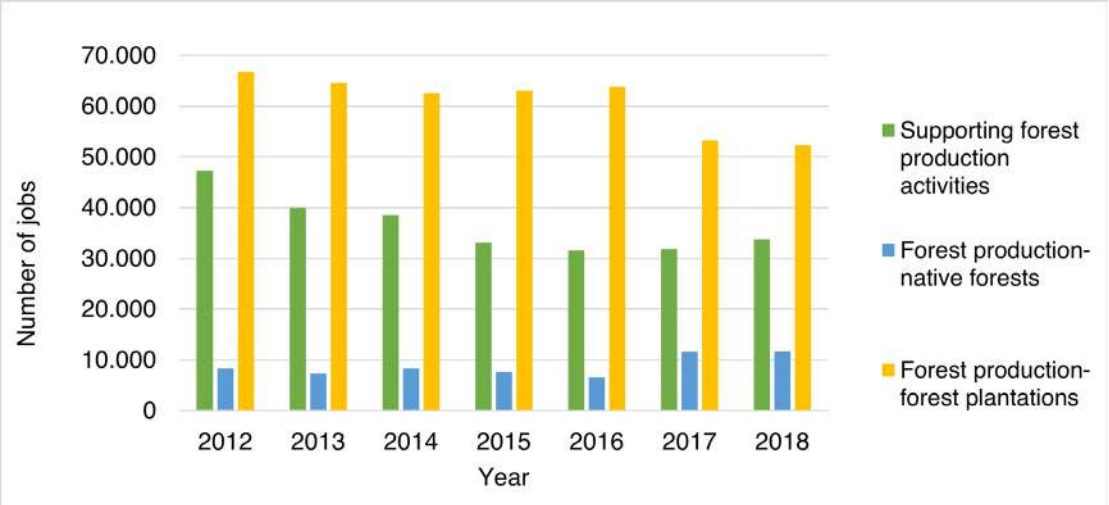


Figure 2: Employment (number of jobs) within forestry and logging classes from 2012-2018. (Source: Brasil – Secretaria do Trabalho/ME-RAIS, 2019)

- **0210: Silviculture and other forestry activities**

Silviculture and other forestry activities accounted for almost 40,000 jobs in 2016 which was a slight decrease compared to 2015 (FAO, 2020[3]). Formal jobs in forest production in planted and native forests, as well as supporting forest production activities, accounted for 17% of employment in the forest sector (Brasil – Secretaria do Trabalho/ME-RAIS, 2019).

- **0220: Logging**

In 2005, over 200,000 FTE workers were directly employed in the extraction of timber products in Brazil. The Brazilian Amazon region is one of the largest job creators in this category, employing approximately 128,000 workers (De-Souza-Ferreira-Filho & Poschen, 2019). The number of jobs generated from log extraction in the region is equivalent to those generated by other major manufacturing activities, such as manufactured products and machinery and equipment sectors (Ferreira Filho & Fachinello, 2015).

- **0230: Gathering of non-wood forest products**

This activity plays a much bigger role in the Amazon region than nationally, employing approximately 51,000 workers in the former, in contrast to 29,500 workers in the rest of Brazil. In 2005, non-timber forest activities in the Brazilian Amazon generated revenues worth USD 218 million, with USD 100 million coming from products extracted from forests. For this region, Açaí berry (Euterpe oleraceae Mart.) is the most important non-wood forest product, followed by the Brazilian nut (Bertholletia excelsa). There were 9,900 FTE workers directly involved in extraction in 2005, equivalent to 0.1% of total employment in the region. This employment is mostly seasonal and part-time (Ferreira Filho & Fachinello, 2015).

In the southern parts of the Atlantic rainforest, yerba mate (Ilex paraguariensis) is very valuable. Family-based yerba mate production directly generated 700,000 jobs in 180,000 rural properties, which signifies the social and economic relevance of this activity (Chechi et al., 2019).

[3] http://www.fao.org/3/ca9976en/ca9976en.pdf

- **0240: Support services to forestry**

Brazil's planted forest sector is characterized by companies owning and engaging in different production operations. One firm may engage in harvesting raw materials, manufacturing, transport, marketing, and/or retailing and controlling upstream suppliers and downstream buyers. This system enables such firms to possess some of their own forest support services workforce (pest and fire control teams, harvesting machines and operators, etc.), jobs that fall under the planted trees industry. In 2010, there were 50,700 FTE jobs in this category, of which 10.7% of the workers were women. The number of jobs declined to 33,800 in 2018 (Brasil MAPA/SFB, 2019).

3.1.3 State of broader forest sector employment

Forest-related industries significantly contribute to the sector's formal employment (**Figure 3**)

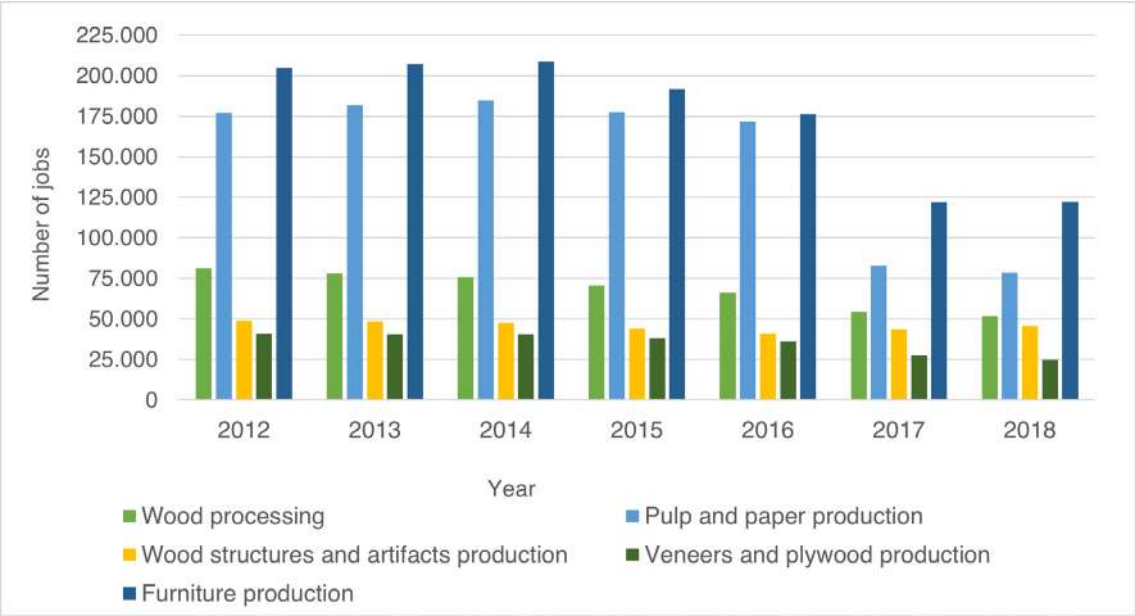


Figure 3: Employment (number of jobs) in forest-related industries from 2012-2018. (Source: Brasil – Secretaria do Trabalho/ME – RAIS, 2019)

A significant decrease in the total number of industrial forest-related jobs was recorded between 2016 and 2018, resulting from the country´s negative GDP growth between 2015 and 2016. However, jobs in 'wood structures and artifacts production' have been increasing since 2016. From the 599,000 people employed in the Brazilian forest sector in 2018 (Amazon region not included), 27% were in pulp and paper industry, 28% in timber industry and 29% in furniture industry. The number of people employed in the timber industry dropped from 193,000 jobs to 162,000 jobs between 2009 and 2018 and so did employment in pulp and paper, veneers and plywood, and furniture production. Jobs created from furniture, and pulp and paper production industries account for 60% of the workforce in forest-related industries in Brazil (Abimci, 2019).

In the Brazilian Amazon, in 2005, over 525,000 workers were employed in forest products harvesting and processing. The timber production chain of native and planted forests employed 136,600 people in timber extraction and charcoal production, and 403,000 people in timber processing (De-Souza-Ferreira-Filho & Poschen, 2019).

The general decrease in the number of jobs generated during the 2012-2018 period was largely driven by increased mechanization in the industry. The political-economic instability that Brazil has been facing since 2014 has also negatively impacted the sector forcing many companies to either reduce or shut down activities, resulting in massive layoffs between 2015-2018 (Abimci, 2019).

3.1.4 Outlook on green jobs in the forest sector

National parks stewardship concessions are increasing in Brazil, intended at attracting investments in innovative management, generating jobs, and expanding human and financial resources to be used in environmental conservation (ICMBio, 2020[4]). Demand for forest certification is also likely to increase which will offset the reported decline in support services jobs with auditing, certificate manager, among others.

Bioeconomy is listed as one of the priority sectors for development in Brazil (CNI, 2013, German Bioeconomy Council, 2016), and one of the first initiatives is the Bioeconomy Brazil–Sociobiodiversity Programme (Brasil MAPA, 2019[5]). Through the programme, a total of BRL 4.3 million will be allocated to small and medium rural producers, family farmers, traditional people, and communities in four Brazilian states to enhance production based on the Bioeconomy principles. Initially, 12,000 people will benefit directly and indirectly from the products and services generated from the socio-biodiversity of rural communities. It is expected that similar models will be replicated throughout the Brazilian territory, boosting greener markets and production chains, as well as the creation of green and decent jobs.

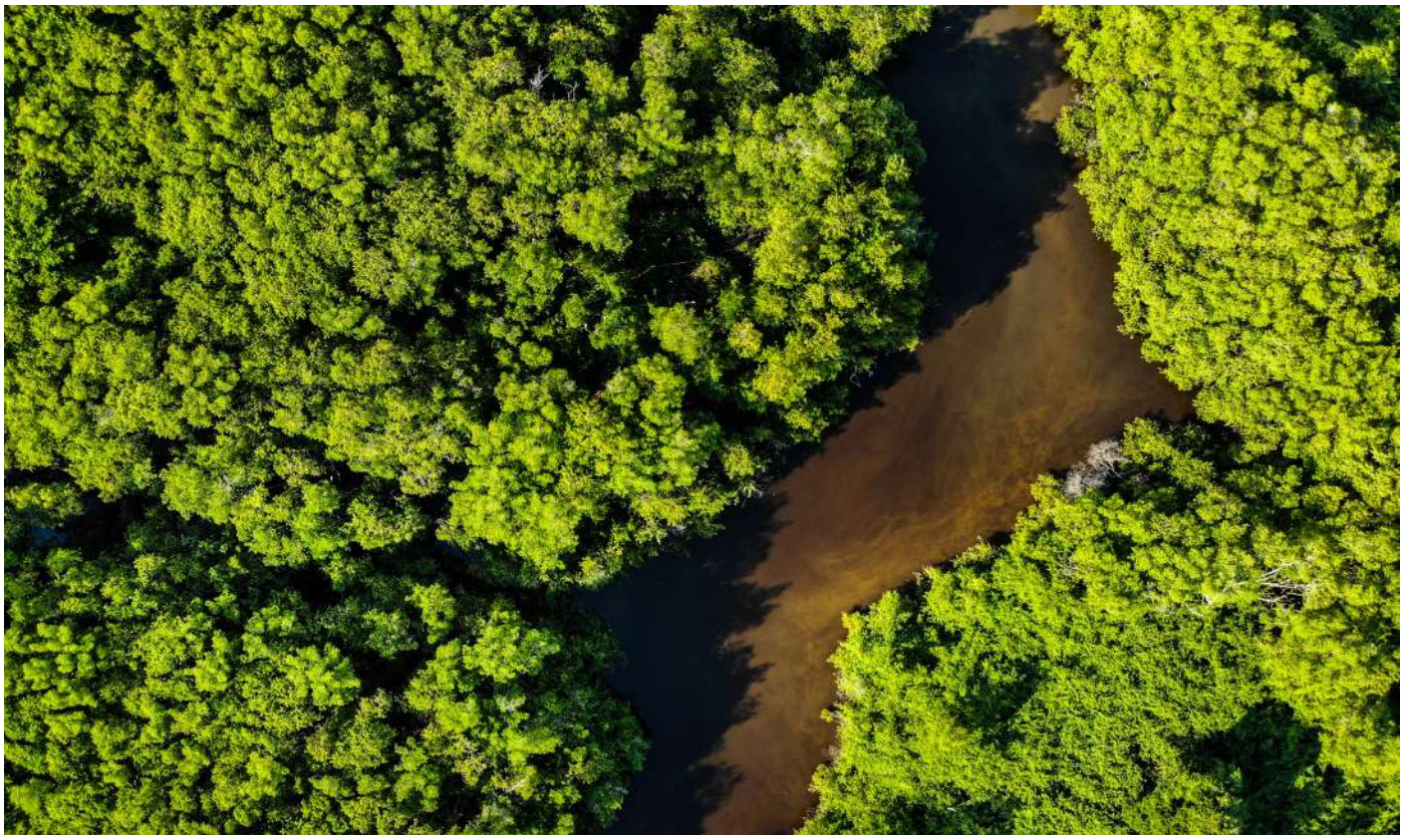


Photo: Thiago Japyassu / Pexels

[4] https://www.gov.br/icmbio/pt-br/assuntos/visite-as-unidades-de-conservacao-federais/concessao-nos-parques

[5] https://www.gov.br/agricultura/pt-br/assuntos/agricultura-familiar/bioeconomia-brasil-sociobiodiversidade

Brazil committed to restore 12 million hectares by 2030 in its Intended Nationally Determined Contribution (INDC) and the Bonn Challenge. Plans are underway to restore a further 10 million hectares of agroforestry systems and degraded pasture lands. In the process 190,000 jobs are envisioned to be created annually up to 2030 (Brasil MMA, 2017).

The Floresta+ Programme, launched in 2020 with a reserve of BRL 500 million initially targeting the Amazon region is considered as one of the largest schemes for payment for ecosystem services (PES) in the world today. It will be paying actors involved in activities that improve, conserve, and restore the native vegetation (Brasil MAPA, 2020[6]; Brasil, 2021).

A revised PES law was issued extending the scheme nationally and establishing that individuals or legal entities can benefit if they engage in activities that protect natural resources (Brasil, 2021). The list of activities that can be remunerated is extensive and it will certainly promote the creation and formalization of green and decent jobs.

3.1.5 Additional trends in forest-related employment

Mergers among forest industry companies

Brazil's position in the global market as an industrial forestry plantation player has been strengthened because of mergers among the forest companies. Two of the biggest pulp and paper companies, Suzano and Fibria, merged in 2019 without compromising a significant number of jobs. In addition to owning plantations, the big companies also control the local and regional out-growers for supplementary timber supply. Jobs generated through these schemes are offered on short-term contracts, thus not applying regulations on leave, pensions, dismissal rules, and unemployment benefits (Ibá, 2019).

Professional training of the forest workforce

Several training programmes exist for different categories of the sector's workforce. The Forest Operator Training Centre (Cenfor) has trained around 2,000 machine operators from forestry companies in the country and abroad, in addition to students in Forest Engineering programmes (Unicentro, 2020[7]). The Centre has invested in state-of-the-art equipment like 3D virtual reality simulators, machine engines, mechanical, hydraulic and electrical components, computers and a VAN vehicle (mobile training unit), to ensure that machine operators are up to date with the technological advancements.

Training of forest engineering graduates on pulp and paper manufacturing processes and management aspects is offered through the Pulp and Paper Managers Training Programme (PPGCP) (ABTCP, 2020[8]). The Preparation of Forest Managers (PPGF) of the Forestry Science and Research Institute (IPEF) programme has trained 161 forestry engineers. Most of them currently work in private companies and/or as consultant freelancers (IPEF, 2020[9]).

The Young Apprenticeship Programme provides an opportunity for students from 14 years to work in mid-sized and large companies including forest-related companies. The companies are required by law to hire apprentices equivalent to 5 to 15% of the workforce (Brasil, 2000).

[6] https://www.gov.br/pt-br/noticias/meio-ambiente-e-clima/2020/07/ministerio-do-meio-ambiente-instituiu-o-programa-floresta

[7] https://fundacaounicentro.com.br/projeto-cenfor/

[8] https://abtcp2020.org.br/en/

[9] https://www.ipef.br/gestores/

3.1.6 Trends in forest-related tertiary education

Currently, 64 public and private institutions offer 74 forest engineering bachelor's degree programmes (SNIF, 2019[10]). Since the establishment of the first forest-oriented programme in 1960 (SNIF, 2019), the number of new courses established has been on a gradual increase. Presently, there is at least one institution offering an undergraduate forest engineering programme in each state in Brazil. With the rise in the number of forest engineering bachelor programmes, enrolment and the number of graduating students increased from 1995-2016 to around 1,800 per year. The peak of the number of graduated students was in 2016, which was followed by a slight decline since 2017 (**Figure 4**).

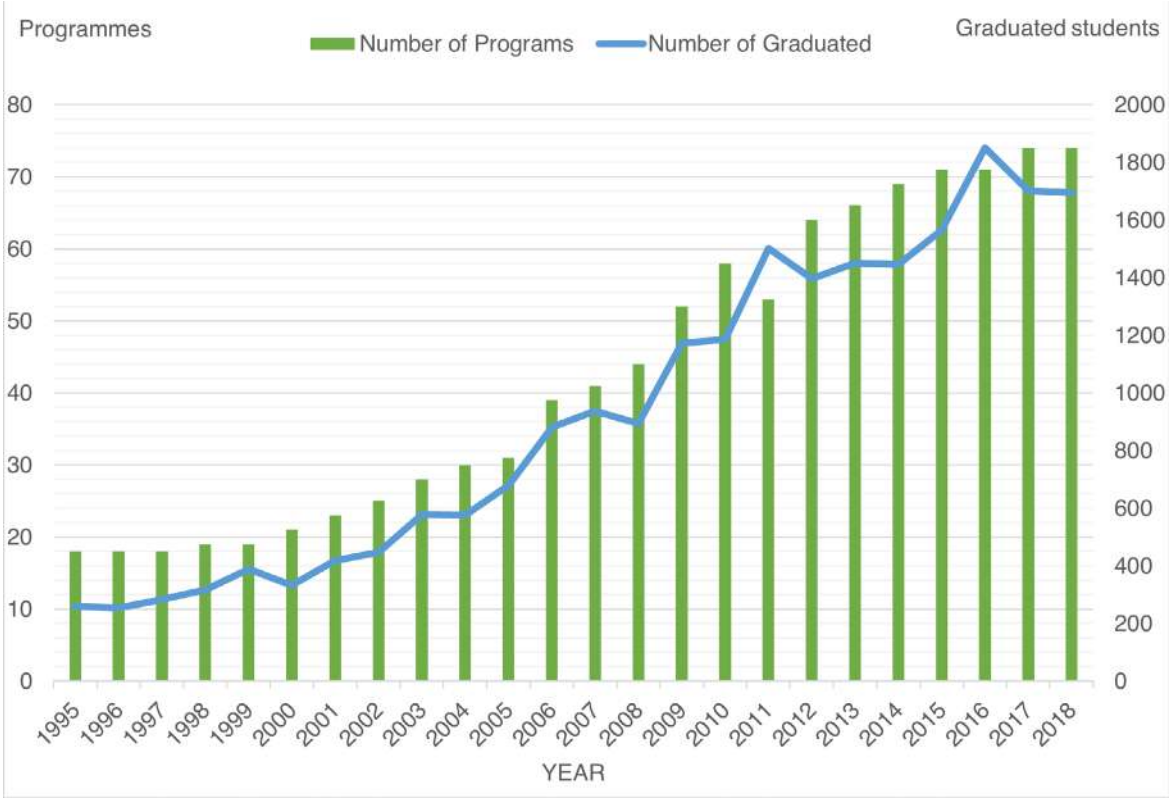


Figure 4: Forest Engineering bachelor programmes and graduates from 1995 to 2018. (Source: SNIF, 2019)

By 2018, there were 43 postgraduate programmes (M.Sc. and PhD) in 23 institutions. Postgraduate enrolment remained relatively stable between 2013 and 2018, with enrolments ranging between 800-920 students for master's (Academic and professional Master´s degrees included) and 600-700 candidates for Doctorate degree programmes. In 2017, approximately 1,500 candidates enrolled in postgraduate programmes, with 560 graduating (Brasil MAPA/SFB 2019; SNIF 2019).

** Academic and professional Master´s degrees considered.*

[10] http://snif.florestal.gov.br/pt-br/graduacao

3.2 China

3.2.1 Background

China's forest area was 220 million hectares in 2019, which represents 5.2% of the global forest area (National Forestry and Grassland Administration (NFGA), 2019). In 2018, China's plantation forests reached 80 million hectares, which is the greatest area of plantations globally. The domestic forest industry output value reached USD 1,018 billion in 2017 (0.01% of the global GDP) and has been increasing by 20% annually since 2007.

However, the industry has an unbalanced structure with proportions of 33:48:19 for primary industry (harvesting, management), secondary industry (processing) and tertiary industry (service) respectively in 2017 (NFGA, 2018). China's forest product trade amounted to USD 150 billion in 2017, approximately a third of the global value (NFGA, 2018). The subsequent sections provide an overview of forest-related employment and tertiary education in China from 2007-2020.

3.2.2 State of employment in forestry and logging

China is one of the countries with the highest number of formal jobs in the forest sector: approximately 3.8 million* jobs, translating to 29% of world's formal employment in the forest sector (ILO[11]). However, the volume has been on the decline for the past 10 years in forestry and logging. According to NFGA, employment in forestry and logging (including log transportation) decreased by 15.8% from 1.3 million in 2008 to 1.1 million in 2017 (**Figure 5**). Primary industry employment (harvesting and management) accounted for 66.8% while processing industry was at 3.1% and service industry stood at 28.8% in 2017.

**forestry, wood industry and the pulp and paper industry*

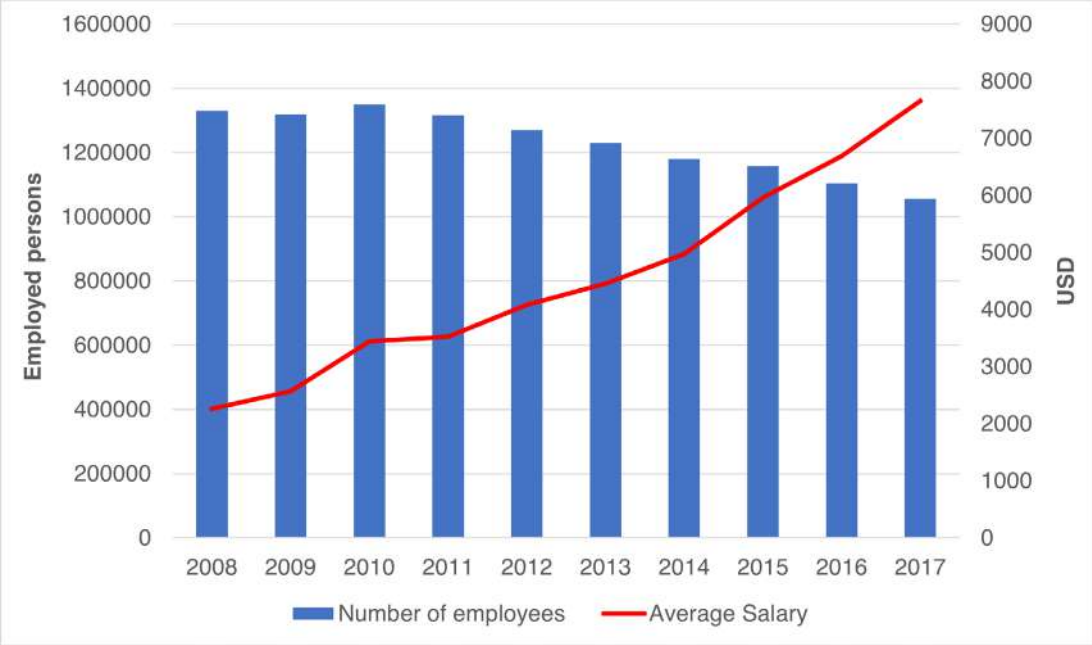


Figure 5: Forestry and logging employment and wages from 2008 to 2017. (Source: China Forestry Statistical Yearbook, 2017)

[11] https://www.ilo.org/global/industries-and-sectors/forestry-wood-pulp-and-paper/lang--en/index.htm

A modification of the data from China Forestry Statistical Yearbook 2017*, indicates that silviculture and other forestry activities accounted for 41.4%, logging for 16.3%, gathering of non-wood forest products for 0.58% and forestry support service accounted for 8% of the total employment in the forest sector China in 2017 (**Table 2)**.

Table 2: Distribution of workers across forestry and logging classes*, 2017. (Source: Adapted from China Forestry Statistical Yearbook, 2017)

ISIC Code	Classes of activities 2010	Employment	% of total employment
0210	Silviculture and other forestry activities	481,513	41.4
0220	Logging	189,642	16.3
0230	Gathering of non-wood forest products	6,733**	0.58
0240	Support services to forestry	92,961***	8

**The categories used in the China Forestry Statistical Yearbook and China Forestry and Grassland Development Report have been modified to suit this study, therefore the % do not add up to 100%.*

***Data only covered employment related to fruit tree and flower planting and collection. In China collection of non-wood forest products by farmers from nearby forests is permitted however, there is no official data on employment.*

**** This includes forest production and technical service workers, does not include the forestry public management agencies and civil societies.*

Employment fluctuations occurred within silviculture and forest management, logging and transportation, and support services to forestry classes between 2007-2018 due to several reasons. China implemented six ecological forestry programmes from 2000 to 2010 through the national strategy on prioritizing ecological and environment protection. One of the six programmes, "The National Forest Protection Programme (NFPP)" banned the commercial harvest of natural forests, resulting in massive job losses in state owned logging and transportation companies in the North East and South West of China. The ban still stands with the launch of the second phase of NFPP in 2011 which runs up to 2020 with a possible extension to 2030.

The number of jobs in silviculture and forest management has, however, increased from 2013 to 2017 (**Figure 6**) and reached to 481,000 in 2017 (NFGA, 2017). These jobs were related to the target of afforesting 33.3 million hectares and sustainably managing 40 million hectares by 2020 as part of the 13th Five-year Forestry Development Plan (2016-2020). In state owned forest farms, many logging jobs changed to silviculture which includes nursery activities and forest management triggered by the NFPP.

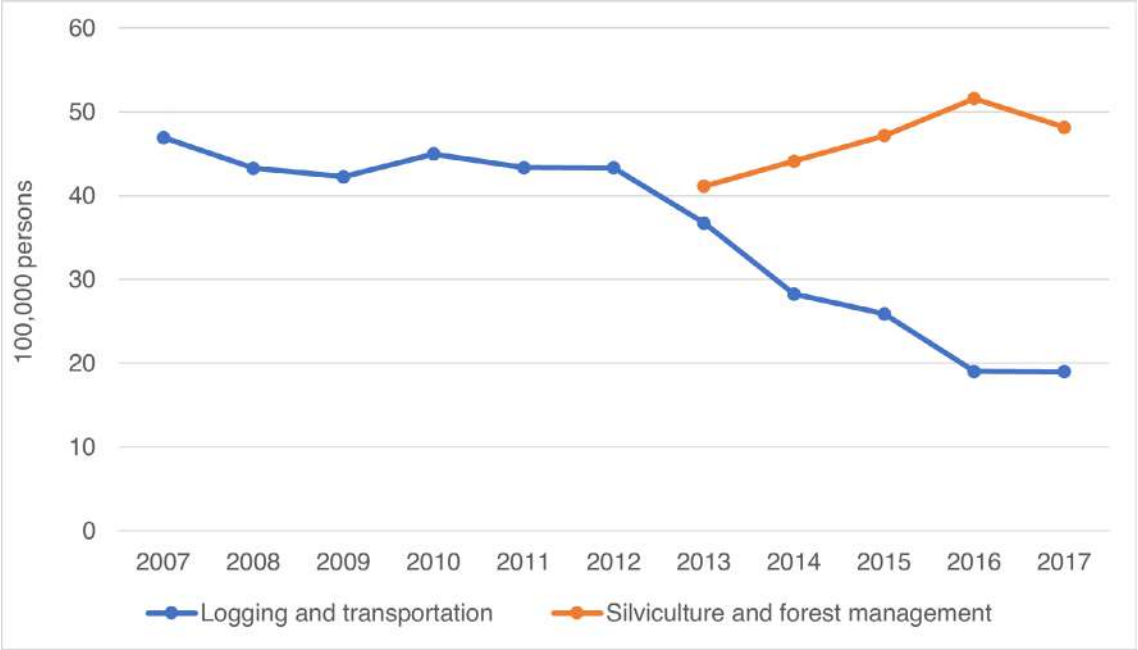


Figure 6: Employment in logging and transportation vs silviculture and forest management. (Source: China Forestry Statistical Yearbook, 2017)

3.2.3 State of broader forest sector employment

Forest-related production sectors listed in the China Forestry Statistical Yearbook are primary industry, process industry, and service industry. Process industry also includes "timber, bamboo, rattan processing industry" which employed 20,600 people in 2017. China is the largest furniture and wooden floor producer and exporter globally (Chen, 2016). There were 3,200 furniture factories, and 2,300 wooden flooring factories nationwide in 2015 offering over 500,000 jobs (Zhu, 2017).

3.2.4 Outlook on green jobs in the forest sector

Green economic development and ecological civilization (a dynamic equilibrium state where humans and nature interact and function harmoniously[12]; Frazier et al 2019) were adopted as part of the national development strategies in 2012 making China shift her economic development to a sustainable path (Green Economy Development Index in China, 2013[13]). As such, China has set ambitious afforestation targets including:

- Increasing China's forest cover rate to 23% by 2020 which has been achieved; 26% by 2035 and 30.6% by 2050 which is the world average forest cover rate and
- Attaining a forest stock of 16.5 billion m^3 by 2020; 21 billion m^3 by 2035 and 26.5 billion m^3 by 2050.

These targets will lead to the generation of new jobs in silviculture and forest management with the estimated new job opportunities expected to reach to 47.6 million in 2020, and 77.1 million in 2050 (ILO, 2010[14]). Along with the increase in middle-income class and urbanization,

[12] https://link.springer.com/article/10.1007/s10980-019-00772-4
[13] http://tjyj.stats.gov.cn/CN/Y2013/V30/I3/72
[14] www.ilo.org/beijing/what-we-do/publications/WCMS_155395/lang--en/index.htm

the demand for ecosystem services particularly recreation has been on the rise. Forest tourism and forest well-being related jobs are expected to continuously increase and generate more new jobs. In 2017, there were a total of 3,500 forest parks in China generating an income of USD 15.7 billion, while providing 176,200 direct jobs in the forest sector and over 900,000 tourism-related jobs (Qin & Bao, 2019). The jobs created could reach 1.4 million by the end of 2020 through the implementation of the national policy supporting forest tourism development (Ke, 2011).

According to the 13th Five-year plan (2016-2020) on bioenergy development, by 2020 the bioenergy industry's annual sale income will increase to USD 17.2 billion and provide 4 million jobs (China National Energy Bureau, 2016[15]). Forests play an integral role in bioenergy development providing 350 million tons of forest residues and waste that could be used to produce biomass and replace 200 million tons of coal (State Forestry Administration, 2013). Forest bioenergy development will increase the number of jobs needed for expanding the forest energy plantations and increasing biomass production.

3.2.5 Additional trends in forest-related employment

Tough work and safety environment and low wages

The forestry sector in 2017 reported 449 injuries; 36 serious injuries and 34 deaths, with approximately half of the injuries and deaths recorded in silviculture and forest management as well as logging and transportation (NFGA, 2018). In addition to accidents, forestry work in China is also characterized by low wages. The country's average annual wage was USD 10,600 (Chinese Statistical Bureau; China statistic yearbook 2017, 2018[16]) while the average annual wage in the forest sector was USD 7,600 in 2017 (NFGA, 2018). These rates are 28.7% lower than the national average wage and 60% lower than the average wage for IT and finance industry jobs. The increase in the forest sector wages was four-fold from 2008 to 2017, but the sector was still ranked among the bottom three in term of wages in 2017 (NFGA, 2018).

Photo: Pxfuel.com

[15] http://www.gov.cn/xinwen/2016-12/06/content_5143612.htm

[16] http://www.stats.gov.cn/tjsj/ndsj/2017/indexch.htm

3.2.6 State and trends in forest-related tertiary education

There are nine universities offering 23 forest-related programmes. Some of the new programmes offered include: Forestry Economy, Nature Reserve, Furniture Design and Engineering, Biomass Energy and Materials, and Forestry Equipment and Information Technology. The total number of students from technician certificate/diploma level to doctorate level who graduated in 2015 was 152,900 compared to 13,700 in 1990 (**Figure 7**). The number of undergraduate students who graduated from forestry universities has been on the rise from 4,600 in 1990 to 46,100 in 2015, and the increase is expected to continue due to the anticipated creation of new green jobs in the forest sector.

The need for advanced degrees like bachelor's has also increased due to mechanization, which on the other hand has led to the decrease in the number of graduates from forestry technical schools working in the logging and transportation sector. The number of graduates from forestry technical schools (major of forestry and grass) decreased from 75,000 in 2013 to 35,000 in 2018. In 2018, 69,200 students graduated with a major in Forestry or Grassland at bachelor's level, while 8,800 graduates obtained a master's degree in the same, and 747 obtained PhD degrees (NFGA, 2018).

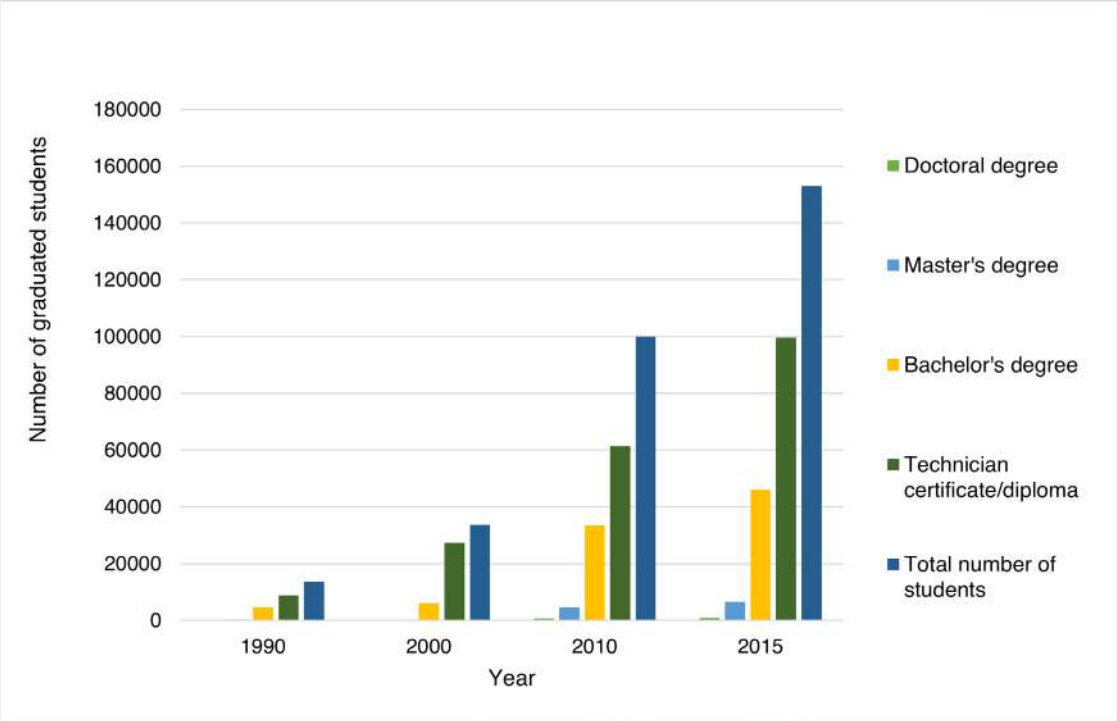


Figure 7: Graduating students from technician certificate/diploma to doctorate degree level. (Source: Global Forest Resources Assessment-China, 2020[17])

[17] http://www.fao.org/3/ca9980en/ca9980en.pdf

3.3 Finland

3.3.1 Background

Finland has about 22.8 million hectares of forest and poorly productive forest land, equivalent to 75% of the total land area. 19.8 million hectares of the land area is utilized for timber production. The current volume of growing stock in forests is 2.47 billion m^3, which is 40% more than in 1971 according to the National Forest Inventory (fieldwork 2014-2018). The annual forest growth is about 108 million m3 (Härkönen, 2019; Vaahtera et al., 2019; Viitanen et al., 2019a). The most common form of tenure is non-industrial private forest ownership (NIPF) with over 620,000 Finns owning 60% of the forests. Women account for 25% of the forest owners. The state owns 26%, the forest industry 9%, and the remaining 5% is divided among municipalities, parishes, joint forests, and other communities. NIPF owners supply over 80% of the timber required by the forest industry. The average size of forest property entities is 31 hectares. However, the numbers of small woodlots with less than 10 hectares and large holdings over 100 hectares are on the rise (Vaahtera et al., 2019). The subsequent sections provide an overview of forest-related employment and tertiary education in Finland from 1975-2018 and a projection up to 2020.

3.3.2 State of employment in forestry and logging

The total number of forest workers has remarkably declined since the 1980s mainly due to mechanization of timber harvesting, new technological innovations, and the increase in labour productivity. After the 1980's, the number of people employed in forestry and logging in Finland halved (**Figure 8**). The recession between 1990-1993 had a significant effect on the Finnish economy, e.g. many forest organizations were merged, and overall job opportunities within forest sector decreased. According to Statistics Finland, forestry employed 21,000 workers in 2018 (Kallioniemi, 2019a; Official Statistics of Finland, 2020a*). The workers are distributed as follows:

- 0210 - silviculture and other forestry activities: 6,000 workers including forest management
- 0220 - logging: 11,000 workers
- 0230 - gathering of non-wood forest products: not recorded
- 0240 - support services to forestry: 4,000 workers

** The figures have been rounded to the nearest thousand according to the Statistics Finland guidelines.*

During the past years, the amount of forest workers has been rather stable, and a growing trend may be observed for workers in logging. New manufacturing plants are increasing the wood harvesting tasks in forests. Due to the peak in the forest industry's business cycle, the highest demand for roundwood was in 2018, and total fellings in Finland were approximately 8% higher compared to the previous year. This was also reflected in active roundwood trade and logging from NIPF owners' forests, which increased by 16% compared to the previous year. Despite the high harvested volumes in 2018, the number of employed persons in forestry remained rather stable (Kallioniemi, 2019a, Viitanen et al., 2019b).

Employment in forestry represented 34% of the total forest sector workforce. Women account for 12% of all forestry workers.

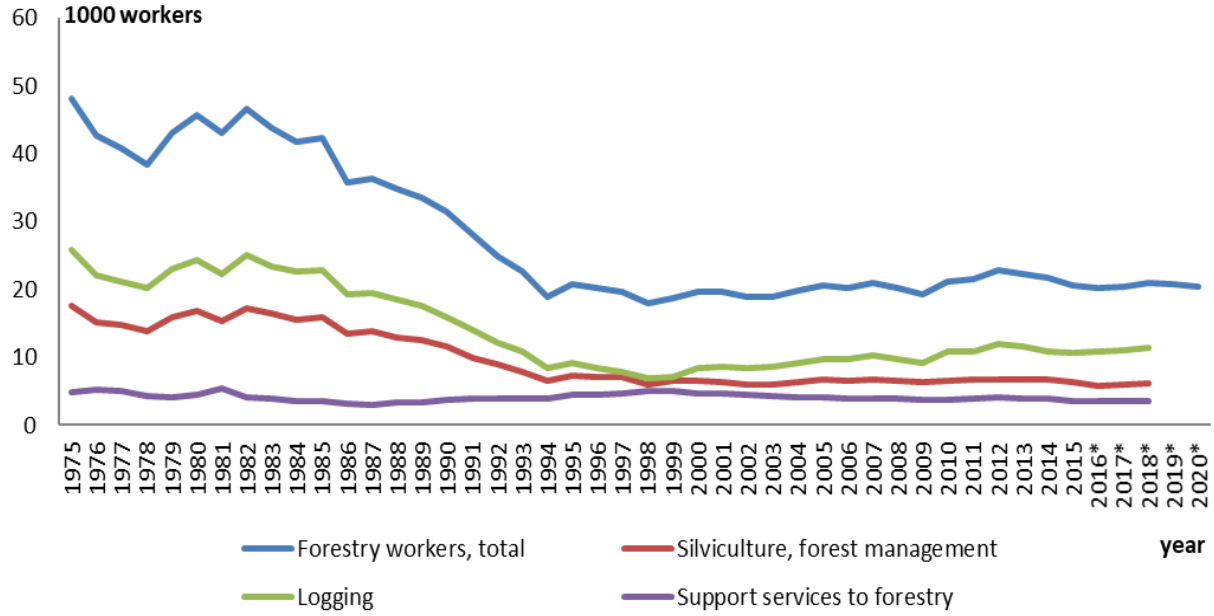


Figure 8: Employment in forestry in Finland since 1975 (1,000 workers).
(Source: Statistics Finland[18], Employment and Kallioniemi, 2019a)

Forestry in Finland is characterized by a high number of small enterprises and self-employed entrepreneurs, such as logging and short-haul transportation companies, involved in forestry work. Overcapacity of harvesting technology, tough competition among the enterprises and low profitability as well as increased productivity are typical attributes of the sector. The number of entrepreneurs and their family members declined by 7% (9,000, in 2018 compared to previous year) which may also indicate the growth of enterprises involved. At the same time, the number of workers in formal employment increased by 5% (12,000) (Kallioniemi, 2019a).

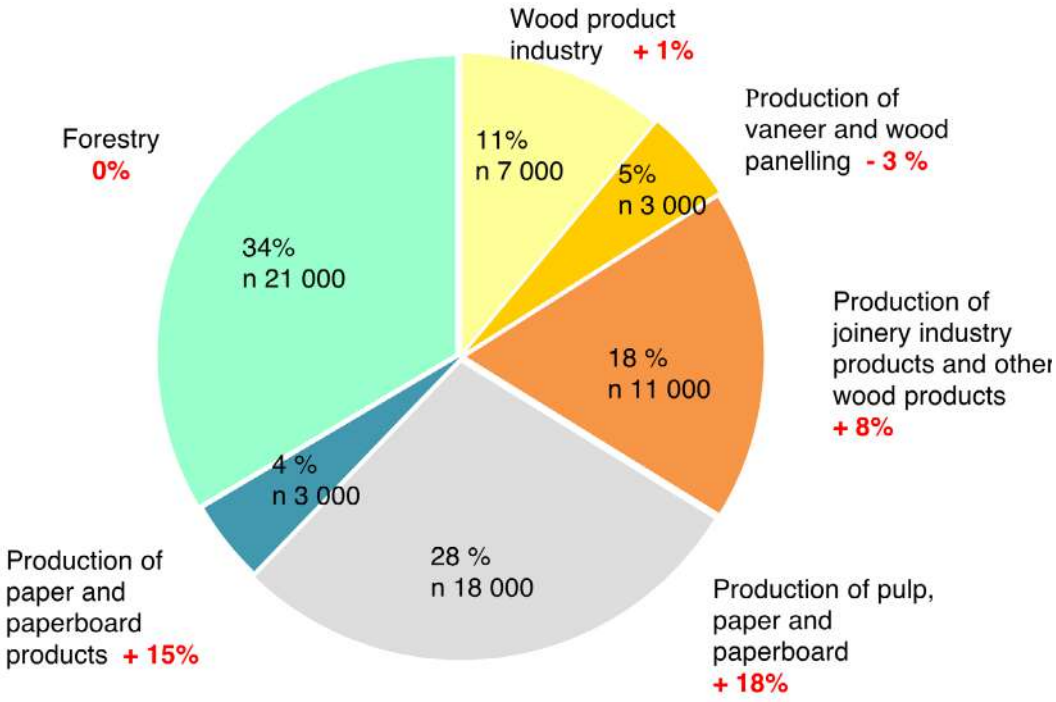
Wood-based energy consumption has increased during the past years as wood (mainly small diameter thinning trees, branches and twigs, residues from wood processing industry and black liquor from pulp and paper industry) has been the most important energy source in Finland. It is estimated (Viitanen et al., 2020; Routa, 2020), that the higher price of emission allowances endorses the demand and competitiveness of wood chips and by-products in energy consumption because of the need to replace fossil fuels.

Berry and mushroom picking are an integral part of the Finnish culture. Even though there are no exact statistics, it is estimated that up to half of Finns collect berries or mushrooms every year (Parviainen & Västilä, 2011) during free time and as a hobby. Foreign short-term berry pickers also arrive in Finland during the season. In 2015, the harvested berry yield was estimated at 64.5 million kilogrammes but this varies annually. Most of these collected non-wood (or natural or wild) products are for domestic consumption. Close to 530 companies were engaged in the non-wood products sector in Finland in 2018, of which about 90% were micro-enterprises with less than ten employees. In total, these companies employed about 2,100 people and have a turnover of around EUR 530 million (Wallius et al., 2020).

[18] http://www.stat.fi/til/tyokay/index_en.html

3.3.3 State of broader forest sector employment

Employment in the forest industry (pulp and paper and wood product) decreased by 17,000 workers (-29%) from 2008 to 2018, as significant number of paper machines closed down due to overcapacity and declining paper demand due to digitalization in offices and societies. Also, a downturn in the economy during 2008-2009 affected the job opportunities within the forest sector. In 2018, 42,000 people were employed in the industry which is equivalent to 66% of all workers in the broader forest sector (**Figure 9, 10**). This was 9% more than in 2017 and was mainly due to an increase in pulp and paperboard production capacity and active housing construction (Kallioniemi, 2019b). The share of women workers was 16% in wood-products industries and 19% in pulp and paper industries.



** The numbers in red colour represent the percentage change from 2017.*

Figure 9: Distribution of workers in the Finnish forest sub-sectors in 2018.
(Source: Statistics Finland[19]; Kallioniemi, 2019b)

[19] http://www.stat.fi/til/tyokay/index_en.html

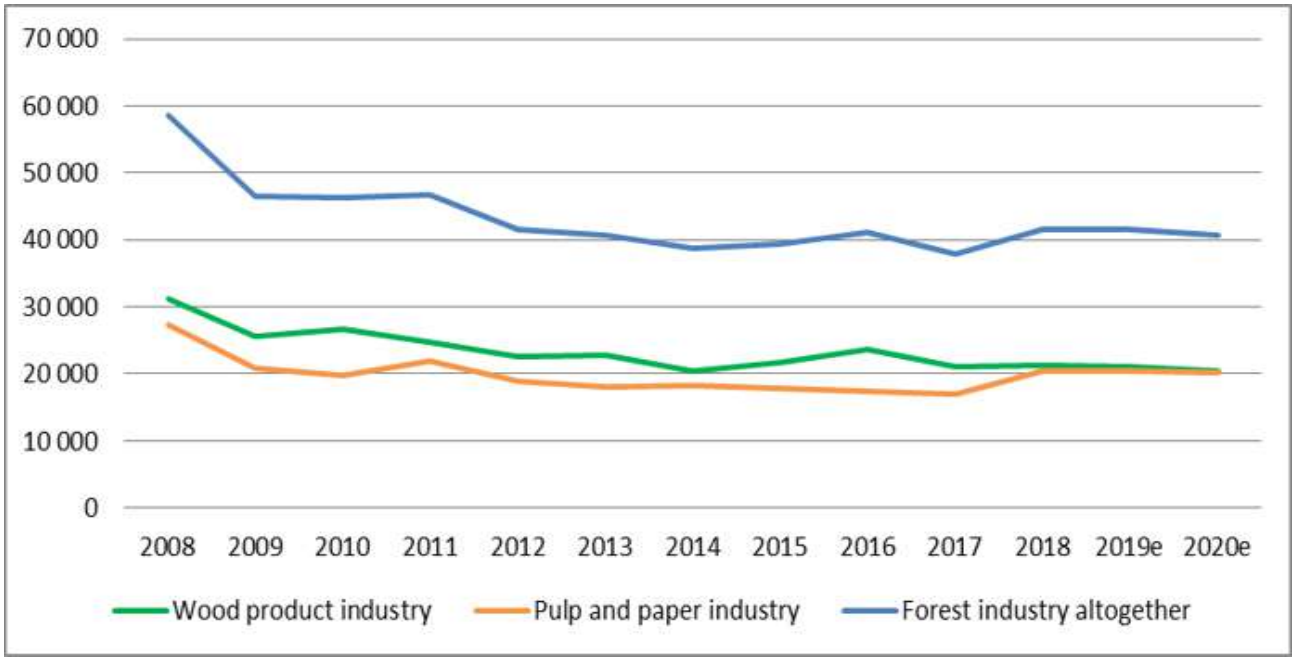


Figure 10: Employment in Forest Industry 2008–2018; Forecasts 2019 and 2020.
(Source: Official statistics of Finland, 2010a, Kallioniemi, 2019b)

Wood is presently promoted as a sustainable and healthy building material and is also utilized in multi-storey residential buildings and large non-residential buildings as well as in packaging. Different kinds of new and innovative wood-based products are being invented and developed in Finland to meet this demand. Some of the innovative wood-based products include: engineered wood products such as LVL (laminated veneer lumber) and CLT (cross laminated timber) for construction, wood-based textile fibres, biodegradable composite to substitute plastics in packaging, biofuels and bioethanol (Viitanen et al., 2019b). Plans to establish new biorefineries in Finland are underway and, if implemented, they will be able to create a few thousand jobs, both directly and indirectly. While the workforce needed in "traditional" forest industry is decreasing, these new products obviously provide new jobs within the forest sector.

The magnitude and need for work force are difficult to estimate, but most probably at least a few hundred jobs will be created. Increasing the value added to wood-based products is not an easy or fast task; as much as the new political programmes and targets are currently in favour of renewable wood, which has several competitive advantages e.g. lightness, processability, less noise and dust on site compared to concrete (Viitala & Mutanen, 2020). Value addition does not necessarily translate to more jobs.

It is worth noting that not all the work closely related to forestry and forest industry is captured under these categories. Workers in wood transportation by roads, railways and floating of timber, for example, are counted under the general transportation sector. It is estimated that 3,000 entrepreneurs and salary earners are engaged in long-distance wood transportation to production plants. In addition, road construction and road improvement work in forests, forest drainage, peatland forest management and remediation are included in excavation sector. Tourism related to forests or to forest environment is accounted for under tourism sector (Kallioniemi, 2019a). Although most of the jobs related to the new forest products are statistically included under forest sector, there are categories, such as biofuels and fibre-based textiles, which are classified in other industries.

3.3.4 Outlook on green jobs in the forest sector

The Finnish Bioeconomy Strategy was established in 2014 and is based on the principles of sustainable development (Finnish Bioeconomy Strategy, 2014[20]). In 2018, bioeconomy accounted for 17% of the total output and 12% of the value added in the Finnish national economy. The forest sector offers a significant contribution in bioeconomy accounting for 39% of the total bioeconomy output (Luke, 2019[21]) and employed 62,500 persons in 2018. In total, the bioeconomy sector has employed 303,200 people in Finland corresponding to 12% of the total labour force, a slight increase of 0.5% from 2017. According to the bioeconomy database, 35,400 persons were working in nature tourism and recreation in 2018 (**Figure 11**).

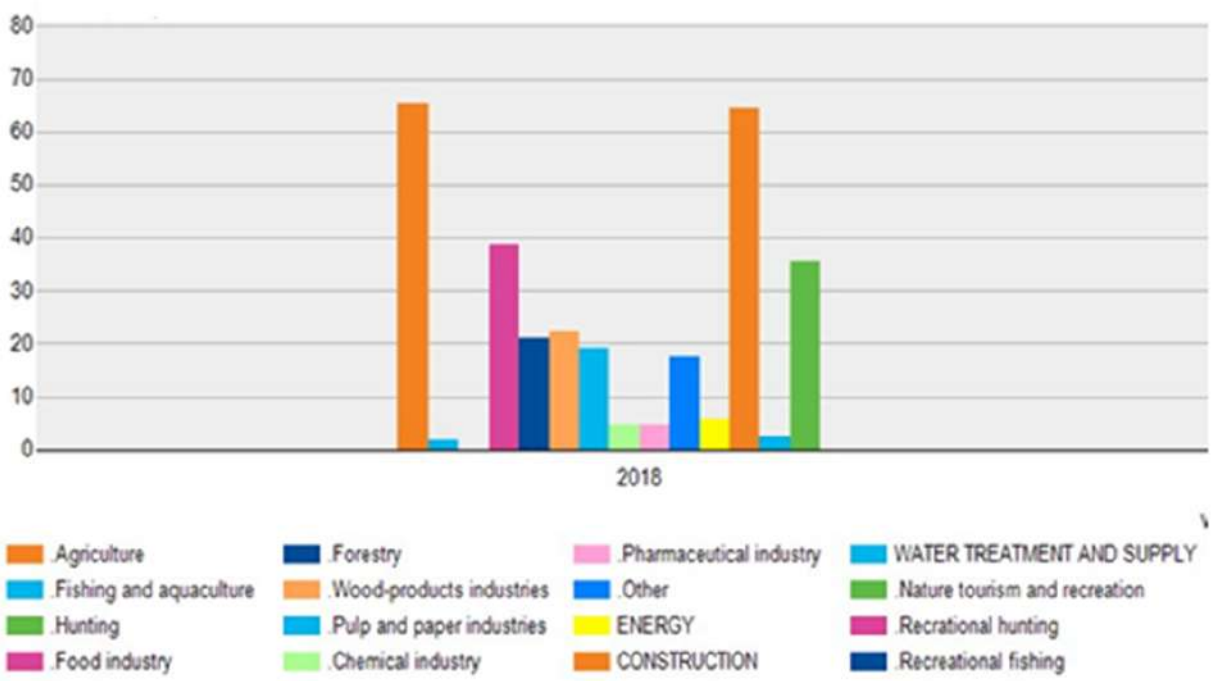


Figure 11: Employed persons in bioeconomy per 1,000 persons. (Y axis: 1000 persons) (Source: Official Statistics Finland; LUKE, 2020[22])

3.3.5 Additional trends in forest-related employment

Short-term work tasks among foreign workers

Under EU law, citizens of member countries are permitted to move freely and to work for a maximum of three months in another EU country without any work permit. This work force is vital for the Finnish forest sector especially in forestry work (e.g. as tree plantation and tree nursery workers) and forest machine drivers for different kind of enterprises. Special arrangements were made during Covid-19 outbreak to ensure that the workers travel to Finland. However, these short-term workers are mostly not included in survey statistics which are based on persons settled permanently in Finland. Therefore, their numbers are not known but could be estimated to be a few thousand.

[20] http://biotalous.fi/wp-content/uploads/2014/08/The_Finnish_Bioeconomy_Strategy_110620141.pdf

[21] https://www.luke.fi/en/news/the-bioeconomy-continues-to-lean-heavily-on-the-forest-sector/

[22] http://statdb.luke.fi/PXWeb/pxweb/en/LUKE/LUKE__10%20Muut__02%20Biotalouden%20tuotos/03_Bio_talouden_tyolliset.px/?rxid=d8d87dad-ebf2-4d0d-8b21-5fb0d9fa0db5

Increasing labour productivity leading to job losses

Since 2011, labour productivity in the forest industry in Finland has grown faster than the national average, especially in the sawmill industry. Globally operating enterprises such as United Paper Mills Ltd. (better known as UPM), Stora Enso Ltd. and Metsä Board Ltd. have been utilizing high technology devices and methods, including robotics and digitalization. In the long run, these technologies are likely going to decrease employment in the sector (Kallioniemi, 2019b).

3.3.6 State and trends in forest-related tertiary education

Forest Sciences and Forest Engineering are the programmes offered at undergraduate level, while Forest Sciences, European Forestry and Forest Engineering are offered at the postgraduate level (Finnish Forest Association[23]). The number of graduates from technician certificate/diploma level was on the rise from 1990 up to 2000 when it started declining, except for bachelor's level where the number of graduates increased from 271 in 2000 to 405 in 2010 but dropped to 320 in 2015 (**Figure 12**).

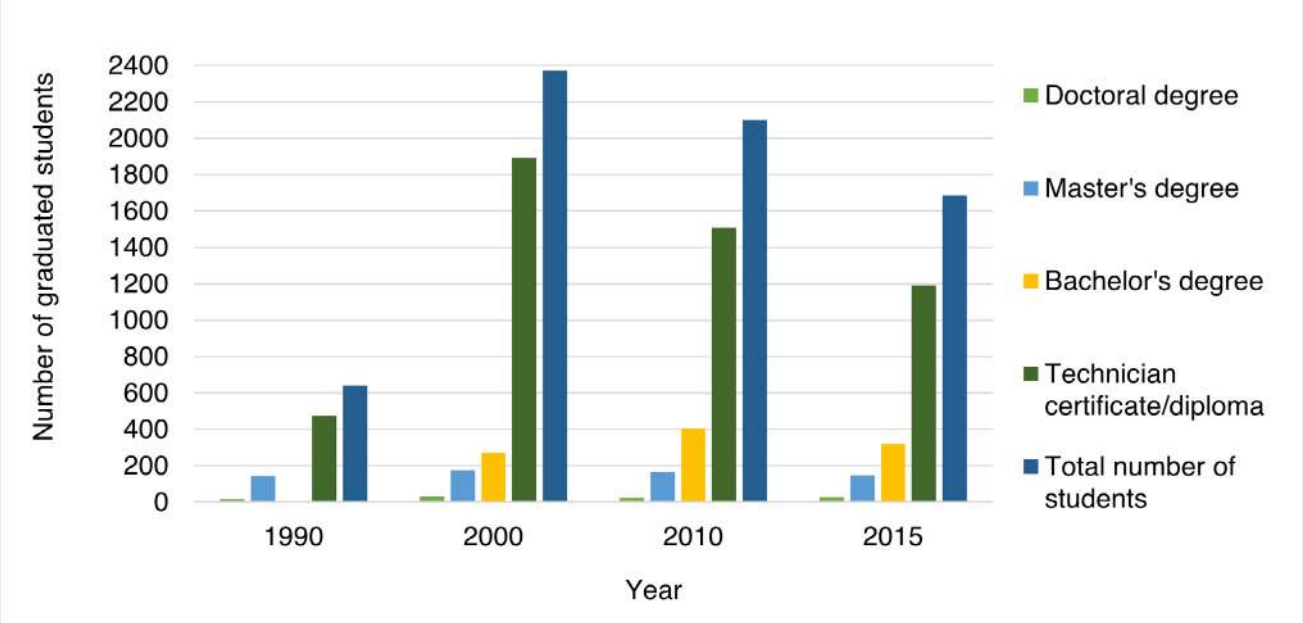


Figure 12: Number of graduated students in forestry and forest industry education. (Source: Global Forest Resources Assessment-Finland, 2020[24])

[23] https://smy.fi/metsa-puhuu/metsaalan-koulutus/

[24] http://www.fao.org/3/ca9995en/ca9995en.pdf

3.4 Germany

3.4.1 Background

Germany has a forest area of 11.4 million hectares with 48% of this area under private ownership. According to the National Forest Inventory 2012, the standing volume was 336 m³/ha while the annual harvest for roundwood without bark was 76 million m³/year and 95.9 million m³/year for roundwood including loss (branches, bark) (Federal Ministry of Food and Agriculture[25]). Aside from forestry and logging, Germany's forest-related economic sectors include: wood working industries, wood manufacturing, pulp and paper as well as wood trading industries. The country follows a tradition of selling timber by the roadside and companies involved in further processing are different from the forest enterprises. The subsequent sections provide an overview of forest-related employment and tertiary education in Germany from 2000-2018.

Photo: Pxfuel.com

3.4.2 State of employment in forestry and logging

Forestry alone plays a comparatively small role in the economy of the forestry and wood cluster compared to the sectors involved in further processing of wood. There were 70,000 workers in the country's forestry sector (silviculture and other forestry activities, logging, gathering of wild non-wood forest products and support services to forestry) in 2015 compared to 77,300 in 2000 (**Figure 13**). A major contribution to the decline was the reduction of directly employed forest workers by forest enterprises (i.e. forest owners). The numbers exclude wood-industry (sawmills, furniture, packaging etc.), wood construction industry, pulp and paper industry, publishing and printing as well as timber trade (Thünen Institute, 2016[26]).

[25] https://www.bundeswaldinventur.de/

[26] https://www.thuenen.de/de/wf/zahlen-fakten/produktion-und-verwendung/clusterstatistik-forst-holz/

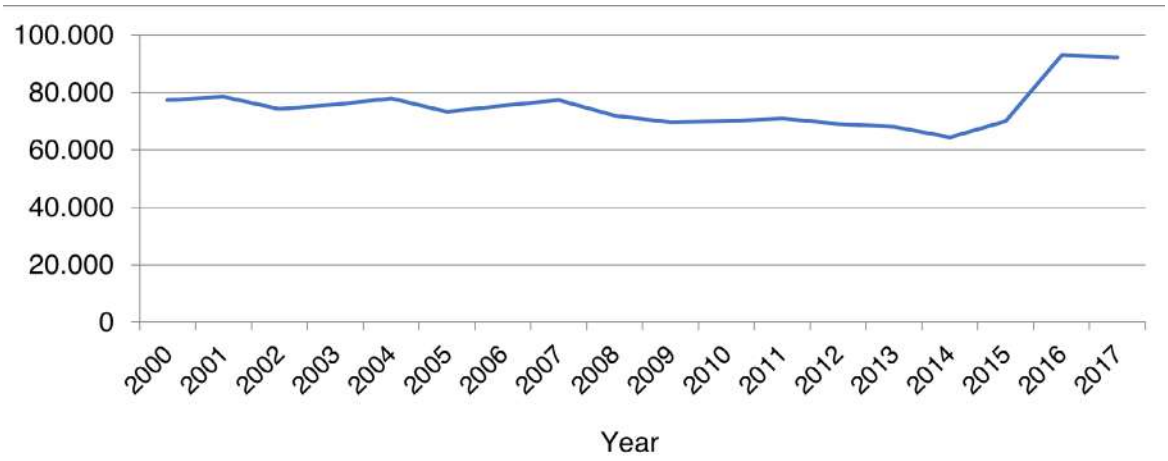


Figure 12: Number of employees in forestry in Germany (2000-2017). (Source: Thünen Institute[27])

Data used in this section is obtained from the German cluster-statistics on forestry and wood industries by the Thünen Institute (2016[28]). The data refers to the number of employees but not number of FTEs.

**It should be noted that the increase from 2015 to 2016 is not based on the rise of the real figures but as a result of changes in the statistical basis.*

3.4.3 State of broader forest sector employment

The timber cluster, comprising of wood processing, wood production, construction, pulp and paper, printing and publishing, and timber trade, employed 1.4 million people in 2000, 1.1 million people in 2010 and 988,000 people in 2017. The number of enterprises offering employment decreased from 104,500 in 2010 to 88,300 in 2017. Contrary to the general decline in employment and the number of enterprises, the number of workers in wood construction sector has been on the rise from 208,000 workers in 2000 to 238,400 workers in 2017. More than 50% of the workforce in the wood construction sector was in the building joiner and fitters category. The number of employees in timber trade increased from 15,302 in 2010 to 17,419 in 2017 (**Table 3**).

[27] https://www.thuenen.de/de/wf/zahlen-fakten/produktion-und-verwendung/clusterstatistik-forst-holz/
[28] https://www.thuenen.de/de/wf/zahlen-fakten/produktion-und-verwendung/clusterstatistik-forst-holz/

Table 3: Employment in the timber cluster* in 2000, 2010 and 2017.
(Source: Thünen-Institute[29])

Germany	2000		2010		2017	
	Enterprises	Total employees	Enterprises	Total employees	Enterprises	Total employees
Wood processing industry	**4,361**	**66,475**	**3,622**	**47,077**	**3,094**	**44,481**
Sawmill industry	4,068	43,665	3,305	30,423	2,774	28,154
Wood based panels industry	293	22,810	317	16,654	320	16,327
Further processing wood industry	**30,510**	**377,532**	**22,922**	**227,179**	**22,560**	**229,336**
Furniture industry	12,597	215,973	11,318	131,466	11,706	133,768
Wood packaging industry	702	12,241	901	12,021	850	12,320
Wood work industry	12,213	103,950	8,096	60,852	7,728	64,331
Other wood processing	4,998	45,368	2,607	22,840	2,276	18,917
Wood in construction	**37,106**	**208,060**	**39,996**	**210,329**	**40,157**	**238,361**
Carpenter	11,216	95,254	13,111	67,868	13,405	75,921
Building joiner and fitters	24,635	106,854	25,667	128,910	24,744	146,659
Parquet reclining (until 2008)	1,255	5,952	0	0	0	0
Prefabricated buildings (since 2009)	0	0	1,218	13,551	2,008	15,781
Paper industry	**2,970**	**158,603**	**2,386**	**134,233**	**2,123**	**131,105**
Mechanical pulp and pulp production	78	11,515	82	6,194	61	3,399
Paper production	650	58,300	514	46,860	426	40,313
Paper processing	2,242	88,788	1,790	81,179	1,636	87,393
Publishing and printing industry	**26,122**	**532,568**	**21,748**	**405,776**	**17,955**	**328,055**
Publishing industry	9,163	246,012	8,175	196,157	7,144	155,345
Printing industry	16,959	286,556	13,573	209,619	10,811	172,710
Timber trade	**3,457**	**17,107**	**2,777**	**15,302**	**2,386**	**17,419**
Timber trade with round- and sawnwood	1,542	8,048	1,278	6,997	1,061	7,096
Wholesale of other semi-finished wood products and wooden construction elements	1,915	9,059	1,499	8,305	1,325	10,323
Timber cluster total*	**104,526**	**1,360,345**	**123,338**	**1,062,774**	**88,275**	**988,757**

** Excludes forestry and logging classes; highlighted fields indicate an increase in the number of employees.*

***Highlighted sections represent an increase in the number of jobs between 2000 and 2017.*

[29] https://www.thuenen.de/media/institute/wf/HM_div._Statistik_Dateien/Dateien_-_Bilanzen_-_Tabellen/Produktion_Verwendung/Clusterstatistik/en_table_forest_and_timber_cluster.xlsx

3.4.4 Outlook on green jobs in the forest sector

The concept of green jobs based on the definition of the International Labour Organization (ILO 2020[30]) has obviously not been taken up by German labour politics beyond a small community of experts. One reason may be that in Germany the connotation of green jobs is traditionally related to all professions in the forestry and agriculture sector. In official publications e.g. by the Ministry of Agriculture, 14 professions are listed (including forest worker, agricultural worker, animal care worker, distiller, hunter). The definition is based on formal vocational job profiles and formal vocational education regulations (BMEL[31]). Initiatives on green jobs in the forest sector, in the wider, ILO-related sense, are not visible in public although initiatives exist.

That said, several new employment fields are emerging in the forest sector but there are no figures available on the number of jobs they provide. Nature education is gaining importance in Germany with more than 1,500 forest kindergartens which use forests as a learning environment for nature education. Start-up enterprises in the field of “nature event management” are also on the rise (e.g. guided mountain bike tours and nature walks). There is also increased use of forests as a physical (and spiritual) environment by individual service providers. However, the slight growth will most likely not compensate the reduction of the workforce in the wood processing industries, especially given the pace at which they are growing, and the different natures of skills required.

3.4.5 Additional trends in forest-related employment

Reduction in the core workforce

Forest operations jobs in the state forest enterprises significantly decreased from 14,900 in 1999 to 7,600 in 2017 (**Figure 14**). Forest service enterprises took up much of the related work and currently provide about twice as many jobs as the state forest enterprises which were the major employer a few years back.

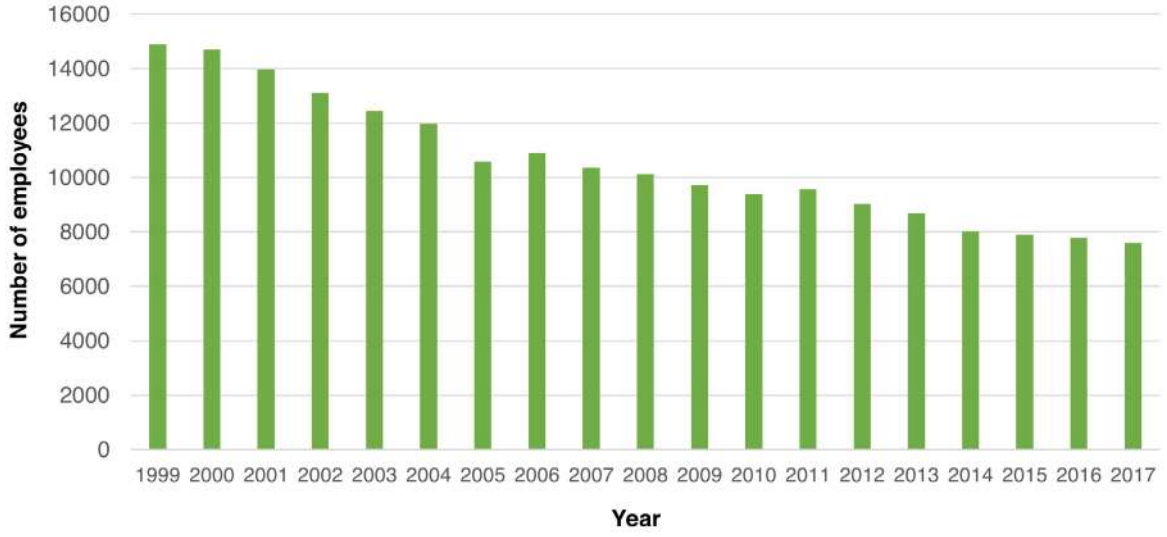


Figure 14: Workforce directly employed by the state forest enterprises.
(Source: KFW, 2019[32])

**Numbers provided are not in FTE*

[30] https://www.ilo.org/global/topics/green-jobs/news/WCMS_220248/lang--en/index.htm
[31] https://www.bmel.de/DE/Laendliche-Raeume/07_GrueneBerufe/_node.html
[32] *Own data-unpublished*

The last full assessment of state forest workers (German Federal States) in 2011 showed that the share of older workers in the workforce was increasing. Over 3,700 workers were aged between 50-54 years while less than 500 workers were found in the 20-24 years age group. This development which according to expert opinions is further aggravating, provides an enormous challenge for the German forest sector. One approach to tackle the problem is to maintain a functional vocational education system. About 1,500 young people undertake apprenticeships in forestry annually in Germany and this could rejuvenate the forestry work force at least to some extent, provided that forestry will be attractive enough to compete with other job opportunities.

Increased demand for competent workers

The search for competent forest workers has proved to be an uphill struggle for the whole forest sector due to the eminent scarcity of such workers. Demand for workers to carry out harvesting, reforestation and regeneration to cope with the acute forest damages (bark beetle disaster) is on the rise. New emerging risks (e.g. dead standing timber) related to nature conservation and biodiversity goals also create the need for competent workers with (much) higher risk management skills.

Increase in short-term foreign workers

The big unknown currently is the number of migrant workers mainly from South-East Europe who work in German forests temporarily. These workers are hired by forest service providers, mainly for motor-manual timber harvesting operations. Information on the competences of this workforce, and safety issues is not known. It is reported by contractors and foresters that this work force is needed to compensate the shortfall of competent domestic workers. The need for workers to carry out manual work may increase in the coming years since enormous areas will need to be recultivated after the disastrous bark beetle calamity which has hit German forests for the third year in a row. It can only be stated that there will be a huge demand for workers which will most likely not be met by the domestic labour market.

Improvement in workers' safety in German state forest enterprises

Forestry continues to be among the most dangerous occupations. The nature of the work itself (e.g. use of chainsaws) and the physical environment in forests create a wide range of accident risks which require considerable attention by workers and professionals.

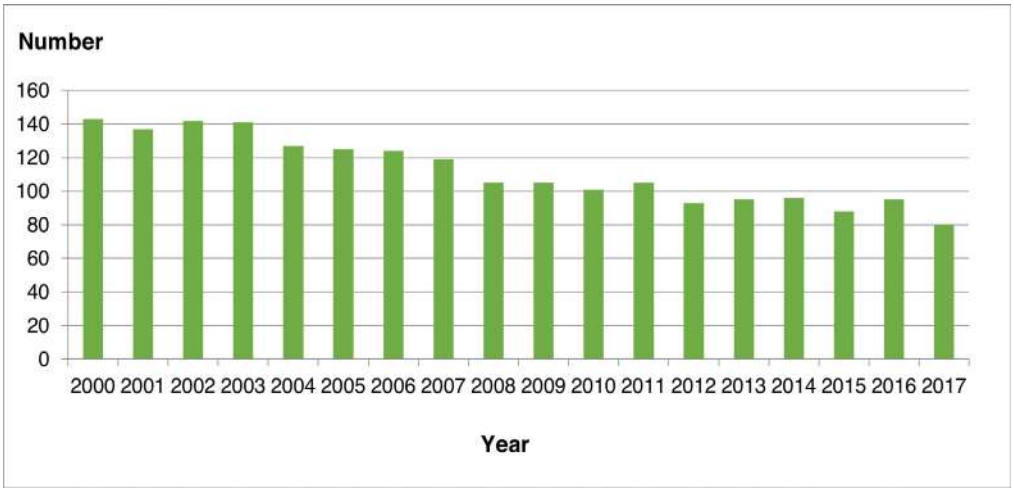


Figure 15: Accident frequency per 1,000 forest workers between 2000- 2017. (Source: KFW[33])

[33] https://unfallzahlen.kwf-online.de/

An example from the German state forests shows that the relative accident frequency has continuously decreased over time (**Figure 15**). This could be attributed to the huge effort in training, work organization and technology. The need to cope with risks and quality requirements calls for competences of forest workers which are normally obtained in formal training, i.e. a three years apprenticeship.

3.4.6 State and trends in forest-related tertiary education

Forest Sciences and Forestry programmes are offered by 4 universities and 5 Universities of Applied Sciences[34]. Some new programmes that have been recently introduced in the universities include: M.Sc. Urban Tree and Woodland Management; B.Sc. Wood Technology (dual) and M.Sc. Forest System Transformation and B.Eng. Open Land Management. From 2001-2018, the number of students in Forest Sciences and Forestry programmes increased steadily from 3,700 in 2001 up to 6,500 in 2018 (**Figure 16).**

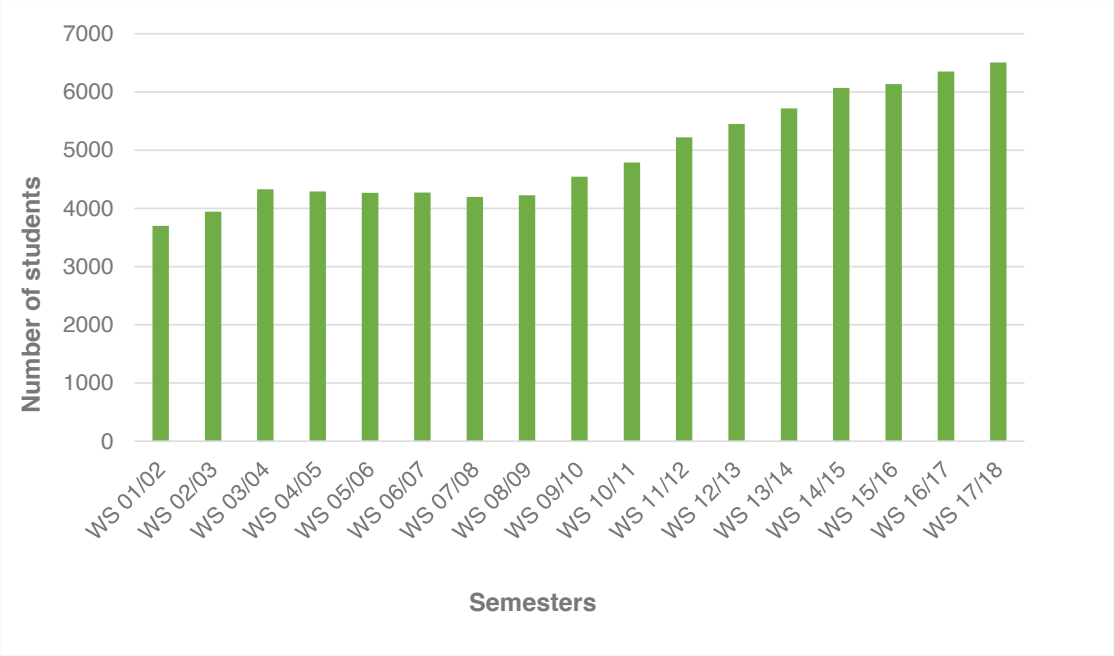


Figure 16: No. of students of Forestry Sciences and Forestry from 2002-2018.
(Source: Higher Education Compass[35] and contacted persons in the respective universities)

The number of students graduating in forestry and wood-related studies from technician certificate to doctoral level declined from 1,800 in 1990 to 1,600 in 2010 but has since been steadily rising again with 1,800 students graduating in 2015 (Global Forest Resources Assessment-Germany, 2020[36]).

[34] https://www.hochschulkompass.de/agrar-und-forstwissenschaften/

[35] https://de.statista.com/statistik/daten/studie/269925/umfrage/studierende-der-forstwissenschaft-und-wirtschaft-in-deutschland/

[36] http://www.fao.org/3/ca9997en/ca9997en.pdf

3.5 Indonesia

3.5.1 Background

Indonesia's official forest land use zone is divided into two categories: state forest (120.6 million hectares) and non-state forest areas. The state forest areas are further subdivided into three forest types: production forests (57%), protection forests (25%), and conservation forests (18%) (KLHK, 2019). There are two main types of companies in the production forest areas: management of timber plantation, and natural forest management concessions.

- Hak Pengusahaan Hutan (HPH) are natural forest concession; with 262 concession holders existed in 2020.
- Timber plantation estates (318 estates existed in 2020 are further classified into:
    - Hutan Tanaman Industri (HTI), these are Industrial Forest Plantation companies, focussing on the cultivation of short rotation species;
    - Perum Perhutani (PT) are state-owned plantation forest enterprise, focussing on long rotation species, e.g., teak for timber and pine for resin; and
    - "other" plantation estates.

The subsequent sections provide an overview of forest-related employment and tertiary education in Indonesia from 2007-2019.

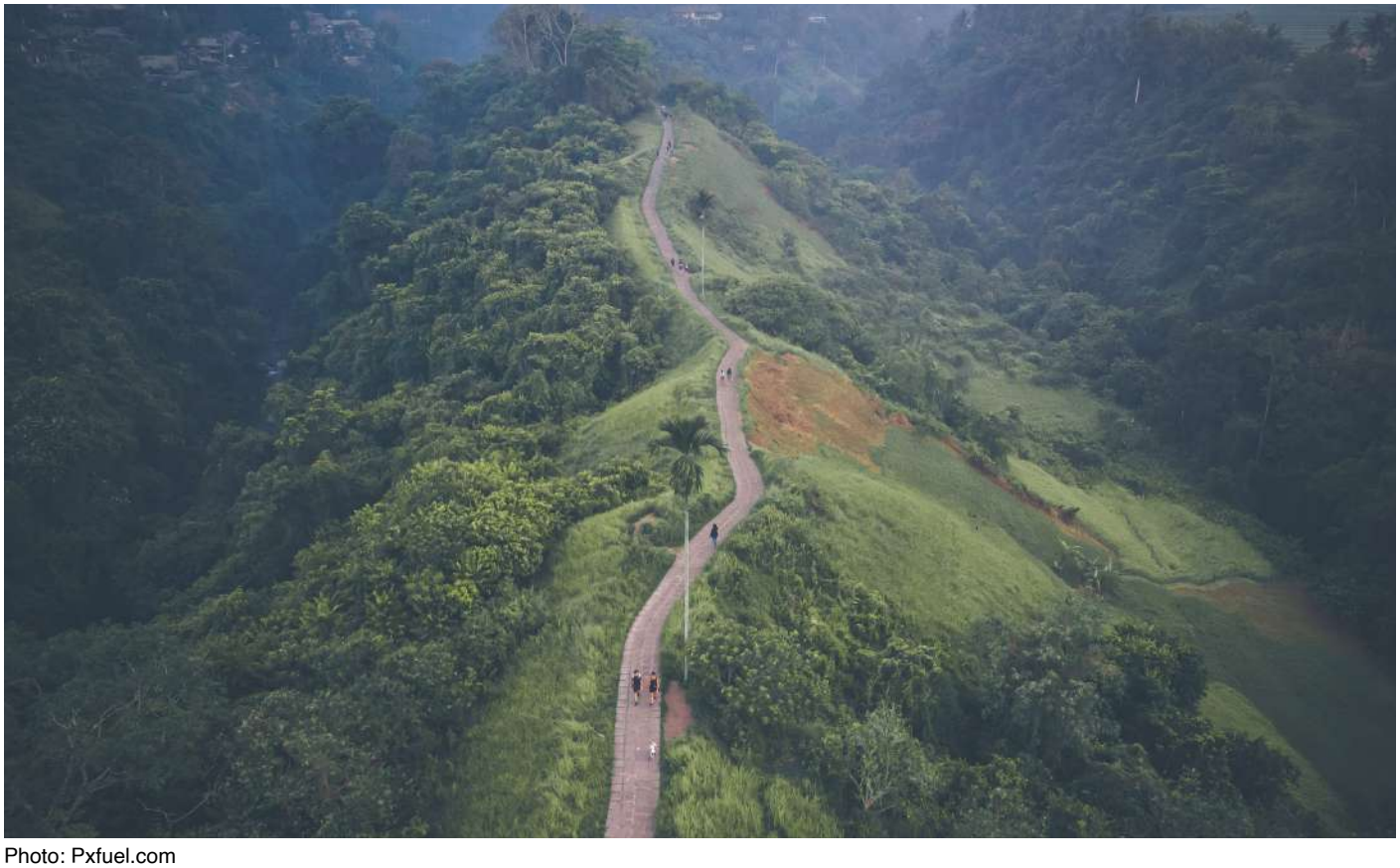


Photo: Pxfuel.com

3.5.2 State of employment in forestry and logging

Most of the forestry and logging activities in Indonesia are carried out in the production forests. In 2019, forestry and logging (ISIC Division 02) contributed 0.66% (equal to IDR104,122 trillion) to the country's GDP. In 2017, the HTI produced 71% of Indonesia's logs, HPH produced 18%, while Perhutani and others produced 11% (BPS, 2019[37]).

The total number of workers in the HPH, HTI, Perum Perhutani and other timber estates decreased from 85,300 in 2007 to 56,700 in 2012, but rose again to 68,800 in 2017. In general, there is a decrease in the total number of workers involved in forestry and logging (**Figure 17**). It should be noted that the figure excludes self-employed workers, workers assisted by family members (unpaid workers), e.g. felling operators, manual skidding workers, forest stand maintenance workers, and workers engaged in forest land preparation, or community forestry operators, due to data unavailability.

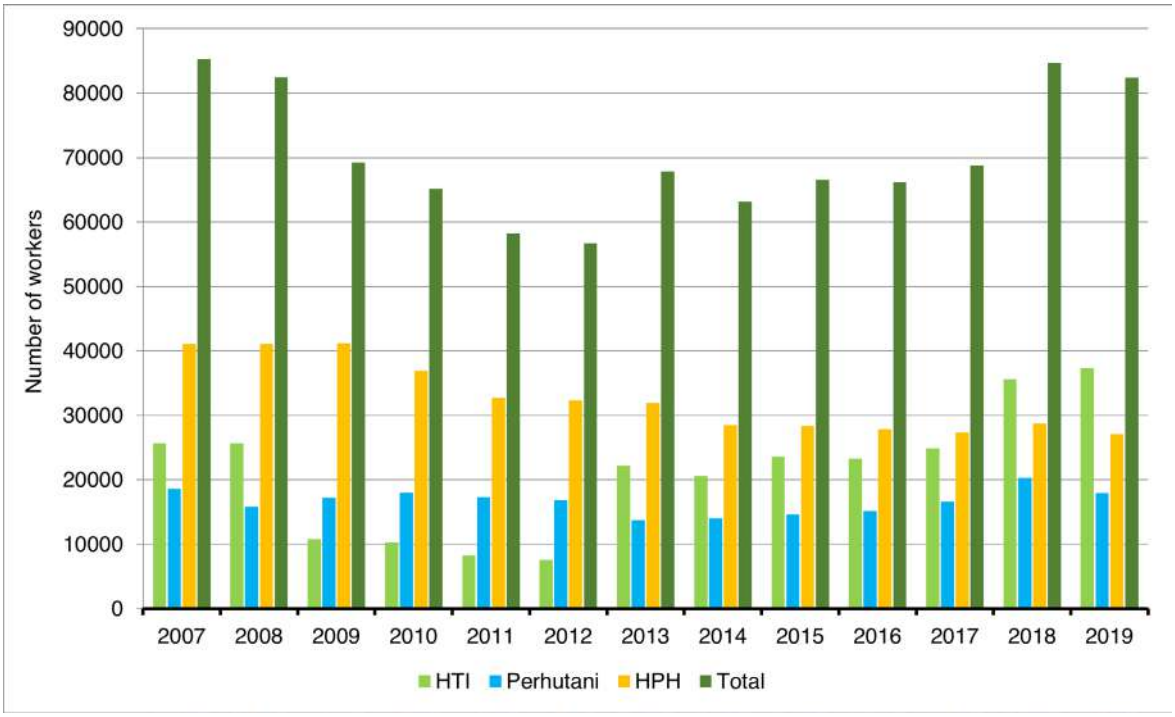


Figure 17: Forestry workers in Indonesia from 2007-2019.
(Source: BPS-Statistics Indonesia)

There are more male workers in the HTI: timber estates (plantation forests), Perhutani: state-owned forest enterprises (plantation forest), and HPH: forest concession estates (natural forests) compared to female workers. Only 14% of females work in HTI, 6% in HPH, and 11% in Perhutani, mostly work as office/administrative staff or nursery workers (**Figure 18**).

[37] https://www.bps.go.id/publikasi.html

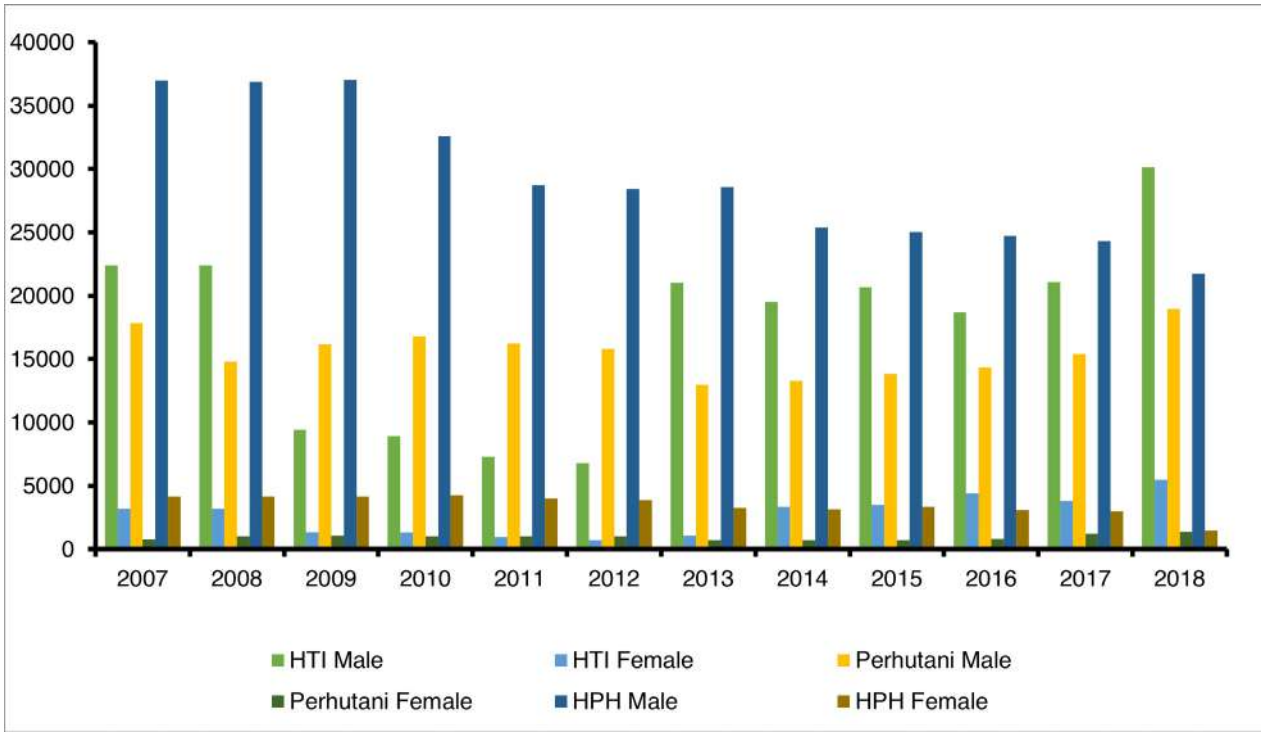


Figure 18: Gender distribution of forest workers. (Source: BPS - Statistics Indonesia, 2007-2018)

3.5.3 State of broader forest sector employment

BPS-Statistics Indonesia (2017) reported an increase in the total number of workers in wood sawmilling and planing, wood and cork products, straw and plaiting material, paper and paper products, and wooden furniture (from 489,900 in 2013 to 615,400 workers in 2017) (**Figure 19**).

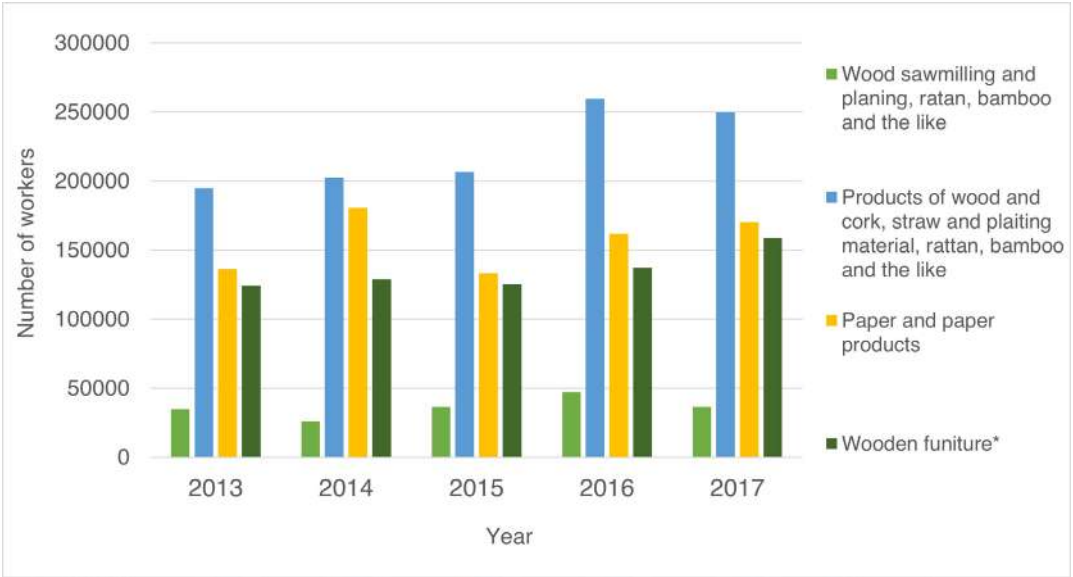


Figure 19: Workers in forest-related industries. (Source: BPS-Statistics Indonesia, 2017)

**wooden furniture: the number presented is assumed to be 75% of total workers involved in the manufacture of furniture and related products of any material except stone, concrete and ceramic.*

3.5.4 Outlook on green jobs in the forest sector

Indonesia developed a National Long-Term Development Plan (RPJPN) 2005-2024[38], which is divided into 5-year Medium Term Development Plans (RPJMN) with clear guidelines on the path towards national development. The green jobs concept is not explicitly stated in the RPJPN but accounted for in the RPJMNs (features in at least 4 out of 7 development agenda of the 2020-2024 RPJMN).

The plan of developing green jobs in the forestry sector is outlined in the Strategic Plan of the Ministry of Forestry and Environment (as the embodiment of the 2020-2024 RPJMN). In the 2020-2024 strategic plan, the Indonesian government has shifted the forest management objectives. Originally focused on timber management, the priority has now shifted to the concept of forest ecosystems management and community-based forest management. Ecotourism has a considerable growth potential. In 2015, tourists in conservation areas reached 4.2 million people, which increased to approximately 7.3 million tourists in 2019. Community access to forest management has also developed considerably.

As of 2019, the total participating households is 712,600 (on an area of 3.6 million hectares). The participation rates are very likely to increase rapidly, considering that the government has prepared an indicative map for community forestry covering an area of 13.6 million hectares. Meanwhile, the export value of animal breeding/wild plants and bioprospecting carried out by applying precautionary principles, sustainability, legality, and traceability has increased rapidly from IDR5.3 trillion rupiah in 2015 to IDR10.03 trillion in 2019. Thus, major activities that will continue to develop are ecotourism in conservation areas, community forestry, animal breeding/wild plants, and bioprospecting.

3.5.5 Additional trends in forest-related employment

Widespread informal employment in forestry and logging

Most of the front line forestry workers are informal workers categorized as temporary or unpaid workers assisting an employer (97,800) or family members' voluntary contribution (118,500) (ILO, 2010). Most of these workers are not registered as workers in the HPH, HTI, or Perhutani. The actual number of informal workers is estimated to be higher than those of formally registered workers.

[38] https://policy.asiapacificenergy.org/sites/default/files/LONG-TERM%20NATIONAL%20DEVELOPMENT%20PLAN%20OF%202005-2025%20%28EN%29.pdf

Professional certification for positions in forest management and assessment

In 2014, the Government of Indonesia recommended that certain tasks in forest management and forest assessments to be carried out by competent technical officers/professionals. Five official professional forestry certification bodies in Indonesia are in charge of the process: the Indonesian Forestry Professional Certification Body (Lembaga Sertifikasi Profesi Kehutanan Indonesia, LSPHI[39]); the Indonesian Forester Professional Certification Body (Lembaga Sertifikasi Profesi Rimbawan Indonesia, LSPRINO[40]); Perhutani Professional Certification Body; Indonesian Forestry Education and Training Center; and National Certification Body for Government Officers.

The total number of professionals that have been certified up to 2020 are 17,400 people spread across 19 certification schemes consisting of forest extension officers, timber legality auditors for Timber Legality Assurance System, middle managers, nursery officers, mandatory Sustainable Forest Management auditors, field supervisors (including chainsaw operators), Geographical Information System officers, forest rangers, forest ecosystem controller, and ecotourism professional guides. The number of the certified officers is increasing steadily, considering the vast forest area that needs to be managed.

Photo: Pxfuel.com

Poor work environment and safety

Majority of the forestry workers not only have low formal education and technical skills, but they also face high occupational safety and health risks. Moreover, the work is physically demanding. An average of 984 accidents and 47 deaths were reported between 2008 and 2015, mostly associated with felling and bucking (data taken only from formal workers). Operator level workers spend an average of 53% of their income on food to compensate high energy expenditure (Yovi & Yamada, 2019).

The Government of Indonesia promotes occupational safety and health (OSH) of the forestry workers. A national mandatory forest certification scheme called "Indonesia's Sustainable Forest Management System" (initiated in 2002 and effected in 2009) articulates the forestry worker's OSH protection. The OSH value is reflected in the scheme's precondition, production, ecology, and social principles. However, the verifiers are inadequate to ensure the presence of a proper and good safety performance (in behaviour domain), as most of the norms only rely on the completeness of safety-related documents (more to the administrative than performance-based assessment) (Yovi & Nurrochmat, 2018).

39 https://www.lsp-lhi.or.id/

40 http://direktoritraining.com/daftar-lembaga-sertifikasi-profesi-lsp-di-indonesia/

3.5.6 State and trends in forest-related tertiary education

There are 68 universities offering forestry programmes in Indonesia (Ministry of Research and Technology/National Agency for Research and Innovation[41]). The total number of graduates from technician certificate/diploma to doctoral level has been rising from 2,300 in 1990 to 9,900 in 2015 (**Figure 20**). In the 2018/19 academic year, there were 24,200 students enrolled in forestry programmes. The IPB University is an exceptional case with a high level of competitiveness, the total number of applicants increased significantly from 2,700 applicants in 2011 (acceptance rate: 389 students) to 7,400 applicants in 2018 (acceptance rate: 352 students) (Ministry of Research and Technology/National Agency for Research and Innovation[42]).

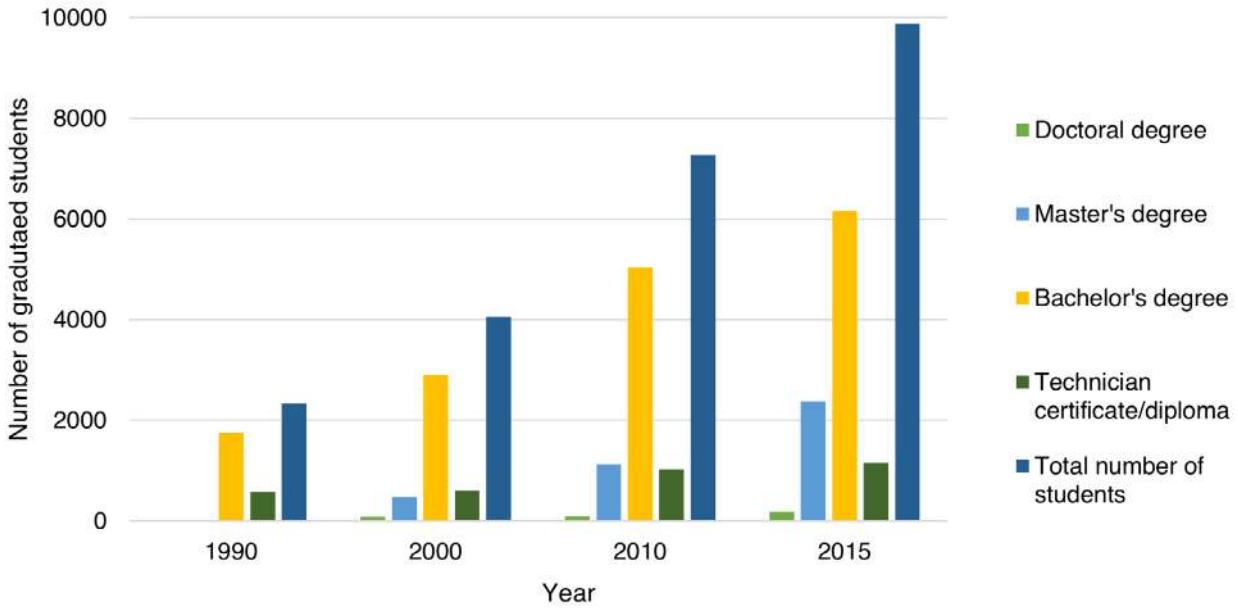


Figure 20: Number of graduated students in forest-related tertiary education.
(Source: Global Forest Resources Assessment-Indonesia, 2020[43])

[41] https://forlap.ristekdikti.go.id/files/downloadinfografis/Ng~~
[42] https://forlap.ristekdikti.go.id/files/downloadinfografis/Ng~~
[43] http://www.fao.org/3/cb0007en/cb0007en.pdf

3.6 South Africa

3.6.1 Background

Natural forests cover approximately 40 million hectares of the country's land surface, which include indigenous forests and woodlands. The indigenous forests comprise about 500,000 hectares while savannah woodland ecosystems cover a further 39 million hectares. Commercial plantations cover approximately 1.26 million hectares of South Africa with over 80% of these located in Mpumalanga, KwaZulu-Natal, and the Eastern Cape provinces. Approximately 57% of the plantation area is managed mainly for pulpwood production, 38% for sawn log purposes, 2% for poles, 2% for mining timber while the remaining 1% is for other purposes. The forest sector (forestry and forest products) contributes about 1% to the country's GDP. More than 80% of the commercial plantations have achieved Forest Stewardship Council (FSC) certification of conformity with sustainable management practices including requirements for competent staff and decent work (Department of Agriculture, Forestry and Fisheries, 2012; FSC 2017[44]).

South Africa has eleven corporate timber growing companies who own 0.9 million hectares (72.9% of the total plantation area), 1,100 commercial timber farmers owning 0.2 million hectares (16.1%), and 25,000 small-scale timber growers owning 0.05 million hectares (3.7%). The state manages 0.09 million hectares (7.3%) through the Department of Environment Affairs, Forestry and Fisheries and five municipalities (Godsmark & Oberholzer, 2019). The subsequent sections provide an overview of forest-related employment and tertiary education in South Africa from 2005-2020.

3.6.2 State of employment in forestry and logging

South Africa's forestry industry* has been a reliable source of employment especially for the rural communities. Domestic and international demand for South African forest products surpassed supply by about 15% in 2008 (Department of Agriculture, Forestry and Fisheries, 2012). The industry provided 59,800 direct jobs and 27,500 indirect jobs in the downstream processing activities, with 30,000 working for forestry contractors in 2018. There are 74 formal sawmilling and veneer plants operating in the country. The ten biggest sawmills process over 50% of the total annual intake (± 4.7 million m^3) and offer 20,000 direct and 8,000 indirect employment opportunities. The three biggest out of the 15 veneer plants in operation take in just under 50% of the total annual intake (± 420 billion m^3) thereby creating 2,200 direct jobs (Godsmark & Oberholzer, 2019).

Four main charcoal plants operate in the country. Two of them account for 80% of the total intake (± 99,000 m3), employing hundreds of charcoal micro manufacturers (Forestry Regulations and Oversight, 2019). No formal studies have been conducted that can describe the trends in employment including informal employment and employment in the native forests over the years. However, the mechanisation of logging operations by forestry companies in South Africa, would translate into reduced employment numbers. The annual volume of timber harvested has also declined in the last 10 years from 18.5 million tons in 2010 to 14.3 million tons, which has also contributed to a reduction in employment.

[44] https://fsc.org/en/document-centre/documents/retrieve/3dad4fe0-0c91-4b0d-b631-dcd799179ff3

Most of the rural households in South Africa's woodland areas depend on non-wood forest products, usually to supplement other forms of income. Between nine and twelve million people use fuelwood, wild fruit and vegetables, medicinal plants and wooden utensils obtained from forests and woodlands (Department of Agriculture, Forestry and Fisheries, 2012).

**(Forestry industry refers to: silviculture, logging and three downstream processing activities: sawmilling, pulp and paper, and wood preservation)*

3.6.3 State of broader forest sector employment

Exports are a very important driver of demand for forest products such as roundwood and accounted for approximately 40% of primary roundwood consumption. The domestic market on the other hand accounted for the remaining 60%. Domestic demand is driven by residential building activities, household consumption expenditure, rising standards of living, a growing mining industry, increasing agricultural output and general manufacturing output (Department of Agriculture, Forestry and Fisheries, 2012).

In 2018, forest-related industries offered 51,400 direct jobs and 18,800 indirect jobs in downstream processing activities with sawmilling being the biggest employer (**Table 4**).

Table 4: Employment in forest-related industries in 2018. (Source: Godsmark & Oberholzer, 2019)

Industry	No. of employees		Total employment
	Direct	Indirect	
Pulp and paper	13,200	10,800	24,000
Sawmilling	20,000	8,000	28,000
Timber board	6,000	n/a	6,000
Mining timber	2,200	n/a	2,200
Other	10,000	n/a	10,000
Total	**51,400**	**18,800**	**70,200**

South Africa has 16 operational Pulp, Paper and Board plants. The five biggest plants take in over 91% of the total annual intake (± 12.5 million m3) and offer 13,200 direct and 10,800 indirect jobs (**Table 4)**.

The estimated public sector employment is 3,700 workers under the Forestry Branch of the Department of Environment, Forestry and Fisheries. The employees perform administrative roles as part of the Department's mandate to regulate the forest industry. Private forest sector employment is estimated at 155,000 workers both in forestry and downstream processing activities (direct and indirect jobs) (Godsmark & Oberholzer, 2019). Forest industry provides entry level jobs in rural areas with 70% workforce being unskilled and generally illiterate. Operations are partly outsourced to over 300 forestry contractors who employ 30,000 people.

South Africa is keen on the use and development of sustainable timber products such as: nanocellulose; bioenergy from plantations, sawmills and other plant residues; and engineered timber products (CLT, LVL, etc.). The use of nanocellulose have so far created high-end jobs in research and development, innovation, and science and engineering. More production plants to manufacture and supply these products will be established.

3.6.4 Outlook on green jobs in the forest sector

The Green Economy is one of the priority sectors in South Africa's New Growth Path aimed at enhancing growth, employment creation and equity. Through clean manufacturing and environmental services, projections show that 300,000 jobs could be created over the next decade (Green Economy Accord[45]). The department of environmental affairs has identified some key areas for greening in construction, transport and infrastructure, energy, water and waste management among others. As much as there are no explicit initiatives in the forest sector itself, there are some important fields that can contribute to green jobs in the sector. Control of invasive alien species such as pine, eucalyptus and acacia is already playing a significant role in South Africa. Plantation forests also offer quite a wide range of tourism opportunities, such as hiking trails, birdwatching, mountain biking, etc and contribute to the creation of green jobs.

3.6.5 Additional trends in forest-related employment

Widespread mechanisation by industries

Mechanization has become increasingly important in South Africa due to the competitive nature of the global timber and fibre markets. To survive international competition, the South African industries have mechanized their operations and have been able to enhance cost effectiveness and sustainability. The use of contractors has increased especially in transport and harvesting and silvicultural operations. So far, mechanization has led to improvements in the working environment ("modernisation") and cost reduction through increased efficiency. However, the downside is the resulting job losses.

Photo: G J Whitby / Pixabay

[45] https://www.gov.za/about-government/government-programmes/new-growth-path

Training of contracting staff in forestry and logging

The South African Forestry Contractors Association (SAFCA) is actively involved in the facilitation and training management of contracting staff. This is done to enhance the economic performance of timber growers. Fire protection, silviculture technical training and health and safety are the most important areas where significant training has been offered with the number of trained staff being on the rise between 2016 and 2018 (**Figure 21**).

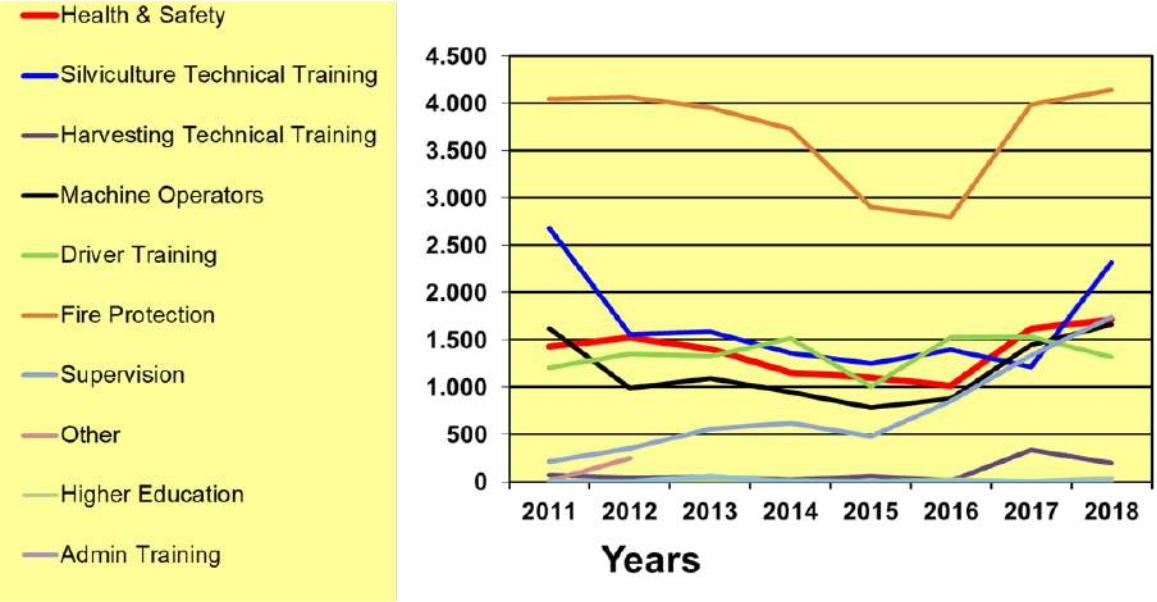


Figure 21: Contracting staff trained between 2011-2018. (Source: Steenkamp, 2019)

Forestry South Africa (FSA) is also involved in the facilitation and training management of emerging growers. Funding for this training is intermittent and is obtained through various government funding initiatives such as the Sector Education and Training Authorities. There is a general decline in the numbers of trained growers (**Table 5**).

Table 5: Emerging growers trained between 2008 and 2020. (Source: Ndlela, 2020)

Courses offered	2008-2009	2009-2010	2011-2012	2015-2016	2017-2018	2019-2020
Capacity Building	75					
Silviculture		711	100	375		
Supporting Personnel			10			
Farm Management				60		
Firefighting				165	270	60
Supervisor					60	30
Chainsaw Operation				77		60
Business Practice					46	
Virtual Reality						2

3.6.6 State and trends in forest-related tertiary education

There are five universities offering forest-related programmes in South Africa. Some universities have introduced new programmes such as: Advanced Diploma (Forestry Management, Wood Technology) and Postgraduate Diploma (Forest and Wood Science). The number of graduates in South Africa has been increasing since 2005 with some year-to-year fluctuations (Figure 22). Nelson Mandela University (NMU) has the highest number of students followed by Stellenbosch University (SU). There is a decreasing number of students in forestry colleges. An example from the "Fort Cox Agriculture and Forestry Training Institute" shows that there were 35 students in 2009 compared to 10 students in 2019 (**Figure 22**).

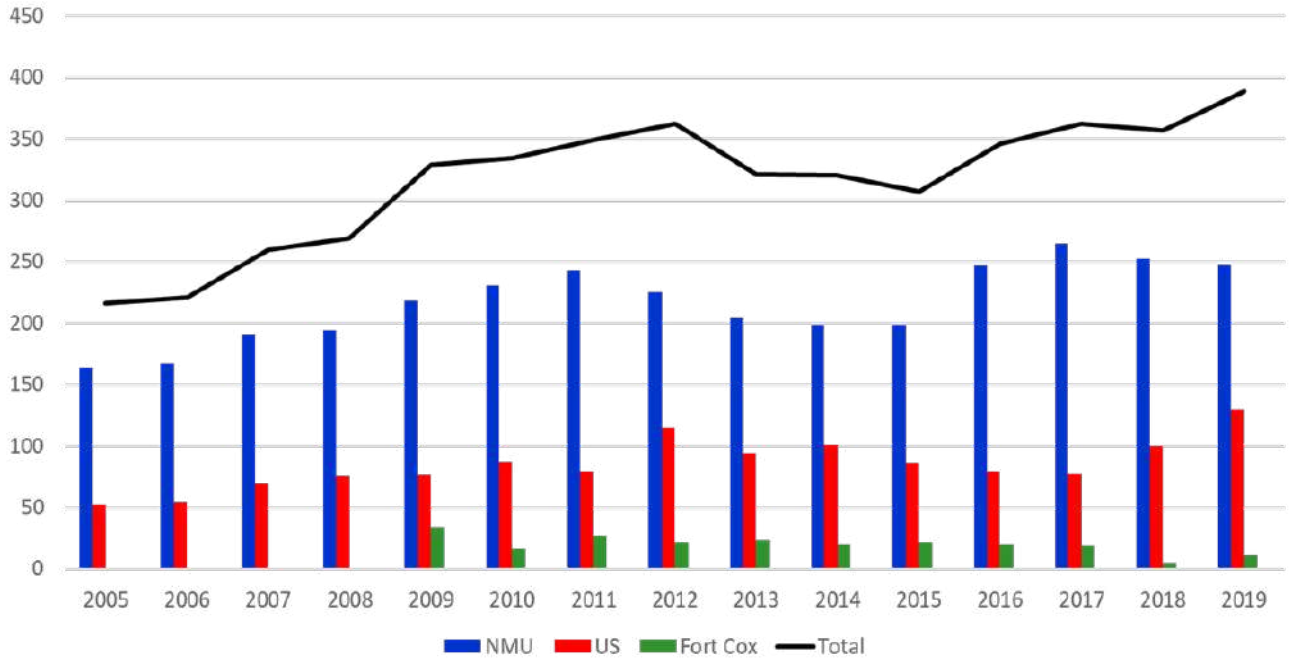


Figure 22: Number of graduates from three tertiary institutions in South Africa. X axis: year; Y axis: number of students (Source: Data obtained directly from Heads of Departments of the respective institutions)

3.7 United States of America

3.7.1 Background

The amount of forest lands in the United States of America (USA) has been relatively stable in recent decades, with the country being about one-third forested, with over 305 million hectares of forestland, highly varied in climate and ecosystems (Alvarez, 2007). Of the forested land 75% is considered natural origin timberland, 8% productive reserve, 6% unproductive reserve, and 11% planted timberland (Oswald et al., 2019). The USA has one of the largest forested area of any nation today, around 8% of the world's forests (FAO, 2010[46]). Most public land ownership is in the western part of the nation, while much of the 58% of private ownerships are in the eastern half. In the 19th century, the USA was heavily deforested, however, today, there is more forestland than 100 years ago, with the number of trees and standing biomass in the country increasing slightly each year (Oswalt et al., 2014). In 2007, over 17 billion metric tons of carbon were estimated to be stored in living forests in the US (Alvarez, 2007). The subsequent sections provide an overview of forest-related employment and tertiary education in the USA between 2000-2018 and a projection of up to 2028.

3.7.2 State of employment in forestry and logging

The North American Industry Classification System (NAICS) Divisions 113 and 115 correspond to forestry and logging in ISIC Division 02 classification. Data from the US Census Bureau for both private and public sectors combined shows a decrease in forestry and logging and associated services from 2000 to 2017, with a sharp decrease occurring from 2005 to 2010, and stable to even slightly growing numbers from 2012-2017 (U.S. Census Bureau, 2017[47]). From 2000-2010, the total number of employees employed within the five industries fell by 63,400 (**Table 6**), likely due to the Great Recession and economic crisis between 2008-2009.

Table 6: Annual industry employment in corresponding ISIC Division 02 classes, 2000, 2005, 2010, 2012, and 2017[48]. (Source: Bureau of Labor Statistics, U.S. Department of Labor: United States Census Bureau, County Business Patterns Survey, All establishments)

Industry	NAICS Code	Number of employees				
		2000	2005	2010	2012	2017
Forestry and logging	113	83,143	69,541	53,525	53,515	54,097
Timber tract operations	1131	3,337	4,524	2,059	2,129	3,883
Forest nursery and gathering forest products	1132	1,677	1,791	1,507	1,658	1,133
Logging	1133	78,129	63,226	49,959	49,728	49,081
Support services for forestry	1153	14,650	14,260	10,486	10,672	12,445

[46] http://www.fao.org/3/al658E/al658E.pdf

[47] https://data.census.gov/cedsci/ & https://www.census.gov/programs-surveys/susb/data/tables.All.html

[48] https://www.census.gov/programs-surveys/susb/data/tables.All.html

3.7.3 State and trends in forest-related tertiary education

Similar patterns as noted above in forestry and logging do also apply to broader forest sector employment (**Table 7**). The five forest-related industries with the highest number of workers in 2017 were: wood product manufacturing (22.3%), paper manufacturing (19%), other wood product manufacturing (13.1%), millwork (6.1%) and pulp, paper and paper board mills (5.5%). A recovery in employment between 2012 and 2017 was especially strong for engineered wood manufacturing, and significant for plywood manufacturing overall, while paper manufacturing has continued to decline since the 2008 recession. Drastic declines in employment occurred in areas categorized as all other wood product manufacturing (97.8%) and newsprint mills (81.5%) (**Table 7**).

Table 7: Industry employment in forest-related sectors: 2000, 2005, 2010, 2012, and 2017. (Source: Bureau of Labor Statistics, U.S. Department of Labor: United States Census Bureau, County Business Patterns Survey, All establishments)

Industry	NAICS Code	No of employees				
		2000	2005	2010	2012	2017
Wood product mfg	**321**	**597,684**	**555,942**	**350,288**	**341,009**	**407,160**
Sawmills and wood preservation	3211	131,353	117,346	78,563	76,446	87,815
Plywood, engineered wood product mfg	3212	120,578	116,365	64,954	59,534	80,503
Hardwood, veneer and plywood mfg	321211	24,050	18,979	11,840	12,163	11,761
Softwood veneer and plywood mfg	321212	27,180	22,646	15,232	13,608	14,874
Engineered wood member mfg	321213	742	7,675	4,546	2,889	5,774
Truss mfg	321214	43,454	45,495	18,499		32,719
Reconstituted wood product mfg	321219	25,152	21,570	14,837	13,423	15,375
Other wood product mfg	3219	345,753	322,231	206,771	205,029	238,842
Millwork	32191	157,685	157,431	97,374	96,892	110,619
Wood window and door mfg	321911	72,999	78,179	49,352	47,123	54,943
Other millwork, including flooring	321918	43,033	46,058	27,147	25,311	33,243
All other wood product mfg	32199	134,564	112,610	62,319	58,982	2,924
Manufactured home, mobile homes	321991	64,568	46,520	21,547	21,057	22,114
Prefabricated wood building mfg	321992	27,325	27,499	14,223	12,441	17,299
Paper mfg	**322**	**553,943**	**453,966**	**365,099**	**355,648**	**345,542**
Pulp, paper, and paperboard mills	3221	177,141	146,933	111,635	108,674	101,082
Pulp mills	32211	9,963	7,731	6,794	8,678	7,776
Paper mills	32212	113,828	100,381	70,172	64,451	59,189
Paper, except newsprint, mills	322121	102,728	95,382	66,041	60,053	57,140
Newsprint mills	322122	11,100	4,999	4,131	4,398	2,049
Paperboard mills	32213	53,350	38,821	34,699	35,545	34,117

The US Bureau of Labor Statistics published employment numbers of conservation scientists and foresters separately by state as part of the Occupational Outlook Handbook (Bureau of Labor Statistics[49]). The West Coast of the United States leads in forester employment with Oregon, Washington, and California in the top five employers of foresters. Minnesota and Wisconsin in the Midwest also had high forester employment in 2018 (**Figure 23**).

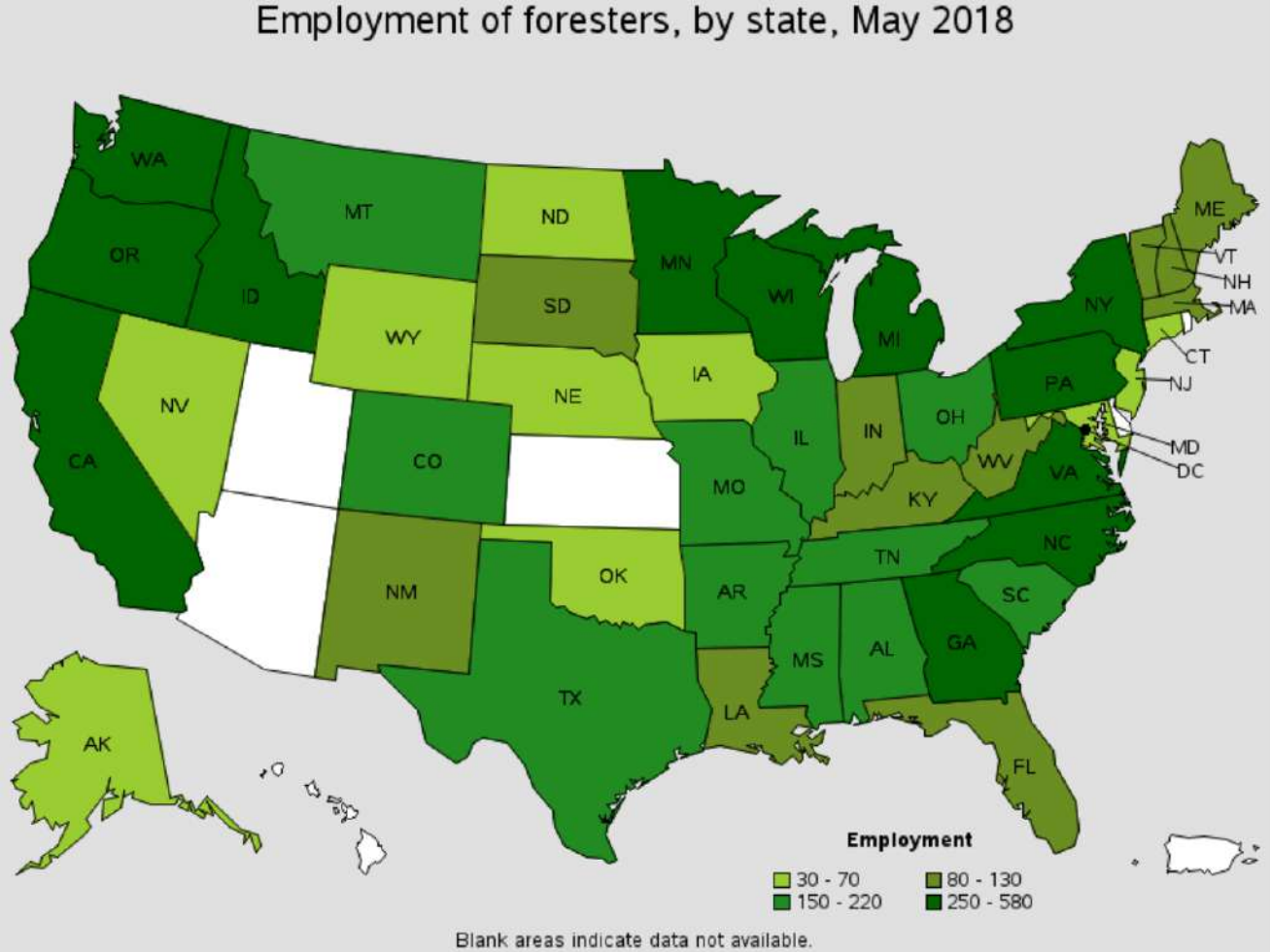


Figure 23: Employment of foresters, by state, May 2018. (Source: Bureau of Labor Statistics, U.S. Department of Labor)

California had a location quotient of less than one which indicates that the occupation is less prevalent in the area than average. On the other hand, a location quotient greater than one indicates the occupation has a higher share of employment than average, which was the case in Oregon, Wisconsin, Washington and Minnesota (**Table 8**). The number varies across states based on budgets, size of managed forests and politics of the state.

[49] https://www.bls.gov/ooh/life-physical-and-social-science/conservation-scientists.htm

Table 8: States with the highest employment levels in the forester occupation in 2018. (Source: Bureau of Labor Statistics, U.S. Department of Labor[50])

State	Employment*	Employment per 1,000 jobs	Location quotient**	Hourly mean wage ($)	Annual mean wage ($)
Oregon	580	0.31	5.30	33.97	70,660
Washington	510	0.16	2.71	33.52	69,720
Wisconsin	460	0.16	2.77	26.83	55,810
California	430	0.03	0.44	38.48	80,030
Minnesota	390	0.14	2.37	30.93	64,330

**Estimates for detailed occupations do not sum to the totals because the totals include occupations not shown separately. The top employment and wage figure estimates are calculated with data collected from employers in all industry sectors, all metropolitan and nonmetropolitan areas, and all states and the District of Columbia.*

***The location quotient is the ratio of the area concentration of occupational employment to the national average concentration.*

**Also note that this particular table is no longer available on the website, which has been updated to 2019.*

3.7.4 Outlook on green jobs in the forest sector

The Green Jobs Initiative of the Bureau of Labor Statistics[51] within the U.S. Department of Labor, which started in 2010, is the main source of national-level data in the U. S. on green (and other) employment in the forest sector and its sub-sectors. The study highlighted the industries that potentially contribute to the production of green goods and services (GGS), the number of green jobs associated with each, and in turn the occupations and wages of those holding these green jobs from 2010 and 2011.

The GGS was a survey-based programme that ran from 2010 to 2013, and defined green goods and services *as businesses that provided services or products that benefit the environment or conserved natural resources, including renewable and efficient energy, pollution reduction, recycling, natural resources conservation, and environmental compliance, education, and public awareness jobs*. Public employment in the U.S. made up only 26% of all employment in green goods and services in 2011 and decreased by 1.9% over the previous year. In contrast, private employment constituted 74% of all GGS employment and increased by 2.3%. Data suggest that about 10% of the green jobs in private industry are in the forest sector, with employment decreasing by 2.7% between 2010 and 2011 (US Bureau of Labor Statistics, 2013[52]).

50 https://www.bls.gov/oes/current/oes191032.htm#st

51 https://www.bls.gov/green/home.htm

52 https://www.bls.gov/ggs/news.htm

3.7.5 Additional trends in forest-related employment

Future projections indicate a decrease in number of foresters employed in forestry and logging According to the US Department of Labor, BLS, the highest number of jobs will be in logging and in the wood manufacturing industries, while most of the future growth is projected to occur in wholesale trade and in professional, scientific, and technical services related to the forest sector (**Table 9**). There will be a decrease in the number of workers in forestry and logging from 7.3% in 2018 to 5.9% of the total occupations in 2028. However, the number of workers under support activities for agriculture and forestry will increase from 1.9% in 2018 to 2.1% in 2028 (**Table 9)**.

Table 9: Projection of employment for foresters by industry (Source: Bureau of Labor Statistics, U.S. Department of Labor[53])

Industry Title	2018 Employment	2018 Percent of Occupation	2018 Percent of Industry	Projected 2028 Employment	Projected 2028 Percent of Occupation	Projected 2028 Percent of Industry	Employment Change, 2018-2028	Employment Percent Change, 2018-2028
Total employment	9	100	0	9.2	100	0	0.1	1.3
Total wage and salary employment	9	99.6	0	9.1	99.6	0	0.1	1.3
Agriculture, forestry, fishing and hunting	0.8	9.2	0.1	0.7	8.1	0	-0.1	-11.4
Forestry and logging	0.7	7.3	1.2	0.5	5.9	1.1	-0.1	-17.8
Logging	0.7	7.3	1.4	0.5	5.9	1.3	-0.1	-17.8
Support activities for agriculture and forestry	0.2	1.9	0.1	0.2	2.1	0.1	0	12.9
Utilities	0.4	4.1	0.1	0.4	4.2	0.1	0	2
Utilities	0.4	4.1	0.1	0.4	4.2	0.1	0	2
Electric power generation, transmission and distribution	0.4	4	0.1	0.4	4	0.1	0	2.1
Electric power generation	0.1	0.6	0	0.1	0.5	0	0	-1.6
Fossil fuel electric power generation	0.1	0.6	0.1	0	0.5	0.1	0	-1.5
Manufacturing	0.9	10.2	0	0.9	9.7	0	0	-3.2
Wood product manufacturing	0.8	9.1	0.2	0.8	8.8	0.2	0	-1.2
Sawmills and wood preservation	0.7	7.4	0.7	0.7	7.2	0.7	0	-1.7
Veneer, plywood, and engineered wood product manufacturing	0.1	1	0.1	0.1	1	0.1	0	2.6
Other wood product manufacturing	0.1	0.6	0	0.1	0.6	0	0	-1.7
Paper manufacturing	0.1	1.1	0	0.1	0.9	0	0	-19.3
Pulp, paper, and paperboard mills	0.1	1.1	0.1	0.1	0.9	0.1	0	-19.6
Wholesale trade	0.1	0.8	0	0.1	0.8	0	0	3.9
Professional, scientific, and technical services	0.3	3.1	0	0.3	3.7	0	0.1	19.6
Professional, scientific, and technical services	0.3	3.1	0	0.3	3.7	0	0.1	19.6
Management, scientific, and technical consulting services	0.2	2.3	0	0.3	2.8	0	0	21.5
Management of companies and enterprises	0.2	2.2	0	0.2	2.3	0	0	6.7
Educational services; state, local, and private	0.4	4.6	0	0.4	4.7	0	0	3.3
Educational services; state, local, and private	0.4	4.6	0	0.4	4.7	0	0	3.3
Junior colleges, colleges, universities, and professional schools; state, local, and private	0.4	4.4	0	0.4	4.6	0	0	4.2
Colleges, universities, and professional schools; state, local, and private	0.4	4.4	0	0.4	4.6	0	0	4.2
Colleges, universities, and professional schools; state	0.4	4.3	0	0.4	4.5	0	0	4
Other services (except public administration)	0.1	1.5	0	0.1	1.5	0	0	7.6
Religious, grantmaking, civic, professional, and similar organizations	0.1	1.4	0	0.1	1.5	0	0	7.8
Grantmaking and giving services and social advocacy organizations	0.1	1.4	0	0.1	1.5	0	0	7.8
Social advocacy organizations	0.1	1.3	0.1	0.1	1.4	0.1	0	7.7
Government	5.6	61.8	0.1	5.7	62.2	0.1	0.1	1.9
Federal government	1.4	15.2	0	1.4	15	0.1	0	0.5
State government, excluding education and hospitals	3.1	34	0.1	3.1	34	0.1	0	1.2
Local government, excluding education and hospitals	1.1	12.6	0	1.2	13.1	0	0.1	5.6

**Employment in thousands*

[53] https://www.bls.gov/ooh/life physical and social science/conservationscientists.htm

Emerging fields of employment in the forest sector

The focus on increasing multifunctionality of forests in the US is gaining importance. Fields of employment beyond forestry and forest-related industries are emerging such as natural resource science, conservation, and management: ecosystem science and management; forest recreation; forest biomaterials and bioenergy; risk management and compliance; and forests and human health.

3.7.6 State and trends in forest-related tertiary education

Enrolment in undergraduate programmes has been on the rise with the reverse happening in graduate programmes. Natural Resource Conservation and Management and Environmental Science and Studies constitute 46% and 54% of undergraduate and graduate student enrolment, respectively, compared to Forestry at 14% and 17%, respectively, unlike four decades ago when forestry constituted nearly half of all NR enrolment (Sharik et al., 2015). While some of this downturn in forestry may be due to relabelling, it is seemingly not much as national accreditation of forestry programmes by the Society of American Foresters (SAF) has strict standards that cannot be met by these other programmes (SAF 2020[54]). For this reason, SAF has created separate standards for Natural Resources and Ecosystem Management programmes.

Table 10: Forestry enrolment by degree level at 61 NAUFRP institutions, 2005–2017. (Source: Sharik et al., 2019)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	% increase 2005-2017*
Bachelor's	3693	3660	3647	3627	3817	3852	4045	4036	3949	3876	3927	4061	4140	12.1
Master's	804	734	704	708	766	773	749	804	681	699	629	575	526	-34.6**
Doctorate	574	580	550	542	537	548	572	502	499	513	493	459	399	-30.5**

**This increase is modest compared to other areas of natural resources. Because of this, demand for Forestry undergraduate majors is exceeding the supply and thus job prospects for recent graduates are very good.*

***The downturn in graduate enrolments (Master's Doctorate) has occurred since 2015, but the reasons are not well understood. One explanation is that it is due to a strong job market, resulting in students with a Bachelor's degree taking jobs rather than going on to graduate school.*

[54] https://www.eforester.org/Main/Certification_Education/Accreditation/Criteria_and_Documents/

4. Summary of key trends in forest-related employment and tertiary education in the seven countries and conclusion

Table 11: Summary of the country insights on forest-related employment and tertiary education.

Country	Employment in forestry & logging	Broader forest sector employment	Green jobs and the forest sector	Additional trends in forest-related employment	Trends in forest-related tertiary education
Brazil	Overall decline in employment, likely also for natural forests, but considerable uncertainty and data gaps	Decreasing number of workers in timber industry from 193,000 to 162,000 between 2009-2018 Jobs in furniture, and pulp and paper production industries account for 60% of the workforce in forest-related industries in Brazil.	Bioeconomy is listed as one of the priority sectors for development in Brazil (CNI, 2013, German Bioeconomy Council, 2016), and one of the first initiatives is the Bioeconomy Brazil–Sociobiodiversity Programme (Brasil MAPA, 2019). Initially, 12,000 people will benefit directly and indirectly from the products and services generated from the socio-biodiversity of rural communities. A government programme for restoration of degraded areas could create 190,000 jobs/year A payment for ecosystem programme called the Floresta+ Programme, was launched in 2020, to provide remuneration to actors involved in activities that improve, conserve, and restore the native vegetation	Existence of big companies because of mergers which strengthens Brazil's position in the global market as an industrial forest plantation player Additional training and certification programmes for forest workers, forest engineering graduates and apprenticeship programmes for students exist.	More than 4-fold increase in forest engineering graduates from 260 in 1995 to 1,700 in 2018 Postgraduate enrolment and graduation remained stable between 2013-2017 (800-920 at master's level and 600-700 at Doctoral level).

Table 11: Summary of the country insights on forest-related employment and tertiary education.

Country	Employment in forestry & logging	Broader forest sector employment	Green jobs and the forest sector	Additional trends in forest-related employment	Trends in forest-related tertiary education
China	Declining number of workers from 1.3 million in 2008 to 1.1 million in 2017 mostly due to the ban on commercial timber harvesting in natural forests Increasing number of jobs in silviculture and forest management from 2013-2017 due to the afforestation programmes (481,000 workers in 2017)	Furniture and wooden floor industries are the largest employers in the sector creating 0.5 million jobs in 2015	Green jobs in silviculture and forest management created through ambitious afforestation programmes off-set losses in logging Forest tourism-related jobs are expanding with 176,200 jobs created in 2017 Forest bioenergy development also offers some green jobs prospects	Highest number of accidents were reported in logging and transport and silviculture and forest management with 449 injuries, 36 serious injuries and 34 deaths reported in 2017 Wages offered to forest workers are 28.7% lower than the national average wage	More than 10-fold increase in number of graduates from technician certificate level/diploma to doctorate from 13,700 in 1990 to 152,900 graduates in 2015

Table 11: Summary of the country insights on forest-related employment and tertiary education.

Country	Employment in forestry & logging	Broader forest sector employment	Green jobs and the forest sector	Additional trends in forest-related employment	Trends in forest-related tertiary education
Finland	A lot of small-scale enterprises exist, and the number of forestry entrepreneurs was 9,000 Number of workers fell by more than half from 1980s mainly due to mechanization, stable in the last decade despite the strong increase output Logging employs 52.4% of the workers In 2018, forestry employed 21,000 which was a third (34%) of all forest sector workers. 57% of these workers were salary earners	Technological solutions, declining paper demand and digitalization have resulted in the loss of 17,000 jobs in pulp and paper industry between 2008-2018 Over half (66%) of forest sector workers were employed in forest industry; 9% increase compared to previous year due to pulp and paperboard production There is growing demand in the use of innovative wood-based products like new materials for construction and packaging, wood-based textile fibres, biofuels, bioethanol etc New biorefineries, if established, will need few thousand new employees	62,500 workers were employed in the forest-related bioeconomy in 2018 Forest sector is the biggest contributor to the bioeconomy (39% of output and 20% employment in 2018) Nature tourism and recreation services employed 35,400 workers	Vital contribution for forest sector by the short-term foreign workers from other European countries working for different kind of enterprises in Finland (e.g. tree plantation, tree nursery workers and forest machine drivers) Increased productivity through mechanization and digitalization has resulted in decreased employment opportunities	Number of graduates from technician certificate level/ diploma to doctorate has been falling since 2000 after strong rise from 1990 up to 2000

Table 11: Summary of the country insights on forest-related employment and tertiary education.

Country	Employment in forestry & logging	Broader forest sector employment	Green jobs and the forest sector	Additional trends in forest-related employment	Trends in forest-related tertiary education
Germany	Decreasing number of workers from 78,600 in 2000 to 70,000 workers in 2015.	Timber cluster comprising of wood production and processing, construction, pulp and paper, and timber trade employed 660,000 persons in 2017 down from 828,000 in 2000 (excluding printing and publishing) Slight growth in the wooden building sector where 238,400 people were employed in 2017 compared to 208,000 in 2000.	Initiatives within the forest sector are not visible but they exist Nature education, recreation, wooden buildings fields are gaining importance: e.g. more than 1,500 forest kindergartens are combining childcare with nature education.	Reduction in core workforce in state forest enterprises from 14,900 workers in 1999 to 7,600 in 2017, replaced by contractors Ageing workforce is a threat to the future of the sector's workforce Increased demand for competent workers to carry out harvesting, regeneration and reforestation to cope with emerging forest risks like back beetles Presence of short-term foreign workers from other European countries mainly in motor-manual timber harvesting operations Decreasing relative accident frequency due to increased training and mechanization from 140 accidents per 1,000 in 2000 to 80 per 1,000 in 2017 among directly employed workers in German States.	Steady increase in the number of Forestry Sciences and Forestry Engineering graduates from 3,700 in 2001 to 6,500 students in 2018 The number of students graduating in forestry and wood sector related studies from technician to doctoral level decreased from 1,800 in 1990 to 1,600 in 2010 but has since been on the rise.

Table 11: Summary of the country insights on forest-related employment and tertiary education.

Country	Employment in forestry & logging	Broader forest sector employment	Green jobs and the forest sector	Additional trends in forest-related employment	Trends in forest-related tertiary education
Indonesia	Decreasing number of forestry workers in the timber estates from 85,300 in 2007 to 56,700 in 2012 but increased to 68,800 in 2017	Increasing number of total workers in wood sawmilling, rattan, bamboo, paper and paper products and wooden furniture from 489,900 in 2013 to 615,400 in 2017	Included in the National Medium Term Development Plan(s) (RPJMN) which is part of the National Long Term Development Plan (RPJPN) 2005-2025 There is a shift in the priority of forest management from timber management to forest ecosystems management and community-based forest management Ecotourism in conservation areas, community forestry, animal breeding/wild plants, and bioprospecting will continue growing	Informal employment is common in the forestry and logging sector, mostly family members (118,500 workers), followed by temporary or unpaid workers (98,700 workers) in 2010 Professional certification by Indonesian national bodies is a requirement for some positions in forest management and assessment, e.g., forest extension officer, timber legality auditors for Timber Legality Assurance System Forestry workers are exposed to high occupational safety and health risks with 984 accidents and 47 deaths reported between 2008-2015 mostly in felling and bucking	The number of graduates from technician certificate/ diploma to doctoral level was 2,300 in 1990 and 9,900 in 2015 24,200 students enrolled in forestry programmes in 2018/19 academic year. At IPB University there was an increase in applications from 2,700 (acceptance rate of 389) in 2011 to 7,400 applications (acceptance rate of 352) in 2018

Table 11: Summary of the country insights on forest-related employment and tertiary education.

Country	Employment in forestry & logging	Broader forest sector employment	Green jobs and the forest sector	Additional trends in forest-related employment	Trends in forest-related tertiary education
South Africa	There were 87,300 workers employed in forestry and logging in 2018 with 30,000 working for contractors	Pulp and paper, sawmilling, timber board, timber mining and others provided 70,200 jobs; sawmilling was the biggest employer (39.9% of the total employment in forest-related industries) in 2018 New timber products e.g. nanocellulose, bioenergy from plantations and other residues have created jobs in research and development, innovation and science and engineering	Green economy is one of the priority sectors in the country's New Growth Path 300,000 jobs will be created in the next decade from clean manufacturing and environmental services There are no explicit initiatives in the forest sector but some important fields that can contribute to green jobs in the sector include employment in the control of invasive alien species such as pine, eucalyptus and acacia, and plantation forests which offer a wide range of tourism opportunities, such as hiking trails, birdwatching, mountain biking, etc	Companies have adopted mechanization to enhance cost effectiveness and sustainability especially in harvesting and transport and silviculture operations resulting in job losses Training of contracting staff is carried out to promote economic performance of timber growers. Staff have mostly been trained in fire protection, silviculture and health and safety	Increasing number of graduates from universities from 210 students in 2005 to 390 in 2019 Decreasing number of students in forestry colleges e.g. there were 35 students in Fort Cox Agriculture and Forestry Training Institute in 2009 and 10 students in 2019

Table 11: Summary of the country insights on forest-related employment and tertiary education.

Country	Employment in forestry & logging	Broader forest sector employment	Green jobs and the forest sector	Additional trends in forest-related employment	Trends in forest-related tertiary education
United States of America	Decrease in the total number of workers in forestry and logging by 63,400 from 2000 to 2010, mostly due to the Great Recession and economic crisis between 2008-2009	The highest numbers of jobs in forest-related industries in 2017 were recorded in wood product manufacturing (22.3%), paper manufacturing (19%), other wood product manufacturing (13.1%), millwork (6.1%) and pulp, paper and paper board mills (5.5%) Drastic decline in employment between 2000 and 2017 occurred in all other wood product manufacturing (97.8%) and newsprint mills (81.5%) industries	Green Jobs Initiative of the Bureau of Labor statistics highlighted industries producing green goods and services, number of jobs, occupations and wages in 2010 and 2011 Public employment in the U.S. made up 26% of all employment in green goods and services (GGS) in 2011 and decreased by 1.9% from the previous year Private employment constituted 74% of all GGS employment and increased by 2.3% from the previous year About 10% of the green jobs in private industry are in the forest sector, with employment decreasing by 2.7% between 2010 and 2011	A decrease in the number of workers in forestry and logging is anticipated from 7.3% in 2018 to 5.9% of the total occupations in 2028 The number of workers under support activities for agriculture and forestry will likely increase from 1.9% in 2018 to 2.1% in 2028 A shift from forestry and logging and wood manufacturing to wholesale trade and professional, scientific, and technical services related to the forest sector is expected by 2028 New fields of employment are emerging in Natural Resource and Environmental Science, Conservation, and Management; Forest Recreation; Forest Biomaterials and Bioenergy; Forests and Human Health; and Risk Management and Compliance	Enrolment in undergraduate programmes has been on the rise by 12.1% from 2005-2017 but declined for master's (-34.6%) and doctorate (-30.5%) programmes There is declining enrolment in forestry programmes at undergraduate (14%) and postgraduate (17%) levels compared to Natural Resource Conservation and Management and Environmental Science and Studies which constitute 46% and 54% of undergraduate and graduate student enrolment, respectively, unlike four decades ago when forestry constituted nearly half of all NR enrolment

Conclusion

The key trends observed in the diverse countries included in the review vary to quite some degree (**Table 11**). A few common conclusions, however, emerge from them regarding forest-related employment and education, which are summarized here, and based on which conclusions for future research are drawn:

Trends in forest-related employment

- With the notable exception of Indonesia, all countries have seen a decline in overall forest-related employment in recent decades.

- In some instances, such as the United States and Brazil, the decline is recent, pronounced and across the board. In others, like Finland and South Africa, it occurred earlier, and numbers have stabilized in recent years.

- The dynamics in the subsectors vary strongly from one country to another.

- Employment in forestry and logging is essential for the supply of raw materials to the forest sector, but its share in relation to total employment in the forest sector varies substantially between countries. In Germany, Indonesia and the USA, it is as low as 10-15% of total employment in the sector, whereas in China and Finland it accounts for 25-30%. South Africa is a particular case with more employment reported in forestry than in the rest of the sub-sectors combined.

- There is a significant decline in employment in forestry and logging observed in all assessed countries, which seems to largely result from productivity gains, primarily from mechanization and information technology. In early adopter countries like Finland the forestry workforce has stabilized over the last decade, but at the same time harvesting levels have significantly increased.

- Outsourcing of work to specialized contractors which has been dominant in the US since the 1980s and in South Africa since the 1990s is a now a prominent trend in Finland and Germany as well, while restructuring is happening in the Brazilian forest sector.

- Structural shifts in the forestry workforce were observed in the countries covered by this study. Forest harvesting (logging) is declining in most cases in absolute terms, but also relative to other forest work like planting, silviculture and conservation. Much forestry work has been outsourced to contractors, particularly in harvesting and transport. For the latter operations it may have reached its peak. Outsourcing of other forest operations and sub-sectors, including those associated with green jobs is still unclear.

- While available data do not permit to assert this unambiguously, there would seem to be a general trend towards upskilling and a growing number as well as rising proportion of workers with tertiary education in the overall forestry workforce.

- A range of drivers can be attributed to the highlighted changes
    - In all countries, drivers for these changes include a growing pressure from globalized forest product markets to increase labor efficiency.
    - In China and the US, the decline in employment in forestry and logging is also connected to bans of logging on natural forests for environmental reasons and/or an also economically motivated shift away from natural forest harvesting to plantation forestry. Similar patterns can also be observed to some degree in Brazil and Indonesia.
- Long-standing concerns on job quality in forestry continue to be observed
    - In some of the countries the concerns are being addressed. China, Germany, Indonesia and South Africa all point to a continued need to improve safety in forestry work. The wages of forest workers in China have been rising, but still remain well below the national average while in Finland the incomes among forest contractors are reportedly low and uncertain.
    - The demand for migrant workers reported in Finland and Germany suggests that forestry cannot meet its workforce needs with nationals in these high-wage countries. There is need for ensuring that the working conditions of these workers are decent.
    - However, the requirements for decent jobs in most of the countries are not often high on the agenda.

Photo: Mrdidg / Pixabay

Green jobs in forest sector

I. Use of the term and evidence

While the phenomenon of green jobs as defined in this report is observed in all countries, the use of the term green jobs varies among the countries studied, so does the connotation given to it. Specific green jobs assessments including in forestry have been carried out by researchers in Brazil, China and the Statistical Office in the United States.

- Around 140,000 green jobs are reported in forestry in Brazil's formal sector, around 5% of the total jobs (Mucoucah, 2009). There were almost 6 million jobs (FTE) in afforestation in 2010 in China. These jobs are seasonal and no assessment of the job quality has been made.

- Official statistics on green jobs have been compiled in the USA, albeit for a few years only, with forestry accounting for 10% of all green jobs in private industry in the USA.

- Germany has experienced a strong increase in forest-based education with around 1,500 forest-kindergartens having been set up over the last two decades.

II. Outlook for the future

There is thus some evidence that green jobs transform occupational profiles and workforce composition. They can also contribute to the creation of new forest-related employment opportunities.

- A planned restoration programme for deforested and degraded areas in Brazil, for example, would create 190,000 jobs annually. Afforestation and rehabilitation programmes underway in China maintain around 500,000 jobs per year, offsetting the continued decline in logging. Indonesia also notes an increase in forest production (plantations) while natural forest harvesting declines.

- Bio-energy from forests has become the largest source of energy in Finland and is growing in China creating more job opportunities.

- Professional, scientific and technical services related to the forest sector are the only segment of forest-related employment projected to grow in the USA. This would at least in part seem to reflect the shifting expectations and management objectives towards multifunctional forests.

Forest-related employment in other sectors is also significant in some countries, most notably in tourism.

- In Finland, nature-based tourism employs 35,000 workers, almost matching forestry.

- Forest parks in China offered 176,000 direct jobs in the forest sector and over 900,000 tourism-related jobs in 2017. Substantial further growth is thought possible.

- In Indonesia, ecotourism in conservation areas, community forestry and bioprospecting have a great potential for growth. The number of tourists in conservation areas grew from 4.2 million people in 2015 to approximately 7.3 million tourists in 2019.

Trends in forest-related tertiary education

- The number of tertiary level graduates from forest-related programmes has strongly increased in the emerging economies Brazil, China, Indonesia and to a lesser extent South Africa. In these countries, there has been an emphasis on upgrading and formal recognition of skills. The requirements for skilled workforce and Occupational Health and Safety (OHS) training by the FSC and the Indonesia Ecolabelling Institute (LEI) has contributed to the certification training of the forest officers in Indonesia, and training of the contracting staff and growers in South Africa. In Brazil, additional training and certification programmes exist for forest workers, forest engineering graduates.

- The numbers of graduates have also slightly increased in Germany. A decline in forest graduates was reported in Finland and the USA. In the USA, there is a shift in tertiary education away from classical forestry programmes to more environment and conservation related ones rather than an overall decline. This trend can also be observed in Germany.

- There is some indication that the average education levels are going up with more advanced degrees being obtained. In some cases, like South Africa, this increase occurs at the expense of technical level graduates.

Knowledge gaps and questions for future research

This report has explored a broad range of issues and revealed some major trends in forest related employment, but important knowledge gaps and related research questions remain. These relate to sociodemographic factors of the workforce in the forest sector, including questions of gender, migrants and ageing of the workforce. In addition, the issue of the quality of forestry jobs needs further exploration and linked to it the attractiveness of the sector and its ability to secure highly qualified workforce, including at graduate level. Finally, the questions of how exactly and to which extent green jobs will impact employment in the forest sector still remain to be answered more conclusively.

We suggest a couple of hypotheses based on the trends explored in this report that could guide future work on the topic:

- Within a shrinking overall forestry workforce, the share and number of graduates with tertiary education is increasing.

- Stronger emphasis on multi-functionality and forest services other than wood production are likely to transform existing forest-related jobs.

- Additional employment in new Green Jobs in the forest-related sector sectors is being created and likely to expand.

- This would seem to offer new opportunities for graduates from forest-related tertiary education, and likely to enhance gender balance in forest-related employment.

In addition to testing these hypotheses, further research should investigate:

- whether important employers in forestry and related sectors agree with the above hypotheses
- whether forest-related tertiary education is tracking trends in forest-related employment and through which means and channels
- whether the diagnosis of forest-related tertiary education coincides with the above hypotheses
- how it is reacting to the trends diagnosed (learning objectives, curricula, learning methods a.o.).
- how to ensure that the informal work can be turned into formal employment, and how to make sure that these offer decent work conditions

Regarding research methodologies, the country studies also demonstrated that data gaps are significant. Overcoming these through conventional surveys would require substantial resources. This suggests that complementary information should be sought through other channels to test the emerging hypotheses. Answers to these questions will have important implications for policies on forests, education and forest related employment.

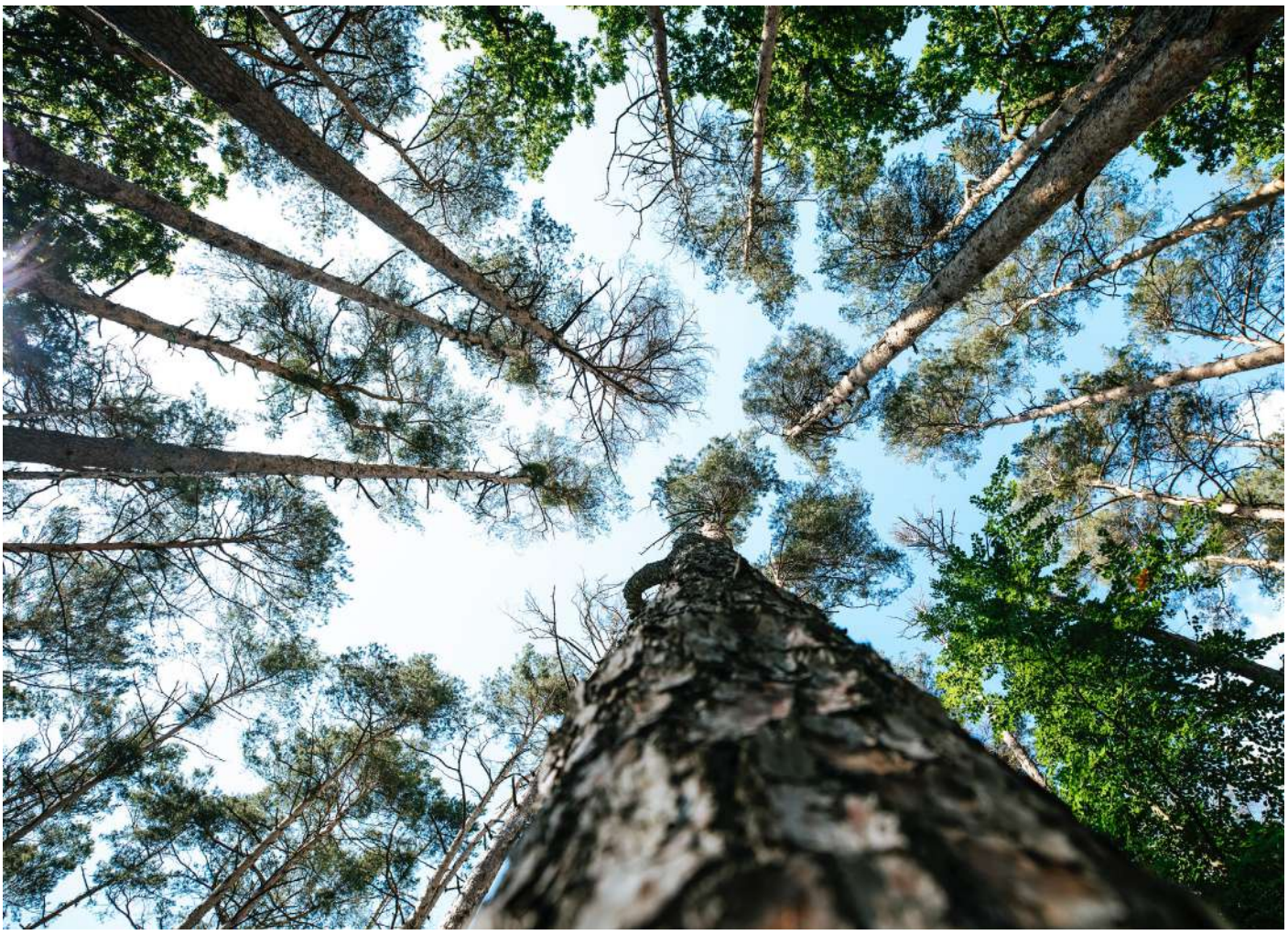


Photo: Markus Spiske / Unsplash

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Annex 1. Guidelines for the country insights

I. Forest-related employment

a) Which sub-sectors make up the forest-related sector in your country?

- Which sub-sectors are shrinking, and which ones are expanding? Are there new ones emerging?

b) What is the current state of employment in relation to the aforementioned sub-sectors in your country, also relating to professional occupations?

- Statistics on distribution of workers, ideally within the sub-sectors?
- How do they correspond with the International Standard Industrial Classification of All Economic Activities (ISIC) Division 2 (Forestry and logging)?
- What is the state of informal forest sector employment in the country? (Please provide numbers where applicable)

c) What are the recent and ongoing major changes in forest sector employment in your country (ideally in numbers and relating to professional occupations where applicable)?

- Changes in public vs. private sector employment
- Do professional trainings and certifications for forest workers exist in your country? What has been the impact?
- What is the state of employment structures in the sector? (Mergers among corporations, downsizing, outsourcing and contracting, unionization of workers)

d) What potential for jobs in and/or depending on forests exist beyond/adjacent to the traditional forestry sector?

- Which (sub) sectors are emerging?
- Which occupations are emerging?
- How have the tasks in the classical occupations changed?

e) Does the concept of green jobs play a role in:

- Your country?
- Your country's forest sector?
- Are there any initiatives on green jobs in the forest sector in your country?

II. Forest-related tertiary education

a) Tertiary Education (Forest professionals)

- Which universities (including Applied Sciences) offer forest-related programmes?
- Which forest-related study programmes/courses are offered and the obtainable degree (B. Sc. MSc, PhD, etc.)?
- Number of students starting and graduating (per degree level)?
- What are the five newest forest-related programmes in your country?

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