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# Green Jobs in the Forest Sector



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# Green Jobs in the Forest Sector

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## ABSTRACT

The study *Green Jobs in the Forest Sector* provides an overview of existing Green Forest Jobs and identifies possible areas for future activities and jobs in the forest sector, and may serve as starting point for further analysis and discussion on the future of Green Forest Jobs. It offers a framework for classifying Green Forest Jobs under seven thematic work areas, outlined in the seven main sections of the study, with a particular focus on major trends, needs and challenges as well as opportunities and prospects for the forest sector. The findings suggest that to promote Green Jobs in the forest sector it is key to: (i) look at forest ecosystem services management as the frame for Green Forest Jobs; (ii) recognize the progress made in the development of Green Forest Jobs and to identify avenues for the future; (iii) enhance the public perception of jobs in the forest sector; (iv) revise existing curricula and develop new ones for catering to the needs of the sector to close the skills gaps; and (v) to facilitate an inclusive transition to green economy through training and support.

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## GLOSSARY

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**Continuing vocational training:** Further vocational training, undertaken by those who have already completed basic or initial training, in order to supplement acquired knowledge or skills (ILO and Cedefop, 2011).

**Core skills/core employability skills:** Non-vocational, non-technical skills or competencies that are needed to perform at work and in society. They apply to work generally, rather than being specific to an occupation or industry. Core employability skills include the ability to work with others and in teams, the ability to solve problems and use technology, communications skills, and learning-to-learn skills. Core skills are also called generic skills, key competencies, key skills, portable skills, soft skills and transferable skills (ILO, 2006).

**Decent work:** A term that sums up the aspirations of people in their working lives – their aspirations for opportunity and income; rights, voice and recognition; family stability and personal development; and fairness and gender equality. Ultimately these various dimensions of decent work underpin peace in communities and society. Decent work is captured in four strategic objectives: fundamental principles and rights at work and international labour standards; employment and income opportunities; social protection and social security; and social dialogue and tripartism (ILO, 1999).

**Green economy/greening the economy:** The process of reconfiguring businesses and infrastructure to deliver better returns on investments of natural, human and economic capital, while at the same time reducing greenhouse gas emissions, extracting and using fewer natural resources, creating less waste and reducing social disparities (UNEP, ILO, IOE and ITUC, 2008; European Commission, 2012).

**Green innovation:** Improvements in products, processes, marketing methods, organizations or institutions that yield higher environmental benefit. Innovation can include technological and non-technological change (Martinez-Fernandez et al., 2010).

**Green jobs:** “Green jobs are defined as jobs that reduce the environmental impact of enterprises and economic sectors, ultimately to levels that are sustainable. This definition covers work in agriculture, industry, services and administration that contributes to preserving or restoring the quality of the environment while also meeting the criteria for decent work – adequate wages, safe conditions, workers’ rights, social dialogue and social protection. It also covers activities related to both mitigation of and adaptation to climate change. This is a working definition. It implies in its inclusivity and breadth that every job can become greener. As time goes on and the transition to a green economy progresses, what is considered a green job today might not continue to be regarded as such in the future. The understanding of green jobs also varies from one country to another” (ILO and Cedefop, 2011).

**Green forest jobs:** A green forest job complies with the principles of sustainable forest management, contributes to the green economy, and is involved in the manufacture of forest products and/or in the performance of forest services.

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## LIST OF ACRONYMS

<b>BLS</b>	US Bureau of Labor Statistics
<b>CO<sub>2</sub></b>	Carbon dioxide
<b>CORINE</b>	Coordination of information on the environment
<b>ECE</b>	United Nations Economic Commission for Europe
<b>EEA</b>	European Environment Agency
<b>EU28</b>	European Union
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>FFRI</b>	Finnish Forest Research Institute
<b>FLEGT</b>	Forest Law Enforcement, Governance and Trade
<b>GIS</b>	Geographic Information System
<b>IEA</b>	International Energy Agency
<b>ILO</b>	International Labour Organization
<b>IOE</b>	International Organization of Employers
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>ITUC</b>	International Trade Union Confederation
<b>IUFRO</b>	International Union of Forest Research Organizations
<b>LiDAR</b>	Light Detection and Ranging
<b>MEA</b>	Millennium Ecosystem Assessment
<b>NGO</b>	Non-Governmental Organization
<b>PEFC</b>	Programme for the Endorsement of Forest Certification
<b>PES</b>	Payments for Ecosystem Services
<b>SDG</b>	Sustainable Development Goal
<b>REDD-plus</b>	United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation and the Role of Conservation, Sustainable Management of Forests and Enhancement of Forest Carbon Stocks in Developing Countries
<b>ToS</b>	Team of Specialists
<b>UNEP</b>	United Nations Environment Programme
<b>UNFF</b>	United Nations Forum on Forests
<b>USDA</b>	US Department of Agriculture
<b>WWF</b>	World Wide Fund for Nature



## BACKGROUND

The United Nations Economic Commission for Europe (ECE) and the Food and Agriculture Organization of the United Nations (FAO) have initiated their cooperation in the service of forestry and people in 1947. Since then, the ECE/FAO Forestry and Timber Section, based in Geneva, has continuously worked with countries and forest stakeholders – ranging from forest owners, to businesses, to environmental non-governmental organizations (NGOs) and international and regional organizations and processes – to address challenges related to sustainable forest management. This has been done through monitoring of the state of forests in the region, analysing and disseminating data, providing a platform for developing evidence-based policies for sustainable forest management, communicating about forest products and ecosystem services and assisting countries in monitoring and managing their forests, for example, through capacity-building activities.

The need for consideration of questions related to the forest sector workforce in the ECE and FAO programme was recognized by member States as far back as 1947, at the International Timber Conference. A concept of joint work between ECE, FAO and the International Labour Organization (ILO) originated a few years later in Geneva. As a result, the Joint Committee on Forest Working Techniques and Training of Forest Workers was founded under the joint auspices of ECE, FAO and ILO in 1954.

At that time, the technical work of the Joint Committee was undertaken by forest experts. Between 1955 and 1978, study groups focused on the importance of job security, competitive wage rates, adequate living conditions, technical training facilities and better safety measures for forest workers. In 1978, a more modernised structure, based on teams of specialists and seminars was established, and the Joint Committee was converted into a network, with a more flexible structure.

Along with the changes of economic context and the transformation of the forest sector itself, the forest workforce experienced a number of structural changes. Accordingly, the topics of ECE and FAO work related to forest workers have broadened and today they include environmental and social cross-cutting topics, such as ecosystem management in forestry, climate change mitigation and adaptation, green economy, gender equity, aging workforce and adaptation of skills to technological developments.

Consideration of these topics in the context of forest sector workforce has been the main focus of the ECE/FAO Team of Specialists (ToS) on Green Jobs in the Forest Sector (ILO/ECE/FAO Experts Network), which continues to build upon the earlier work of the Joint ILO/ECE/FAO Committee. The work of the Team is anchored in the “Rovaniemi Action Plan for the Forest Sector in a Green Economy”, in particular one of its underlying pillars: decent green jobs in the forest sector.

In line with the provisions of the Plan, the ToS has been working on defining, describing and promoting green jobs in the forest sector and has contributed to reinforcing cooperation between forestry training centres, with a view to shaping the future of employment in the sector.

The Team continuously provides advice and support to the ECE/FAO Forestry and Timber Section work on topics related to employment in the forest sector, including through identifying needed competencies, education and training for the forest sector in the context of a green economy.

This study paper is the result of the work of the ECE/FAO Team of Specialists on Green Jobs in the Forest Sector (ILO/ECE/FAO Joint Expert Network), carried out in line with the mandate of the ECE/FAO Integrated Programme of Work for 2014-2017. The knowledge gathered has been built on literature research, as well as on workshops, seminars and enquiries, which were organized by the Team during that period.

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## SUMMARY

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Despite the multiple functions that forests provide, the forest sector is not commonly perceived as a sector which creates or has a potential to create a variety of jobs. However, in a number of countries, the generally small contribution of the forest sector as a formal employer as presented in official statistics may likely be an underestimation. This is due to the fact that, in spite of the decline of the number of workers in traditional forestry operations over the past several years, mainly in Europe and North America, growing demand for “environmental goods and services” has significantly driven an increase of the number of occupations in the forest sector, in particular those related to ecosystem management and recreation. Therefore, the number of jobs attributable to forestry could be much larger than today’s estimates and is worth closer investigation.

The ECE/FAO Team of Specialists on Green Jobs in the Forest Sector (ILO/ECE/FAO Joint Expert Network) undertook the analysis of the current landscape of occupations in the forest sector, in order to provide a comprehensive overview of the existing and potential jobs related to forests. The Team took into account the widely accepted sustainability criteria for realistic, fairly compensated, and environmentally safe jobs, and focused on identifying green forest jobs, anchored in the green economy.

The study agreed that promoting green forest jobs contributes to the implementation of the 2030 Agenda for Sustainable Development and supports the achievement of a number of Sustainable Development Goals (SDGs). Green forest jobs are of particular relevance to achieving SDG 1 “No poverty”, SDG 3 “Good health and well-being”, SDG 5 “Gender equality”, SDG 8 “Decent work and economic growth”, SDG 13 “Climate change” and SDG 15 “Life on Land”.

The study focuses on understanding the potential of green jobs in the forest sector, one of the key sectors contributing to the transition to a green economy and, hence, sustainable development. It provides guidance on how to carry out the identification of current and anticipated skill needs for the green economy and green jobs. The information gathered was clustered in seven thematic areas: “Wood and Energy Production”, “Agroforestry and Mountain Forestry”, “Social and Urban Development”, “Forest Management, Inventory and Planning”, “Biodiversity and Ecosystem Functioning”, “Health and Recreation”, “Education and Research”, and nineteen related fields of activity. Each of the nineteen fields of activity is described in a short summary of general skills, expertise and professions needed in that field. Furthermore, specific activities, products and services are described and job specifications are listed.

The aim of the study is to provide a starting point for further analysis and discussion on the future of green forest jobs and identification of measures supporting their development.

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An aerial photograph showing a massive log raft on a river. The raft is composed of hundreds of logs stacked in neat rows, forming a large rectangular area. A tugboat with a white cabin and a red stripe is positioned to the right of the raft, moving through the water. The water is a dark, rippling green. The logs are of various shades of brown and grey, showing signs of weathering. The overall scene depicts a traditional logging operation.

1.

INTRODUCTION



## 1. Introduction

Transformative global forces, such as globalization, urbanization, demographic changes towards an ageing society and technology development, have had a far reaching, long-term impact on the functioning of the economy, society and on the quality of environment. They have implied structural changes in employment trends, organization of labour activities and mobility patterns.

In addition, in the short term, the weak economic performance in the last decade and the outlook for the upcoming years, which remains below expectations, have had a strong direct impact on the ability of the global economy to generate sufficient number of jobs and to improve the quality of employment for workers. For instance, despite the constant decrease in unemployment rates in Northern, Southern and Western Europe, USA and Canada since the 2008 crisis, the long-term and structural unemployment patterns have recently worsened, due to mismatch of skills with the labour market demand. On the other hand, for many emerging market countries, chronic working poverty and poor-quality employment experienced by workers in vulnerable forms of employment remain a central concern.

To stay competitive, all sectors of the economy need to continuously adapt to the latest trends on a nearly real-time basis. This calls for an increased focus on workforce adaptability, especially as regards development of new skills, in particular those related to technological innovation and social skills. It also requires establishing flexible organizational structures with decentralized hierarchy, which can ensure resilience and flexibility of working teams.

In the forest sector, standing up to the challenges of a relatively unstable and fast-paced transforming economy is combined with structural changes, appropriate to traditional economic sectors, such as globalization of commodity markets, rural depopulation and an aging population. These phenomena altogether provide a complex framework, which influences forest sector employment.

Forests are increasingly attractive to people as a place of leisure and recreation but are less and less appealing as a workplace. Risks of occupational injury and fatal accidents, low wages on average and low social status make the sector unattractive to the younger generation. The State of Europe's Forests 2015 report notes that "around 30 per cent of people employed in forest related activities in Europe are 49 years old or over. This percentage is increasing. Across Europe, women account for only 20 per cent of the overall forest workforce" (Forest Europe, 2015a).

The nature of forest work is changing due to technological development and mechanization. In many cases, it is becoming less safe due to pressure on productivity. With increased mechanization, which requires more skills, few workers are paid more, however mechanization often results in an oversupply of a low-skilled workforce.

The structures of forest work are also changing. Large companies have merged, downsized, relocated, restructured or closed, often with drastic consequences for workers and communities. Unions do not have a lot of influence, nor do they offer the security that they once did. Much of the former work of corporations, particularly that of harvesting, has been outsourced to a rapidly growing number of contractors who have different work, management and communication cultures.

The challenges of developing a sustainable workforce include making forest jobs safer, better paid, and more attractive for young workers and women. It also implies adapting training and education to the variety of changing requirements, such as mechanized harvesting or increased communication with forest users. Reforming the sector implies looking at new and innovative types of jobs which encompass the latest developments in technology and research, and ecosystem services management.

Given the above, it is important to investigate how the forest sector workforce can adapt to changing trends in order to enhance economic, social and environmental benefits of forests in the context of a green economy and the 2030 Agenda for Sustainable Development.

### *Towards a green economy – opportunities and challenges for the labour market*

The green economy concept was developed by the United Nations Environment Programme (UNEP) in 2010. It defines a green economy as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP, 2010).

The bioeconomy concept, presented by the Harvard Business School scientists in 1997, encompasses an ecological view that is much more focused on biotechnology, the intensive use of natural resources and on the stimulation of economic growth. The bioeconomy favours bio-based products and is accordingly focused on biomass enterprises and their efficient operation. From a forest perspective, the bioeconomy concept is consistent with sustainable forest management as well as with the provision of forest ecosystem services which should be further strengthened.

A green economy uses investments in creating green goods and services to generate new job opportunities. In relation to that, the term "green jobs" has spread rapidly over the past several years. Jobs are green when they help reduce negative environmental impact, ultimately leading to environmentally, economically and socially sustainable enterprises and economies. More precisely, green jobs are decent jobs that improve energy and raw materials efficiency; limit greenhouse gas emissions; minimize waste and pollution; protect and restore ecosystems; and support adaptation to the effects of climate" (ILO, 2015a; ILO and Cedefop, 2011). For UNEP (ILO, 2010), green jobs minimize the adverse environmental impacts of enterprises and economic sectors by preserving or restoring the quality of the environment. The International Labour Organization (ILO), UNEP, the International

Organization of Employers (IOE) and the International Trade Union Confederation (ITUC) jointly launched the Green Jobs Initiative (ILO and Cedefop, 2011) in 2008.

According to Forest Europe, “green jobs opportunities result from employment in production of green products and services and/or employment in environmentally friendly processes providing they are decent jobs. Generally, all jobs associated with sustainable forest management have a potential to be green” (Forest Europe, 2015b).

In 2010, the US Bureau of Labor Statistics (BLS) initiated the collection of data on green jobs through a survey to measure the number of jobs associated with producing green goods and services and the use of environmentally friendly production processes. The BLS methodology estimated the number of green jobs per industry based on the green jobs found at individual establishments within each industry sector. It did not designate an industry as “green” nor count all jobs in that industry as green jobs, since establishments in the industry may also produce goods and services that are not considered green. However, one of the conclusions of the survey was that agriculture, forestry and fishing should be surveyed more in detail in the context of green jobs.

The European Union’s Green Employment Initiative describes the opportunities for the labour market in the context of a green economy: “The potential of employment creation linked to the production of energy from renewable sources, energy efficiency, waste and water management, air quality improvement, restoring and preserving biodiversity and developing green infrastructure is significant and is resilient to changes in the business cycle. For instance, a 1 per cent increase in the rate of growth of the water industry in Europe can create between 10,000 and 20,000 new jobs. Tourism and recreation in Natura 2000 sites are estimated to directly support around 8 million jobs corresponding to 6 per cent of the total employment in the EU. Implementing existing legislation on waste prevention and management could create more than 400,000 new jobs and the review of the waste legislation now proposed by the EU Commission could create an estimated further 180,000 jobs, while opening up new markets, making better use of resources, reducing dependence on imports of raw materials, and lowering pressure on the environment” (European Commission, 2014).

Based on existing definitions of green jobs, the ECE/FAO Team of Specialists on Green Jobs in the Forest Sector (ILO/ECE/FAO Joint Expert Network) developed a definition of a Green Forest Job as one that complies with the principles of sustainable forest management<sup>1</sup>, contributes to a green

economy<sup>2</sup>, and is involved in the manufacture of forest products and/or in the performance of forest services.

### Green Skills

Green restructuring generates demand for new skills as existing producers reorient activities towards new markets and products. The new environmentally-driven competences relate to the application of new technologies and to management requirements related to changes in production and organisational models, for instance, with an emphasis on value added services and communication. Green skills cover not only expert knowledge in new thematic areas but also awareness of environmental and social aspects related to specific economic activities and the willingness to learn about sustainable development.

In the context of a green economy, new skills are needed and consequently new education courses will be needed. All member States have some system for forecasting occupational changes and framing education and training responses; it is the basis for State-driven investment in new qualifications and related education and training provision. Existing systems allow gradual adjustment to qualifications and curricula in response to changing demands, including those driven by investment in low-carbon goods and services.

To revise and extend these existing systems to the needs of a green economy, a new strategy for green skills will be needed. The role of sectoral experts and social partners will be important for the necessary analysis and subsequent qualification and training reform. Therefore, it is important that forest experts are involved in specific knowledge building initiatives in defining changes in competence requirements, and in promoting changes related to the vocational and education training system for the sector. This study is one example of a collaborative effort to move in that direction, conducted by the experts of the ECE/FAO Team of Specialists on Green Jobs in the Forest Sector (ILO/ECE/FAO Joint Expert Network).<sup>3</sup>

## 1.1 Areas for the Development of Green Forest Jobs

Following the recent trend in the development of the working force in classical forestry, this sector will further reduce in numbers in the future but the green forest jobs proportion will increase and gain more importance.

The following diagram (see figure 1) shows a wide range of forest and forestry related activities, which can be grouped into seven main thematic areas of green forest jobs. In addition, figure 1 illustrates that green jobs have been a

1 Sustainable forest management (SFM) was defined in 1993 in the Helsinki resolution H1 as “the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems” (Forest Europe, 1993).

2 The process of reconfiguring businesses and infrastructure to deliver better returns on investments of natural, human and economic capital, while at the same time reducing greenhouse gas emissions, extracting and using fewer natural resources, creating less waste and reducing social disparities (UNEP et al., 2008).

3 The outline of this study was developed at the ECE/FAO Team of Specialists on Green Jobs in the Forest Sector (ILO/ECE/FAO Joint Expert Network) meeting in Bern, in October 2014 and was subsequently adapted.

feature of the forest sector for a long time (traditional), have recently emerged (new established), or that there is potential for new fields of work within these seven forest and forestry related activities (future). It also shows that all of these seven areas of activities overlap, meaning that these activities require knowledge of what occurs in the other spheres of activity.

Within the abovementioned seven thematic areas, this study identifies 19 fields of activity in the forestry sector (see table 1). These fields of activity as well as 47 examples of green forest jobs are listed and described in the following chapters.

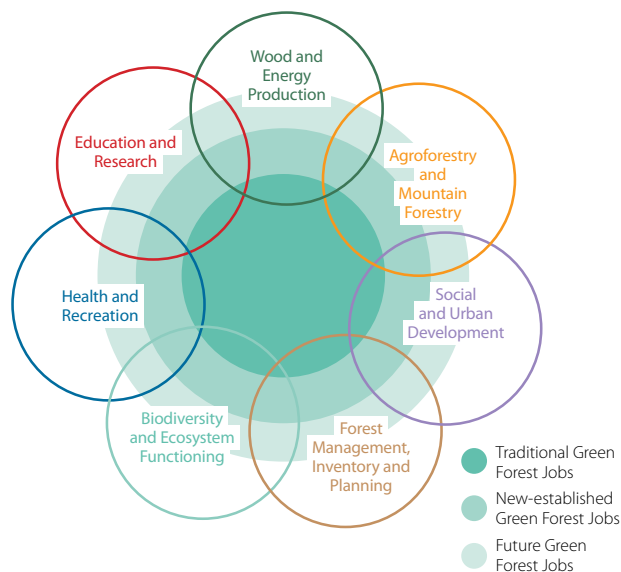
Many of these fields of activity contribute significantly to rural development. Most new green forest enterprises and initiatives will be located in rural areas and most of the new forest products and services generated as a result will stimulate the creation of local green forest jobs.

A study by University College Dublin estimated that with regards to Ireland, “an annual afforestation programme of 15,000 hectares would create 490 jobs, mostly rural, in forest establishment, forest management, timber harvesting, road haulage, and timber processing. For every 100 of these jobs, an extra 70 full-time equivalent jobs would be generated elsewhere. Of crucial importance is the fact that these are long-term jobs and located in rural Ireland” (VEON, 2016).

**TABLE 1** 19 fields of activity for future green forest jobs in forestry

7 Thematic areas	19 Fields of activity
Wood and Energy Production	<ul style="list-style-type: none"> <li>• Wood Production</li> <li>• Energy Production</li> </ul>
Agroforestry and Mountain Forestry	<ul style="list-style-type: none"> <li>• Agroforestry</li> <li>• Mountain Forestry and Soil Bioengineering</li> </ul>
Social and Urban Development	<ul style="list-style-type: none"> <li>• Urban Forestry and Arboriculture</li> <li>• Culture and Forests</li> </ul>
Forest Management, Inventory and Planning	<ul style="list-style-type: none"> <li>• Forest Inventory and Forest Monitoring</li> <li>• Planning, Governance, Sustainable Forest Management</li> <li>• Pests, Disease and Forest Fires</li> <li>• Risk Management and Contingency Planning</li> </ul>
Biodiversity and Ecosystem Functioning	<ul style="list-style-type: none"> <li>• Biodiversity Conservation and Nature Protection</li> <li>• Climate Change</li> <li>• Forests and Water</li> <li>• Mycoforestry</li> </ul>
Health and Recreation	<ul style="list-style-type: none"> <li>• Forest Ecotherapy</li> <li>• Recreation, Leisure and Sports</li> </ul>
Education and Research	<ul style="list-style-type: none"> <li>• Education, Further Training and Knowledge Transfer</li> <li>• Forest Research</li> </ul>
	<ul style="list-style-type: none"> <li>• Other New Fields of Activity</li> </ul>

**FIGURE 1** The outline of green forest jobs proposed by the study



**TABLE 2** Examples of green forest jobs

Wood and Energy Production	<ul style="list-style-type: none"> <li>• Forest machine operator</li> <li>• Log salvager</li> <li>• Wood supply chain manager</li> <li>• Local energy procurers</li> <li>• Procurement forester</li> <li>• Short rotation plantation manager</li> </ul>
Agroforestry and Mountain Forestry	<ul style="list-style-type: none"> <li>• Agro forester</li> <li>• Project manager forests and natural hazards</li> <li>• Project manager forest and protective structures</li> <li>• Forest soil bioengineer</li> <li>• Urban permaculturist</li> <li>• Local natural hazard advisors</li> </ul>
Social and Urban Development	<ul style="list-style-type: none"> <li>• Forest historian</li> <li>• Arboricultural officer</li> <li>• Forest culture interpreter</li> <li>• Funeral forest manager</li> <li>• Urban forester</li> <li>• Adventure park forester</li> </ul>
Forest Management, Inventory and Planning	<ul style="list-style-type: none"> <li>• Forest planner</li> <li>• Forest inventory specialist</li> <li>• Forest policy coordinator</li> </ul>
Biodiversity and Ecosystem Functioning	<ul style="list-style-type: none"> <li>• Forest wildlife manager</li> <li>• Forest fire fighter</li> <li>• Forest protection advocate and grassroots organizer</li> </ul>
Health and Recreation	<ul style="list-style-type: none"> <li>• Forest interpretive guide</li> <li>• Forest ecotherapy guides</li> </ul>
Education and Research	<ul style="list-style-type: none"> <li>• Forest communicator</li> <li>• Marketing and communication manager</li> <li>• Forest pedagogue (teacher)</li> <li>• Civil science facilitator</li> </ul>





2.

WOOD AND  
ENERGY  
PRODUCTION



## 2. Wood and Energy Production

In this chapter, two fields of activity “Wood Production” and “Energy Production” are outlined. Facts, major trends, opportunities and skills concerning these specific green forest jobs are highlighted and existing job examples are given.

### 2.1 Wood Production

#### *Background and Outline of the Field of Activity*

Wood production and sustainable forest management are the basis for the whole forest industry, as wood is the raw material for all of these activities (e.g. fibre, cellulose, papers and boards, sawn wood, energy). Wood production involves a chain of activities in the forest such as planting, stand management, thinning, harvesting and the coordination of transportation and logistics. All of this integrates into the wood chain, also often referred to as the supply chain or wood flow. It starts with “standing trees in forests and continues with harvesting, bucking, sorting, transportation to terminals, sawmills, pulp mills, paper mills and heating plants, conversion into products such as pulp, paper, lumber, and ends at different customers” (Carlsson et al., 2005). These activities provide the majority of forest jobs in areas with a strong forest industry. Many of these jobs are now mechanized and can be defined as “green jobs in the forest sector” wherever they comply with the principles of sustainable forest management, contribute to a green economy, and are involved in the manufacture of forest products and/or in the performance of forest services.

In addition to the basic skills and practice of forestry, a high level of expertise about the local conditions (e.g. climate, soil, wind, hydrology, mechanization) for forest management and wood production is required from both workers and management experts.

#### *Facts and Figures*

Globally, in 2005 there were approximately 1.2 billion hectares of forest managed primarily for the production of wood and non-wood forest products and at least 10 million people employed in forest management and conservation (FAO, 2010). In the European Union (EU28) in 2013, there were approximately 2.2 million persons employed in the forest sector, 24 per cent within forestry, 48 per cent within the wood products industry and 27 per cent within the pulp and paper industry (Finnish Forest Research Institute (FFRI), 2014). Hence, about 1.056 million people were employed in the wood-products industry in the EU28 in 2013.

Wood production in EU28 increased between 2000 and 2015, both in terms of roundwood production (from 411 million m<sup>3</sup> to 446 million m<sup>3</sup>) and also in sawnwood production (from approximately 101 million m<sup>3</sup> to 103 million m<sup>3</sup>) (Eurostat, 2017).

#### *Major Trends, Needs and Challenges*

The mechanization of the forest sector is an ongoing process which varies among countries (Asikainen et al., 2009) and impacts green forest jobs. Manual forest jobs have noticeably decreased and have been replaced by forest machines and wood processors. This development is ongoing and will increase in the future. At the same time, the jobs specifications of most of the different types of forest specialists have also significantly changed and digitalization will markedly change the way of working in the major wood production and service sectors.

Differences within countries regarding the degree of mechanization are due to the varying characteristics of the forests, the forest ownership structure, harvesting methods, labour availability, historical factors, and what specific role the forest industry plays in the country. The rate of mechanization also impacts harvesting costs, occupational safety and labour availability, which may pose challenges to the forest sector.

Other strong trends are the increasing interest and related policies concerning biodiversity, climate change, forest recreation and forest protection. These policies may impact the level of attention given to timber production functions and services in some areas, for instance, urban forests. This may signify that attention is being geared towards the above fields, while focusing less on wood production.

#### *Opportunities and Prospects for the Forest Sector*

Despite the international trends, it is unlikely that all manual work in the forest will be fully mechanized, particularly in the areas of small scale forestry enterprises, mountain and urban forestry, wood production and various forest ecosystem management services. Forest workers still have an important role to play in all forest operations, especially in wood production. Highly skilled forest workers will be required for very specialized forest work in the future. Areas with high biodiversity demands, special landscape needs, forest recreation potential and urban forestry possibilities will offer great opportunities for these forest workers and specialists.

Even though the production and use of printing paper has declined, developments in the wood construction, packaging materials, biocomposites, renewable energy and biofuels for transportation sectors maintain and increase the demand for wood. Hence, more jobs in these areas could be created from the increasing demand of such renewable and bio products.

**TABLE 3** Tasks, activities and services in the field of activity “Wood Production”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Growing and harvesting healthy forest stands in accordance with the principles of sustainable forest management</li> <li>• Meeting the demands of industry, the environment and society in a cost efficient manner</li> <li>• Optimizing the supply chain in harvesting and transport through cooperation between forest administration, forest owners and industry, including an improvement in infrastructure</li> <li>• Keeping up-to-date with mechanization innovation</li> <li>• Training forest staff in necessary skills and practices</li> <li>• Maintenance of technical equipment</li> <li>• Development of new value adding products and methods by promoting the use the best available technology</li> <li>• Facilitating and promoting cooperative timber harvesting and other forest operations between small-scale and private forest owners</li> <li>• Ensuring the efficient and effective operation of all wood production logistic systems</li> <li>• Maintaining and improving transparency within the chain of custody and certification systems</li> </ul>	<ul style="list-style-type: none"> <li>• Forest management processes</li> <li>• Communication and support to forest owners</li> <li>• Timber harvesting and wood production processes</li> <li>• Ergonomics, work safety</li> <li>• Forest road and water engineering</li> <li>• Forest inventories and planning</li> <li>• Research in the domain of new wood products; e.g. wood derived chemicals</li> <li>• Certification</li> <li>• Logistics</li> <li>• Timber grading, marketing and sale</li> <li>• Collaboration with the wood, timber, pulp and paper industry</li> <li>• Promotion of public relations and marketing to increase regional wood consumption and demand</li> <li>• Liaison with architects, designers, builders and other key players in the wood industry chain</li> </ul>

The rapid increase in the rate of forest mechanization and digitalization will offer significant green job opportunities for machine operators and experts in forest management and wood production. These jobs will require new skills and expertise, as mechanization progresses into new areas such as in the management of young stands. Forest digitalization will also demand new skills from the workforce in planning and managing most operations in the wood production services sector.

Forestry professionals will increasingly play a leading role, within the wood chain process of mediating in potential disputes between the different forest disciplines and stakeholder interests (e.g. forest, sawmill and wood industry), improving and strengthening collaboration amongst these stakeholders, and promoting consumer demand and added value for all wood and timber products. With this in mind, there will be significant job opportunities available for forest personnel with appropriate training and expertise in marketing, dispute resolution and public relations.

### **Forest Skills and Expertise**

An expert in production forestry nowadays needs a much broader range of skills than before. In previous decades,

the technical and practical skills in the practice of forestry dominated. Although these skills are still very important, the understanding and practice of appropriate social, public relations and communication skills will be more acute in the future.

Mechanization in the forest sector has positively influenced some aspects of forest work by facilitating and replacing hard physical work by different mechanized operations. In addition, developments in work safety and equipment will continue to mitigate job related safety risks. However, increasing of the number of safety specialists will be needed, which also creates new green jobs opportunities. The skills needed by forest workers and machine operators will be different and this is where appropriate retraining is needed.

Wood production jobs are related to strategic, tactical and operative planning for timber trading and process optimization. Therefore, special knowledge is needed in terms of timber grading, storage and conservation techniques, timber transportation to the customer, timber marketing and all the related logistical and organizational skills.

The logistic systems involved from the forests to the product manufacturers will be more complicated and precise,

**TABLE 4** Outlook on jobs that would be increasingly needed in the field of activity “Wood Production”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Technical ability to achieve high production in various forest types</li> <li>• Meeting the needs of small scale forestry, the environment and society</li> <li>• Successfully dealing with any silvicultural problems associated with the various climatic, edaphic and biotic conditions in forest areas</li> <li>• Familiarization with market needs and the use of new technology</li> <li>• Organizing ability and interpersonal skills</li> <li>• Ability and willingness to work outdoors</li> </ul>	<ul style="list-style-type: none"> <li>• Specialists, experts in forest management and engineering</li> <li>• Experts in wood trade, procurement and logistics</li> <li>• Forestry consultants</li> <li>• Forestry entrepreneurs</li> <li>• Forestry machinery operators</li> <li>• Forestry technicians and skilled specialized forestry workers</li> <li>• Wood specialists</li> <li>• Experts on forest communications and customer relations</li> <li>• Specialists in marketing and wood trading</li> <li>• Specialists in documentation, statistics</li> <li>• Inspectors in forest certification</li> </ul>

**TABLE 5** Examples of green forest jobs in the field of activity “Wood Production”

Example	Short description
Log Salvagers, British Columbia, CA	<p>“Log salvagers literally salvage logs out of the sea which got lost during logging to not only to make a profit out of it and use all the felled timber instead of wasting it, but also to ensure safety in the tourist season, when many boats drive along the bays.”</p> <p><a href="http://wol.jw.org/en/wol/d/r1/lp-e/102002923#h=21">http://wol.jw.org/en/wol/d/r1/lp-e/102002923#h=21</a>  <a href="http://wlssc.ca/">http://wlssc.ca/</a></p>
Procurement foresters, CA	<p>Procurement foresters are responsible for the oversight and management of the procurement, purchase and sale of timber/logs, measure and appraise timber values, determine bid values, contracts, merchandise logs, layout harvest operations and assure quality control. Key to green jobs, procurement foresters monitor compliance with sustainable forestry practices.</p> <p><a href="https://www.pacificforestfoundation.org/management-supervision">https://www.pacificforestfoundation.org/management-supervision</a></p>
Forest machine operators, UK	<p>The operators are able to use forestry machines to fell trees, drag them out of the forest, cut logs to the required length, and either stack logs or load them on trucks for transport. Key to green jobs, the operators are also responsible for making sure the stand, riparian zones and soils are left in an environmentally friendly condition.</p> <p><a href="http://www.mwmac.co.uk/index.php/training/forestry-machines/">http://www.mwmac.co.uk/index.php/training/forestry-machines/</a></p>
Wood supply chain managers, CH	<p>The wood supply chain managers work at the interface of wood production, transportation, trade and processing and provide sound knowledge and administration skills to the allocation, scheduling, transportation and movement of forest products, resources or material and are organizationally involved in its processing. Key to green jobs, wood supply chain managers ensure that the supply chain is both efficient and sustainable, limiting the needless use of energy and reducing or eliminating waste,</p> <p><a href="http://rauricawald.ch/page.asp?DH=13">http://rauricawald.ch/page.asp?DH=13</a></p>

concerning timing and the products needed. In addition to the necessity for excellent logistic skills, there will be a need for competent communication experts in a larger environment of many different stakeholders.

The growing wood energy sector will also bring new efficiencies and adaptation challenges to the wood logistic chains. All of these wood production systems should meet high standards of cost-effectiveness, energy and resource efficiency and environmental performance.

## 2.2 Energy Production

### *Background and Outline of the Field of Activity*

The growth and the potential for energy production from forest resources is considerable. The sector is developing differently, depending on government policy and markets. Strategies and measures to increase wood procurement for energy production must be within the limits of sustainable forest management, keeping environmental, social and economic constraints in mind. The forest sector has a major opportunity to contribute to energy security and mitigation of climate change, by replacing fossil fuels with renewable wood energy and by sequestering carbon in forests and in forest products (ECE and FAO, 2007).

### *Facts and Figures*

Renewable energy accounted for 14 per cent of the world's total primary energy supply in 2014 (International Energy Agency, 2016). "Solid biofuels represented the largest share of renewable energy, amounting to 44.5 per cent in the EU" (ECE and FAO, 2016a) and were thus "the main source of renewable energy in the EU28 in that year" (ECE and FAO, 2016b). According to data from the ECE/FAO Joint Wood Energy Enquiry 2015, wood energy accounted for 37.5 per cent of renewable energy supply (Steierer, Glasenapp and Nemestothy, 2016). The same study showed that 3.5 per cent of the total primary energy supply derives from wood and wood waste. In 2013, wood was the principal source of renewable energy in the ECE Region, accounting for about half of all renewable energy consumption (ECE and FAO, 2014).

In the European Union (EU28), energy consumption originating from wood and wood waste is approximately 5 per cent (FFRI, 2014). There are significant differences among the European countries, with wood energy's contribution to total energy consumption being highest in Latvia, Finland and Sweden (> 20 per cent) and smallest e.g. in United Kingdom, Ireland, Netherlands, Luxembourg, Malta, Cyprus (less than 2 per cent). In the CIS region, wood energy consumption increased in 2016 compared to 2015. Total wood pellet production increased by 2 per cent (ECE, 2017). In North America, the production of wood pellets was about

9.2 million tonnes, an increase by 6.7 per cent compared to 2015 (ECE, 2017).

### *Major Trends, Needs and Challenges*

"Biofuels create less environmental impact than fossil fuels like coal although they contain less energy per unit of weight. New technologies and improved quality of fuel can virtually eliminate harmful emissions during combustion. For this reason, biomass-derived energy is attracting renewed interest and is expected to increase rapidly as a source of energy" (ECE and FAO, 2016a).

The future potential of this energy source is dependent on national policies, the wood market for bioproduct industries and the local energy market.

The mechanization of the wood energy production sector will proceed and new machines and logistic systems will be developed in parallel with the wood procurement chains. Generally it is expected that the mechanization rate in the wood energy sector will be high in areas where wood production is optimal.

### *Opportunities and Prospects for the Forest Sector*

It is expected that the global trends promoting renewable raw materials will also boost the forest energy sector, creating more green forest jobs in harvesting, transportation, logistics and energy raw material management. As the energy market in this sector is local, the speed of the development will vary in different areas depending on different conditions (e.g. legislative and socio economic framework).

There is a big opportunity in the forest sector related to energy production, if development of wood and energy supply chains are coordinated in order to achieve the best possible efficiencies in the entire wood production chain.

### *Forest Skills and Expertise*

Generally, the skills required in the future will be the same as in the wood production sector (see table 4 and table 7). The procurement and logistics of raw material for the bioproduct industry and energy needs are often integrated in order to achieve a high cost-efficiency.

**TABLE 6** Tasks, activities and services in the field of activity “Energy Production”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Development of the energy production chain and coordination with the wood production chain</li> <li>• Development of lignin based industries</li> <li>• Procurement and logistics, flow of raw materials</li> <li>• Development of adapted planning and harvesting technologies</li> <li>• Marketing</li> <li>• Research and development of products</li> </ul>	<ul style="list-style-type: none"> <li>• Promotion and practical implementation of the use of woody biomass and forest residues for heat and energy production</li> <li>• Integration of energy production strategies into forest management practice</li> <li>• Continuous dependable sourcing and provision of energy wood</li> <li>• Appropriate logistics</li> <li>• Information and marketing campaigns</li> </ul>

**TABLE 7** Outlook on jobs that would be increasingly needed in the field of activity “Energy Production”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Understanding of the wood energy production and supply chain and the political, technical and legal challenges associated with the bioproduct sector</li> <li>• Knowledge and practical experience in marketing, forest inventory, geographic information system (GIS) and wood procurement</li> </ul>	<ul style="list-style-type: none"> <li>• Integrated wood and forest energy producers</li> <li>• Specialists in biomass marketing and logistics</li> <li>• Experts in wood energy procurement</li> <li>• Experts in trade and communications</li> <li>• Forest entrepreneurs and operators</li> <li>• Local energy production entrepreneurs</li> <li>• Coordinators advising wood energy producers and biomass co-generation plants</li> <li>• Wood energy consultants</li> </ul>

**TABLE 8** Examples of green forest jobs in the field of activity “Energy Production”

Example	Short description
Short rotation plantation managers, DE	Short rotation plantation managers develop and manage fast growing tree plantations. The work includes planning, site preparation, planting, management, harvesting, logistics and preparation for processing. <a href="http://www.wald21.com/">http://www.wald21.com/</a>
Local energy procurers, FI	Local energy procurers take care of both raw material feed and the procurement of wood energy (heating and/or electricity). They are responsible for increasing the province’s energy self-sufficiency in co-operation with energy producers, peat and heat entrepreneurs and forest owners. The work also includes responsibility for forestry work, chipping and transport, and comprises the whole bioenergy chain, from the forest to eventual heat generation. <a href="http://www.kaskihake.fi/">http://www.kaskihake.fi/</a>





3.

AGROFORESTRY  
AND MOUNTAIN  
FORESTRY



## 3. Agroforestry and Mountain forestry

This chapter deals with forest related land use in terms of “Agroforestry” and “Mountain Forestry and Soil Bioengineering”. Facts, major trends, opportunities and skills concerning these specific green forest jobs are highlighted and existing job examples are given below.

### 3.1 Agroforestry

#### *Background and Outline of the Field of Activity*

Agroforestry combines the cultivation of multi annual woody plants like trees and shrubs with agricultural crops and/or animals on the same space. The combination of these different forms of land use varies in time and space. Agroforestry is based on economic and ecological interactions between annual and multiannual plants as well as between animals.

Different systems of agroforestry are used worldwide, including: improved fallows, taungya (a mixed catch crop system in the transition period from agriculture to forestry land use), home gardens, alley cropping, growing multipurpose trees and shrubs in farmlands, boundary planting, farm woodlots, orchards and tree gardens, tree plantations, shelterbelts, windbreaks, conservation hedges, fodder banks, live fences, silvopastoral systems and apiculture with trees (FAO, 2017). The US Department of Agriculture (USDA) distinguishes between agroforestry farming systems (silvopasture, alley cropping and forest farming) and linear agroforestry practices (windbreaks and riparian forest buffers) (USDA, 2017a).

There is significant potential for the creation of green forest jobs in these areas.

#### *Facts and Figures*

According to FAO, targeted investments in sustainable forestry, of which agroforestry comprises a significant part, could generate 10 million new jobs, globally. Such new green jobs could include establishing and managing urban and peri-urban green spaces through agroforestry practices, improving watersheds, protecting forests from fire and building roads and trails for recreation sites. These jobs are generally characterized by low capital requirements and high diversity, and have multiplier effects of generating additional 1.5- to 2.5-fold local employment gains in the economy (Nair and Rutt in FAO, 2011).

#### *Major Trends, Needs and Challenges*

Agroforestry not only helps fight hunger and malnutrition in poor rural and urban areas but also helps to improve

sustainable land use and biodiversity in the world. Agroforestry is becoming increasingly popular, as it reflects a self-reliant or earth friendly lifestyle. Urban communities are taking up the idea of permaculture, which entails the use of patterns that can be found in natural ecosystems and has largely been described as a philosophy of working with, rather than against nature; of protracted and thoughtful observation, rather than protracted and thoughtless labour; and of looking at plants and animals in all their functions, rather than treating any area as a single product system (Mollison, 1991). The practice of urban agriculture and food production is further associated with open space, recreation, and community development, exemplified in the emerging trend of private or community gardens, forests or permaculture developments.

Despite the fact that agroforestry systems are gaining attention internationally and that there is an increasing body of scientific evidence to support them, they face many challenges and obstacles for their successful acceptance. According to FAO, some of the hurdles are as follows:

- Under-developed markets for tree products in comparison to agriculture.
- Agricultural policies put most emphasis on commercial agriculture (monoculture) and mainly support large-volume, large-scale approaches to agricultural, food and fuel products.
- There is still a limited awareness of the advantages of agroforestry.
- Agroforestry is often subject to policy conflicts and omissions, creating gaps or adverse incentives that work against its development. Moreover, the various organizational cultures and objectives within different departments may not allow room for agroforestry (FAO, 2017a).

#### *Opportunities and Prospects for the Forest Sector*

Agroforestry has an impact on many sectors, so there is a strong demand for people who are experienced in the coordination of farm and non-farm natural resource management. In order to enable stakeholders to increase the scale of Agroforestry and promote its acceptance, programmes need to be developed and put on the political agenda. Self-learning and knowledge-sharing are critical for upscaling good agroforestry practices. Research and development will play a critical role.

Thanks to their knowledge of sustainable forest management, forest professionals can play a leading role in applying agroforestry in the forest sector. They can develop value chains for the newly-produced tree products and assist in projects design, implementation and optimization phase with an advisory service. The potential for the creation of green forest jobs in this particular area is very good.

**TABLE 9** Tasks, activities and services in the field of activity “Agroforestry”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Mediating and communicating among different sectors</li> <li>• Promotion of agroforestry as a sustainable and promising future land use system</li> <li>• Establishing community based agroforestry systems</li> <li>• Researching different methods and approaches to generating sustainable jobs in this area</li> </ul>	<ul style="list-style-type: none"> <li>• Combination of forestry and agriculture practices</li> <li>• Wood pasture management</li> <li>• Land use engineering</li> <li>• Agroforestry action plans and policies</li> <li>• New agroforestry systems</li> </ul>

**TABLE 10** Outlook on Jobs that would be increasingly needed in the field of activity “Agroforestry”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Practical knowledge of agroforestry, forestry and horticulture</li> <li>• Relevant field work experience in these disciplines</li> <li>• Excellent communication and mediation skills</li> <li>• Marketing knowledge and research competencies</li> <li>• Land resource optimization and management skills</li> </ul>	<ul style="list-style-type: none"> <li>• Forest farmers</li> <li>• Agroforest specialists in urban areas (lifestyle promoters)</li> <li>• Agroforest specialists in poor areas (food security specialist)</li> <li>• Permaculturists, permaculture consultant</li> <li>• Agroforestry planners and managers</li> <li>• Agroforestry technicians</li> </ul>

**TABLE 11** Examples of green forest jobs in the field of activity “Agroforestry”

Example	Short description
Agroforestry consultants, CA	Agroforestry consultants provide: agroforestry best-practices to apply to specific conditions, site-specific management plans, select optimal plants, technical advice, and information on legislation and regulations. <a href="http://www.4bm.ca/services/agroforestry.cfm#Consultation">http://www.4bm.ca/services/agroforestry.cfm#Consultation</a>
Forest food managers, CA, UK, US	Forest food managers work together with community groups to carry out inventories, restore, create and maintain urban food forests. <a href="http://www.resilience.org/stories/2014-08-01/20-urban-food-forests-from-around-the-world/">http://www.resilience.org/stories/2014-08-01/20-urban-food-forests-from-around-the-world/</a>

### Forestry Skills and Expertise

The field of agroforestry will require that professionals have a broad understanding, not only of trees but also of agricultural systems, food production and land management. As they collaborate with landscape architects and gardeners, forestry professionals need to rely on their long-term and sustainable management training concerning tree growth and management. Good communication, teaching and moderation skills will be needed in order to promote the benefits of agroforestry among the various related sectors. Marketing and researching new approaches and products will also be important.

## 3.2 Mountain Forestry and Soil Bioengineering

### Background and Outline of the Field of Activity

Mountain forests characterized by specific site conditions as a result of steep slopes and the related interaction with climatic factors. Due to those site conditions, mountain regions are often affected by avalanches, debris flows, floods, landslides, erosion and rock fall (Zingari et al., 2002). Mountain forestry therefore has to deal with very challenging and sometimes impossible harvesting situations, higher production costs and economic risks as well as with harsh

climatic conditions (Stoehr, 2009). In such regions, mountain forests play a protective role against natural hazards and risks as they protect soil, slopes and human activities from hydro-geological damage (Notaro et al., 2008; Berger et al., 2004). Mountain forestry is furthermore an interdisciplinary approach where socio-economic aspects and multiple user interests have to be integrated (Price et al., 2011).

Mountain forestry is also closely linked with soil bioengineering. Soil bioengineering is an old and widely used mitigation treatment for slope and embankment stabilization and erosion control of disturbed sites. It is based on living plant material as structural components and often used in combination with auxiliary materials, e.g. geotextiles (Schiechtl, 1980; Lewis, 2000; Graf et al., 2003). Several techniques exist to deal with different site conditions and situations, such as live fascines and crib walls, brush layering, and branch packing. Along with these technical functions (protection and stabilization), soil bioengineering structures also fulfil many important ecological and landscaping functions and have significant economic benefits by reducing costs associated with damage to: roads, settlements and natural resources.

Mountain forestry and soil bioengineering utilize specific forest management systems for natural hazard mitigation, the planning and application of adapted management regimes and harvesting techniques, as well as planning of “classical” protection concepts. In particular, planning measures (e.g. danger zone planning), involve technical protection measures or constructions.

### Facts and Figures

Mountain forests represent 23 per cent of the earth’s forest cover (Price et al., 2011). European mountain ecosystems have been more affected by climate change. For example, the Alps have experienced a temperature increase of twice the global average over the second half of the twentieth century (Moreschek et al., 2009).

In Switzerland alone, more than 130,000 buildings, thousands of km roads and rail lines are protected by mountain forests against natural hazards, with about half of these forests,

managed as protective forests with special restrictions (Schutz Schweiz Wald, 2017).

Mountain forests and shrublands in Central Asia cover almost five million hectares, including 2.5 million hectares of coniferous forests, and more than 350,000 hectares of globally significant fruit-and-nut forests (walnuts, almonds, pears, apples, cherries and pistachios). Mountain forests not only provide important watershed protection and erosion control, but they also contribute to the regulation of water courses and the retention of groundwater (FAO, 2012). Research conducted by the World Bank in 2009 suggests that the Caucasus and Central Asia have the highest degree of vulnerability to climate change, with mountainous regions especially affected due to rising temperatures and changes in precipitation (UNEP, 2017).

### Major Trends, Needs and Challenges

*Safeguarding the protective functions of mountain forests from the adverse impacts of climate change is one of the biggest future challenges.* “[...] Casualties and damage due to hazards in mountain regions will increase irrespective of global warming, especially where populations are growing and infrastructure is developed at exposed locations. But climate change will definitely increase the [natural disaster] risk due to the fact that expected increases of heavy rainfall, heat waves, and glacier melt will amplify hazards in many mountains worldwide, and in areas where they have not been known in the past” (Marty et al., 2009). Disturbances by wind throw and bark beetle infestation are likely to increase due to climate change, both in frequency as well as extent (Price et al., 2011). Equally, rock fall and landslides will be additional risks due to temperature rise.

### Opportunities and Prospects for the Forest Sector

Risk analysis and management will be some of the main tasks for mountain foresters in the future. With their combined and profound knowledge of ecological interactions, ecosystem functioning and technical knowledge, forest professionals are best suited for working in this field. As mountain forest management provides an effective and cost-efficient way of natural hazards mitigation this is a promising future opportunity for green forest jobs creation.

**TABLE 12** Tasks, activities and services in the field of activity “Mountain Forestry and Soil Bioengineering”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Adaptation of mountain forest and natural hazard management to climate change</li> <li>• Quantifying the protective effect of mountain forests against natural hazards</li> <li>• Improvement of natural hazard modelling and related mountain forest management</li> </ul>	<ul style="list-style-type: none"> <li>• Natural hazard management</li> <li>• Protective forest management</li> <li>• Soil bioengineering</li> <li>• Bioengineering</li> <li>• Biological control</li> </ul>

### Forest Skills and Expertise

In the field of mountain forestry, knowledge about identifying risks, controlling natural hazards, planning prevention systems, developing and implementing silvicultural techniques that mitigate natural hazards and applying biological engineering solutions is essential.

Soil bioengineers are responsible for restoration planning of devastated sites with plant structures and other technological, ecological and economic solutions. A wide

knowledge of plant properties (e.g. species identification and their ecological and growth characteristics), soil and stability aspects, timber support systems and natural hazard management is necessary for this field of work.

Mountain forestry and soil bioengineering jobs deal with the biological and technical analysis, mitigation and prevention of the effects of natural hazards (see table 14). The main issues concerning risk management are discussed in chapter 2.4.4.

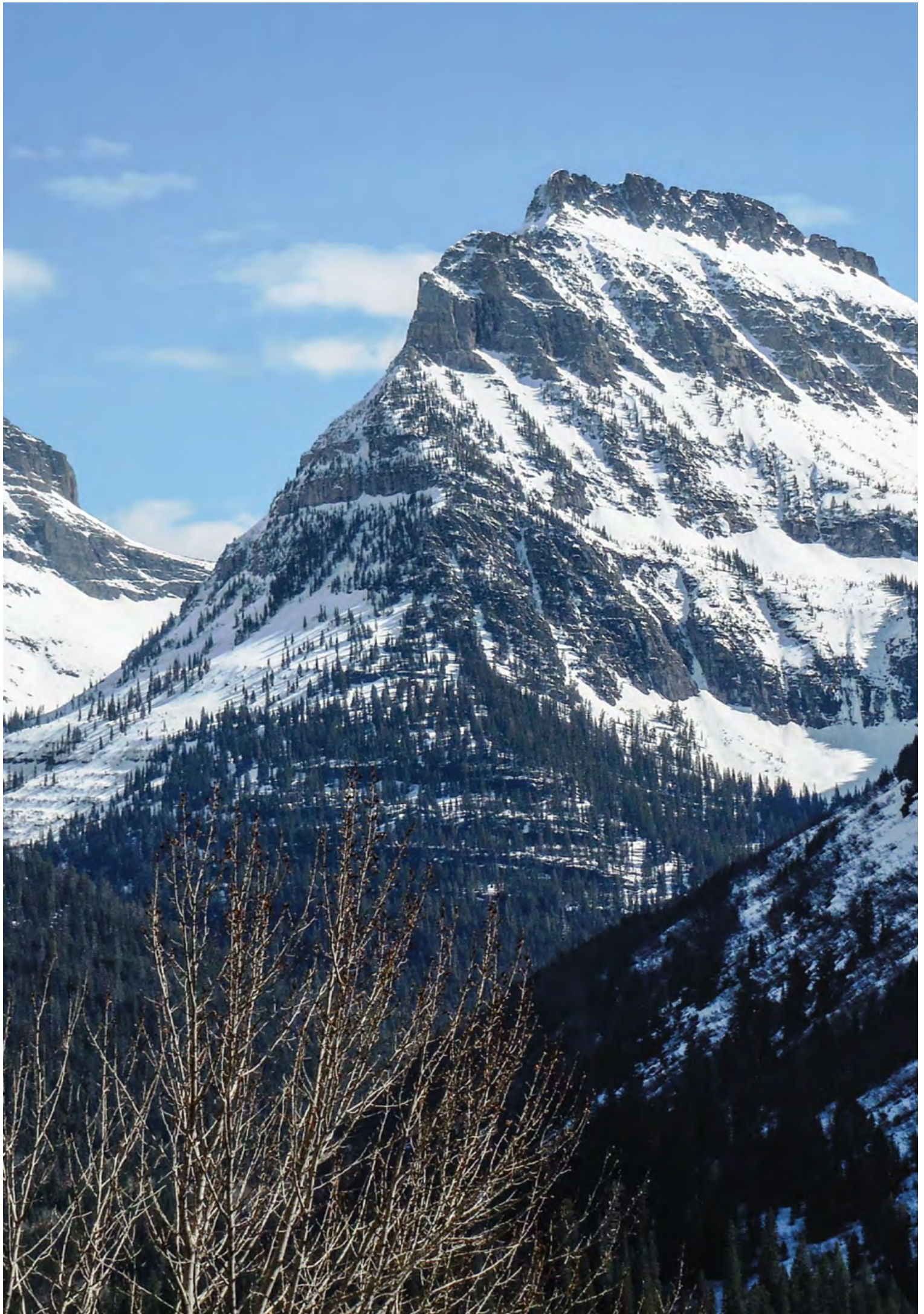
**TABLE 13** Outlook on jobs that would be increasingly needed in the field of activity “Mountain Forestry and Soil Bioengineering”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Advanced knowledge of mountainous forest harvesting techniques</li> <li>• Detailed knowledge of natural hazard detection, control and mitigation</li> <li>• Awareness of appropriate protective forest management measures</li> </ul>	<ul style="list-style-type: none"> <li>• Specialists in mountain forestry</li> <li>• Specialists in mountain forest management</li> <li>• Specialists in natural hazard management</li> <li>• Soil bio-engineers</li> </ul>

**TABLE 14** Examples of green forest jobs in the field of activity “Mountain Forestry and Soil Bioengineering”

Example	Short description
Specialists in forests and natural hazards, Forest Department, Grisons, CH	<p>These specialists are responsible for the following tasks: Compilation of natural hazard statistics, processing forest related risk analyses and evaluation, separation of hazard zones, compilation of statistical data on protective forests and protective structures regarding avalanches, rock fall, erosion, landslides and floods.</p> <p><a href="http://www.gr.ch/DE/institutionen/verwaltung/bvfd/awn/naturgefahren/Seiten/Naturgefahren.aspx">www.gr.ch/DE/institutionen/verwaltung/bvfd/awn/naturgefahren/Seiten/Naturgefahren.aspx</a></p>
Specialists in forest and protective structures Forest Department, Grisons, CH	<p>These specialists are responsible for the following tasks: Consultation with support constructors about the design, planning and implementation of protective structures against avalanches, rock fall, erosion and landslides as well as for the establishment of early warning systems and monitoring stations.</p> <p><a href="http://www.gr.ch/DE/institutionen/verwaltung/bvfd/awn/naturgefahren/Seiten/Naturgefahren.aspx">www.gr.ch/DE/institutionen/verwaltung/bvfd/awn/naturgefahren/Seiten/Naturgefahren.aspx</a></p>









4.

SOCIAL  
AND URBAN  
DEVELOPMENT



## 4. Social and Urban Development

This chapter addresses forest development in an urban context and deals with the fields of activity “Urban Forestry and Arboriculture” and “Culture and Forests”. Facts, major trends, opportunities and skills concerning these specific green forest jobs are highlighted and existing job examples are given below.

### 4.1 Urban Forestry and Arboriculture

#### *Background and Outline of the Field of Activity*

The establishment and maintenance of urban trees has a long history in the field of arboriculture. Traditionally, urban green areas have been designed and managed by landscape architects and horticulturists.

The concept of urban forestry and urban forests is relatively new and has only been disseminated since the 1960s. Urban forestry deals with the location and function of forest stands and other tree dominated vegetation – such as forests, woodlands, parks, groups of trees, street tree plantings or single trees – in or near urban areas. Consequently, this field is strongly related to the benefits urban trees and forests provide to society, e.g. physiological, psychological, sociological, economic and aesthetics. Urban forestry is thus the art, science and technology of managing urban trees and forests for the benefit of humankind (Randrup et al., 2005).

Urban forestry contributes to the environmental sustainability, economic viability and livability of urban settlements. It therefore comprises not only the planning, design and management of sustainable, resilient urban forest landscapes but also the management of residents and their related claims and demands concerning urban trees and forests (FAO, 2016).

Arboriculture is an important component of urban forestry. The term “arboriculture” is composed of “arbor” (= tree) and “cultura” (= caring or tending) and means the cultivation of single trees or small tree groups based on tree biology and it is about tree care, tree vitality assessment and tree safety inspection in urban areas (Dujesiefken et al., 2005). In addition, it takes aesthetic considerations into account.

The management of individual trees starts with suitable tree species selection for best adaptation to urban settings, together with choosing proper planting, watering, fertilization and mulching regimes together with techniques for the protection of trees and branches (e.g. stakes and supports).

#### *Facts and Figures*

The world is urbanizing quickly. Since 2008, more than half the world’s population lives in cities and towns (for the first time in history). By 2050, this percentage is expected to expand up to 70 per cent (FAO, 2016).

The benefits of urban trees and forests have many positive effects on the economy of cities, but are largely unknown to residents and policy makers. For example, London’s 8.4 million trees produce an annual benefit of about £132 million (Rogers et al., 2015). The monetized benefits of urban trees and forests outweighed their maintenance costs by ratios of between 1.37 and 3.09 as shown in five US cities (McPherson et al., 2005).

#### *Major Trends, Needs and Challenges*

Urbanization and changing demographics create challenges to human health and wellbeing. Urban forestry can provide some responses to these challenges. Urban development – as often practiced – results in the depletion and degradation of natural ecosystems in and around urban areas, the drastic loss of vital ecosystem services and, potentially, little resilience to disturbances, such as those caused by climate change (FAO, 2016). At the same time, the demand on urban forests by residents is increasing – especially concerning leisure and recreation – while understanding of natural processes and benefits from forests and green infrastructure decrease.

However, many residents have become less familiar with such developments, for example, the benefits of clean air and water, improved mental health and trees as a source of food and energy (FAO, 2016). The lack of space for plants and trees caused by buildings and infrastructure limits the positive impact of forests and trees, especially in urban areas. Therefore, urban forestry will be needed to strengthen urban forest ecosystem services and thus urban qualities.

Urban forestry practitioners not only need to design and manage healthy, stable, attractive and accessible urban forests able to cope with different demands, but they also have to promote and improve the understanding and acceptance of forests and forest management in urban settings.

#### *Opportunities and Prospects for the Forest Sector*

Increasing urbanization and the importance of green infrastructure in urban settings testify to the potential for green forest job creation in urban forestry. For example, the city of Manchester (UK), supports an estimated 15,500 urban forestry jobs (1.2 per cent of total employment) in areas such as the processing of forest products, tree-related tourism, and professional forestry-related services (Connor, 2013 in FAO, 2016).

Besides providing job opportunities, forestry can play a leading role in promoting the benefits of trees and forests in the context of sustainable urban development. Promoting

**TABLE 15** Tasks, activities and services in the field of activity “Urban Forestry and Arboriculture”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Planning and designing urban trees and forests</li> <li>• Managing urban trees and forests</li> <li>• Maintaining the ecosystem services of urban trees and forests</li> <li>• Valuation, communication and promotion of the benefits of ecosystem services of urban trees and forests</li> <li>• Liaison with urban forest stakeholders</li> <li>• Managing and improving the understanding and image of urban forestry as a stand-alone field of activity or profession.</li> <li>• Creating an urban forester mind-set by combining existing disciplines, such as arboriculture and forestry with other required skills</li> </ul>	<ul style="list-style-type: none"> <li>• Urban forest policy and governance</li> <li>• Green infrastructure planning</li> <li>• Urban forest strategy and action planning</li> <li>• Urban forest design and maintenance planning</li> <li>• Urban forest benefit assessments</li> <li>• Extending and strengthening the education and capacity building of urban forestry at different levels</li> <li>• Establishing a certification scheme of urban foresters</li> <li>• Tree assessments</li> <li>• Arboriculture</li> <li>• Landscaping</li> </ul>

the role of trees and forests, ranging from purely aesthetic considerations to the provision of goods and services will improve the acceptance of general forest management.

In the US, since the mid-1990s, urban forestry has increasingly focused on environmental, conservation, economic and social benefits of community trees (McPherson, 2006), and it is estimated that at the end of the past millennium, urban trees accounted for about 25 per cent of the contiguous United States' national total canopy cover (Dwyer et al., 2000). Hence, urban forestry is at different stages of development across the ECE Region. However, there is great potential for green forests jobs all over the region, especially with the development of urban recreation areas.

### Forestry Skills and Expertise

Urban forestry requires a wide range of skills and knowledge. It entails dealing with variable natural environment, such as harsh and extreme growing conditions, on the one hand and with urban society and urban landscape managers and planners on the other hand. Urban foresters have to liaise on a regular basis with other personnel such as: landscape architects, landscape and park managers, amenity horticulturists, urban ecologists; and non-plant related professionals such as: planners, public health experts and engineers. Urban forestry is about forest recreation, satisfying the demands of users, providing information and advice; but it is also about managing biotic, abiotic and anthropogenic stress, assessing tree vitality and health, establishing optimal pruning regimes, root-friendly pavement and nursery production (Nilsson et al., 2005; Konijnendijk et al., 2005).

As regards the special arboricultural skills required, workers should be able to assess the health status of individual trees, recognize dangerous and vulnerable trees and decide on appropriate treatments. Special knowledge on tree growth, tree biology and the tree's response under adverse urban conditions is needed as well as an expert understanding about tree architecture, tree vitality and diagnostic methods. Working in arboriculture also requires identification, control and management of pests and tree diseases, as well as tree care practices, such as wound treatments and crown stabilization.

### Examples

Urban forestry is a relatively young and multifaceted discipline and is mostly integrated into traditional forest job positions. Some of the already existing job possibilities are mentioned below.

## 4.2 Culture and Forests

### Background and Outline of the Field of Activity

Most of our forests have a cultural value, described by the International Union of Forest Research Organizations (IUFRO) as follows: “Many of the world's “primary forests” and biodiversity “hotspots” are located in regions with the highest diversity of indigenous populations who manage their natural resources based on their distinctive cultures and their associated traditional knowledge and wisdom. In other rural environments, a long history of integration of forestry and agricultural activities has also created land use forms and biological diversity that is closely connected to complex

**TABLE 16** Outlook on jobs that would be increasingly needed in the field of activity “Urban Forestry and Arboriculture”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Communication skills for managing complex stakeholder relations</li> <li>• Public relation skills for interacting with residents</li> <li>• Competencies in planning, designing, managing and maintenance of trees and forests</li> <li>• Comprehensive knowledge and competencies in ecology, forestry, agroforestry, ecosystem functioning, ecosystem services and their valuation, climate change, tree care, economic and social issues related to health care, recreation and leisure and environmental education</li> </ul>	<ul style="list-style-type: none"> <li>• City foresters</li> <li>• Urban forest managers</li> <li>• City arborists</li> <li>• Green urban infrastructure planners and managers</li> <li>• Urban forest management consultants</li> <li>• Urban forest food producers (Urban agro-foresters)</li> <li>• Arboriculture technicians</li> <li>• Landscape designers</li> <li>• City climate change adaptation experts</li> </ul>

**TABLE 17** Examples of green forest jobs in the field of activity “Urban Forestry and Arboriculture”

Example	Short description
City tree officers of London, UK	Tree officers take care of urban trees and will generally act as either consultants (tree advisors or arboriculturists) or contractors (tree surgeons or arborists). <a href="http://www.ltoa.org.uk">http://www.ltoa.org.uk</a>
Urban forestry coordinators, Georgia, US	Urban forestry coordinators supply forestry knowledge to communities, educational programmes and materials, assist with wildland-urban interface issues. <a href="http://www.gfc.state.ga.us/community-forests/">http://www.gfc.state.ga.us/community-forests/</a>
Urban forest stewardship coordinators, Oakville, California, US	Urban forest stewardship coordinators search, train and support local volunteers to carry out on-the-ground stewardship activities to improve the health of trees and woodlands in their neighbourhoods. <a href="http://oakvillegreen.org/job-posting-urban-forest-stewardship-coordinator/">http://oakvillegreen.org/job-posting-urban-forest-stewardship-coordinator/</a> <a href="http://oakvillegreen.org/programs/oakville-treekeepers/">http://oakvillegreen.org/programs/oakville-treekeepers/</a>
Tree consultants, Southampton, UK	Consultants provide consultation on tree health, safety, preservation, trees and buildings, planning and legal issues. <a href="http://www.mjctreeservices.co.uk">http://www.mjctreeservices.co.uk</a>
Tree contractors, Cambridge, UK	Contractors (“tree surgeons”), provide specialist tree planting, pruning and felling services. Some may also advise on maintenance requirements and pest and disease control. <a href="http://johntalbot.co.uk/">http://johntalbot.co.uk/</a>
Arboricultural officers, UK	Arboricultural officers organize inspection and surveys of trees, offering advice and training to private owners and local councils, selecting plants and designing landscaping schemes. <a href="https://www.uhi.ac.uk/en/courses/hnd-arboriculture-and-urban-forestry">https://www.uhi.ac.uk/en/courses/hnd-arboriculture-and-urban-forestry</a> <a href="http://www.charteredforesters.org/">http://www.charteredforesters.org/</a>

landscape patterns" (IUFRO, 2007). The "local knowledge is not only a thing to be conserved as of cultural value in its own right (e.g. indigenous knowledge of forest medicinal plants; traditional stories attached to forest locales), but it can be instrumental in the interpretation of the cultural value of landscape" (Tabbush, 2010: 27).

The cultural value of forests is often linked with social, spiritual and amenity aspects and integrated in the concept of sustainable forest management (Tabbush, 2010; IUFRO, 2007). According to the Millennium Ecosystem Assessment (MEA, 2005) the cultural services and benefits people obtain from nature or forests include: education, inspiration, spiritual well-being and religion, recreation and ecotourism, cultural heritage, aesthetics, as well as health and well-being and social contacts.

As Tabbush stated (2010), the cultural capital of forests comprises: a) the "embodied cultural capital" understood as all the values and norms that stakeholders (e.g. visitors, local communities) bring to woodlands and, b) "objectified cultural capital" being all the physical attributes of woodlands that are of cultural value.

### Facts and Figures

The State of Europe's Forests report underlined (Indicator 6.11) the importance of cultural and spiritual values: "Around one million sites with cultural and spiritual values have been recorded within forests and other wooded land, of which around three-quarters were classed as "Cultural heritage" (Forest Europe, ECE and FAO, 2011).

Globally, an estimated 3.7 per cent of the world's forests are designated for the provision of recreation, tourism, education or conservation of cultural and spiritual heritage. "The top five countries with forest areas designated for social services were Brazil, the Russian Federation, China, Japan and Ukraine, which together designated some 142 million hectares for this purpose. Brazil has designated 119 million hectares, or

more than one-fifth of its forest area, for the protection of the culture and way of life of forest-dependent peoples. This area accounts for more than three-quarters of the total area of forest designated for social services worldwide" (FAO, 2010).

### Major Trends, Needs and Challenges

Within Europe there are an increasing number of countries allotting cultural and spiritual values to forest sites, reflecting a growing recognition of their importance. This means that there is potential for job creation in services related to "cultural and historical functions, e.g. sacred, religious, other forms of spiritual inspiration, landscape features, aesthetic enjoyment and inspiration, and sites historic artefacts" (Forest Europe, ECE and FAO, 2011).

Over the last decades, burial culture has significantly changed in many regions in Europe due to the limited amount of cemeteries. Cremation has become an alternative and is further expanding. Linked to the above, funeral forests are a growing trend, which also accommodate the desire for burials with natural and spiritual dimensions. Today more than 100 funeral forests have been established, especially in Central European countries, where the ashes can be spread or columbaria have been integrated in or close to funeral forests.

Another field of activity is the preservation and practice of historical forest professions, such as charcoal burning, timber rafting/log driving or medieval forest glassmaking (Schutzgemeinschaft Deutscher Wald, 2017). Reviving such traditional practices contributes to the preservation of cultural heritage. Forest related cultural heritage does not only exist in terms of knowledge or practices, but can also be connected to historical sites located inside forests, such as megalithic tombs, for example, in Sweden or Germany.

In North America, despite the influence of "European" culture, indigenous people maintain a spiritual relationship with the forest within their culture. According to their tribal culture, forests provide many forms of life that are interdependent

**TABLE 18** Tasks, activities and services in the field of activity "Culture and Forests"

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Identifying and researching cultural and aesthetic development opportunities in forests</li> <li>• Establishing a network of funeral forests</li> <li>• Creating, facilitating and managing diverse and innovative cultural activities in forests to create Green Forest Job opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• Cultural functions of forests; forest heritage</li> <li>• Historical forest information and research</li> <li>• Cultural objects in forests, cultural interpretation of forests and forestry</li> <li>• Myths and history; photography, folklore</li> <li>• Spiritual places</li> <li>• Burial grounds in forests</li> <li>• Art, literature, craft in and from forests</li> </ul>

and essential to each other (Tippeconnic, 1995). There is an increasing interest and support by Native Americans people for their culture, language, traditions, values and beliefs. Vocationally, there are now professionals in North America that liaise with tribal representatives regarding forest management in areas where forests have significance to tribal culture and work with archaeologists to ensure that identified sacred sites are preserved (USDA, 2012; Union of Ontario Indians, 2015).

### Opportunities and Prospects for the Forest Sector

Cultural changes in societies lead to new demands on forest services. There are different opportunities for forest experts to work in the forest cultural related field. One very promising development are the funeral forests mentioned above, which generate need for specific services on a regional scale, e.g. set up of a regulatory framework, selection and establishment of forests and trees as well as their maintenance to support and prepare for the funeral forest ceremonies. These regional developments vary significantly within Europe. Connecting people with the cultural values of forests can go beyond

funeral forests, as there are other life events, such as marriage or a birth which can be related to trees and honoured in a forest setting, e.g. with a tree planting ceremony.

There are many other job opportunities related to cultural, spiritual, historic, aesthetic, artistic, literary, therapeutic and mystical values of trees and forests, such as preservation of cultural heritage of indigenous cultures and historical sites inside forests or maintaining knowledge about historical forest professions. These cultural benefits are now being studied in a greater detail in the context of job creation opportunities, particularly in the areas of ecotourism, ecotherapy, forest aesthetics, forest amenity and recreation.

### Forest Skills and Expertise

Most cultural, artistic and aesthetic aspects of forests are generally associated with strong social, personal and subjective emotions. Therefore, forest personnel working in the cultural settings of forests need to be mindful of the different concerns and attitudes of forest visitors (see table 19).

**TABLE 19** Outlook on jobs that would be increasingly needed in the field of activity “Culture and Forests”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Mindful, tactful and attentive when dealing with the concerns and sensitivities of forest visitors from different cultural backgrounds</li> <li>• Open minded and interested in other cultures, traditions, views and interpretations of life as well as forest history</li> <li>• Excellent communications and public relations skills.</li> <li>• General knowledge of the arts, culture and history</li> </ul>	<ul style="list-style-type: none"> <li>• Forest archivists, forest historians</li> <li>• Landscape artists</li> <li>• Arts and handicrafts, wood turners</li> <li>• Forestry cultural event organizers</li> <li>• Forest interpreters (landscape interpreters)</li> <li>• Funeral foresters</li> </ul>

**TABLE 20** Examples of green forest jobs in the field of activity “Culture and Forests”

Example	Short description
Funeral forest managers, DE	Responsible for the conceptual design, adapted forest management, preparation and processing of the forest funeral services by providing support, information and guidance <a href="http://www.müritz-ruheforst.de/">http://www.müritz-ruheforst.de/</a>
Forest historians, DE	The forest historian is a researcher and teacher focusing on the changing relationships of humans to their naturally existing and managed forest resources. Important aspects are the societal demands placed on the forest over time. The historian deals with the changes in forest functions and the impact of man on the design and development of the landscape. In accordance with the cultural significance of the subject, the historian is in close contact with other scientific disciplines. <a href="https://www.wald-und-forstgeschichte.uni-freiburg.de/">https://www.wald-und-forstgeschichte.uni-freiburg.de/</a>



A man in a dark blue zip-up jacket and blue jeans stands in a forest, looking up and to the right while holding a tablet. On the ground around him are various pieces of field equipment: a silver metal case, a black bag, a solar panel, a small table with a laptop, and a large black backpack with orange straps. The background is a dense forest of tall, thin trees with green foliage.

5.

FOREST  
MANAGEMENT,  
INVENTORY  
AND PLANNING



## 5. Forest Management, Inventory and Planning

This chapter addresses forest development in terms of “Forest Inventory and Forest Monitoring”, “Planning, Governance and Sustainable Forest Management”, “Pests, Disease and Forest Fires” and “Risk Management and Contingency Planning”. Facts, major trends, opportunities and skills concerning these specific green forest jobs are highlighted and existing job examples are given below.

### 5.1 Forest Inventory and Forest Monitoring

#### *Background and Outline of the Field of Activity*

Forest inventories and monitoring aim to determine the status, changes, and trends in indicators of specific forest conditions. Data about trees, stands and sample plots are obtained annually or at regular intervals to provide reliable forest resource information for national forest policy development, planning and sustainable management. Data sampling mostly focuses on general parameters concerning sustainable forest development and management, such as forest cover, tree species, tree growth, wood production, utilization, regeneration and rejuvenation, mortality, forest health and biodiversity issues (e.g. deadwood, insects, disease). Datasets from forest inventories and monitoring are now also widely used to more accurately predict and evaluate many other environmental, social and economic parameters.

The fields of activity include: conducting of resource and health inventories (including tree measurements and foliage evaluations), understory vegetation composition and structure estimates, site characteristics and soil evaluations.

Data sampling, detailed analysis and the utilization of accurate measurement procedures and protocols are crucial for the successful completion of forest inventories and reliable forest monitoring. There is a need for more forestry personnel trained in the recent technological advances such as: satellite imagery, remote sensing, photointerpretation, light detection and ranging (LiDAR), use of drones, and geographic information systems. The potential for additional green forest jobs in this area is considerable. Technical colleges and universities need to prepare forestry students to become familiar with the changing technology by providing up to date curricula.

#### *Facts and Figures*

Monitoring of forests can be done in timescales, which can also be described as continuous or periodic systems of inventory. Different timescale systems have different pros and cons related to information quality, utility, and efficiency (Gillespie, 2005). For instance, the US changed from a periodic inventory system (7 to 15 year intervals depending on the state) to a continuous one (USDA, 2017b). In contrast, Germany, publishes their forest inventory periodically about every ten years. These different systems have varying implications for the workforce, especially related to long-term employment versus “ad hoc” employment, advancements in technologies, (in)stability in funding, among others.

#### *Major Trends, Needs and Challenges*

There are major ongoing technological advances and changes in the work direction of forest inventory and forest monitoring. Although fieldwork is still needed, there is now a strong shift to the digitalization of the entire forest data gathering and analysis process due to this extensive technological progress. Many raw data sets are currently generated via remote sensing without the need for time consuming field work.

Continuous education and training to keep up with this technological progress is critical for workers in this field.

#### *Opportunities and Prospects for the Forest Sector*

Job opportunities in this area will always be available and may increase with the development of new technologies supporting national forest inventory processes (see table 23).

**TABLE 21** Tasks, activities and services in the field of activity “Forest Inventory and Forest Monitoring”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Wider use of new remote sensing technology and statistical analysis</li> <li>• Adaptation and adoption of sampling and inventory design based on new, mostly digitalized data sampling methods</li> <li>• Interpreting and management of large raw data sets (e.g. satellite and LIDAR data)</li> </ul>	<ul style="list-style-type: none"> <li>• Data management and compilation</li> <li>• Data interpretation</li> <li>• Data analysis</li> <li>• Forest growth forecasts</li> </ul>

**TABLE 22** Outlook on jobs that would be increasingly needed in the field of activity “Forest Inventories and Forest Monitoring”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Knowledge in using new technologies</li> <li>• Strong physical abilities and ability to work in remote and rugged areas</li> <li>• Practical knowledge of forests and forest ecology</li> <li>• Willingness to work on own initiative for extended long periods away from own home base</li> <li>• Knowledge of forest inventory and forest monitoring</li> <li>• Excellent map reading and orienteering skills</li> <li>• Strong statistical and programming knowledge</li> <li>• Competencies in data management</li> </ul>	<ul style="list-style-type: none"> <li>• Field workers and inventory surveyors</li> <li>• Remote sensing specialists</li> <li>• Specialists in inventory statistics</li> <li>• Interpreters of inventory data</li> <li>• Data managers</li> </ul>

**TABLE 23** Examples of green forest jobs in the field of activity “Forest Inventories and Forest Monitoring”

Example	Short description
Biometrician and inventory specialists, British Columbia, CA	They work on traditional and new technology solutions in data sampling, analysis and management. It includes working with existing inventory data, enhancing inventories with remote sensing and LIDAR and providing expertise in the areas of growth and yield, site index predictions, and inventory audits. Data work requires knowledge in growth and yield models (e.g. TASS/TIPSY and VDYP (BC models); MGM, and GYPSY (boreal models). <a href="http://www.forsite.ca/services/geomatics-lidar-remote-sensing">http://www.forsite.ca/services/geomatics-lidar-remote-sensing</a>
Forest inventory crew leaders, US, USDA Forest Service	Their work involves planning, logistics, mentoring crew members, contacting land owners for access; locating study plots using GPS and aerial photo baseline techniques; conducting extensive resource and health inventories including tree measurements and foliage evaluations, understorey vegetation composition and structure estimates, site characteristics and soil evaluations, etc.; using various measurement instruments and electronic data recorders. The crew leader is not an official supervisor, but does give day-to-day direction to the crew. <a href="http://www.forestry.alabama.gov/fia.aspx?bv=5&amp;s=0">http://www.forestry.alabama.gov/fia.aspx?bv=5&amp;s=0</a>

### Forest Skills and Expertise

Data collection and analysis specialists are responsible for data reporting and have to be able to work with geo-information and remote sensing technologies, such as satellite data and LiDAR laser systems. They have to be familiar with computer simulations and diverse statistical analysis. A good technological and mathematical understanding is a prerequisite in such job profiles. Inventory planners need to have a practical understanding of survey design and need to adapt it to new sampling techniques.

Field workers need to have strong physical abilities and a sound understanding of forest ecology and silviculture.

They further need to be good team players as field work is conducted in teams.

## 5.2 Planning, Governance, Sustainable Forest Management

### Background and Outline of the Field of Activity

Forest governance comprises all the social and economic systems that affect how people interact with forests, including bureaucracies, laws, policies, traditional norms as well as culture, patterns of land tenure, and markets (FAO, 1997). It aims to further develop appropriate forest policies (e.g. national



forest programmes), legislation, institutional frameworks and incentives to promote and improve sustainable forest management and sustainable development.

As defined by Forest Europe in Resolution H1 (1993), sustainable forest management means “the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems” (Forest Europe, 1993). An important approach to reach and maintain that aim is forestry planning. According to FAO, forestry planning is changing from assessing forest timber resources and formulating forest industry strategies to integrating different points of view concerning “sustainable development” and “sustainable forestry”. Planning is expected to mediate between diverse interests and choose between different forest management options, while taking into consideration these various interests.

The main tasks in this area are: monitoring and assessment of forest governance; continuous improvement of forest planning approaches, instruments and surveys. National forest programmes and forest management plans are important tools for the implementation of sustainable forest management.

This field of activity also includes tasks such as consultation and participation with stakeholders, partnerships creation, social dialogue, corporate social responsibility and workplace compliance.

Additionally, there is a need for capacity building on policy analysis and research at the national level to ensure that forest governance takes account of challenges related to informal work, low productivity and wages and promotes decent work.

### Facts and Figures

About 80 per cent of the ECE forests are already under forest management plans or equivalent (according to three different methods of estimation). Between 2006 and 2013, the area of forests certified as sustainably managed in the ECE Region expanded by 45 per cent. Almost all ECE member States are members of one or more regional processes of criteria

and indicators of sustainable forest management, notably the Montréal Process and Forest Europe. Taken together, these trends indicate that there are very significant areas of sustainably managed forests in the ECE Region, and that this share has been growing over the past two decades – or that there is a stronger ability and determination to demonstrate this trend” (ECE and FAO, 2015).

### Major Trends, Needs and Challenges

“Forest management planning is an essential element of the SFM implementation process but it is not a legal requirement in many ECE countries, in which small-scale family forest ownership is dominant. In such cases, a forest management plan is understood as a valuable tool for “business planning” of forest activities, which duly considers the three sustainability pillars. However, it is left for the owner to set objectives for how to achieve the sustainability requirements defined in the national legislation or the applicable SFM certification standard. The area under forest management plans is useful as an indicator for assessing progress towards SFM but it needs to be complemented by holistic measures such as, criteria and indicators or certification” (ECE and FAO, 2015).

One of the challenges of successful forest management is keeping all key stakeholders informed, involved and obtaining sufficient resources (financial and staff) for conducting planning as well as for developing national forest programme processes (Forest Europe, 2015b).

### Opportunities and Prospects for the Forest Sector

Forest planning and governance are two of the main areas ensuring sustainable, long term forest management, thus development of activities in these two areas is needed. According to PEFC, “criteria for sustainable forest management must be constantly adapted to new circumstances and they must reflect the national context, specific ecological and environmental conditions as well as social, economic, political, cultural and spiritual dimensions” (PEFC, 2017). Governance and sustainability implementation need to be monitored through a systematic process of data collection and analysis of forest management, policies, strategies, action and budget plans (Cowling, 2014).

**TABLE 24** Tasks, activities and services in the field of activity “Planning, Governance, Sustainable Management”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Safeguarding forest sustainability which is under threat from globalization, increasing economic pressures and social demands</li> <li>• Compliance with national and international forest programme goals, programmes and standards</li> </ul>	<ul style="list-style-type: none"> <li>• Forest management plans</li> <li>• Forest governance plans</li> <li>• Forest governance assessments</li> <li>• Standards and indicators for forest sustainability</li> </ul>

**TABLE 25** Outlook on jobs that would be increasingly needed in the field of activity “Planning, Governance, Sustainable Management”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Knowledge of legislation issues related to forest management and policy at international, national or regional levels</li> <li>• Knowledge about different levels of forest sustainability and their control mechanisms</li> <li>• Highly organized and technologically capable</li> <li>• Mediation and communications skills</li> <li>• Ability to successfully deal with multiple priorities</li> </ul>	<ul style="list-style-type: none"> <li>• Forest mediators</li> <li>• Forest planners</li> <li>• Forest sustainability specialists and controllers</li> <li>• Forest stakeholder and participation specialists</li> <li>• Forest policy advisors and coordinators</li> </ul>

**TABLE 26** Examples of green forest jobs in the field of activity “Planning, Governance, Sustainable Management”

Example	Short description
Forest policy coordinators, BirdLife International, Cambridge, UK	<p>Forest policy experts provide expert advice and assistance to BirdLife Partners in relation to forest management, planning and policy processes, including FLEGT (Forest Law Enforcement, Governance and Trade) and REDD-plus (United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation and the Role of Conservation, Sustainable Management of Forests and Enhancement of Forest Carbon Stocks in Developing Countries), with a particular focus on forest conservation. They develop forest policy advocacy strategies and work plans, help to coordinate, implement and evaluate a forest policy initiative. Policy analysis and advocacy in a conservation/development setting and forest governance, with a high level involvement in programme management, policy formulation and advocacy will be done.</p> <p><a href="http://www.birdlife.org/sites/default/files/forest_policy_coordinator_-_jd.pdf">http://www.birdlife.org/sites/default/files/forest_policy_coordinator_-_jd.pdf</a></p>

### Forest Skills and Expertise

Political and strategic understanding of underlying mechanisms as well as willingness to mediate among conflicting stakeholder interests are crucial for the implementation of sustainable forest management. Therefore knowledge of different forest stakeholders as well as having practical experience in setting up and implementing sustainability assessments will be crucial for forest managers.

In addition, a background in science, law, public policy and communications is desirable.

## 5.3 Pests, Disease and Forest Fires

### Background and Outline of the Field of Activity

The world's forests are continually under severe threat from pathogens, insects, other pests and the ravages of forest fires. These have become more serious as a result of recent climate change and increased intercontinental movement of forest plants, timber and wood products. These factors expose forests to diseases, insect infestations and fire damage.

Forest authorities need to devise contingency plans (Forest Service, Ireland, 2000) and strategies to rapidly contain or eradicate possible disease outbreaks and insect infestations: These plans could be based on the following model (McAree and Mackenzie, 1993):

- Early notification of forest disease or insect attack
- Rapid identification of the causative agent(s)
- Survey of the affected area(s)
- Tracing of the source of the outbreak
- Remedial actions to counteract the damage and the pathogen
- Monitoring of the forest estate for possible recurrence of the problem

### Facts and Figures

The “Global Information On Outbreaks And Impact Of Major Forest Insect Pests And Diseases” paper states that “despite the significant adverse impacts and indications that outbreaks of forest insect pest and diseases are on the increase, there

**TABLE 27** Tasks, activities and services in the field of activity “Pests, Disease and Forest Fires”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Ongoing survey of forests - private and public - for injurious pests and diseases</li> <li>• Certification of forests and forest nurseries for disease free status and issuing of certificates or plant passports</li> <li>• Inspection of sawmills and timber yards and liaison with timber trade. Compilation of trade statistics</li> <li>• Processing of advisory queries on forest plant health matters and assistance with felling licenses concerning dead, dying or dangerous trees</li> <li>• Familiarisation with and implementation of forestry aspects of plant health legislation</li> <li>• Liaison with other government departments and customs authorities on forest protection issues</li> <li>• Provision of assistance and advice on forest plant health matters to other interested bodies</li> <li>• Involvement with public awareness campaigns, with lectures and seminars relating to forest protection</li> <li>• Prevention of forest fires, preparation of firefighting strategic plans, firefighting management</li> <li>• Prevention and management of forest pests and diseases and animal damage</li> </ul>	<ul style="list-style-type: none"> <li>• Early notification of new diseases and insects; e.g. Forest Insect and Disease Surveys (FIDS) - Canada</li> <li>• Rapid identification of forest pests or pathogens</li> <li>• Survey of site to determine extent of infestation or infection</li> <li>• Detection of the source of the disease or pest problems</li> <li>• Action to control and prevent further spreading</li> <li>• Monitoring of the problem to prevent further outbreaks</li> <li>• Develop and implement forest fire and control strategies</li> </ul>

has been no attempt to systematically gather and analyse comprehensive information on the type, scale and impact of such outbreaks over time at the global level. Dissemination of information on successful protection and control strategies has also been limited” (Allard et al., 2003).

This puts into perspective the gaps in knowledge concerning the epidemiological potential of forest pests and diseases on different continents, especially related to the problems associated with climate change. Climate change is expected to exacerbate disturbances such as wildfire, forest pests and invasive species (ECE and FAO, 2015). For example, Bentz et al. (2010) found that climate change has direct and indirect effects on the infestation of bark beetles in the Western United States and in Canada, as populations of bark beetles are directly influenced “by shifts in temperature and indirectly through climatic effects on community associates and host trees”.

### Major Trends, Needs and Challenges

A recent major change on the European institutional level was the introduction of the European Commission COM (2013) 267 Proposal for a regulation on protective measures against

pests of plants (Forest Europe, 2015a). According to the 2015 report “The State of Europe’s Forests”, “nearly 30 per cent of [European] countries revised policy objectives by putting stronger emphasis on climate change or control of problems such as forest fires, pests and diseases, and invasive species. Most of the measures are aimed at monitoring forests pests and diseases” (Forest Europe, 2015a). In the US, the National Strategic Framework for Invasive Species Management from 2013 is guiding the efforts to manage pests that threaten an estimated 731 million acres of forests there (USDA, 2017c). However, relating to jobs on the ground, at present there is a worldwide shortage of professionally qualified forest pathologists, entomologists and laboratory staff to implement and oversee the necessary forest protection contingency plans, strategies and pest risk assessments.

### Opportunities and Prospects for the Forest Sector

The potential for the creation of green forest jobs in all of these sectors is of great significance. The provision of green forest jobs in these areas would ensure that vital global national forest resources are adequately monitored and protected, particularly in countries with economies in transition.



**TABLE 28** Outlook on jobs that would be increasingly needed in the field of activity “Pest, Disease and Forest Fires”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• To advise on the practice of sound forest management as a first defence against insect disease and fire outbreaks and to encourage this approach in the private sector</li> <li>• To take steps to identify risks from abroad and institute all reasonable measures to prevent the entry and establishment of non-indigenous pests and diseases</li> <li>• To advise, where necessary, on appropriate plant health legislation and on other preventative measures</li> <li>• To provide for the early detection of forest pests, diseases and forest fires</li> <li>• To arrange or advise on the control or eradication of pests and diseases potentially destructive or actually causing damage to any forest or forest products</li> <li>• To provide assistance and advice on forest plant health matters to interested bodies</li> <li>• To advise on the undertaking of appropriate research and maintain contact with domestic and international organizations and foreign forest health authorities with a view to issuing and exchanging information leading to the development of controls</li> </ul>	<ul style="list-style-type: none"> <li>• Forest disease and insect control inspectors and surveyors</li> <li>• Forest pathologists and entomologists</li> <li>• Forest laboratory technicians and specialists</li> <li>• Specialists on forest disease and insect taxonomy and identification</li> <li>• Forestry experts on phytosanitary legislation</li> <li>• Forest protection specialists</li> <li>• Forest mycologists</li> <li>• Forest fire control specialists</li> </ul>

**TABLE 29** Examples of green forest jobs in the field of activity “Pests, Disease and Forest Fires”

Example	Short description
Forest fire fighters, CA	Forest fire fighters have to safely, efficiently and effectively suppress wildland fires while protecting citizens' property and forest resources. <a href="http://www.eco.ca/career-profiles/forest-firefighter/">http://www.eco.ca/career-profiles/forest-firefighter/</a>
Masters of scent detection dogs of harmful organisms ; Sniffer-dog teams specialized in harmful organisms, CH	The scent detection teams are specially trained to identify and combat certain pest diseases like the Asian long horned beetle. Their scent detection work consists mainly in the detection of harmful organisms in trees and shrubs, wooden containers like crates or pallets or tree nurseries. <a href="https://www.anoplophora-spuerhunde.ch/">https://www.anoplophora-spuerhunde.ch/</a>
Tree surgeons/arborists trained on harmful organisms, UK	Special trained tree surgeons are enabled to detect and combat harmful pest diseases like the dangerous insect “Asian long horned beetle”. <a href="https://www.ltoa.org.uk/news/295-biosecurity-preventing-the-spread-of-harmful-organisms">https://www.ltoa.org.uk/news/295-biosecurity-preventing-the-spread-of-harmful-organisms</a>

### Forest Skills and Expertise

Foresters and other staff will have to be trained on how to develop integrated disease or pest control programmes to protect vulnerable forest areas. This will involve learning and practicing the principles of disease and insect control such as resistance, eradication, exclusion, protection, avoidance and therapy.

Forest staff will also have to be trained in the various disease and insect control methods such as regulatory, physical, cultural or biological as well as in the latest techniques for the prevention and control of forest fires.

## 5.4 Risk Management and Contingency Planning

### Background and Outline of the Field of Activity

Natural disasters often result from a combination of natural hazards and human activities. Natural hazards are physical events such as wildfires, storms or floods; and from a forest perspective they are frequently followed by disease and insect outbreaks. They mostly occur unexpectedly and may apply to a region within a country or region that encompasses multiple countries. The management of natural disaster risks requires an integrated approach which seeks to protect human life and property (according to the principle of proportionality) by deploying both financial and personnel resources effectively and efficiently. It is generally managed in four different phases:

- **Mitigation** (prevention): land use planning, technical measures, biological measures;
- **Preparedness** (preparation): organization, resource planning, deployment planning, insurance;
- **Immediate response** (intervention and recondition): alert, rescue, damage mitigation, information, instructions as well as provisional repair, supply and disposal, transport systems, communication, financing, emergency legislation; and

- **Recovery**: definitive repair, reconstruction, strengthening of resilience, financing.

It also includes the interaction between institutions, financial mechanisms, regulations and policies.

### Facts and Figures

The occurrence of natural disasters worldwide has increased in frequency over the past 50 years and has affected an increasing number of people (Laframboise et al., 2012). For instance in Europe, the average area of forests affected by disturbances other than fires, insects, diseases or other animal damage almost doubled between 1990 and 2000, primarily due to the effects of severe storms such as those that struck Western Europe in December 1999 (FAO, 2006).

In Europe, "more than half of all the damage to forests by volume is due to wind and there is a worrying increasing trend in damage levels" (Gardiner et al., 2013: 11). But also in North America storms have detrimental effects on forests and the forest industry. For example, according to the US Department of Agriculture, hurricane Katrina heavily affected five million acres of forest across Mississippi, Louisiana and Alabama, equalling about \$5 billion of "loss in potential timber revenues" (Sheikh, 2005).

### Major Trends, Needs and Challenges

As described above, the incidence of natural disasters worldwide has steadily increased and affected more people. Accordingly, the management of natural disasters will become more important. Due to climate change, tree stability is likely to be affected in three ways: the "increase in extreme wind speeds"; "longer periods of unfrozen soils [...] leading to reduced root anchorage in winter"; and "increased winter precipitation leading to more saturated soils and reduces root anchorage" (Lindner and Rummukainen in Gardiner et al., 2013).

Management of natural disasters is an interdisciplinary task as many different sectors, organizational levels, responsibilities and agendas are concerned. The forest sector

**TABLE 30** Tasks, activities and services in the field of activity "Risk Management and Contingency Planning"

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Implementation of risk or disaster management cycles</li> <li>• Coordination of different responsibilities</li> <li>• Task-Force setup</li> <li>• Contingency planning investigations and research</li> </ul>	<ul style="list-style-type: none"> <li>• Assessing and applying theories and concepts of the risk management cycle, devising and implementing contingency plans and assessing risk prevention</li> <li>• Organization of emergency responses</li> <li>• Survey of damage (location, extent)</li> <li>• Operational planning and organization</li> <li>• Managing and coordinating workgroups, particularly taking the initiative during disaster relief scenarios at national and international levels</li> </ul>

has been adversely affected by many of these disaster events. Therefore it needs an ongoing risk and disaster management strategy, and contingency plan, drawn up in conjunction with all concerned bodies (e.g. municipalities, emergency organizations, civil engineers).

### Opportunities and Prospects for the Forest Sector

Forests and natural hazards have always been linked and forest professionals have a long tradition of dealing with the analysis and mitigation of these hazards. The management process however requires more organizational, planning and leadership inputs and investment to ensure that forest professionals are properly trained and aware of the necessity of contingency planning and implementation.

### Forest Skills and Expertise

The University of Vienna (2017) describes the competence profile of their MSc. course on "Risk Prevention and Disaster Management" as follows: "The ability to look beyond the restricted borders of individual disciplines, gaining a more holistic view on risk prevention and disaster management, as well as developing a flexible attitude and reaction towards the ever changing needs of populations and their environments and thus being able to rise to new work-related/professional challenges."

Complex disaster risk reduction management requires knowledge of different methods of risk prevention and management. The scope of applied skills is diverse and ranges from operational, during disaster relief, to conceptual, designing prevention strategies. The green forest job potential in these areas is therefore significant (see table 32).

**TABLE 31** Outlook on jobs that would be increasingly needed in the field of activity "Risk Management and Contingency Planning"

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Decisiveness and leadership skills</li> <li>• Conceptual thinking</li> <li>• Planning and coordination skills</li> <li>• Organizational talent</li> <li>• Communication skills</li> </ul>	<ul style="list-style-type: none"> <li>• Development of contingency plans</li> <li>• Risk and disaster management</li> <li>• Planning of risk prevention and preparedness</li> <li>• Emergency organiser and leader</li> </ul>

**TABLE 32** Examples of green forest jobs in the field of activity "Risk Management and Contingency Planning"

Example	Short description
Risk and disaster managers, AT	<p>Risk and disaster managers deal with the consequences of natural hazards and endeavours to reduce losses by concentrating not only in the phase following a disastrous event but also on the time before an event occurs by planning ahead for prevention and preparedness. They will assess and apply appropriate national and international theories and concepts in an effort to minimize risk and maximize safety and security.</p> <p><a href="http://www.postgraduatecenter.at/en/programs/health-natural-sciences/risk-prevention-and-disaster-management/">http://www.postgraduatecenter.at/en/programs/health-natural-sciences/risk-prevention-and-disaster-management/</a></p>
Local natural hazard advisors, CH	<p>Advisors take a consultative position before (hazard prevention), during (immediate response) and after (damage analysis) a hazard event. Their involvement begins with small measures: e.g. the timely removal of cars from the hazard zone, the timely clearing of cellars and the provision of sandbags and other items to reroute and remove flood waters. They are involved in the implementation of the Civil Protection Concept at the community level.</p> <p><a href="http://www.planat.ch/en/authorities/prevention/">http://www.planat.ch/en/authorities/prevention/</a></p>







A man wearing a plaid shirt, a black vest, blue jeans, and glasses is crouching on the bank of a small stream in a forest. He is holding a clear plastic bottle and a small tool, likely a pipette or syringe, and is carefully transferring liquid from the stream into the bottle. To his right, there is a silver metal case or equipment box. The forest is lush with green trees and foliage, and the stream flows over rocks, creating small rapids. The overall scene is a natural, outdoor setting.

6.

BIODIVERSITY  
AND  
ECOSYSTEM  
FUNCTION



## 6. Biodiversity and Ecosystem Function

This chapter is about forest related ecosystem functions. The fields of activity “Biodiversity Conservation and Nature Protection”, “Climate Change”, “Forests and Water” and “Mycoforestry” are outlined and presented. Facts, major trends, opportunities and skills concerning these specific green forest jobs are highlighted and existing job examples are given.

### 6.1 Biodiversity Conservation and Nature Protection

#### *Background and Outline of the Field of Activity*

Forests around the world comprise many different habitats and encompass a wide range of plants, animals and micro-organisms at different organizational levels with associated genetic diversity. Therefore, they are among the most important repositories of terrestrial biological diversity and they provide a wide array of goods and services for mankind (UNEP, FAO and UNFF, 2008).

The biodiversity in forests allows species to adapt continuously to changing environmental conditions and contribute to functioning ecosystems. From a human perspective, forest biodiversity also maintains the potential for tree breeding and improvement and of meeting human needs for goods and services (FAO, 2006).

Work in this field includes the conservation, restoration, promotion and management of forest biodiversity, including addressing biodiversity loss, such as: unsustainable forest management, introduction of invasive alien plant and animal species, infrastructure development, road building, hydro-electrical development, urban sprawl, mining and oil exploitation, anthropogenic forest fires, pollution, and climate change (UNEP, FAO and UNFF, 2008).

#### *Facts and Figures*

The biological diversity of forests is declining on a global scale. The reasons for the loss of forest biodiversity are manifold and range from loss, fragmentation and degradation of forests to increasing globalization of the timber trade with consequent adverse environmental impacts often occurring far from the place of consumption (UNEP, FAO and UNFF, 2008; Chaudhary et al., 2016). In the ECE Region, forest biodiversity varies greatly due to: geographical location, climate conditions, use of forests, population density, settlement history, forestland ownership structure and the fragmentation of forests within

the landscape caused by other land use forms” (ECE and FAO, 2015). In 2010, in the ECE Region “8 per cent (132 million ha) [were] designated for biodiversity”, including “strictly protected forest areas as well as those actively managed for biodiversity” (ECE, FAO, 2015). This number increased to approximately 12 per cent in 2015 (ECE and FAO, 2015).

#### *Major Trends, Needs and Challenges*

“Forest management practices are developing towards greater integration of biodiversity aspects thus allowing for improved habitat conditions for threatened species. Biodiversity-oriented management practices, however, show effects in the long run and rely on long-term monitoring of the development of threatened forest species” (Forest Europe, ECE and FAO, 2011). “A quantitative understanding of the impacts of different forest management regimes on biodiversity in different regions of the world is crucial to any efforts to reconcile biodiversity conservation and economic interests” (Chaudhary et al., 2016).

In the ECE Region, two main approaches have been applied to conserve and maintain biodiversity in forests: 1) the creation of a protected area network, and 2) the orientation of sustainable forest management outside the specifically protected areas to maintain large-scale biodiversity.

The report “Forests in the ECE Region” found that the area of protected forests for biodiversity increased continually from 2000 to 2012. Furthermore, “in many ECE countries the international commitments on biodiversity, notably the Aichi targets, are being integrated into national legislation and policies but implementation is challenging” (ECE and FAO, 2015).

Monitoring of biodiversity loss plays an important role in the development of adaptive management measures. Giving biodiversity and its loss an economic value is one method to better visualise the importance of ecosystems. Therefore, new approaches and models are being developed in that area.

#### *Opportunities and Prospects for the Forest Sector*

Biodiversity conservation will become more important in the future, because of a rising awareness within society of its significance to functional ecosystems. Forest professionals will play a key role in understanding and shaping overall biodiversity conservation strategies in the future through their knowledge and actions in forest ecosystems.

#### *Forest Skills and Expertise*

The conservation of forest biodiversity requires knowledge of sustainable - forest and - wildlife management, species, habitat, ecosystem functionality, biodiversity conservation, protection of soils, management of genetic resources, as well as the development and implementation of appropriate policies and practices.



**TABLE 33** Tasks, activities and services in the field of activity “Biodiversity Conservation and Nature Protection”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Strengthening the understanding of biodiversity value within society and organize further gathering of information about biodiversity loss, ecosystem functioning and management</li> <li>• Conserving biodiversity under changing conditions (e.g. climate change) and the increase in social demands and activities</li> <li>• Economic valuation of different biodiversity aspects (genus, species, landscapes) and analysing their various interactions and trade-offs</li> <li>• Conservation and enhancement of forest biological diversity</li> </ul>	<ul style="list-style-type: none"> <li>• Enhancement of the bee population</li> <li>• Habitat creation, restoration and management</li> <li>• Nature protection; conservation and enhancement of biodiversity, safeguarding wildlife habitats</li> <li>• Monitoring of species and ecosystems</li> <li>• Wildlife management and protection; hunting</li> <li>• Botanical management and conservation</li> <li>• Soil management and protection</li> <li>• Management and conservation of genetic resources</li> </ul>

**TABLE 34** Outlook on jobs that would be increasingly needed in the field of activity “Biodiversity Conservation and Nature Protection”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Comprehensive knowledge about species, , habitat requirements and maintenance</li> <li>• Detailed knowledge about ecosystems, ecosystem functioning and their underlying processes, mechanisms and trade-offs</li> <li>• Planning, organization and implementation of field work, surveys and species promotion</li> <li>• Passion for nature and nature protection</li> </ul>	<ul style="list-style-type: none"> <li>• Environmental forestry technicians</li> <li>• Forest ecologists</li> <li>• Forest botanists and forest zoologists</li> <li>• Game animal manager</li> <li>• Wildlife technicians</li> <li>• Bee keepers</li> <li>• Surveyors</li> <li>• Forest engineers, specialists in forest management</li> </ul>

**TABLE 35** Examples of green forest jobs in the field of activity “Biodiversity Conservation and Nature Protection”

Example	Short description
Forest protection advocates and grassroots organizers, US	Forest protection advocates and grassroots organizers identify, analyse and track legislation issues related to forest management and policy. The advocates will do several works at the Congress; e.g. educate congressional staff and members about the threats to the nation’s forests, forest ecology and processes, direct lobby members to oppose legislation that would harm nation’s forests as well as acquire congressional support for a proactive forest protection bill. <a href="http://johnmuirproject.org/">http://johnmuirproject.org/</a>
Wildlife managers, UK	Wildlife managers spend a lot of time outdoors, including work with sick or hurt animals. Forest Wildlife Managers have an excellent knowledge of the forest ecosystem and animal behaviour. They must ensure that groups of animals affected by human development activities are safe and healthy. They enforce laws, investigate violations, write reports and advise various organizations. <a href="https://www.reading.ac.uk/biologicalsciences/pg-taught/biosci-pgtmscwildlifemgmtconservation.aspx">https://www.reading.ac.uk/biologicalsciences/pg-taught/biosci-pgtmscwildlifemgmtconservation.aspx</a>

## 6.2 Climate Change

### Background and Outline of the Field of Activity

Forests and soils sequester and store carbon as well as clean and regulate water. With these properties forests and soils are effectively protecting climate and water resources. Therefore, sustainable forest management is an effective framework for forest-based climate change mitigation and adaptation.

However, climate change is affecting the planet and consequently forests ecosystems and soils. Forest management will require reliable information on forest resilience to the impacts of climate change in order to make decisions about silvicultural practices and policy in the future.

### Facts and Figures

The European Environment Agency (EEA, 2017) recently summarized the major known observations in the context of climate change:

- Many impacts on forest ecosystems are taking place, such as changes in soil conditions, extension of phenological stages, altitudinal and latitudinal migration of plant and animal species (generally northward and to higher elevations), changes in species interactions and species composition, including local extinctions..
- Further changes of biodiversity and ecosystem properties are expected.
- In Europe 14 per cent of the habitats and 13 per cent of the species are under pressure; projections indicate a more than doubling of these figures in the near future.
- Changes in soil moisture are projected: a decrease in the Mediterranean and an increase in Northern Europe, with a direct impact on forest ecosystems and their services.
- Further increase of forests fires and incidence of forest diseases and pests is foreseen. In general forest growth is

projected to decrease in Southern Europe and to increase in Northern Europe, but with substantial regional variation.

- The problem of invasive species in Europe is likely to be exacerbated.

While "US forests and associated wood products currently absorb and store the equivalent of about 16 per cent of all carbon dioxide (CO<sub>2</sub>) emitted by fossil fuel burnt in the US each year" (Melillo et al., 2014), the WWF pointed out that deforestation and forest degradation "represent up to 20 per cent of global anthropogenic CO<sub>2</sub> emissions, more than the entire global transport sector (which accounts for 13 per cent)" (WWF International, 2011).

### Major Trends, Needs and Challenges

The major disturbances in the ECE Region forests are storms, drought, fires, diseases and insects. There is increasing evidence that all these disturbances are sensitive to climatic factors and that frequency and intensity of disturbance events will increase due to climate change. Risk mapping and risk mitigation tools are consequently needed for forest management planning.

Forest managers should have access to localized information describing the past and potential future climate conditions of the targeted forest area, including a number of variables describing relevant bioclimatic indicators affecting forest growth and vitality. It is crucial to understand the frequency and duration of drought periods occurred in the past, and how these are projected to develop under climate change scenarios. The same type of analysis will be needed for the wet climate conditions.

The most important measure in adaptive forest management may be the species and genotype selection in the forest's regeneration stage. Species distribution models have been applied for more than two decades in climate change impact studies to make projections under future climate site conditions. However, as climate conditions are dynamically

**TABLE 36** Tasks, activities and services in the field of activity "Climate Change"

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Analysing and promoting forest carbon markets and certifications and strengthening the role of forests in mitigating the effects of climate change</li> <li>• Researching the impact of climate change on species resilience and adaptation</li> <li>• Identifying robust/resilient tree species</li> <li>• Collecting and studying forest phenological data</li> </ul>	<ul style="list-style-type: none"> <li>• Offsetting agricultural emissions</li> <li>• Increase afforestation, reforestation, nursery production</li> <li>• Paris Agreement commitments (carbon sequestration)</li> <li>• Management of genetic resources</li> <li>• Adaptation of species and ecosystems (climate change)</li> <li>• Monitoring and evaluating changes and developments in forest ecosystems</li> </ul>

**TABLE 37** Outlook on jobs that would be increasingly needed in the field of activity “Climate Change”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Sound knowledge of climate change issues and related forest adaptation and management scenarios</li> <li>• Developing interdisciplinary thinking and working skills</li> <li>• Advanced knowledge of forest carbon policy, carbon protocols (compliance and voluntary), and carbon accounting standards</li> <li>• Experience in different programming applications and statistical software</li> <li>• Experience in marketing forestry services to forest owners, investors, and advisors</li> </ul>	<ul style="list-style-type: none"> <li>• Specialists in climate adaptation of forests</li> <li>• Forest climate surveyors, forest inventory specialists</li> <li>• Forest carbon specialists and modellers</li> <li>• Forest phenology specialists</li> </ul>

**TABLE 38** Examples of green forest jobs in the field of activity “Climate Change”

Example	Short description
REDD-plus forest management and carbon markets specialists, Chemonics, EC	These specialists have anticipated responsibilities in carbon finances, carbon sequestration issues, forest planning, REDD-plus policy and local governance as well as monitoring. <a href="https://www.devex.com/jobs/redd-forest-management-carbon-markets-specialists-302899">https://www.devex.com/jobs/redd-forest-management-carbon-markets-specialists-302899</a> <a href="http://www.chemonics.com">http://www.chemonics.com</a>
Forest carbon modellers, Bluesource / San Francisco, US	Project and team leaders foster forest carbon modelling efforts, support business development in forest carbon space, identifying and pursuing new commercial opportunities and developing design and implementation of forest carbon offset projects. <a href="http://www.bluesourcecan.com/market-makers/environmental-markets/climate-change-mitigation-services/">http://www.bluesourcecan.com/market-makers/environmental-markets/climate-change-mitigation-services/</a>
Climate change advisors, UK	Climate change advisors advise national and local government departments, engage effectively with NGOs, the private sector, and other bilateral and multilateral agencies. <a href="https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/214122/technical-competencies-climate-environment-advisers.pdf">https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/214122/technical-competencies-climate-environment-advisers.pdf</a>

changing, it is not always clear whether suitable species should be selected for current or future climate. Nevertheless, it is crucial for managers to understand how the current species pool is likely to be affected by climate change. Information is needed for selection of resilient species in adaptive forest management.

### Opportunities and Prospects for the Forest Sector

Job opportunities will be created in climate scenarios modelling and in conducting forest climate assessments for summarizing the impacts of climate change on forests. Such analyses at local levels will be an important issue for practical

implementation as well as a baseline for consultation with local communities about climate adaptation strategies and management scenarios.

Carbon sequestration and storage in forests will increase in importance. The work perspectives will include both: a) the analysis of forests as carbon source and sink; and b) the development of forest carbon markets. “One initiative that is expected to result in a big job push is a scheme to Reduce Emissions from Deforestation and Forest Degradation (REDD-plus). An assessment of only 41 REDD-plus projects revealed that 1,500 jobs were created” (Webbe, 2014).



### *Forest Skills and Expertise*

Comprehensive knowledge on the interrelationships between climate, climate change, greenhouse gas emissions, forest ecosystem functionality and management as well as identifying feedback processes will be very important in this field. Experience in political economy and the governance of climate change, the environment, and sustainable forest management will also play an important role in this working area.

Knowledge of forest carbon accounting and trading, carbon markets, conducting and examining detailed REDD-plus assessments and deriving recommendations for their implementation is of high importance. A detailed understanding of the forestry aspects of the Intergovernmental Panel on Climate Change (IPCC) reports is needed together with related carbon sequestration policy and governance issues.

## **6.3 Forests and Water**

### *Background and Outline of the Field of Activity*

Water is the most vital element of our natural resources and is essential for all forms of life. Forests and woodlands have a close relationship with water resources whilst forest management and water quality are closely linked. Sustainable forest management is essential to ensure the supply of quality, fresh water, provide protection from natural hazards such as flooding or soil erosion and to conserve aquatic biodiversity.

Land management activities can affect water flows and degrade the quality and ecology of waters. This has implications for the economic, environmental and social benefits that water provides.

Many countries rely on “protective forests” to preserve the quality of drinking water supplies, alleviate flooding, erosion, landslides and the loss of soil.

The benefits of protective forests and sustainable forest management for water quality are increasingly recognized, and riparian woodland is being created to safeguard the water environment. While there may be water trade-offs in terms of the potential for forests to reduce water yield (e.g. due to storm water run-offs), these are usually compensated by the water quality and other ecosystem services provided by forests – for example biodiversity, carbon sequestration, landscape enhancement and recreation.

### *Facts and Figures*

The 2015 edition of the FAO Global Forest Resources Assessment reported that 24 per cent of global forests were protected for soil and/or water conservation. On average, 38.7 per cent of forests have a management objective for soil and/or water conservation. This is primarily due to North

American countries where over 80 per cent of forests are managed to protect soils and/or water. In Europe, where most forests are under private ownership, only 12 per cent of forests are reported to be managed for soil and/or water protection, and in Russia only 10.6 per cent.

Forests play an important role in supplying cities with drinking water. According to Dudley and Stolton (2003), about one-third (33 of 105) of the world's largest cities obtained a significant proportion of their drinking-water directly from forested protected areas. In the ECE Region, six large cities (Madrid, Barcelona, New York, Los Angeles, Vienna and Sofia) indicated that protected forested areas play an important part in their water supply.

### *Major Trends, Needs and Challenges*

“The availability and quality of water in many regions of the world are more and more threatened by overuse, misuse and pollution.... Moreover, climate change is altering forest's role in regulating water flows and influencing the availability of water resources ... Therefore, the relationship between forests and water is a critical issue that must be accorded high priority” (Calder et al., 2007).

There is a need for new forms of adaptive management to maintain forests and their water related ecosystem services. This is even more important in terms of adverse impacts of climate change and in regions with a lack of water in adequate quantity and quality. One challenge will be to define the group of stakeholders directly dependent on the forest water resources provided by forests and sustainable forest management in a changing climate.

### *Opportunities and Prospects for the Forest Sector*

Forests and water links are gaining importance and recognition thanks to forests' positive impacts on water availability and quality. Riparian woodlands remove water pollutants from agricultural, industrial and domestic sources (Calder, 2007; Dudley and Stolton, 2003) as well as act as sponges to mitigate floods in downstream areas, by extending and delaying peak flows (Calder et al., 2002). Conversely, some forestry operations and practices, if not implemented in accordance with the principles of sustainable forest management, may have detrimental effects on water quality and the aquatic environment. With these two contrasting approaches, there are opportunities for the employment of forest professionals and the creation of new green forest jobs to ensure that the forest water ecosystems are protected and managed in accordance with a defined standard, e.g. with a Code of Best Forest Practice and a suite of Environmental Guidelines (Forest Service Ireland, 2000).

Other opportunities for job creation are, for example, the development of forest and water policies and the adaptation of forest management practices concerning drinking water and other related forest ecosystem services.

**TABLE 39** Tasks, activities and services in the field of activity “Forests and Water”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Developing institutional mechanisms to enhance synergies concerning forests and water</li> <li>• Implementing and enforcing action programmes at national and local levels</li> <li>• Further strengthening interdisciplinary approaches and cooperation</li> <li>• Developing and implementing payments for ecosystem services (PES) schemes</li> </ul>	<ul style="list-style-type: none"> <li>• Managers of forests along creeks, rivers and lakes; specialists on integrated catchment management</li> <li>• Specialists in water related adaptive forest management</li> <li>• Forest drinking water experts and promoters; PES specialists</li> <li>• Forest hydrologists</li> <li>• Fishery experts</li> <li>• Experts on water assessments</li> </ul>

**TABLE 40** Outlook on jobs that would be increasingly needed in the field of activity “Forests and Water”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Understanding of the interactions between forests, trees and water</li> <li>• Understanding of forest hydrology</li> <li>• Aptitude for promoting the strong and often hidden role of forests in terms of drinking water management</li> <li>• Public relations and communication skills</li> <li>• Knowledge about PES</li> </ul>	<ul style="list-style-type: none"> <li>• Managers of forests in riparian zones.</li> <li>• Specialists in water related adaptive forest management</li> <li>• Forest drinking water experts and promoters; payment for environmental services specialists</li> <li>• Forest hydrologists</li> <li>• Fishery experts</li> <li>• Experts on water assessments</li> </ul>

**TABLE 41** Examples of green forest jobs in the field of activity “Forest and Water”

Example	Short description
Forest drinking water promoters, DE	As a mediator between forest ecology and the economy the forest drinking water promoters are responsible for the conversion of monoculture forests to nature-oriented deciduous forests in order to improve the drinking water from forests. Tasks comprise the organization of local campaigns (community based planting sessions), public relations, launching private and public partnerships and public-oriented actions. <a href="http://www.trinkwasserwald.de/">http://www.trinkwasserwald.de/</a>

## 6.4 Mycoforestry

### Background and Outline of the Field of Activity

Mycoforestry is an ecological forest management system devised to enhance forest ecosystems and plant communities through the introduction of beneficial mycorrhizal and saprophytic fungi. This symbiotic process can enhance the yields of forest crops, provide biological control against

soil-borne pathogens and produce edible mushrooms – an economically valuable product. Wood waste can be recycled back into the ecosystem, planted restoration sites after felling can be biologically enhanced and the productive capacity of forest sites can be improved by bioremediation interventions. “Without fungi, there are no forests. Mycoforestry is the use of fungi to sustain forest communities and can be used to help accomplish the preservation of native forests, the recovery

and recycling of woodland debris, the enhancement of replanted trees, the strengthening of ecosystem sustainability and economic diversity” (Stamets, 2005: 69).

### Facts and Figures

Forest soil ecosystem and mycorrhizal fungi form an important symbiosis with almost 200m of mycorrhizal hyphae per gram of forest soil. Almost 76 per cent of all angiosperms and nearly all non-Pinaceae gymnosperms retain such an association (Dickie, 2005).

### Major Trends, Needs and Challenges

According to Stamets (2005), mycoforestry is an emerging scientific field and to ensure its successful implementation broadly standardized protocols and techniques need to be developed and perfected. With this in mind, Stamets has identified six main areas of forest mycology that show great potential for research and development and which could deliver many decent green forest jobs in the years to come. These job areas are categorized as follows (Hawkins, 2009): mycoremediation, mycofiltration, mycomedicines, mycopesticides, myconol and mycoforestry practice.

Stamets’s “Six Ways Mushrooms can Save the World” (Stamets, 2005; Hawkins, 2009) include:

**Mycoremediation:** healing of damaged ecosystems through the introduction of specialist fungi able to break down toxins, rebuild soil and repair the subtle balance of nature.

**Mycofiltration:** the cleansing of polluted and disease-ridden watercourses by using mycelial mats to soak up infections and poisons. Another use is to help prevent erosion. Mats of mycelium can knit together soils, as well as making them more appealing places for plants to grow. This low-maintenance,

cement-free method to shore up roadsides and bolster areas prone to flooding are proving extremely effective in trials.

**Mycomedecines:** development of powerful and as-yet untapped antibiotics, potentially highly active against a wide range of viruses and biological warfare agents.

**Mycopesticides:** a chemical-free alternative to controlling damaging insect species.

**Myconol:** a potential source of ecologically-sound biofuel exists in the form of Myconol (an extremely useful side-product of other culturing processes).

**Mycoforestry:** mushrooms are forest guardians. All the above mentioned mushroom values give one of the strongest cases for preservation of the world’s forests in the face of our changing climate. Forests are the heartlands of mushrooms, and mushrooms may well be ever-more crucial to our survival and the health of the biosphere.

### Opportunities and Prospects for the Forest Sector

Conducting research on different aspects of mycorrhizal fungi benefits to forestry and forest management. Putting into practice the results of research can create opportunities in this field of activity. More details are included in the table below.

### Forest Skills and Expertise

Current forestry education and training curricula need to be modified to include the benefits of mycoforestry.

To achieve these objectives, there is an urgent need to prioritize the creation of more new green jobs in the various disciplines of mycology research, laboratory diagnostics, fungal taxonomy, mycoremediation and biological control.

**TABLE 42** Tasks, activities and services in the field of activity “Mycoforestry”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Production of disease-free nursery stock</li> <li>• Plus-tree seed orchards establishment and management</li> <li>• Development of edible and medicinal mushroom production facilities</li> <li>• Inoculation of forest nurseries with appropriate mycorrhizal fungi</li> <li>• Bioremediation research</li> <li>• Practice of mycoremediation and mycoforestry</li> <li>• Development of mycopesticides</li> <li>• Development of a new sustainable building material</li> </ul>	<ul style="list-style-type: none"> <li>• Mycoforestry; introduction of beneficial mycorrhizal and saprophytic fungi</li> <li>• Enhancing yields of forest crops</li> <li>• Production of edible mushrooms; Hazelnut-Truffles-Farm –Shiitake –Mushroom production</li> <li>• Fungal forests</li> <li>• Recycling of wood waste</li> <li>• Improvement of forest sites</li> <li>• Biological control</li> </ul>



**TABLE 43** Outlook on jobs that would be increasingly needed in the field of activity "Mycoforestry"

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• University or third-level degree/diploma standard of education in the discipline of forest mycology</li> <li>• Practical laboratory experience of the isolation, identification and classification of forest fungi</li> <li>• Working knowledge of and research competency in the forest mycology interest areas of mycoremediation, mycofiltration, mycomedicines, mycomedicines, myconol and the practice of mycoforestry</li> </ul>	<ul style="list-style-type: none"> <li>• Mycology researchers</li> <li>• Specialists in mycology laboratory diagnostics</li> <li>• Forest mycologists, specialists in fungal taxonomy</li> <li>• Specialists in mycoremediation and biological control</li> <li>• Managers of fungal forests</li> <li>• Laboratory and field technicians</li> <li>• Producers of edible fungi, e.g. truffles, ceps, chanterelles</li> </ul>

**TABLE 44** Examples of green forest jobs in the field of activity "Mycoforestry"

Example	Short description
Forest mycologists, UK	Expertise in the isolation, identification, classification and culture of forest fungi. Knowledge and practical experience of working on all aspects of mycoforestry <a href="http://www.sciencemag.org/careers/2009/07/fun-fungi-mycology-careers">http://www.sciencemag.org/careers/2009/07/fun-fungi-mycology-careers</a> <a href="http://www.ima-mycology.org/">http://www.ima-mycology.org/</a>
Field workers and surveyors	Working in the forest environment to assist with field studies and the gathering of samples and research data
Laboratory technicians	Assisting the forest mycologist with general laboratory support and back-up. Helping with the preparation of aseptic samples for future identification and culturing.





A person is running on a paved path through a forest of tall, thin pine trees. The ground is covered in dry, brown pine needles. The runner is wearing a black long-sleeved shirt, black leggings, a black beanie, and bright green shorts. The scene is captured from a side profile, showing the runner in mid-stride.

7.

HEALTH AND  
RECREATION



## 7. Health and Recreation

This chapter is about forest related human health and recreation as seen in the fields of activity “Forest Ecotherapy” and “Recreation, Leisure and Sports”. Facts, major trends, opportunities and skills concerning these specific green forest jobs are highlighted and existing job examples are given.

### 7.1 Forest Ecotherapy

#### *Background and Outline of the Field of Activity*

Forest ecotherapy is gaining international recognition as a form of health restoring recreation in which nature does the healing. It helps heal minds, bodies, hearts and spirits within a forest setting. Forest ecotherapy has proven physical and psychological health benefits. These include lowered blood pressure, lowered heart rate, lowered stress hormones levels. The result is elevated mood and stress reduction, improved sleep and acceleration of recovery from surgery and illness.

#### *Facts and Figures*

Research has shown that communing with nature in an ecotherapeutic setting induces psychological improvements in mood, concentration and attention (Ulrich, 1981), reduced mental fatigue (Kuo, 2001) and a reduction in stress-related diseases (Hartig et al., 1991). In Ireland, a pilot programme of forest walks organized for people suffering from depression was evaluated and it was found that participants registered improvements in mood immediately following the walks (Iwata et al., 2016). In Austria, a postgraduate study is being established on “health in forests”. In South Korea – based on

the Act of Social Welfare Policy, introduced in 2015 – forest welfare experts are trained in the theory and practice of forest ecotherapy.

#### *Major Trends, Needs and Challenges*

The practice of forest ecotherapy originated in Japan during the 1980s as Shinrin-yoku which translates as “taking in the forest atmosphere” or “forest bathing”. Today, it has become a major component of preventive health care and healing in Japanese medicine. Researchers, primarily in Japan and South Korea, have established a robust body of scientific literature on the health benefits of spending time relaxing in the forest. The concept explains that if a person visits a forest area and walks in a relaxed way there are many calming, rejuvenating and restorative benefits to be gained from concentrating on five senses: sight, smell, hearing, touch and taste. Forest and other professionals are becoming increasingly aware of these forest benefits and are attending courses on science and the practice of ecotherapy (Association of Nature and Forest Therapy, 2017).

#### *Opportunities and Prospects for the Forest Sector*

There is great scope in the forest ecotherapy area for more evidence-based studies and for the training of suitable forestry personnel, particularly forest interpreters and guides.

Utilizing forests effectively in health promotion could contribute to reducing public health care budgets and create new sources of income by creating green forest jobs.

Medical doctors are now issuing “Green Prescriptions” to stressed patients advising them to experience the five senses in a forest setting. The Millennium Ecosystem Assessment has listed ecosystem goods and services which are utilized in the practice of forest ecotherapy as important (MEA, 2005).

**TABLE 45** Tasks, activities and services in the field of activity “Forest Ecotherapy”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Site selection, establishment and development of suitable forest ecotherapy areas in suitable forests</li> <li>• Organization of forest ecotherapy and nature walk sessions in suitable forest locations</li> <li>• Provision of training and mentoring on forest ecotherapy to suitable and relevant personnel</li> <li>• Advocating for and promoting public awareness and acceptance of the benefits of forest ecotherapy</li> </ul>	<ul style="list-style-type: none"> <li>• Health restoring recreation; forest bathing</li> <li>• Ecotherapy services in the forest</li> <li>• Green care and green prescriptions</li> <li>• Forest therapy centres</li> <li>• Measurable non-timber benefits</li> <li>• Nature walks/Forest interpretation</li> </ul>

**TABLE 46** Outlook on jobs that would be increasingly needed in the field of activity “Forest Ecotherapy”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Communication and forest interpretation skills</li> <li>• Detailed knowledge and awareness of the practice and philosophy of Shinrin-yoku or “forest bathing”</li> <li>• Competency in public relations and interviewing methodology</li> <li>• Basic training in psychology and general mental health issues</li> </ul>	<ul style="list-style-type: none"> <li>• Researchers on forest healing effects</li> <li>• Forest ecotherapists</li> <li>• Medical doctors working in forest therapy centres</li> <li>• Sports professionals, forest health coaches</li> <li>• Forest educators and guided walks leaders</li> </ul>

**TABLE 47** Examples of green forest jobs in the field of activity “Forest Ecotherapy”

Example	Short description
Forest therapy guides, US; IE	Forest therapy guides facilitate safe gentle walks, providing instructions—referred to as “invitations”—for sensory opening activities along the walk following a standard protocol <a href="http://www.natureandforesttherapy.org">http://www.natureandforesttherapy.org</a> <a href="http://www.naturehealthandwellbeing.ie">www.naturehealthandwellbeing.ie</a>
Integrative forest therapists and forest health counsellors, DE	They support the therapeutic treatment of psychological and psychosomatic disorders as well as helps to strengthen health and well-being by experiencing the forest in all human dimensions and senses, physical, emotional, cognitive and social. <a href="https://www.eag-fpi.com/kurzzeitausbildungen/naturnahe-therapieformen/waldtherapie/">https://www.eag-fpi.com/kurzzeitausbildungen/naturnahe-therapieformen/waldtherapie/</a>

There is strong potential for the creation of green jobs in this multidisciplinary sector, as is the provision of more educational jobs promoting these forest health benefits.

### Forest Skills and Expertise

Forest ecotherapy theory and practice courses or modules are not featured on the curriculum of most forestry schools and universities. These educational and practical training courses should be provided to help develop new skillsets which will be required by a new cohort of forest professionals.

The challenge for the future is the promotion of research and the dissemination of knowledge on the health benefits of forest ecotherapy. It is gaining more recognition and credit as an important antidote to stressful living. This calls for strong co-operation between different sectors, especially between health and environmental professionals.

## 7.2 Recreation, Leisure and Sports

### Background

As an antidote to modern stressful and unhealthy lifestyles, the demand for recreation and nature-based ecotourism

activities within forests has increased rapidly over the past few years. With this in mind, the goal of forest recreation should be to select, maintain and develop forest recreation and amenity areas to provide quality outdoor experiences for all recreational users.

### Facts and Figures

A number of studies at the national and local levels show the importance of the forests for recreation, leisure and sports to local communities. The most often practiced activities are walking (solo or with a dog), biking and jogging. The average duration of a forest visit is between 30 minutes and two hours (Pauleit and Lupp, 2016).

The employment opportunities and income generated from recreation activities, such as tourism, can be substantial for local communities and businesses providing goods and services supporting these activities (ECE and FAO, 2015). Governments have recognised these non-marketed values of forests and this is reflected by the increasing area of recreational space that countries have made available to the public since 1990 (Forest Europe, ECE and FAO, 2011).

**TABLE 48** Tasks, activities and services in the field of activity “Recreation, Leisure, Sport”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Guiding and advising visitors with a focus on the different fields of activity, e.g. biking, canoeing, physical training</li> <li>• Selecting, developing, operating and maintaining forest recreation and amenity areas to provide quality outdoor experiences for all recreational users</li> <li>• Security responsibility, visitor management</li> <li>• Personal coaching</li> <li>• Stakeholder management in recreational forests</li> <li>• Catering for different fields of interest such as outdoor activities, nature protection and requests from the tourist sector</li> <li>• Community education and group training</li> </ul>	<ul style="list-style-type: none"> <li>• Forest recreation; forests as an antidote to a stressful life; meditation in forests</li> <li>• Many outdoor pursuits, e.g. hiking, biking, camping, physical training, orienteering</li> <li>• Nature trails</li> <li>• Visitor management</li> <li>• Forests and ecotourism</li> <li>• Food foraging, e.g. collecting berries, mushrooms, fruits and nuts</li> </ul>

**TABLE 49** Outlook on jobs that would be increasingly needed in the field of activity “Recreation, Leisure, Sport”

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Social skills to communicate with stakeholders such as tourist offices, visitor centres and landowners</li> <li>• Familiarization with the different needs and demands of different stakeholders</li> <li>• Holistic approach to the job</li> <li>• Knowledge of applicable regulations in the particular sectors</li> <li>• Knowledge of forestry and the natural environment</li> </ul>	<ul style="list-style-type: none"> <li>• Recreation foresters</li> <li>• Forest rangers</li> <li>• Forest tourist guides</li> <li>• Outdoor pursuit activities organizers</li> <li>• Forest interpreters</li> <li>• Forest ecotherapists</li> <li>• Forest nature trail designers</li> </ul>

### Major Trends, Needs and Challenges

The provision of these forest recreational services has considerable potential to generate sustainable green jobs and contribute to local economies.

### Opportunities and Prospects for the Forest Sector

Forest ecotourism and recreation development has strong potential for government employment generation and economic stimulus programmes and offers some unique advantages in fulfilling a number of important economic, social and environmental objectives. The ecotherapeutic and ecotourism potential of forests could bring significant economic benefits to local communities and economies through the creation of direct and indirect green jobs.

Table 48 provides an overview of the future tasks and duties, activities, products and services associated with forest

recreation management. It is expected, that ongoing trends in increasing numbers of forest visitors will require greater management resources to provide more individual attention and support for visitors and improve public relations.

### Forest Skills and Expertise

Foresters working in the recreation, leisure and sports sectors do not necessarily have to possess specialist knowledge of all the different fields of activity, but they need to have a holistic approach with certain knowledge of the different sectors combined with a full set of social skills.

The abundance of green forest jobs in this area is testimony to the recognition of the non-timber benefits of forests. The real potential for the development of the forest ecotourism sector exists especially in touristic and forest regions with high overall landscape values. In Great Britain and Ireland, there



are job titles directly referring to recreation (e.g. “recreation forester”) or with opportunities to specialize in forest recreation. In Lithuania, there is a specific degree programme “Urban and Recreational Forestry” at the Sleksandras

Stulginskis University. Forest recreation and leisure studies are now being incorporated into many degree programmes across Europe and other continents.

**TABLE 50** Examples of green forest jobs in the field of activity “Recreation, Leisure and Sport”

Example	Short description
Swiss rangers, CH	Swiss rangers are responsible for visitor direction and management, public relations, guided tours or oral presentations, wildlife monitoring, mandatory regulation at protective areas, conservation and maintenance work, research, tourism and marketing. <a href="http://www.swiss-rangers.ch">http://www.swiss-rangers.ch</a>
Forest and park supervisors, US	Forest and park supervisors supervise, organize and perform work on park infrastructure or resource protection programs, maintains relevant stakeholders and communicates park activities. Furthermore they maintain records, prepare reports and make appropriate recommendations, coordinate manpower and drafts budgets. Seasonal forest and park supervisors assist the forest and park supervisors in the seasonal operation. <a href="http://www.mass.gov/eea/docs/dcr/employment/forest-park-supv-i.pdf">http://www.mass.gov/eea/docs/dcr/employment/forest-park-supv-i.pdf</a>
Forestry technicians in recreation, US	Forestry Technicians who work in the recreation sector provide information to visitors of parks, protect, maintain, and gather data on forests, grassland and mountains. <a href="http://study.com/articles/Forestry_Technician_Job_Description_Duties_and_Requirements.html">http://study.com/articles/Forestry_Technician_Job_Description_Duties_and_Requirements.html</a>
Adventure park foresters, CH	They are responsible for construction and maintenance of adventure parks. After certain training additionally responsible for instructions and safety for the visitors of such parks. <a href="http://www.seilparks.ch/asp/start.asp?PAGE=060">http://www.seilparks.ch/asp/start.asp?PAGE=060</a>
Outdoor sport and recreation guides, CA, US, NZ	Outdoor sport and recreation guides organize and conduct outdoor activities such as mountain expeditions, rafting trips, hunting trips, fishing trips and trail rides. <i>There are different diplomas for the different activities.</i> <a href="https://occinfo.alis.alberta.ca/occinfopreview/info/browse-occupations/occupation-profile.html?id=71002679">https://occinfo.alis.alberta.ca/occinfopreview/info/browse-occupations/occupation-profile.html?id=71002679</a>
Trail constructors, CH	Trail constructors plan, construct and maintain mountain bike trails. Furthermore they consult all involved parties (e.g. authorities, forest owners, bike communities). <a href="http://www.trailworks.ch/">http://www.trailworks.ch/</a>
Ecotourism tour guides, US	They lead a group of ecotourists to certain regions. They plan, organize and implement ecotours on all kind of different terrains and guide people to a holistic and sustainable experience of their environment. <a href="http://www.schoolsintheusa.com/careerprofiles_details.cfm?carid=1177">http://www.schoolsintheusa.com/careerprofiles_details.cfm?carid=1177</a> <a href="http://www.ecotourism.org/ecodestinations-south-america">http://www.ecotourism.org/ecodestinations-south-america</a>









8.

EDUCATIONAL  
AND RESEARCH



## 8. Education and Research

This chapter covers different educational and communication aspects of forest knowledge, experiences and training opportunities. The fields of activity “Education, Further Training and Knowledge Transfer” and “Forest Research” are outlined and facts, major trends, opportunities and skills relating to the specific green forest jobs in these areas are highlighted and existing job examples are given below.

### 8.1 Education, Further Training and Knowledge Transfer

#### *Background and Outline of the Field of Activity*

Forest education covers a wide range of opportunities, possibilities and targets. On the one hand, forest education promotes environmental interpretation and awareness and, on the other hand, it is concerned with the education of those working in forest management and timber production.

Children and adolescents will be the decision makers of the future and should be familiar with the forest ecological cycle. Forest education gives them the opportunity to improve their understanding, and knowledge of the natural world and the forest environment. They can learn about forest ecosystems and impart this knowledge to future generations to ensure that forests are sustainably managed.

Educating people for forest-related jobs means professional schools and universities should teach to ensure that forest management, in terms of all activities including planting, thinning and felling and the use of forest tools and

machinery, complies with the principles of sustainable forest management.

The public and environmental protection organizations keep a watchful eye on the quality of work in the forest sector. Their perception of environment protection may not always be based on forest knowledge. Therefore, sustainable forestry operations could be mistakenly seen as being environmentally damaging. This can result in inhibiting or halting necessary forestry works and in adversely affecting essential forestry operations.

#### *Facts and Figures*

There are problems globally in the forest sector, especially in developing countries, regarding the decency of work. This is largely due to growing illegal logging activities; child and forced labour; less access to schools; poor working conditions and pay for women, youth and migrant workers; dangerous work; low access to services like health care; and low wages (ILO, 2015b).

Forest workers often have lower than average wages, which makes forestry a less attractive work sector (ECE and FAO, 2015). Forest employers have encountered increasing difficulties to recruit workers with appropriate skills due to the continuously changing nature of forest work.

The introduction of mechanization and organization reforms in forest management have contributed significantly to the reduction of the forestry workforce. This trend of decreasing employment in the forest sector is particularly apparent in Central-Eastern Europe and the Russian Federation (Forest Europe, ECE and FAO, 2011).

#### *Major Trends, Needs and Challenges*

Training schools are delivering training courses, but candidates for forestry training are declining in numbers.

**TABLE 51** Tasks, activities and services in the field of activity “Education, Further Training and Knowledge Transfer”

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Education and training of teachers</li> <li>• Training foresters in teaching and communications and further developing their interpersonal skills as well as strengthening their report writing, social media and presentation skills</li> <li>• Developing new innovative teaching methods within the forest sector</li> <li>• Building up training institutions for all aspects of forest operations and forest ecology</li> <li>• Strengthening the ability to attract research and training funding from other agencies</li> </ul>	<ul style="list-style-type: none"> <li>• Teaching and training of teachers</li> <li>• Forest kindergartens; education and training</li> <li>• Nature-study and education days in the forest</li> <li>• Communication and visibility (importance of forests in a green economy)</li> <li>• Forestry education and rural development</li> <li>• Knowledge transfer among different forestry-related disciplines</li> <li>• Creation of partnerships between different stakeholders and across disciplines</li> </ul>

Up to date occupational health and safety matters and their adoption should be highlighted in all forest education programmes. Safety protocols should be adapted to reflect all technological changes in order to conform to ILO standards and guidelines in that area.

Retraining programmes should be developed and be available to enable changes in career pathways.

Forestry training is expensive due to the low ratio of pupils per instructor and the necessary training prerequisites (e.g. forestry machines and equipment, safety and logistic costs, new technologies). Currently, it is becoming progressively difficult to fund forestry training adequately.

One of the main tasks facing the forest sector is to promote and strengthen the public's view of sustainable forest management practices. Mindful of this, foresters have to break new ground in communicating and interacting with all relevant stakeholders to ensure that they understand and support the development and protection of forest resources.

Furthermore, more effort has to be devoted to highlighting the importance of forests, green forest jobs, forest products and forest ecosystem services, which strengthen the invaluable contribution that forests and forest workers make to society and its well-being.

### Opportunities and Prospects for the Forest Sector

The future prospects for the creation of green forest jobs appear promising and achievable thanks to a growing

interest in nature and its protection, modernization of work and the need for highly qualified forestry personnel.

### Forest Skills and Expertise

Working in forests requires appropriate qualifications and their constant update. Knowledge that is evolving quickly includes: latest communication techniques, technical and organizational requirements, health regulations, certification schemes such as PEFC, FSC, ISO and environmental regulations. The training needs of older foresters should be particularly taken under consideration. Nobody should be allowed to work in a forest environment without relevant and suitable qualifications. Adapting and amending national regulations can be a realistic objective to ensure the availability of flexible forest workforce in the future.

Training in the forest sector suggests formal education in vocational schools and universities. Non-formal and innovative forms of training (particularly in sustainable forest management) such as role modelling, collective learning or coaching may be very important in the future.

Finally, it is vital that the technical and communication skills are strengthened and supported by knowledge of workers' rights, social dialogue, occupational safety and health. They should be integrated into all 19 fields of activity mentioned in this paper to ensure that the new green forest jobs align with decent work practices.

**TABLE 52** Outlook on jobs that would be increasingly needed in the field of activity "Education, Further Training and Knowledge Transfer"

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Awareness and understanding of SFM</li> <li>• Awareness and understanding of the forest ecology and forest ecosystem services</li> <li>• Awareness and understanding of the different functions and values of forestry</li> <li>• Ability and enthusiasm to communicate to different audiences</li> </ul>	<ul style="list-style-type: none"> <li>• Teachers in the forest</li> <li>• University lecturers, forest instructors</li> <li>• Forest interpreters</li> <li>• Forest guided walk leaders</li> <li>• Nature study and outdoor pursuits professionals</li> <li>• Public relations personnel</li> </ul>

**TABLE 53** Examples of green forest jobs in the field of activity "Education, Further Training and Knowledge Transfer"

Example	Short description
Marketing and communication managers, UK	They encourage people to visit the forests and appreciate their presence and heritage. The work includes presentations and writing stories for children, as well as managing events for the open public and communication between different institutions. <a href="http://www.woodlandtrust.org.uk/jobs/meet-our-team/">http://www.woodlandtrust.org.uk/jobs/meet-our-team/</a>



## 8.2 Forest Research

### Background and Outline of the Field of Activity

Research can be defined as a) careful or diligent search; b) a studious inquiry or examination; especially: investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws; and c) the collecting of information about a particular subject (Merriam-Webster, 2017).

The Forestry Commission of the UK Forestry Commission's Research Agency (2017), for example, described their research as themes related to "social, economic and environmental aspects of sustainable forestry in a multifunctional landscape" and listed the following specific topics in their scope: climate change, forest mensuration, modelling and forecasting, land regeneration (e.g. afforestation of contaminated land) and urban greening, people, trees and woodlands (e.g. relationships between forestry and society), protecting trees (e.g. pest control), forest management (e.g. silviculture), tree improvement (genetic variation, breeding), biodiversity (ecosystem services, e.g. wildlife management, flood mitigation, carbon sequestration), woodlands and the environment (e.g. interactions between forests and their physical and historic environment).

Another area in research and development (R&D) deals with improving wood material properties for broader applicability. Research effort is targeted, for example, at chemical modification of wood to render it inert to various types of degradation or at using special structural wood characteristics to develop novel wood functionalities inspired by biological processes.

### Facts and Figures

The International Union of Forest Research Organizations (IUFRO) has about 700 Member Organizations in over 100 countries (IUFRO, 2017). In the ECE Region, forestry research institutes accumulate in North America and Europe, with low representation in the Caucasus and Central Asia.

Notably, official development aid spent on forestry research has been declining since 2007, contrary to forest policy and administration. There are significant differences between various countries' budget allocation to forest research (ECE and FAO, 2015).

### Major Trends, Needs and Challenges

Forest research activities evolve and have to adapt continuously to changing social, economic and environmental circumstances. In the past, research programmes were mostly concerned with optimizing forest management practices but today forest research emphasis seems to have switched to tackle more fundamental and specific subjects such as climate change effects and phenology (modelling scenarios), biodiversity, ecosystem interaction and biotechnology.

#### Opportunities and Prospects for the forest Sector

Opportunities for work in forest research are diverse and there are funding opportunities available, especially for international co-operative research. In this period of climate change and move towards sustainability, the importance of sound and interdisciplinary research is critical for the delivery of empirical data to practitioners and political decision makers. The future prospects for the creation of green forest jobs associated with this particular branch of research look very promising.

**TABLE 54** Tasks, activities and services in the field of activity "Forest Research"

Future Tasks and Duties	Activities, Products and Services
<ul style="list-style-type: none"> <li>• Detecting future trends</li> <li>• Testing and development of new techniques, concepts, tools and methods</li> <li>• Application of scientific methods</li> <li>• Systematic analysis and monitoring of major developments and elaboration of recommendations for forest practice</li> <li>• Communication of research outcomes within the scientific community as well as within forest practice</li> <li>• Research to further support the creation of new and sustainable green forest jobs</li> </ul>	<ul style="list-style-type: none"> <li>• Issue management and trend analysis</li> <li>• Trend scenarios and forest modelling studies</li> <li>• Scientific methods, analyses and statistics as well as scientific writing</li> <li>• Forest research</li> <li>• Government targeted investment in green jobs</li> <li>• Delivering innovative and creative solutions</li> <li>• Problem solving</li> <li>• Preparation of policy briefs and position papers</li> </ul>

### Forest Skills and Expertise

Skills and knowledge are strongly related to the specific field of research. In general, a command of scientific methodology, analysis and statistics as well as scientific writing are needed.

Researchers need to have the ability to analyse and investigate a specific topic or problem in a very detailed and scientific manner. Moreover, they should be able to devise a clearly defined and objective methodology to attempt to solve scientific problems..

Drafting and composing research proposals as well as the ability to teach and supervise students are also skillset requirements for researchers. Therefore, as a basic requirement, teaching skills and leadership qualities are desirable as well the ability and enthusiasm for undertaking and completing research projects.

Forest researchers work in all conceivable forest related scientific fields ranging from general research to more applied science fields, from genetics to management and from the forest soil to the atmosphere as well as from forest ecology to sociology and economics.

**TABLE 55** Outlook on jobs that would be increasingly needed in the field of activity "Forest Research"

Key competencies, skills to be developed	Jobs that would be increasingly needed
<ul style="list-style-type: none"> <li>• Ability to analyse problems and devise solutions</li> <li>• Knowledge of scientific methodology and scientific writing</li> <li>• Communication skills</li> <li>• Ability to work with scientific ethos and principles</li> <li>• Ability to work on own initiative, in a self-reliant and self-starter manner</li> <li>• Team playing</li> </ul>	<ul style="list-style-type: none"> <li>• Forest researchers</li> <li>• Forest technicians</li> <li>• Trend analysts</li> <li>• Forest statisticians</li> <li>• Scientific research communicators and disseminators</li> </ul>

**TABLE 56** Examples of green forest jobs in the field of activity "Forest Research"

Example	Short description
Researchers in forest atmosphere exchange, US	They investigate the ecosystem metabolism in terms of ecosystem CO <sub>2</sub> exchange, evapotranspiration and energy fluxes between the forest and the atmosphere by applying eddy-covariance flux measures, soil respiration chamber campaigns or micrometeorological advection studies. <a href="http://harvardforest.fas.harvard.edu/major-research-topics/major-research-topics/forest-atmosphere-exchange">http://harvardforest.fas.harvard.edu/major-research-topics/major-research-topics/forest-atmosphere-exchange</a>
Researchers in forest molecular genetics and genomics, US	Researchers identify and characterize genes regulating wood formation, crown form, adaptive traits and disease resistance. <a href="https://www.fs.fed.us/psw/topics/forest_genetics/molecular.shtml">https://www.fs.fed.us/psw/topics/forest_genetics/molecular.shtml</a>







## 9. Other new fields of activity

It is likely that new fields of activity in the forest sector will appear in the future. Catering for the unknown is a continuous and challenging task for all forestry professionals and other professions associated with the forest industry. Regular trend analysis, clearly focused research and the incessant quest for innovative ideas and techniques will bring new knowledge and experiences together. It may lead to changes in work practices, which can create both opportunities and challenges that affect the forest workforce. There is scope for the generation of a number of new green forest jobs if the forest sector adapts and adjusts rapidly to these new circumstances by amending its *modus operandi* to new fields.



## 10. Conclusions

The 2030 Agenda for Sustainable Development provides a major policy framework for countries at all levels of development. However, the capacity of countries to put in place supporting policies will influence the ability of an economy to cope with shifting towards sustainability.

The transition to a green economy impact on workers will vary depending on the economic sector and the country in question. In some cases, the transition may result in both the loss of jobs and the creation of new jobs. However, in most cases, it will be the way in which the work is undertaken that will change rather than entirely new jobs. Thus, it is essential that governments work with sectoral experts and social stakeholders to close the current skill gaps and anticipate the future workforce needs in the context of a green economy.

Given the current expectations attached to forests as carbon sinks and considering their role as: providers of renewable raw material, pools of biodiversity, regulators of water flows and other environmental services; it is clear that green jobs in forests will play an increasingly important role in the future. The forest sector will need to rapidly adapt to new skill demands as a consequence of new environmental policies, health awareness and to address climate change. Figure 2 displays the key areas of activities identified in the study. The nineteen identified fields of professional activities accentuate the broad spectrum of jobs based on the multi-functionality and non-timber benefits of forest ecosystem services and the forest sector.

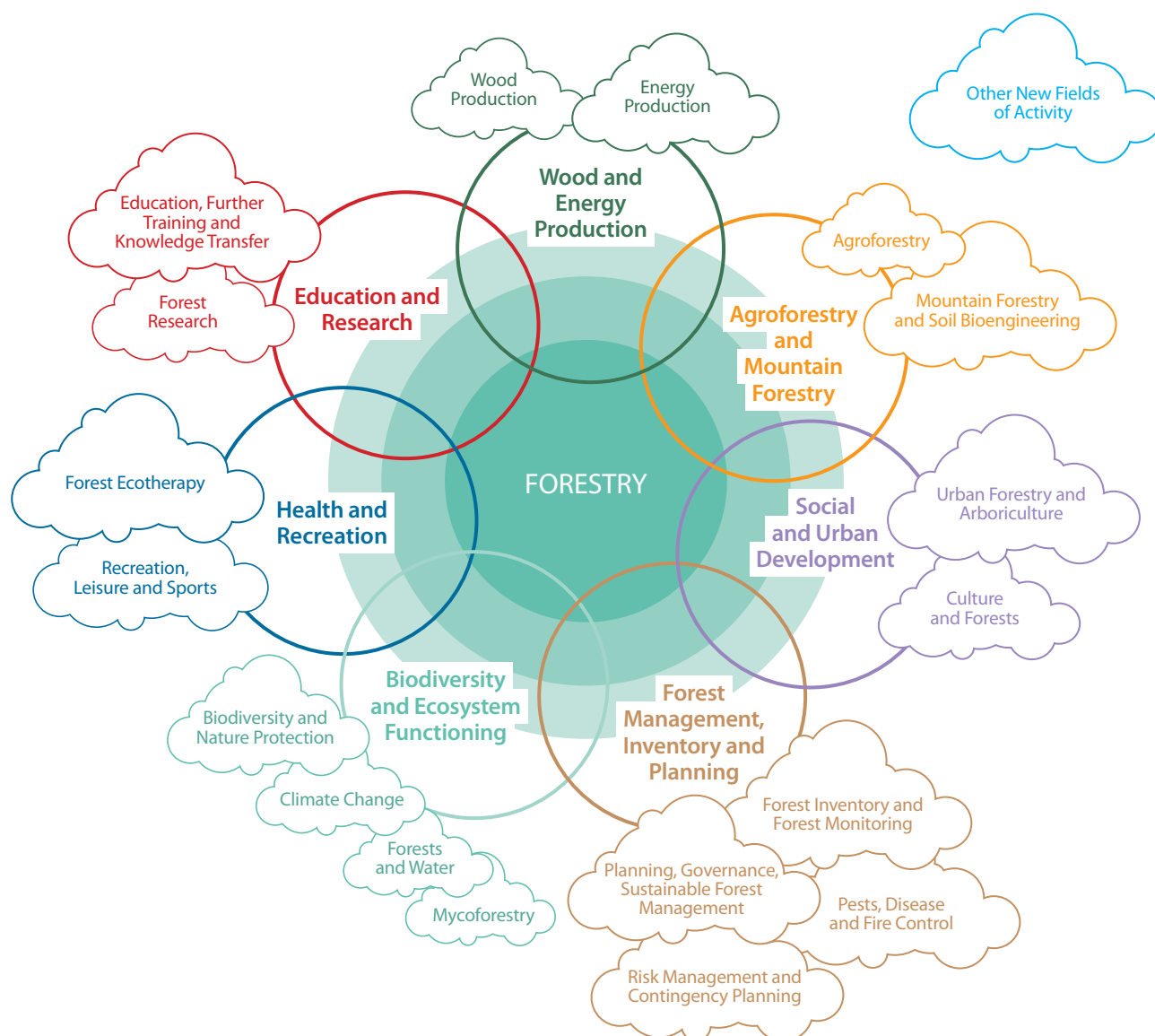
Notwithstanding major gaps in data availability, particularly in the countries of Central Asia and the Caucasus, the present study finds that a number of green forest jobs already exist in industrialized. However, they are still a minor component in the pool of jobs available in the forest sector.

The list below summarizes some key conclusions which can be drawn from the analysis undertaken by the ECE/FAO Team of Specialists on Green Jobs in the Forest Sector (ILO/ECE/FAO Joint Expert Network) in the present study and which can serve for further discussion on the future of green forest jobs and actions supporting their further development.

### 1: Forest ecosystem services management is the pillar for green forest jobs.

Sustainable development and a green economy are stimulating new types of job opportunities within the forest sector. Until recently, forest jobs mostly dealt with traditional silviculture and activities centred around timber harvest (classical forestry sector). However, the scope for the creation of new green forest jobs needs to be seen in a broader context of all forest functions, for instance in areas related to health, recreation and tourism in the forests. Examples of green forest jobs, presented in this study, are based on forest ecosystem services management and will likely embrace a much broader range of tasks and functions in the form of jobs in the future.



**FIGURE 2** Examples of fields of professional activities in the forest sector under the seven thematic areas

*The potential for green forest jobs is different in each region or in each country according to the existing context; a systematic analysis of their potential is an important first step for the development of further forestry related policies.*

## 2: Green forest jobs are developing but the progress is still slow.

One of the shortcomings related to green jobs identified in the study relates to the creation of green jobs in the forest sector, which is still advancing too slowly to contribute substantially to a tangible increase of employment in the sector. Moreover, too few of the green jobs in the sector are being created for those who need them most: young people, women and rural populations. Creating quality, green and

decent work is still difficult in the current working structures of the forest sector.

## 3: The public perception of forest sector, and related jobs, does not reflect all its merits.

The forest sector needs to become more innovative in attracting qualified people to fill new jobs. The Open Book of Green Forest Jobs<sup>4</sup>, developed by the ECE/FAO Team of

<sup>4</sup> [www.hashdoc.com/greenforestjobs](http://www.hashdoc.com/greenforestjobs)

Specialists on Green Jobs in the Forest Sector (ILO/ECE/FAO Joint Expert Network), is one example in that direction.

**4: Revision of existing curricula and design of new career paths is fundamental to address the skill gaps.**

An assessment of the training and education needs and adaptation of existing curricula to the skills needed are preconditions for training sustainable forest careers of the future. A systematic, fact based review of emerging skill needs and development of relevant training measures will require collaboration of a network of stakeholders from different disciplines. One example in that direction is the work on ECE/FAO Team of Specialists on Green Jobs in the Forest Sector (ILO/ECE/FAO Joint Expert Network) on reinforcing cooperation between forestry training centres.

**5: Training and support are key for an inclusive transition to a green economy.**

For many forest enterprises, particularly small and medium-sized, support in the retraining of workers and managers will be required to adapt to the requirements of a green economy. It is also important to note that while some occupational groups will make significant gains in the transition to a green economy, others may incur substantial losses. In cases where jobs will be lost, support from the government and social partners may be needed to help shift workers to new occupations.

In summary, this study concludes that the future of green forest jobs lies within the forest ecosystem services management and that it is important to recognize the progress that has been made in green forest jobs development so far. However, further development in this area will strongly depend on the public perception of the forest sector, and related jobs, the adaptation of existing curricula to new career paths, and the support to workers in adapting their skills to the requirements of jobs in a green economy.

Certainly, the list of examples of thematic areas and fields of professional activities could be extended. Therefore, this study may be considered as starting point for further analysis.

The ECE/FAO Team of Specialists on Green Jobs in the Forest Sector (ILO/ECE/FAO Joint Expert Network) invite forest workers, experts, academics and other stakeholders to engage in an active dialogue to enrich the discussion about the future of green forest jobs. Such an exchange could facilitate the identification of measures supporting the development of green forest jobs and strengthen a knowledge-based policy development in this area.

\* \* \* \*

The ECE and FAO together with ILO, are leading organizations in the work on green jobs in the forest sector. They collaborate with a number of international and local stakeholders on defining, describing and promoting green forest jobs, needed competencies, education and training for the forest sector in the context of a green economy. For more information on this work, please contact Ms. Alicja Kacprzak (Alicja.kacprzak@fao.org).



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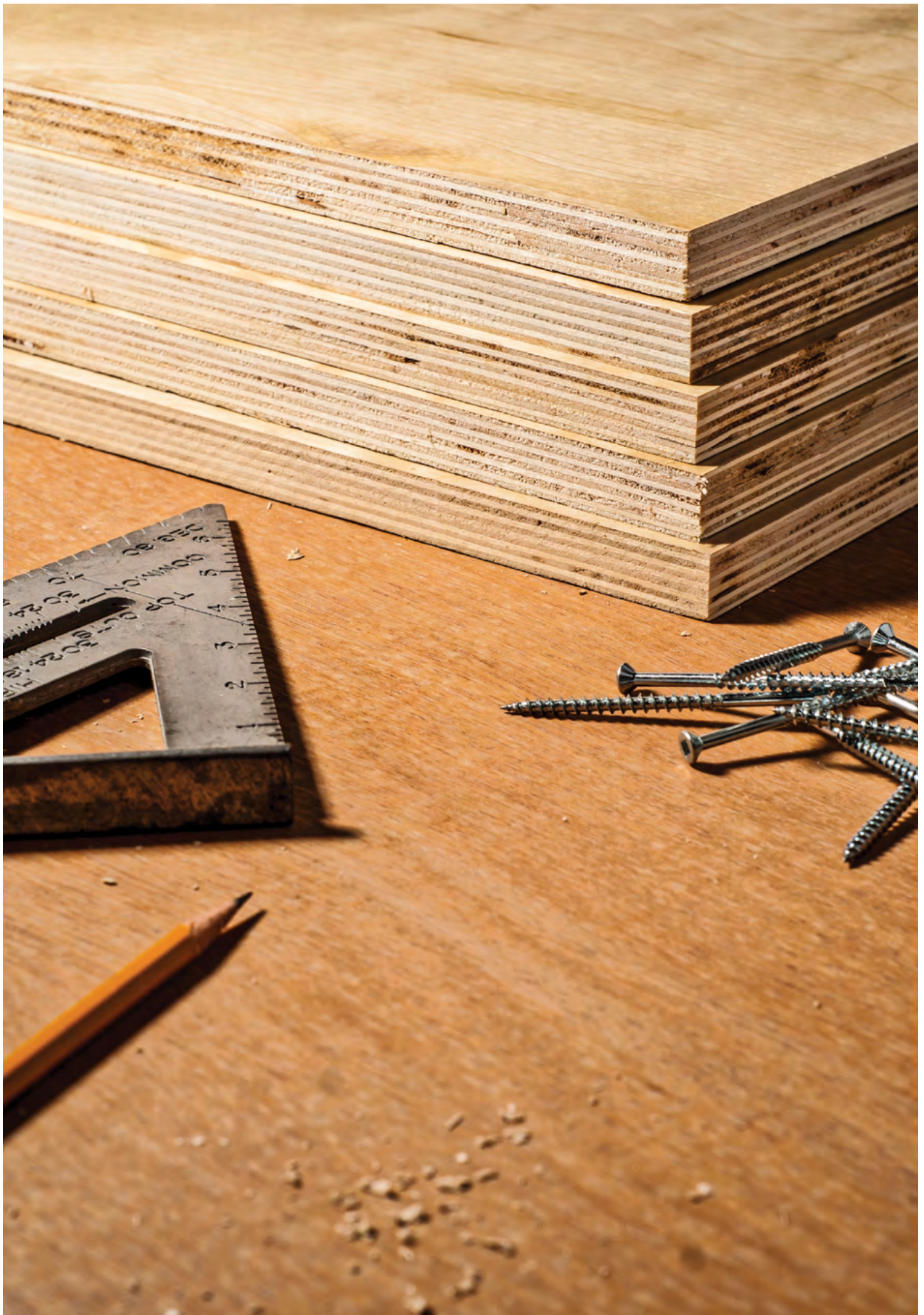
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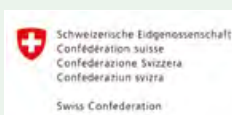


# Green Jobs in the Forest Sector

## Geneva timber and forest discussion paper 71

The study *Green Jobs in the Forest Sector* provides an overview of existing Green Forest Jobs and identifies possible areas for future activities and jobs in the forest sector, and may serve as starting point for further analysis and discussion on the future of Green Forest Jobs. It offers a framework for classifying Green Forest Jobs under seven thematic work areas, outlined in the seven main sections of the study, with a particular focus on major trends, needs and challenges as well as opportunities and prospects for the forest sector. The findings suggest that to promote Green Jobs in the forest sector it is key to: (i) look at forest ecosystem services management as the frame for Green Forest Jobs; (ii) recognize the progress made in the development of Green Forest Jobs and to identify avenues for the future; (iii) enhance the public perception of jobs in the forest sector; (iv) revise existing curricula and develop new ones for catering to the needs of the sector to close the skills gaps; and (v) to facilitate an inclusive transition to green economy through training and support.

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